Ontario Geological Survey
Aggregate Resources Inventory
Paper 95

Aggregate Resources Inventory of the

Township of Scugog

Regional Municipality of Durham

Southern Ontario

by Staff of the Engineering and Terrain Geology Section, Ontario Geological Survey

1986

Ministry of
Northern Development
and Mines
Ontario

ISSN 0708-2061
Printed in Ontario, Canada
ISBN 0-7743-7291-5

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Canadian Cataloguing in Publication Data

Main entry under title:
Aggregate resources inventory of the Township of Scugog, Regional Municipality of Durham

(Ontario Geological Survey aggregate resources inventory paper,
ISSN 0708-2061 ; 95)
ISBN 0-7743-7291-5

1. Aggregates (Building materials)—Ontario—Scugog (Township) I. Ontario Geological Survey. Aggregate Assessment Office. II. Ontario. Ministry of Northern Development and Mines. III. Series.

TN939.A333 1986   553.6'2'0971356   C86-090860-7

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The Mineral Resources Staff of Lindsay District and Central Region of the Ministry of Natural Resources assisted in the collection of data, field checking and review of this report.

Ontario Geological Survey
1986: Aggregate Resources Inventory of the Township of Scugog, Regional Municipality of Durham; Ontario Geological Survey, Aggregate Resources Inventory Paper 95, 39p., 9 tables, 3 maps, scale 1:50 000.

500-86

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Aggregate Resources Inventory of the Township of Scugog Regional Municipality of Durham

by Staff[1] of the Engineering and Terrain Geology Section

1. Project Supervisors: Dale W. Scott and I. Szoke; field work and report by R. Gorman; compilation and drafting by Staff of the Aggregate Assessment Office. The Mineral Resources Staff of Lindsay District and Central Region of the Ministry of Natural Resources assisted in the collection of data, field checking and review of this report.

Manuscript accepted for publication by Chief, Engineering and Terrain Geology Section, June 5, 1986. This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

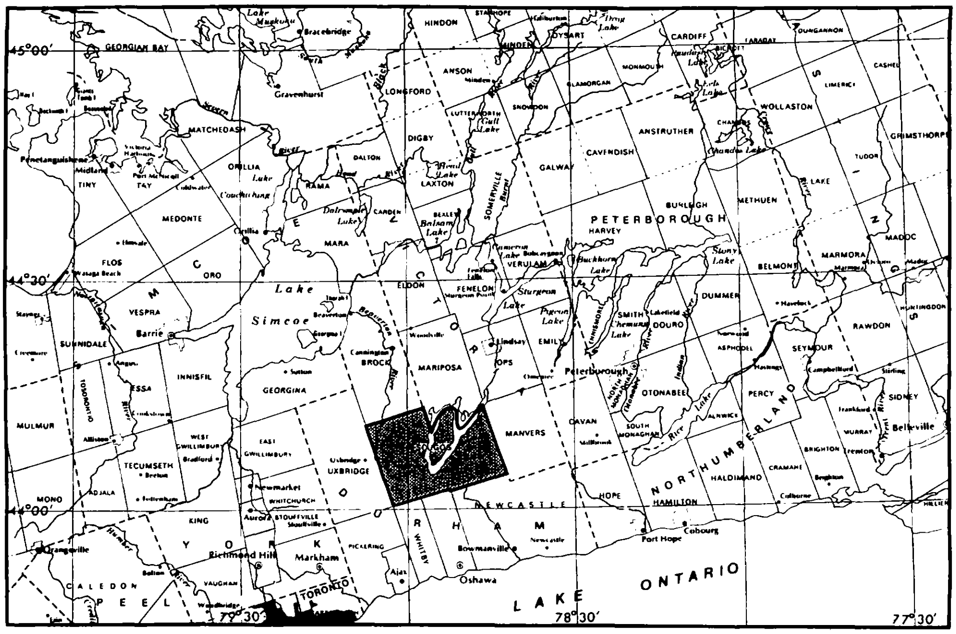


__Figure 1.__ Key Map Showing the Location of the Township of Scugog, Scale 1:1 800 000.

This report includes both an inventory and analysis of sand and gravel as well as bedrock resources in the Township of Scugog. The report is part of the Aggregate Resources Inventory Program for townships and municipalities designated under the Pits and Quarries Control Act.

In the Township of Scugog, three areas containing significant amounts of sand and gravel have been selected for possible resource protection at the primary level. The Selected Areas occupy 2390 acres (970 ha), exclusive of licenced properties. An estimated 1750 acres (710 ha) are currently available for extraction, containing resources of approximately 166 million tons (151 million tonnes). The parts of the Selected Areas which are available for extraction represent 4 percent of the total area occupied by sand and gravel deposits in the township and 6 percent of the total resource tonnage.

Selected Sand and Gravel Resource Area 1 is part of the Oak Ridges Moraine and consists of two deposits of glaciofluvial origin located in the southern portion of the township. This outwash is the township's most important aggregate source and it contains an estimated 144 million tons (131 million tonnes) of sand and gravel. Other glaciofluvial and ice-contact deposits have been selected at the primary level of significance. An estimated 22 million tons (20 million tonnes) of sand and gravel are available from these deposits.

The remainder of the Oak Ridges Moraine and a number of smaller ice-contact stratified drift deposits have been selected as Sand and Gravel Resource Areas of Secondary Significance. The resources in this part of the moraine are relatively unexploited. Additional subsurface exploration may confirm suitable sites for extractive development.

The Township of Scugog is underlain by Upper Ordovician limestone and shale of the Lindsay Formation, and shale of the Blue Mountain Formation. Since both formations are covered by more than 80 feet (24 m) of drift, no areas have been selected for possible resource protection.

Selected Resource Areas are not intended to be permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Introduction

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1984, the total tonnage of mineral aggregates extracted was 109 million tons (99 million tonnes), greater than that of any other metallic or nonmetallic commodity mined in the Province (Weatherson 1986).

Although mineral aggregate deposits are plentiful in Ontario, they are fixed-location, nonrenewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is usually greatest in urban fringe areas where land use competition is extreme. For these reasons the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resources Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion on those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

This report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.

The report includes an assessment of sand and gravel resources as well as a discussion on the potential of bedrock-derived aggregate. The most recent information available has been used to prepare the report. As new information becomes available, revisions may be necessary.

Part I — Inventory Methods

FIELD AND OFFICE METHODS

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References) as well as field examination of potential resource areas. Field methods include the examination of natural and man-made exposures of granular material. Most observations are made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications, the Ontario Geological Survey, and by Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites include estimates of the total face height and the proportion of gravel- and sand-sized fragments in the deposit. Observations are also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure, subsurface materials may be assessed by hand augering and test pitting, supplemented by test hole drilling, and geophysical surveys using hammer seismic equipment. The symbols for and locations of sample sites, test hole sites, and geophysical traverse lines are noted on Map 1.

Deposits with potential for further extractive development or those where existing data are scarce, are studied in greater detail. Representative layers in these deposits are sampled in 25- to 100-pound (11- to 45-kg) units from existing pit faces or from test pits. The samples are analysed for grain size distribution, and in some cases Los Angeles abrasion, absorption, and Magnesium Sulphate soundness tests and petrographic analyses are carried out. Analyses are performed either in the laboratories of the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications, or in the Geoscience Laboratories. Geoservices Section, Ontario Geological Survey.

The field data are supplemented by pit information on file with the Soils and Aggregates Section of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and "workability" of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The location, size, and depth of extraction of pits licenced under the Pits and Quarries Control Act are obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The cooperation of the above-named groups in the compilation of inventory data is gratefully acknowledged.

Aerial photographs at various scales are used to determine the continuity of deposits, especially in areas where information is limited. Water well records, held by the Ontario Ministry of the Environment, are used in some areas to corroborate deposit thickness estimates or to indicate the presence of buried granular material. These records are used in conjunction with other evidence.

Topographic maps of the National Topographic System, at a scale of 1:50 000, are used as a compilation base for the field and office data. The information is then transferred to a base map, also at a scale of 1:50 000, prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

RESOURCE TONNAGE CALCULATION TECHNIQUES

SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been established, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known or can be estimated. The computation methods used are as follows. First, the area of the deposit, as outlined on the final base map, is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data such as test holes and water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2500 (the density factor). This factor is approximately the number of tons in a one-foot (0.3 m) thick layer of sand and gravel, one acre (0.4 ha) extent, assuming an average density of 110 pounds per cubic foot (1766 kg per cubic metre).

Tonnage = Area x Thickness x Density Factor

Tonnage calculated in this manner must be considered only as an estimate. Furthermore, such tonnages represent amounts that existed prior to any extraction of material (i.e. original tonnage) (Table 1, Column 4).

The Selected Sand and Gravel Resource Areas in Table 3 are calculated in the following way. Two successive subtractions are made from the total area. Column 3 accounts for the number of acres unavailable because of the presence of permanent cultural features and their associated setback requirements. Column 4 accounts for those areas that have previously been extracted (e.g. wayside and abandoned pits are included in this category). The remaining figure is the area of the deposit currently available for extraction (Column 5). The available area is then multiplied by the estimated deposit thickness and the density factor (Column 5 x Column 6 x 2500) to give an estimate of the sand and gravel tonnage (Column 7) presently available for extractive development and/or resource protection.

Reserve estimates are calculated for deposits of primary significance. Reserve estimates for deposits of secondary and tertiary significance are not calculated in Table 3, however the aggregate potential of these deposits is discussed in the report.

BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of bedrock formations overlain by less than 50 feet (15 m) of unconsolidated overburden is determined from bedrock geology maps, drift thickness and bedrock topography maps, and from the interpretation of water well records. The measured extent of such areas is then multiplied by the estimated quarriable thickness of the formation, based on stratigraphic analyses and on estimates of existing quarry faces in the unit. In some cases a standardized estimate of 60 feet (18 m) is used for thickness. Volume estimates are then multiplied by the density factor (the estimated weight in tons of a one-foot (0. 3 m) thick section of rock, one acre (0.4 ha) in extent).

Resources of dolostone are calculated using a density factor of 165 pounds per cubic foot (2649 kg per cubic metre) or 3600 tons per acre (8070 tonnes per hectare). Sandstone resources are calculated using a density estimate of 146 pounds per cubic foot (2344 kg per cubic metre) and shale resources are calculated with a factor of 150 pounds per cubic foot (2408 kg per cubic metre).

UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units, Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures. Data are generally rounded off in accordance with the Ontario Metric Practice Guide (Metric Committee 1975).

The tonnage estimates made for sand and gravel deposits are termed possible resources (see Glossary, Appendix B) in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p.7) and with the Association of Professional Engineers of Ontario (1976).

Part II — Data Presentation and Interpretation

Three maps, each portraying a different aspect of the aggregate resources in the municipality, accompany the report. Map 1, "Distribution of Sand and Gravel Deposits", gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, "Selected Sand and Gravel Resource Areas", shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, "Bedrock Resources" shows the distribution of bedrock formations, the thickness of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

MAP 1: DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

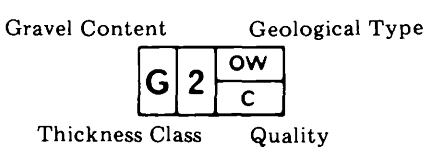
Map 1 is derived from existing surficial geology maps of the area or from aerial photograph interpretation in areas where surficial mapping is incomplete. The map shows the extent and quality of sand and gravel deposits within the study area and the present level of extractive activity.

On the map, all sand and gravel deposits are outlined and shaded. The present level of extractive activity is also indicated. Those areas which are licenced for extraction under the Pits and Quarries Control Act are shown by a solid outline and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner, location and licenced acreage of the pit, as well as the estimated face height and percentage gravel. A number of unlicenced pits (abandoned pits or wayside pits operating on demand under authority of a permit) are identified by a numbered dot on Map 1 and described in Table 2. Similarly, test hole locations appear on Map 1 as a point symbol and are described in Table 7. Geophysics lines are shown on Map 1 by a line symbol and are interpreted in Table 8.

Map 1 also presents a summary of available information related to the quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbols which are found on the map. The Deposit Symbol appears for each mapped deposit and summarizes important genetic and textural data. The Texture Symbol is a circular proportional diagram which displays the grain size distribution of the aggregate in areas where bulk samples were taken.

DEPOSIT SYMBOL

The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for every deposit shown on Map 1. These components are illustated by the following example:



This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess silt and clay may limit uses of the aggregate in the deposit.

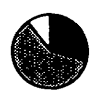
The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate (greater than 4.75 mm) makes up less than 35 percent of the whole deposit. "G" indicates that the deposit contains more than 35 percent gravel.

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identifies the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identifies the main quality limitations that may be present in the deposit as discussed in the next section.

TEXTURE SYMBOL

The Texture Symbol provides a more detailed assessment of the grain size distribution of material sampled during field study. These symbols are derived from the information plotted on the aggregate grading curves found in the report. The relative amounts of gravel, sand, and silt and clay in the sampled material are shown graphically in the Texture Symbol by the subdivision of a circle into proportional segments. The following example shows a hypothetical sample consisting of 30 percent gravel, 60 percent sand, and 10 percent silt and clay:



MAP 2: SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 2 is an interpretative map derived from an evaluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the selected sand and gravel resource areas are first delineated by geological boundaries and then classified into three levels of significance: primary; secondary; and tertiary. Each area of primary significance is assessed as to its probable relative value as a resource in the municipality and is given a deposit number which denotes its ranking order. All such deposits are shown by dark shading on Map 2.

Deposits of secondary significance are not ranked numerically in this report, but are indicated by light shading on Map 2. Such deposits are believed to contain significant amounts of sand and gravel. Although deposits of secondary significance are not considered to be the "best" resources in the report area, they may contain large quanitities of sand and gravel and should be considered as part of the aggregate supply of the area.

Areas of tertiary significance are outlined on the map by a solid line but have no shading. They are not considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

Selected Sand and Gravel Resource Areas of primary significance are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity, and distribution of resources in the region in which the report area is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

SITE SPECIFIC CRITERIA

Deposit Size

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1 (greater than 20 feet (6 m) thick), and containing more than 35 percent gravel are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

Aggregate Quality

The limitations of natural aggregates for various uses result from variations in the lithology of the particles composing the deposit, and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the deposit symbols on Map 1. They are: gravel content (G or S); fines (C); oversize (O); and lithology (L).

Three of the quality indicators deal with grain size distribution. The gravel content (G or S) indicates the suitability of aggregate for various uses. Deposits containing at least 35 percent gravel in addition to a minimum of 20 percent material greater than the 26.5 mm sieve are considered to be the most favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.

Excess fines (high silt and clay content) may severely limit the potential use of a deposit. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphalt aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a "C" in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent oversize material (greater than 4 inches (10 cm) in diameter) may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so it must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

Another indicator of the quality of an aggregate is lithology. Just as the unique physical and chemical properties of bedrock types determine their value for use as crushed rock, so do various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone, and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high quality uses such as concrete and asphalt. Similarly, highly weathered, very porous and friable rock can restrict the quality of an aggregate. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol shows either "C", "O", or "L" or any combination of these indicators, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt is made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of both the Ontario Ministry of Transportation and Communications (M.T.C.) and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations.

Quality data may also appear in Table 9, where the results of M.T.C. quality tests are listed by test type and sample location. The types of tests conducted and the test specifications are explained in Appendices B and E, respectively.

Analyses of unprocessed samples obtained from test holes, pits or sample sites are plotted on grain size distribution graphs. On the graphs are the gradation specification envelopes for Ontario Ministry of Transportation and Communications' products: Granular Base Course A, B and C; Hot-Laid Asphaltic Sand Nos. 1,2,3,4, and 8; and concrete sand. By plotting the gradation curves with respect to the specification envelopes, it can be determined how well the unprocessed sampled material meets the criteria for each product. These graphs, called Aggregate Grading Curves, follow the tables in the report.

Location and Setting

The location and setting of a resource area has a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on extractive development, such as thick overburden or high water table, are less valuable resource areas because of the difficulties involved in resource recovery. Second, permanent man-made features. such as roads, railways, powerlines, and housing developments, which are built on a deposit, may prohibit its extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The area rendered unavailable by these features is shown for each resource area in Table 3 (Column 3).

The assessment of sand and gravel deposits with respect to local land use and to private land ownership is an important component of the general evaluation process. These aspects of the evaluation process are not considered further in this report, but readers are encouraged to discuss them with personnel of the pertinent District Office of the Ontario Ministry of Natural Resources.

REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development, it is important to assess both the local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production "market share" of an area will remain roughly at the same level.

The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalites with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.

MAP 3: BEDROCK RESOURCES

Map 3 is an interpretative map derived from bedrock geology, drift thickness and bedrock topography maps, water well data from the Ontario Ministry of the Environment, oil and gas well data from the Petroleum Resources Section (Ontario Ministry of Natural Resources) and from geotechnical test hole data from various sources. Map 3 is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on the one map.

The geological boundaries of the bedrock units are shown by a dashed line. Isolated outcrops are indicated by an "X". Three sets of contour lines delineate areas of less than 3 feet (1 m) of drift, areas of 3 to 25 feet (1 to 8 m) of drift, and areas of 25 to 50 feet (8 to 15 m) of drift. The extent of these areas of thin drift are shown by three levels of shading. The darkest shade indicates where bedrock outcrops or is within 3 feet (1 m) of the ground surface. These areas consitute potential resource areas because of their easy access. The medium shade indicates areas where drift cover is up to 25 feet (8 m) thick. Quarrying is possible in this depth of overburden and these zones also represent potential resource areas. The lightest shade indicates bedrock areas overlain by 25 to 50 feet (8 to 15 m) of overburden. These latter areas constitute resources which have extractive value only in specific circumstances. Outside of these delineated areas, the bedrock can be assumed to be covered by more than 50 feet (15 m) of overburden, a depth generally considered to be too great to allow economic extraction (unless part of the overburden is composed of economically attractive deposits).

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the report area. Those areas which are licenced for extraction under the Pits and Quarries Control Act are shown by a solid outline and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location, licenced acreage and an estimate of face height. Unlicenced quarries (abandoned quarries or wayside quarries operating on demand under. authority of a permit) are also identified and numbered on Map 3 and described in Table 5. Two additional symbols may appear on the map. An open dot indicates the location of a selected water well which penetrates bedrock. The overburden thickness is shown in feet beside the open dot. Similarly, test hole locations appear as a point symbol with the depth to bedrock shown in feet beside it. The test holes may be described further in Table 7.

SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and Communications. The main characteristics and uses of the bedrock units found in southern Ontario are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations. Since vertical and lateral variations in bedrock units are much more gradual than in sand and gravel deposits, the quality and quantity of the resource are usually consistent over large areas.

Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location and setting criteria and regional considerations are identical to those for sand and gravel deposits.

SELECTED RESOURCE AREAS

Selection of Bedrock Resource Areas has been restricted to a single level of significance. Three factors support this approach. First, quality and quantity variations are gradual. Second, the areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material, and third, since crushed bedrock has a higher unit value than sand and gravel, longer haul distances can be considered. These factors allow the identification of alternative sites having similar development potential. The Selected Areas, if present, are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 6.

Selected Bedrock Resource Areas shown on Map 3 are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major bedrock resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Part III — Assessment of Aggregate Resources in the Township of Scugog

LOCATION AND POPULATION

The Township of Scugog occupies an area of 112,550 acres (45 549 ha) in the central part of the Regional Municipality of Durham, northeast of Metropolitan Toronto. The township was incorporated in 1973 and includes the former Village of Port Perry and the former Reach, Cartwright and Scugog Townships (Ontario 1973). The former Scugog Township was established in 1852 from those portions of Reach and Cartwright geographic townships that were isolated on Scugog Island after the creation of Lake Scugog (Canada 1851). Where applicable, the location of data points in this report are identified by the originally surveyed lots and concessions of Reach and Cartwright geographic townships.

The Township of Scugog is shown on portions of the Newmarket (31 D/3) and Scugog (31 D/2) map sheets of the National Topographic System at a scale of 1:50 000. The township is bounded by Manvers Township to the east, the Township of Uxbridge to the west, the Towns of Newcastle and Whitby and the City of Oshawa to the south, and Mariposa Township and the Township of Brock to the north.

The population of the Township of Scugog was 14,645 in 1985 (Ontario Ministry of Municipal Affairs 1986). The majority of the residents are rural-farm or rural-residential inhabitants. Figures from previous years indicate that the township population has increased by approximately 47 percent between 1973 and 1986 (Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1974; Ontario Ministry of Municipal Affairs 1986). Much of this increase can be attributed to the township's scenic recreational value which in turn has attracted a recent influx of rural-residential and seasonal-recreational inhabitants. Such population growth may necessitate the increased production of mineral aggregates to satisfy road-building and construction needs.

The main urban area located in the centre of the study area is Port Perry which represents an important regional trade and retail centre. Several small hamlets such as Greenbank, Seagrave, Manchester and Blackstock also serve the township.

Road access in the township is available by a grid network of paved regional roads and gravel-surfaced township roads. King's Highways 7, 7A, 12 and 47 are also located in the area and conveniently serve as haulage routes to market centres. However, further road development may be hindered because of the rugged topography associated with the Oak Ridges Moraine. Extensive areas of swampy depressions north of the moraine may also restrict road construction.

A single track of the Canadian National Railways serves the northwestern portion of the township. This track runs close to resource areas and may provide for alternate economic aggregate transportation. A track of the Canadian Pacific Railway located immediately south of the township provides excellent access along the extent of the Oak Ridges Moraine.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The physiography and distribution of surficial materials in the Township of Scugog, including the sand and gravel deposits shown on Map 1, are the result of glacial activity that took place in the latter part of the Great Ice Age. This period of time, which lasted from approximately 23 000 to 10 000 years ago, was marked by the repeated advance and melting back of massive, continental ice sheets.

Two lobes of the Laurentide Ice Sheet repeatedly covered the township during the Great Ice Age. The northern lobe advanced from the northeast depositing Newmarket Till (Gwyn 1972). This unit is a light yellowish-brown sand to compact silty sand till that occupies a substantial surface area of the township. The southern, semi-independent lobe (Ontario lobe) was centered in the Lake Ontario basin and advanced from the southeast depositing Halton (upper Leaside) Till (Gwyn and DiLabio 1973). The margins of both lobes were touching or at least in close proximity during the latter part of the Great Ice Age. During periods of warmer climate, ice-front fluctuations caused large amounts of meltwater with glacial debris to be carried off the ice margins. This material eventually accumulated into the trough between the margins of the lobes to form an irregular hummocky ridge named the Oak Ridges Moraine (Chapman and Putnam 1984, pp. 166-169). This ridge forms one of the most distinctive physiographic features in southern Ontario.

The Oak Ridges Moraine extends across the southern part of the Township of Scugog. The moraine has a maximum elevation of more than 1100 feet (335 m) above sea level and varies in width from about one kilometre south of Lake Scugog to a maximum of approximately 10 kilometres north of Chalk Lake. The surface materials of the moraine consist of poorly differentiated silts, sands and gravels that are characteristic of an ice-contact environment (Duckworth 1975; Fraser 1974; Gravenor 1957). There are, however, areas in the moraine that appear to possess a glaciofluvial origin, as the material resembles horizontally stratified outwash. A large part of the moraine north of Chalk Lake shows evidence of extensive glaciofluvial transport. Here, coarse granular material is at or near the ground surface and considerable extraction has taken place. Although the exact depth of the moraine is unknown, water well data indicate the presence of as much as 200 feet (61 m) of stratified sand, gravel and silt. Early workers have even suggested that the moraine may be as much as 700 feet (213 m) thick (Gravenor 1957, p. 27).

After the formation of the Oak Ridges Moraine, the northern or Simcoe ice lobe melted back to the north. Meltwaters ponded between the retreating ice margin and the northern boundary of the moraine produced the Early Schomberg Ponds that covered much of the area (Gwyn 1972).

A later readvance of the Simcoe lobe deposited the first phase of Kettleby Till. The Kettleby Till may be slightly younger than the Halton Till as locations in Reach geographic township reveal Halton Till overlain by a clayey silt till, possibly Kettleby Till (Gwyn 1975; White 1975). Following a short lacustine interval a second and final readvance of the ice deposited the second phase of Kettleby Till (Gwyn 1972; Gwyn and DiLabio 1973). It was probably this final readvance that resulted in the deposition of a characteristic drumlinized till plain known as the Peterborough Drumlin Field (Chapman and Putnam 1984, pp. 169-172). Till from this plain has little value as an aggregate source because of its excessive fines content. However, occasional stratified sand and gravel is incorporated in the drumlins, and this material has been extracted for local use. Most of the sources have a low pit-use rating and frequently the material is suitable only for fill-related purposes (Deike 1978; Gravenor 1957).

With the final retreat of the Simcoe lobe northward from the Oak Ridges Moraine, deposits of the Late Schomberg Ponds were laid down between the retreating ice margin and the moraine. These lacustrine deposits consist of sand, silty sand, silt and clay and varved silts and clay (Gwyn and DiLabio 1973; Fraser 1974; Gravenor 1954, 1957). Clays from the Schomberg Ponds have been extracted near Lindsay for brick making (Fraser 1974; Gravenor 1957).

Several ice-contact stratified drift deposits occur north of the moraine. Although many of these deposits located in the north part of Reach geographic township are small, they contain crushable material that can be utilized for a range of products. Other ice-contact deposits such as the two located in the Cadmus-Nestleton area, are not good aggregate prospects. They consist of often dirty sand with minor amounts of fine noncrushable gravel (Deike 1978). Some ice-contact material, however, is buried beneath the surface till. A large area of ice-contact stratified drift located south of Prospect also is overlain by till. Substantial areas of fine- to medium-grained outwash sand covers much of the western part of the township and extends into the Township of Uxbridge. These deposits consist largely of sand, although local accumulations of gravel may be present.

During the formation of the Schomberg Ponds the margin of the ice sheet became stationary and stagnated or melted-in-place (Gravenor 1957). The two eskers located in the northern part of Reach geographic township are stagnation features. These deposits formed when the margin of the ice was stagnant therefore allowing meltwater to escape in tunnels at the base of the ice. The esker located west of Greenbank is an excellent source of aggregate that has been used in recent years for many road-building and construction products.

The stagnation of the Simcoe lobe marked the end of glacial activity in the Township of Scugog and several postglacial erosional and depositional processes are exhibited. Steep portions of the Oak Ridges Moraine have been sharply altered by wind and water erosion producing irregular, gullied topography (Funk 1977). Extensive eolian windblown forms can be found on Scugog Island and between Lake Scugog and the Nonquon River valley. These sands and silts are generally fine grained and lie at a higher elevation than the Schomberg sands found in the Nonquon valley. Lowland deposits of peat, muck and marl also cover large areas in the township. The Nonquon River valley is such an area.

EXTRACTIVE ACTIVITY

The Township of Scugog has large resources of sand and gravel concentrated in the Oak Ridges Moraine. Numerous sand and gravel pits in the township have been established in ice-contact stratified drift deposits or in glaciofluvial deposits.

Many of the pits became inactive when Reach geographic township and Cartwright geographic township were designated under the Pits and Quarries Control Act in 1971 and 1975, respectively. At the time of writing, records on file with the Lindsay District Office of the Ontario Ministry of Natural Resources indicate that fifteen sand and gravel pits are licenced for extraction. The total area licenced for extraction in the Township of Scugog is 1152.4 acres (466.4 ha). Records of the total annual production from all licenced sources in the Township of Scugog show that the average annual production over the seven-year period from 1976 to 1982 was 1,000,000 tons (910 000 tonnes).

Several of the sources located in the glaciofluvial deposits have a "moderate to high" use rating according to criteria established by the Ontario Ministry of Transportation and Communications (M.T.C.) (Deike 1978). These sources are capable of producing high-quality coarse aggregate. Pits 3, 4 and 7 contain crushable material and are able to produce Hot-Laid (H.L.) No. 4 stone. These properties are also able to supply materials for Granular Base Course (G.B.C.) A and other lesser uses. In some cases sand control is required (Deike 1978).

Eight sand and gravel pits located in the ice-contact portion of the moraine have been licenced for extraction. Most of these properties contain fine-grained aggregate suitable for the production of G.B.C. B and C and select subgrade materials in large quantities and have therefore been given a "low" use rating. However, some of these sources do contain pockets of crushable gravel making them suitable for supplying some road-building and construction products in limited quantities.

SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 1 illustrates the occurrence of sand and gravel deposits in the Township of Scugog. The total area occupied by these deposits is approximately 48,000 acres (19 400 ha), or 43 percent of the total area of the township. The deposits contain possible resources of 2750 million tons (2500 million tonnes). However, much of the materials associated with the Oak Ridges Moraine have limited potential for use as road-building or construction aggregate.

Map 2 illustrates the Selected Sand and Gravel Resources of Primary Significance, as well as the Sand and Gravel Resource Areas of Secondary Significance. Large amounts of good-quality coarse aggregate are available at or near the surface in the extensive glaciofluvial deposit located in the southwestern portion of the township. Other glaciofluvial and ice-contact deposits have also been selected as Primary Resource Areas. The Selected Sand and Gravel Resource Areas of Primary Significance occupy a total available area of 1750 acres (710 ha), exclusive of licenced properties. They contain possible sand and gravel resources of approximately 166 million tons (151 million tonnes). The parts of the Resource Areas which are available for extraction represent 4 percent of the total area occupied by sand and gravel deposits in the township and 6 percent of the total resource tonnage.

The remainder of the Oak Ridges Moraine and three ice-contact stratified drift deposits have been selected at the secondary level of significance. Although these are not the "best" resources, they should be considered as an important part of the township's total aggregate supply.

SELECTED SAND AND GRAVEL RESOURCE AREA 1

Selected Sand and Gravel Resource Area 1 is located along the northern flank of the Oak Ridges Moraine, which occurs along the southern boundary of the township. The outwash deposit constitutes the largest and best quality sand and gravel deposit in the township.

The Resource Area extends westward into the Township of Uxbridge where the deposit has also been a traditional aggregate source for many years. Area 1 is of importance as a regional source of road-building and construction materials, especially for the Metropolitan Toronto market. The eastern geological boundary shown for Area 1 is somewhat generalized because of the limited amount of subsurface data. Additional field investigation is required to identify specific areas of high potential for extractive development.

Four properties are currently licenced under the Pits and Quarries Control Act. Two other pits which were worked prior to the designation of the township are not presently licenced. Pit faces range from 10 to 50 feet (3 to 15 m) in height and expose stratified fine to coarse sand and well-rounded, fine to medium gravel. Although gravel content generally ranges from 15 to 40 percent, a sample from pit no. 4 revealed 54 percent gravel (Figure 2a).

Pit nos. 4 and 7 have been given a "moderate to high" pit use rating (Deike 1978). They contain high quality aggregate which is acceptable for a full range of road-building and construction products with suitable processing and quality control. These products include G.B.C. A, B and C as well as H.L. 4 asphaltic aggregate. Blending is required for hot-laid sand. The only quality limitation in the aggregate is the occasional presence of soft shale fragments. These are easily removed by stockpile aging, i.e. the aggregate is allowed to stand in small stockpiles until the soft particles are broken down by natural weathering processes.

Resource Area 1 occupies 1980 acres (800 ha), exclusive of licenced properties. Cultural constraints and previous extraction reduce the area presently available to 1440 acres (580 ha). Water well data indicate a considerable depth of sand and gravel. Based on an average of pit face heights and selected water well data, the average thickness of usable material in Area 1 has been estimated to be 40 feet (12 m). Therefore, the sand and gravel resources total approximately 144 million tons (131 million tonnes). Road access to Area 1 is provided by King's Highways 7, 7A, 12 and 47 which are located close to the deposits.

SELECTED SAND AND GRAVEL RESOURCE AREA 2

Selected Sand and Gravel Resource Area 2 consists of an esker deposit situated west of Greenbank and the southern extension of a second esker located east of Victoria Corners.

Lee Sand and Gravel operates a licenced property (pit no. 3) in the southern extremity of the esker located west of Greenbank. A 15- to 20-foot (5 to 6 m) face in the property exposes crossbedded stratified medium gravel and coarse sand (Hewitt and Karrow 1963). A sample from pit no. 3 revealed 65 percent gravel (Figure 2a). The aggregate is acceptable for the production of G.B.C. A, B and C as well as H.L. 4 asphaltic aggregate. However, oversize material must be removed or crushed for the production of G.B.C. B and blending is necessary because the sand grades fine and dirty for hot-laid products (Deike 1978).

There are no sand and gravel pits in the second esker east of Victoria Corners. However, Hancock Sand and Gravel Ltd. in the Township of Brock has operated in most of the same esker ridge and much of the surrounding sediments. Variable 30- to 50-foot (9 to 15 m) faces in the property expose irregularly stratified sand and gravel which is approximately 30 to 40 percent gravel. This property is designated as a commercial source and has been given a "high" use rating (Deike 1977).

Resource Area 2 occupies 50 acres (20 ha), exclusive of the licenced property. Deletions for cultural constraints leave 40 acres (16 ha) currently available for extraction. Assuming an average deposit thickness of 15 feet (5 m), sand and gravel resources are estimated to be 2 million tons (2 million tonnes). Road and rail access to the Area is good.

SELECTED SAND AND GRAVEL RESOURCE AREA 3

Selected Sand and Gravel Resource Area 3 consists of five ice-contact stratified drift deposits. Three of these deposits are located northwest of Port Perry and the remaining two are situated west of Marsh Hill.

There are two licenced properties and one unlicenced pit in Selected Area 3 (pit nos. 1, 2 and 21). All of the sand and gravel pits have been given at least a "moderate" pit use rating (Deike 1978). Faces in these pits range in height from 10 to 40 feet (3 to 12 m) and contain pockets of good crushable material suitable for a range of products. These products include G.B.C. A, B and C and selected subgrade material. However, silt and minor amounts of incorporated till are also present in some of the pits necessitating selective extraction procedures. Pit no. 21 is presently depleted - the aggregate from the pit was used for road construction along a section of

King's Highways 7 and 12. The oversize material had to be removed or crushed for the production of G.B.C. B and the sand fraction of the aggregate required blending for hot-laid asphalt (Deike 1978).

Resource Area 3 occupies 360 acres (146 ha), exclusive of the licenced properties. Cultural constraints and previous extraction reduce the area currently available to 270 acres (109 ha). Assuming an average deposit thickness of 30 feet (9 m), sand and gravel resources are estimated to be 20 million tons (18 million tonnes). Road and rail access to the Resource Area is available. A single track of the Canadian National Railways is located immediately east of pit no. 1.

SAND AND GRAVEL RESOURCE AREAS OF SECONDARY SIGNIFICANCE

An extensive area of the Oak Ridges Moraine lying east of Resource Area 1 has been selected at the secondary level of significance. The hummocky topography of this part of the moraine is one of the most outstanding features of glacial physiography in southern Ontario. The northern geological boundary of the moraine has been somewhat generalized because of the limited amount of subsurface data. Interpretation of water well data has been extensively employed to delineate as accurately as possible with available data the potential areas of sand and gravel.

The near surface materials found in the moraine are poorly differentiated silts, sands and gravels that are generally associated with an ice-contact environment (Duckworth 1975). Poor sorting, slumping and discontinuous stratification are a few of the many ice-contact features that are commonly displayed in the moraine. Water well data indicate that the uppermost sediments of the moraine may overlie large quantities of crushable gravel at varying depths. Duckworth (1975, p. 24) reported that "the general sequence of sediments in the deep borings consists of between 0 and 10 metres of surface till which overlies between 50 and 60 metres of sand and/or gravel." For instance, an area of buried sand and gravel has been tentatively identified immediately south of Prospect. The geological boundary shown on Map No. 1 is generalized and has been based on water well data that indicate approximately 13 to 15 feet (4 to 5 m) of till overlying substantial deep deposits of sand and gravel. Pit no. 26 is located in this buried deposit and reveals a veneer of till approximately 10 to 15 feet (3 to 5 m) in thickness overlying 10 to 20 feet (3 to 6 m) of fine to medium sand and pockets of fine to coarse gravel. The material from these pockets is acceptable for a full range of road-building and construction products. The sand grades fine and dirty and blending is required for hot-laid use (Deike 1978). A road-cut located southwest of pit no. 26 also reveals sand and gravel overlain by till.

Currently there are eight licenced properties (pit nos. 8, 9, 10, 11, 12, 13, 14, and 15) and five unlicenced pits (pit nos. 24, 25, 26, 27 and 28) developed in this section of the moraine. Most of these pits have been given a "low" use rating and expose up to 60 feet (18 m) of sandy aggregate suitable for the production of G.B.C. B and C as well as selected subgrade material. Samples taken from pit nos. 10 and 14 revealed 71 percent and 75 percent sand, respectively (Figure 3a). In most of the sources, the sand fraction of the aggregate requires blending for hot-laid asphalt (Deike 1978). Isolated pockets of crushable material can be extracted from some of the pits, therefore increasing the range of materials that can be produced. Pit nos. 24 and 26 possess a "moderate" pit use rating and are capable of producing a greater range of products including G.B.C. A (Deike 1978). Selective extraction procedures must be employed in many of the deposits to avoid masses of silt and till.

A detailed subsurface investigation should confirm (or otherwise) the presence of additional pockets of crushable gravel and thus improve the aggregate potential of the moraine.

Three ice-contact deposits - two located east of Nestleton Station and one located east of Victoria Corners - also have been selected as Resource Areas of Secondary Significance. These deposits are believed generally to be sand sources, however, occasional pockets of fine noncrushable gravel have been removed from the deposits in the Cadmus-Nestleton area. The aggregate was primarily used for backfill purposes and for the production of G.B.C. B and C (Deike 1978).

BEDROCK GEOLOGY

The Township of Scugog is underlain by Upper Ordovician limestone and shale of the Lindsay Formation, and shale of the Blue Mountain Formation. The distribution of the formations is shown on Map 3 (after Liberty 1969 and Russell and Telford 1983).

The Lindsay Formation underlies all of Scugog Island and most of Cartwright geographic township. The formation consists of three members: a Lower Member of fine-crystalline, rubbly, nodular limestone, a Middle Member of grey calcareous claystone containing common shaly partings and an Upper Member (Collingwood Member of Russell and Telford 1983) of black, petroliferous, highly calcareous shale. A drill hole placed by Ontario Hydro at the Darlington Nuclear Power Station site on the Lake Ontario shoreline showed this formation to be 207 feet (63 m) thick. The rock from the Lower and Middle Members is soft and nonresistant to weathering and the numerous clayey partings render the rock unsatisfactory for load-bearing aggregate (Dolar-Mantuani 1975). However, both members have been quarried southeast of Bowmanville in the St. Marys Cement Co. quarry (Town of Newcastle) for use as a raw material in cement production.

Overlying the Lindsay Formation is the brown fissile shale of the Blue Mountain Formation. The Blue Mountain Formation underlies most of Reach geographic township and an area located in the southwestern portion of Cartwright geographic township. The unit consists of brown, slightly petroliferous and slightly calcareous shale. The Blue Mountain Formation is generally not suitable for the production of concrete aggregate. However, testing has indicated that this formation may be acceptable for heat-expanded lightweight aggregate (Guillet 1967).

Regional patterns indicate that the bedrock topography is generally flat and both units possess a gentle regional dip of 20 to 30 feet to the mile (4 to 6 m to the kilometre) towards the southwest (Liberty 1969, p. 86). The thickness of surficial materials overlying these formations is in excess of 80 feet (24 m) and in the Epsom area the drift cover exceeds 500 feet (152 m). Quarrying of the units is, therefore, not practical.

SUMMARY

The sand and gravel deposits of the Township of Scugog were formed during the Great Ice Age. The township has resources of sand and gravel which should be sufficient to meet local needs for a long period of time. Some of the deposits are capable of producing high-quality coarse aggregate suitable for the production of granular base course materials and hot-mix asphalt paving mixes. Further field investigation may identify specific sites of crushable gravel. Although several deposits have been selected for resource protection at both the primary and secondary levels, care should be taken to ensure the continuing availabilty of as much of these resource areas as possible.

Bedrock underlying the Township of Scugog consists of Ordovician limestone and shale of the Lindsay Formation and shale of the Blue Mountain Formation. The Lindsay strata are not suitable for use as aggregate but can be used as a raw material in cement manufacture, however excessive drift cover has prevented any extraction. The township must rely totally on sand and gravel deposits.

Enquiries regarding the Aggregate Resource Inventory of the Township of Scugog should be directed to the Aggregate Assessment Office, Ontario Geological Survey, Ministry of Northern Development and Mines, Room M1B-45, Macdonald Block, Queen's Park, Toronto, Ontario M7A 1W4, (Tel. (416) 965-1663), or to the Ontario Ministry of Natural Resources either at the Lindsay District Office, 322 Kent Street West, Lindsay, Ontario, K9V 4T7 (Tel. (705) 324-6121) or at the Central Region Office, 10670 Yonge Street, Richmond Hill, Ontario, L4C 3C9 (Tel. (416) 884-9203).

TABLE 1. TOTAL SAND AND GRAVEL RESOURCES, TOWNSHIP OF SCUGOG*.

1 Class No.	2 Deposit Type (see Appendix C)	3 Areal Extent Acres (Hectares)	4 Original Tonnage Millions of Tons (Tonnes)
1	G-E	25 (10)	1 (1)
	G-IC	210 (85)	16 (14)
	S-IC	17,400 (7000)	1520 (1380)
	S-IC (buried deposit)	580 (235)	51 (46)
	S-LP	330 (134)	16 (14)
	G-OW	2170 (880)	217 (197)
	S-OW	11,300 (4550)	560 (510)
	G-E	45 (18)	2 (2)
	G-K	15 (6)	1 (1)
	S-LP	5500 (2230)	206 (187)
	S-OW	230 (93)	9 (8)
	S-WD	5000 (2020)	62 (56)
		48,000 (19 400)	2750 (2500)

N.B. Minor variations in all tables are caused by rounding of data.

*Identified deposit areas within the Scugog Indian Reserve 34 have been omitted on all tables.

TABLE 2. SAND AND GRAVEL PITS, TOWNSHIP OF SCUGOG.

1 No.	2 MTC No.	3 Owner/ Operator	4 Lot	5 Con.	6 Licenced Areas Acres (Hectares)	7 Face Height Feet (Metres)	8 % Gravel
LICENCED PITS							
Reach Geographic Township							
1	N02-036	James Sabiston	3,4	12	140.0 (56.7)	10-40 (3-12)	30-50 (in places)
2	N02-150	L.J. Kydd	3	11	10.0 (4.0)	15-25 (5-8)	<20 (partially overgrown)
3	N02-049	Lee Sand & Gravel	5,6	10	79.9 (32.3)	15-20 (5-6)	40-50 (partially overgrown)
4	N02-052	Vicdom Sand & Gravel (Ontario) Ltd.	1	5	54.0 (21.8)	20-50 (6-15)	30-50
5	-	Van Camp Contracting Ltd.	1	5	45.7 (18.5)	20-25 (6-8)	15-35
6	N02-099	Griffin & Sellers	4	4	25 (10.1)	20 (6)	20-30 (above groundwater level)
7	-	Harnden & King Construction Ltd.	1,2	4	63.4 (25.7)	40 (12)	30-40
8	-	Harnden & King Construction Ltd.	10	2	57.0 (23.5)	15-30 (5-9)	30-35 (pockets)
9	-	K.J. Beamish Construction Co.	10	1	19.6 (7.9)	10-15 (3-5)	<20
10	S02-088	R.B. Holtby	11	1	90.7 (36.7)	15-30 (5-9)	<10
Cartwright Geographic Township							
11	S02-163	Harnden & King Construction Ltd.	2,3	1	201.3 (81.5)	25-40 (8-12)	<10
12	S02-166	Three Brothers Falls Ltd.	4,5	1	253.4 (102.6)	-	- (unopened)
13	-	Scugog Township	E-1/2 12	1	13.1 (5.3)	15-20 (5-6)	0 (sand source)
14	-	Van Camp Construction Ltd.	16	1	24.4 (9.9)	10-25 (3-8)	<20 (pockets)
15	-	The Corporation of the Township of Scugog	21	2	74.9 (30.3)	25-40 (8-12)	10
TOTAL LICENCED AREA IN TOWNSHIP OF SCUGOG					1152.4 (466.4)		

TABLE 2. SAND AND GRAVEL PITS, TOWNSHIP OF SCUGOG.

1 No.	2 MTC No.	3 Owner/ Operator	4 Lot	5 Con.	6 Licenced Areas Acres (Hectares)	7 Face Height Feet (Metres)	8 % Gravel
UNLICENCED PITS*							
Reach Geographic Township							
16	N2-088	Forley (Love)	11	12		15 (5)	variable
17	N2-70	Stroud	2	9		15-20 (5-6)	20 (partially overgrown)
18	N2-12	Stroud	3	9		15-20 (5-6)	20
19	N2-41	B. Brown	8	9		15-30 (5-9)	20-30 (partially overgrown)
20	N2-48	Dobson	10	9		8-10 (2-3)	20 (partially overgrown)
21	N2-42	Parish	11	9		15-30 (5-9)	- (depleted)
22	N2-51	Symes	1	5		10 (3)	- (overgrown)
23	-	Unknown	7	5		10 (3)	30-40
24	N2-34	Tripp	3	2		20-35 (6-11)	20 (partially overgrown)
25	S2-043	Puckrin	10	1		12-25 (4-8)	0-40 variable (partly overgrown)
26	S2-45	Fitzpatrick	14	1		30-35 (9-11)	30-40 pockets (partially overgrown)
Cartwright Geographic Township							
27	S2-123	Lieshman	4	3		40-60 (12-18)	<10 (partially overgrown)
28	S2-164	Graham	4	3		20-30 (6-9)	<5 (partially overgrown)

*Abandoned pits or wayside pits operating on demand under authority of a permit.

TABLE 3. SELECTED SAND AND GRAVEL RESOURCE AREAS, TOWNSHIP OF SCUGOG.

1 Deposit No.	2 Unlicenced Area Acres (Hectares)	3 Cultural Setbacks Acres (Hectares)	4 Extracted Area Acres (Hectares)	5 Available Area Acres (Hectares)	6 Estimated Deposit Thickness Feet (Metres)	7 Available Aggregate Millions of Tons (Tonnes)
1	1980 (800)	520 (210)	20 (8)	1440 (580)	40 (12)	144 (131)
2	50 (20)	10 (4)	0 (0)	40 (16)	15 (5)	2 (2)
3	360 (146)	70 (28)	20 (8)	270 (109)	30 (9)	20 (18)
	2390 (970)	600 (243)	40 (16)	1750 (710)		166 (151)

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, TOWNSHIP OF SCUGOG.

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
		-NONE-		

TABLE 5. QUARRIES, TOWNSHIP OF SCUGOG.

1 NO.	2 MTC NO.	3 OWNER/ OPERATOR	4 LOT	5 CON.	6 LICENCED AREA Acres (Hectares)	7 FACE HEIGHT Feet (Metres)

-NONE-

TABLE 6. SELECTED BEDROCK RESOURCE AREAS, TOWNSHIP OF SCUGOG.

1 **DEPOSIT NO.**	2 **DEPTH OF OVERBURDEN** Feet (Metres)	3 **UNLICENCED AREA** Acres (Hectares)	4 **CULTURAL SETBACKS** Acres (Hectares)	5 **EXTRACTED AREA** Acres (Hectares)	6 **AVAILABLE AREA** Acres (Hectares)	7 **ESTIMATED WORKABLE THICKNESS** Feet (Metres)	8 **AVAILABLE RESOURCES** Millions of Tons (Tonnes)

-NONE-

TABLE 7. SUMMARY OF TEST HOLE DATA, TOWNSHIP OF SCUGOG.

-NONE-

TABLE 8. SUMMARY OF GEOGPHYSICS DATA, TOWNSHIP OF SCUGOG.

-NONE-

TABLE 9. AGGREGATE QUALITY TEST DATA, TOWNSHIP OF SCUGOG.

-NONE-

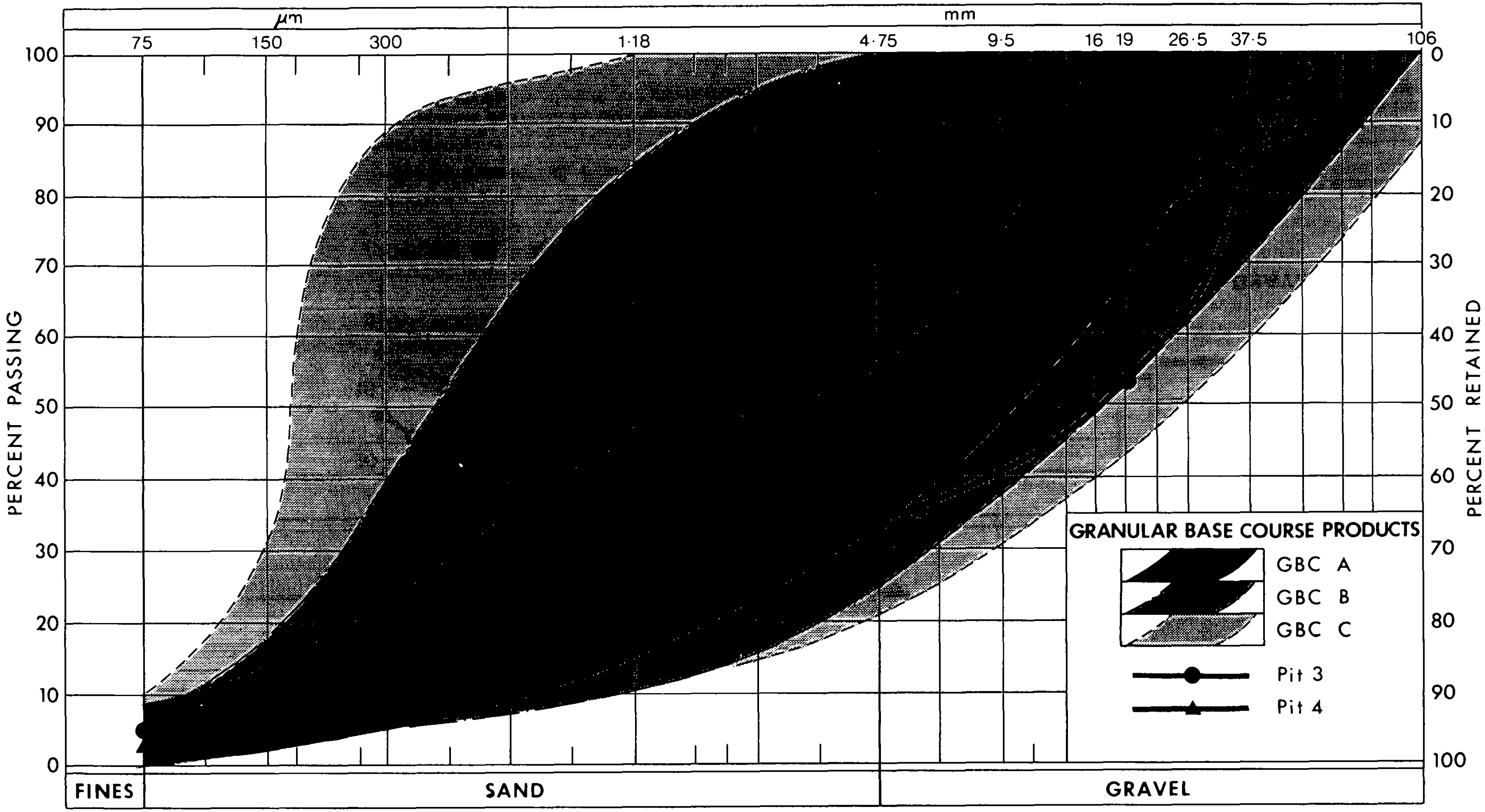


FIGURE 2a: AGGREGATE GRADING CURVES, TOWNSHIP OF SCUGOG;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

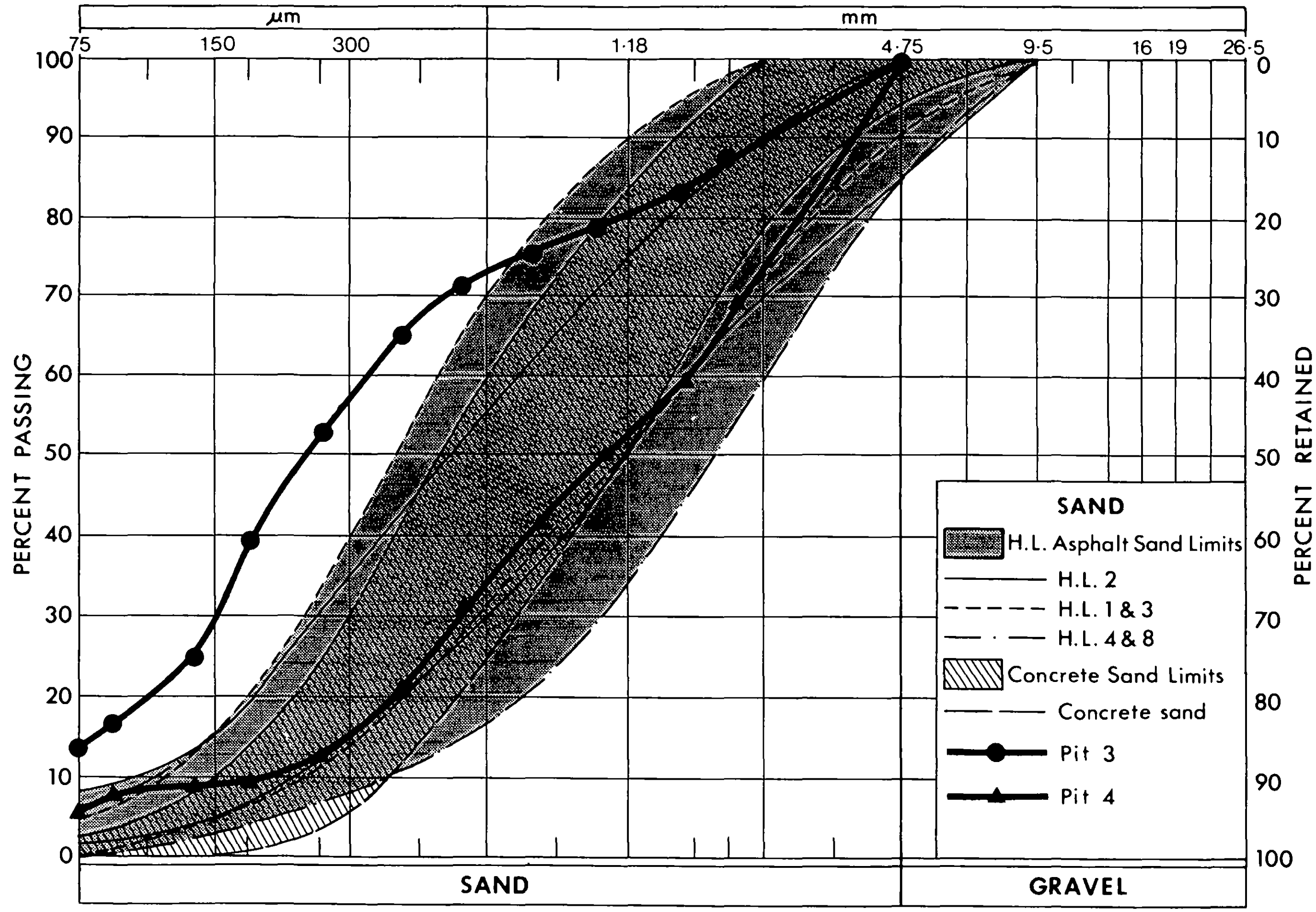


FIGURE 2b: AGGREGATE GRADING CURVES, TOWNSHIP OF SCUGOG;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

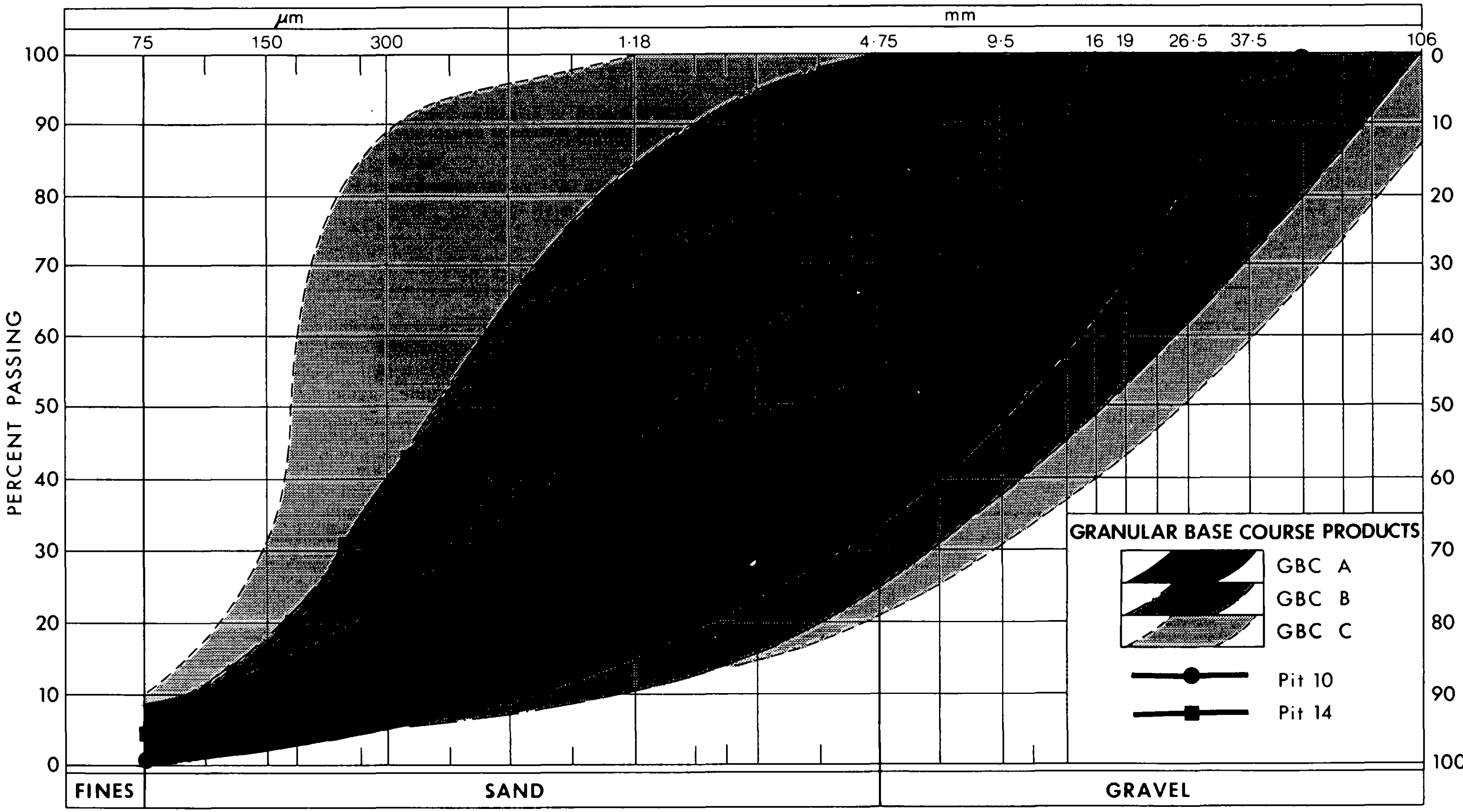


FIGURE 3a: AGGREGATE GRADING CURVES, TOWNSHIP OF SCUGOG;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE: Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

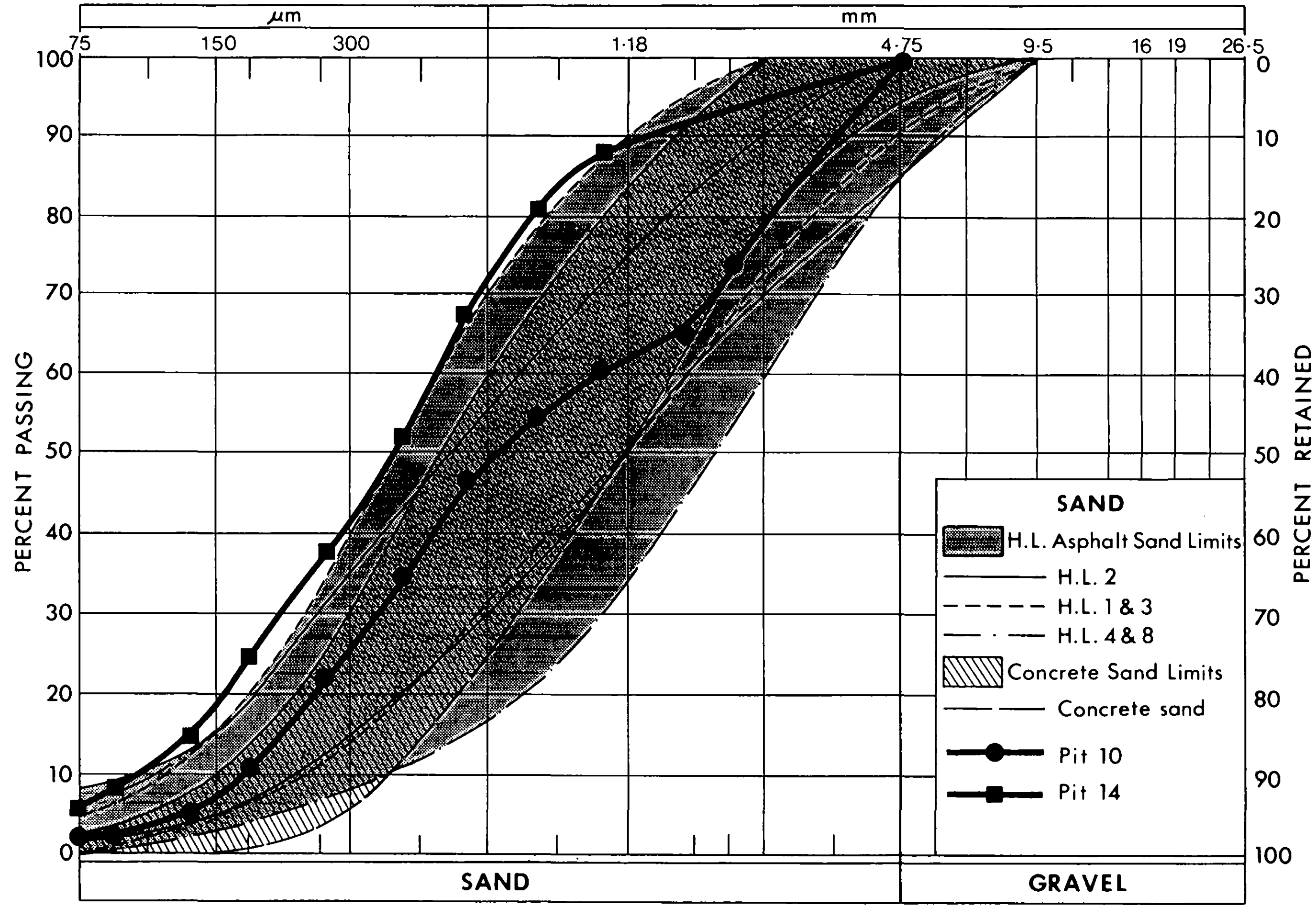


FIGURE 3b: AGGREGATE GRADING CURVES, TOWNSHIP OF SCUGOG;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

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Appendix B — Glossary

Abrasion resistance: Tests such as the Los Angeles abrasion test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

Absorption capacity: Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

Aggregate: Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various-sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

Alkali-aggregate reaction: A chemical reaction between the alkalis of portland cement and certain minerals found in rocks used for aggregate. Alkali-aggregate reactions are undesirable because they can cause expansion and cracking of concrete. Although perfectly suitable for building stone and asphalt applications, alkali-reactive aggregates should be avoided for structural concrete uses.

Beneficiation: Beneficiation of aggregates is a process or combination of processes which improves the quality (physical properties) of a mineral aggregate and is not part of the normal processing for a particular use, such as routine crushing, screening, washing or classification. Heavy media separation, jigging, or application of special crushers (e.g. "cage mill") are usually considered processes of beneficiation.

Blending: Required in cases of extreme coarseness, fineness, or other irregularities in the gradation of unprocessed aggregate. Blending is done with approved sand-sized aggregate in order to satisfy the gradation requirements of the material.

Cambrian: The first period of the Paleozoic Era, thought to have covered the time between 570 and 500 million years ago. The Cambrian precedes the Ordovician Period.

Clast: An individual constituent, grain or fragment of a sediment or rock, produced by the mechanical weathering of larger rock mass. Synonyms include particle and fragment.

Crushable aggregate: Unprocessed gravel containing a minimum of 35 percent coarse aggregate larger than the No. 4 sieve (4.75 mm) as well as a minimum of 20 percent greater than the 26.5 mm sieve.

Deleterious lithology: A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions.

Devonian: A period of the Paleozoic Era thought to have covered the span of time between 395 and 345 million years ago, following the Silurian Period. Rocks formed in the Devonian Period are among the youngest found in Ontario.

Dolostone: A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolostone is also known as dolomite).

Drift: A general term for all unconsolidated rock debris transported from one place and deposited in another, distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

Drumlin: A low, smoothly rounded, elongated hill, mound, or ridge composed of glacial materials. These landforms were formed beneath an advancing ice sheet, and were shaped by its flow.

Eolian: Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

Fines: A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (0.075 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

Glacial lobe: A tongue-like projection from the margin of the main mass of an ice cap or ice sheet. During the Pleistocene Epoch several lobes of the Laurentide continental ice sheet occupied the Great Lakes basins. These lobes advanced then melted back numerous times during the Pleistocene, producing the complex arrangement of glacial material and landforms found in southern Ontario.

Gradation: The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particles are as follows:

Boulder	more than 200 mm
Cobbles	75-200 mm
Coarse Gravel	26.5-75 mm
Fine Gravel	4.75-26.5 mm
Coarse Sand	2-4.75 mm
Medium Sand	0.425-2 mm
Fine Sand	0.075-0.425 mm
Silt, Clay	less than 0.075 mm

Granular base course: Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

Hot-laid (or asphaltic) aggregate: Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1, 3 and 4), or as binder course (H.L. 2 and 8) used to bind the surface course to the underlying granular base course.

Lithology: The description of rocks on the basis of such characteristics as color, structure, mineralogic composition and grain size. Generally, the description of the physical character of a rock.

Magnesium sulphate soundness test: This test is designed to simulate the action of freezing and thawing on aggregates. Those aggregates which are susceptible will usually break down and give high losses in this test.

Meltwater channel: A drainage way, often terraced, produced by water flowing away from a melting glacier margin.

Ordovician: an early period of the Paleozoic Era thought to have covered the span of time between 500 and 435 million years ago.

Paleozoic era: One of the major divisions of the geologic time scale thought to have covered the time between 570 and 230 million years ago, the Paleozoic Era (or Ancient Life Era) is subdivided into six geologic periods, of which only four (Cambrian, Ordovician, Silurian and Devonian) can be recognized in southern Ontario.

Petrographic examination: An aggregate quality test based on known field performance of various rock types. The test result is a Petrographic Number (P.N.). The higher the P.N. the lower the quality of the aggregate.

Pleistocene: An epoch of the recent geological past including the time from approximately 2 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

Possible resource: Reserve estimates based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

Precambrian: The earliest geological period extending from the consolidation of the earth's crust to the beginning of the Cambrian.

Shale: A fine-grained, sedimentary rock formed by the consolidation of clay, silt or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone and mudstone.

Silurian: An early period of the Palezoic Era thought to have covered the time between 435 and 395 million years ago. The Silurian follows the Ordovician Period and precedes the Devonian Period.

Soundness: The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and construction aggregates.

Till: Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

Wisconsinan: Pertaining to the last glacial period of the Pleistocene Epoch in North America. The Wisconsinan began approximately 100 000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of southern Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

Appendix C — Geology of Sand and Gravel Deposits

The type, distribution, and extent of sand and gravel deposits in southern Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 100 000 to 7000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

Ice-Contact Terraces (ICT): These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous because of extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive because of the variability of the deposits both in terms of quality and grain size distribution.

Kames (K): Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits, producing internal structures characterized by bedding discontinuties. The deposits consist mainly of irregularly bedded and crossbedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the rare presence of excess fines (silt- and clay-sized particles).

Eskers (E): Eskers are narrow, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels within or at the base of glaciers, or in channels on the ice surface. Eskers vary greatly in size. Many, though not all eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout Ontario, and are significant components of the total resources of many areas.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits commonly extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensively extracted and are amenable to rehabilitation and sequential land use.

Undifferentiated Ice-Contact Stratified Drift (IC): This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits because of their lack of continuity and grain size variability. They are given a qualitative rating based on existing pit and other subsurface data.

Outwash (OW): Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. The deposits occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

Alluvium (AL): Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment, on its bed or on its floodplain. The probability of locating large amounts of crushable aggregate in alluvial deposits is low, and they have generally low value because of the presence of excess silt- and clay-sized material. There are few large postglacial alluvium deposits in Ontario.

GLACIOLACUSTRINE DEPOSITS

Glaciolacustrine Beach Deposits (LB): These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of southern Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the source material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

Glaciolacustrine Deltas (LD): These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In southern Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near-ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

Glaciolacustrine Plains (LP): The nearly level surface marking the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources because of their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

GLACIAL DEPOSITS

End Moraines (EM): These are belts of glacial drift deposited at, and parallel to, glacier margins. End moraines commonly consist of ice-contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best areas within the moraine is usually poorly defined.

EOLIAN DEPOSITS

Windblown Deposits (WD): Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in southern Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments almost always consists of fine to coarse sand and are usually well sorted. The probabiltiy of locating crushable aggregate in windblown deposits is very low.

Appendix D — Geology of Bedrock Deposits

BEDROCK SUITABLE FOR CRUSHED STONE PRODUCTS

Bass Islands Formation (Upper Silurian)

(Includes the Bertie Formation of the Niagara Peninsula) Composition: Medium- to massive-bedded, aphanitic, brown dolostone with shaly partings. Thickness: 35 to 60 feet (11 to 18 m) near Hagersville. Uses: Quarried for crushed stone on the Niagara Peninsula at Fort Erie, Cayuga, Hagersville, and Dunnville. Los Angeles Abrasion Test: 17-35% loss; Absorption: 1.4%. Shaly parts are unsuitable for aggregate because of high soundness losses.

Bobcaygeon Formation (Middle Ordovician)

Composition: Compact, homogeneous, medium- to thin-bedded, fine-grained limestone with some argillaceous and shaly partings. Thickness: The lower unit is 40 to 72 feet (12 to 22 m) thick in the east and the remainder of the formation is 40 feet (12 m). Uses: Quarried at Kirkfield and Marysville for crushed stone. The Bobcaygeon Formation has consistently acceptable quality for granular base course materials and concrete.

Bois Blanc Formation (Lower-Middle Devonian)

Composition: Brownish grey, medium-crystalline, medium- to thin-bedded, cherty limestone, commonly fossiliferous. Limestone may be silty or sandy in places. Thickness: 9 to 200 feet (3 to 61 m). Uses: Quarried at Hagersville, Cayuga, and Port Colborne for crushed stone. High cherty content makes much of the material unsuitable for concrete aggregate. Los Angeles Abrasion Test: 14-28% loss; Soundness Test: 4-10% loss; Absorption: 0.7-2.0%.

Dundee Formation (Middle Devonian)

Composition: Fine- to medium-crystalline, brownish grey, medium- to thick-bedded, dolomitic limestone with shaly partings, sandy layers, and chert in some areas. Thickness: 60 to 160 feet (18 to 49 m). Uses: Quarried near Port Dover and Pelee Island for crushed stone. Used at St. Marys as raw material for portland cement. Los Angeles Abrasion Test: 22-32% loss; Absorption: 0-4%.

Gull River Formation (Middle Ordovician)

Composition: Member A: thin- to thick-bedded, interbedded, grey argillaceous limestone and buff to green dolostone with a maximum thickness of 60 feet (18 m). Members B and C are dense, aphanitic limestones with argillaceous dolostone interbeds. Uses: Quarried at Kirkfield and Uhthoff for crushed stone. The product is generally fresh and compact with good cubic-shaped factor, low clay content, low absorption, and low soundness losses. Smooth particle surfaces may cause adhesion problems for asphalt. There is some alkali reactivity in a few of the layers.

Lockport and Amabel Formations (Middle Silurian)

Composition: Amabel Formation (Waterdown to the Bruce Peninsula): massive, fine-crystalline dolostone, with reef facies dolostone near Georgetown. Lockport Formation (lateral facies equivalent to the Amabel Formation from Waterdown to Niagara Falls): thin- to massive-bedded, fine-to medium-grained dolostone.

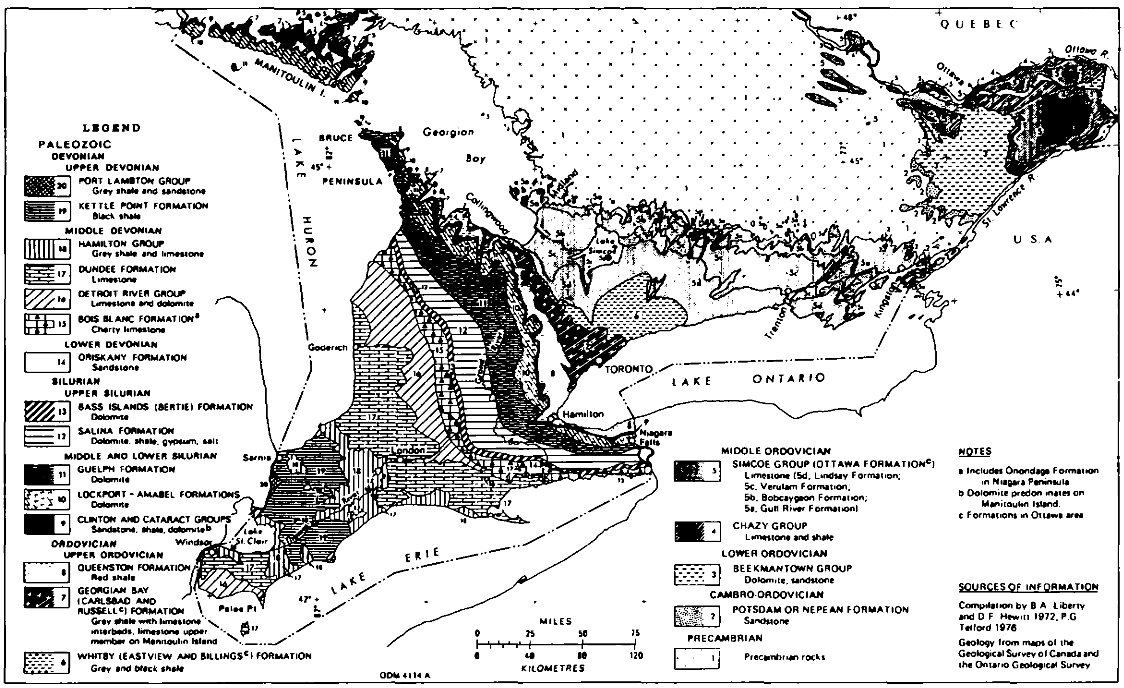

Figure 4. Bedrock Geology of Southern Ontario.

Thickness: Amabel Formation: maximum observed thickness of 84 feet (26 m). Lockport Formation: up to 130 feet (40 m). Uses: The Lockport and Amabel Formations have been used to produce lime, crushed stone, concrete aggregate and building stone throughout their area of occurrence, and are a resource of provincial significance. Los Angeles Abrasion Test: 21-35% loss; Soundness Test: 2.0% loss; Absorption: 0.4-1.6%.

Onondaga Formation (Middle Devonian)

(Equivalent to the Detroit River Group, with a textural change) Composition: Edgecliff Member: medium-bedded, fine- to medium-grained, dark grey cherty limestone with an estimated thickness of 25 to 30 feet (8 to 9 m). Clarence Member: massive-bedded, dark grey-brown, fine-grained, very cherty limestone having estimated thickness of 26 feet (8 m). Moorehouse Member: medium-bedded, dark grey-brown or purplish brown, fine- to coarse-grained, variably cherty limestone with an estimated thickness of 15 to 25 feet (5 to 8 m). Uses: Quarried for crushed stone on the Niagara Peninsula at Welland and Port Colborne. High cherty content makes much of the material unsuitable for concrete aggregate.

Ottawa Formation (Middle Ordovician)

Composition: Lower Phase (Lowville and Pamela Beds): shale, some sandstone and dolostone. Thickness: 100 feet (30 m). Middle Phase (Hull, Rockland, and Leray Beds): pure, thick-bedded, crystalline limestone. Thickness: 150 feet (46 m) near Ottawa. Upper Phase (Cobourg and Sherman Fall Beds): pure and impure crystalline limestone with few to numerous shaly partings, 450 to 475 feet (137 to 145 m) thick near Ottawa. Uses: The Leray, Rockland, and Hull Beds have been quarried extensively for crushed stone and for building stone. In addition, the Hull Beds are an excellent source of limestone for cement production and agricultural uses.

Oxford Formation (Lower Ordovician)

Composition: Medium- to thick-bedded, grey dolostone, with some shaly partings. Thickness: 240 feet (73 m). Uses: Quarried for crushed stone (road and concrete aggregate) at Ottawa, Brockville, and Smiths Falls.

BEDROCK SUITABLE FOR LIME PRODUCTION AND OTHER CHEMICAL USES

Detroit River Group (Middle Devonian)

(Equivalent to the Onondaga Formation in the Niagara Peninsula, with a textural change) Composition: Near Beachville, the group consists of medium- to microcrystalline, medium-bedded, high-purity limestone. It grades northwards near St. Marys to soft, evenly bedded, fine-grained dolostone with bituminous laminae. Massive, porous, reef facies material also occurs to the north (Formosa Reef Limestone). Thickness: 100 feet (30 m) at Beachville, 350 feet (107 m) at Clinton. Uses: The most important source of high-purity limestone in Ontario is the Lucas Formation of the Detroit River Group at Beachville. Detroit River limestone produces much of Ontario's lime and cement. The Anderdon Member of the Lucas Formation is quarried at Amherstburg for crushed stone.

Grenville Marble (Precambrian)

Composition: Recrystallized fine- to coarse-grained white limestone and dolostone, usually of high chemical purity. Uses: Lime production, but also in small amounts for terrazzo chips, poultry grit, decorative stone, and building stone.

Guelph Formation (Middle Silurian)

Composition: Aphanitic to medium-crystalline, thick-bedded, soft, porous dolostone, characterized in places by extensive vuggy, porous reefal facies dolostone of high chemical purity. Thickness: 100 to 170 feet (30 to 52 m). Uses: The main use is for dolomitic lime in the construction industry. The formation is quarried near Hamilton and Guelph.

Lindsay Formation (Upper Ordovician)

Composition: fine-crystalline, rubbly, nodular-weathering limestone. Collingwood Member: organic-rich interbedded calcareous shales and limestones. Uses: Quarried at Picton, Ogden Point and Bowmanville for cement. The formation is generally unsuitable for crushed stone, concrete aggregate, or granular base course.

Verulam Formation (Middle Ordovician)

Composition: Fossiliferous, pure to argillaceous limestone and interbedded calcareous shale. The rock is not resistant to erosion and commonly weathers to rubble. Thickness: 200 to 300 feet (61 to 91 m). Uses: Quarried at Picton, Ogden Point, and Mara Township for use in cement manufacture. The formation is unsuitable for crushed stone because of clay impurities, many clayey interbeds, and low abrasion resistance, high soundness losses and poor freeze and thaw resistance.

BEDROCK SUITABLE FOR BRICK AND TILE MANUFACTURE

Georgian Bay Formation (Upper Ordovician)

(Formerly known as the Meaford-Dundas and Blue Mountain shales in the Toronto and Bruce Peninsula areas) Composition: Soft, fissile, blue-grey shale with limey or sandy lenses in a few places. Thickness: 640 feet (195 m) at Toronto. Uses: Several producers in the vicinity of Metro Toronto produce brick and structural tile. Lightweight aggregate has been produced at Streetsville by heat expansion of the shale.

Hamilton Group (Middle Devonian)

Composition: Grey shale with interbeds of crystalline and cherty limestone. The group has six formations, but only the Arkona Formation is of commercial value. It is a soft, light grey, calcareous shale which is plastic and easily worked when wet. Thickness: 80 to 300 feet (24 to 91 m). The Arkona Formation has a thickness of 14 to 121 feet (4 to 37 m). Uses: The

Arkona Formation is extracted at Thedford and near Arkona for production of drainage tile.

Queenston Formation (Upper Ordovician)

Composition: Red, thin- to thick-bedded, sandy to argillaceous shale with green mottling and banding. Thickness: 400 to 500 feet (122 to 152 m). Uses: There are several large shale quarries developed in the Queenston Formation in the Toronto-Hamilton region and one at Russell, near Ottawa. All produce brick for construction. The Queenston Formation is the most important source material for brick manufacture in the Province.

BEDROCK SUITABLE FOR OTHER INDUSTRIAL PRODUCTS

Nepean (Potsdam) Formation (Cambro-Ordovician)

Composition: Creamy, coarse-grained, silica sandstone. Uses: Quarried throughout its area of outcrop for building stone, decorative stone, abrasives, and for glass making.

Salina Formation (Upper Silurian)

Composition: Grey and red shale, brown dolomite, and, in places, salt, anhydrite, and gypsum. The formation consists predominantly of evaporite deposits with up to eight members identified. Uses: Gypsum is mined at Hagersville, Caledonia, and Drumbo. Salt is mined at Goderich and is produced from brine wells at Amherstburg, Windsor, and Sarnia.

Blue Mountain Formation (Upper Ordovician)

(Formerly known as the Whitby Formation) Composition: Blue-grey, predominantly non-calcareous shale. Uses: Quarried at Bowmanville for use in cement production.

Appendix E — Aggregate Quality Test Specifications

Four types of aggregate quality tests are often performed by the Ontario Ministry of Transportation and Communications on sampled material. A description of each test is found in Appendix B while the specification limits for each test are included in this Appendix in Table E1. Although a specific sample meets or does not meet the specification limits for a certain product, it may or may not be acceptable for that use based on field performance. Additional quality tests other than the four major tests listed in this Appendix can be used to determine the suitability of an aggregate. The tests are performed by the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications.

TABLE E-1. SELECTED QUALITY REQUIREMENTS FOR MAJOR AGGREGATE PRODUCTS.

	TYPE OF TEST				
	COARSE AGGREGATE				FINE AGGREGATE
TYPE OF MATERIAL	Petrographic Number Maximum	Magnesium Sulphate Soundness - Max. % Loss	Absorption Maximum %	Los Angeles Abrasion Maximum % Loss	Magnesium Sulphate Soundness Maximum % Loss
Granular Base A	200	-	-	60	-
16 mm Crushed Type 'A'	160	-	-	35	-
16 mm Crushed Type 'B'	200	-	-	60	-
Granular Subbase B	250	-	-	-	-
Granular Subbase C	250	-	-	-	-
Granular Subbase D	-	-	-	-	-
Hot Mix - H. L. 1	100	5	1.0	15	16
Hot Mix - H. L. 2	-	-	-	-	20
Hot Mix - H. L. 3	135	12	1.75	35	16
Hot Mix - H. L. 4	160	12	2.0	35	20
Hot Mix - H. L. 8	160	15	2.0	35	20
Structural Concrete and Concrete Base	140	12	2.0	35	16
Pavement Concrete and Exposed Structure Deck	125	12	2.0	35	16

(M.T.C. Forms 1002, 1003 and 1010)

(continued from right margin)

DEPOSIT SYMBOL

Gravel Content — G; Thickness Class — 1; Geological Type — IC; Quality Indicator — C·O

Deposits are identified by Gravel Content, Thickness Class, Geological Type and Quality Indicator. Gravel Content is expressed as a percentage of gravel-sized material (i.e. material retained on the 4.75 mm sieve). Thickness Class is based on potential aggregate tonnage per acre. Geological Type refers to geologic origin. Quality Indicator describes objectionable grain size and lithology.

Gravel Content

G	Greater than 35% gravel.
S	Less than 35% gravel.

Thickness Class

Class	Average Thickness in feet (metres)	Tons per acre (Tonnes per hectare)
1	greater than 20 (> 6)	greater than 50,000 (> 112 000)
2	10-20 (3-6)	25,000-50,000 (56 000 - 112 000)
3	5-10 (1.5-3)	12,500 - 25,000 (28 000 - 56 000)
4	less than 5 (< 1.5)	less than 12, 500 (< 28 000)

Geological Type

AL	Older Alluvium	**K**	Kame
E	Esker	**LB**	Lacustrine Beach
EM	End Moraine	**LD**	Lacustrine Delta
IC	Undifferentiated Ice-Contact Stratified Drift	**LP**	Lacustrine Plain
		OW	Outwash
ICT	Ice-Contact Terrace	**WD**	Windblown Forms

(see Appendix C for descriptions of Geological Types)

Quality Indicator

	If blank, no known limitations present.
C	Clay and/or silt (fines) present in objectionable quantities.
L	Deleterious lithologies present.
O	Oversize particles or fragments present in objectionable quantities.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Test hole data from Aggregate Assessment Office, Ontario Geological Survey, Ontario Ministry of Northern Development and Mines.

Selected drilled water well data from the Ontario Ministry of the Environment.

Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: **Gravenor, 1957.**
Gwyn, 1976 a,b.
Gwyn and DiLabio, 1973.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.
Additional Fieldwork by: Staff of the Aggregate Assessment Office.
This map is to accompany O.G.S. Aggregate Resources Inventory Paper **95**.

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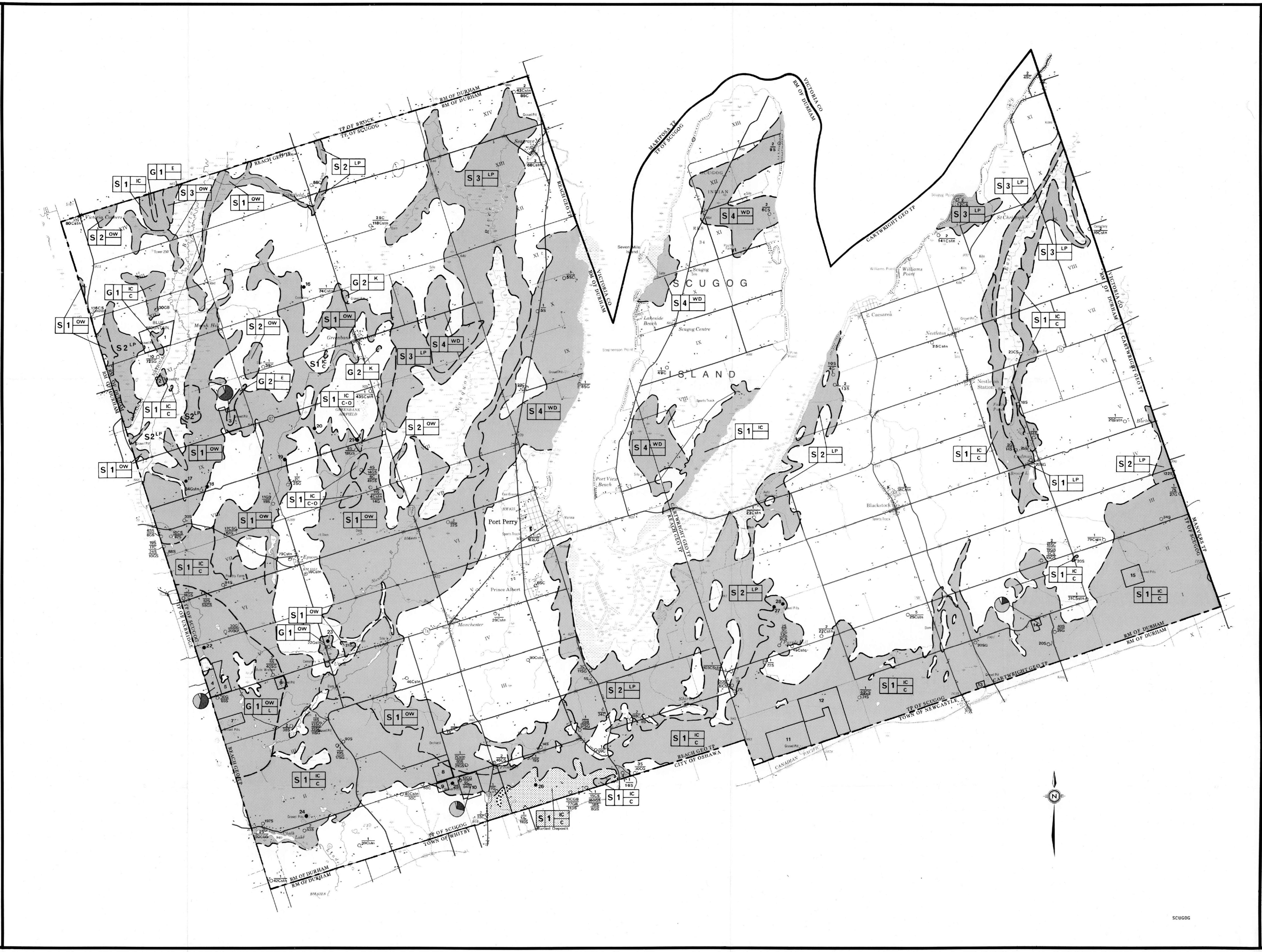
Issued **1986**.

Information quoted for an individual test hole or pit refers to a specific sample or face. Care should be exercised in extrapolating such information to other parts of the deposit.



Ministry of Northern Development and Mines
Ontario

ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

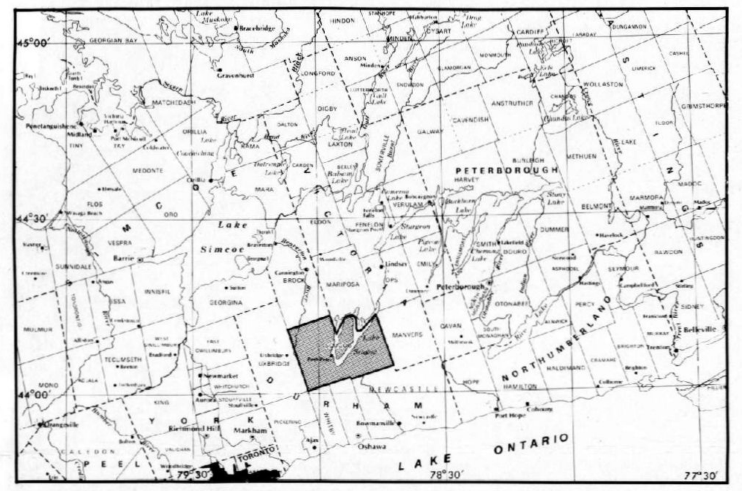
TOWNSHIP OF SCUGOG
REGIONAL MUNICIPALITY OF DURHAM

MAP 1
DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

Scale 1:50 000

Mile 1 — 0 — 1 Mile
Metres 1000 — 0 — 1 Kilometre

NTS Reference: **31 D/2, 31 D/3**



Location Map — Scale 1:1 800 000

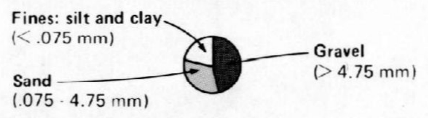
SYMBOLS

(Some symbols may not apply to this map.)

- Township boundary.
- Project area boundary.
- Geographic township within township boundary.
- County, District, Regional or District Municipal boundary.
- City or town limits.
- Park, reserve boundary.
- Geological and aggregate thickness boundary of sand and gravel deposits.
- Buried geological and aggregate thickness boundary of sand and gravel deposits.
- Licenced property boundary; Property number: see Table 2.
- Unlicenced sand or gravel pit*; Property number: see Table 2. *Abandoned pit or wayside pit operating on demand under authority of a permit.
- ·TH·2 Test hole location; Identification number: see Table 7.
- ·SS·1 Selected sample site; Identification number: see Figure 5.
- ·GT·2 Geophysical traverse line; Identification number: see Table 8.
- 6/23G Selected water well location. Layers of materials are described by: reported thickness of material (in feet); reported type of material (number only - overburden, G - gravel, S - sand, C - clay, T - till, B - boulders, Bk - bedrock, Hpan - hardpan, Stn - stones, Silt - silt).
- Texture symbol: see below; see Figures 2 and 3.
- G 1 IC/C·O Deposit Symbol: see below.

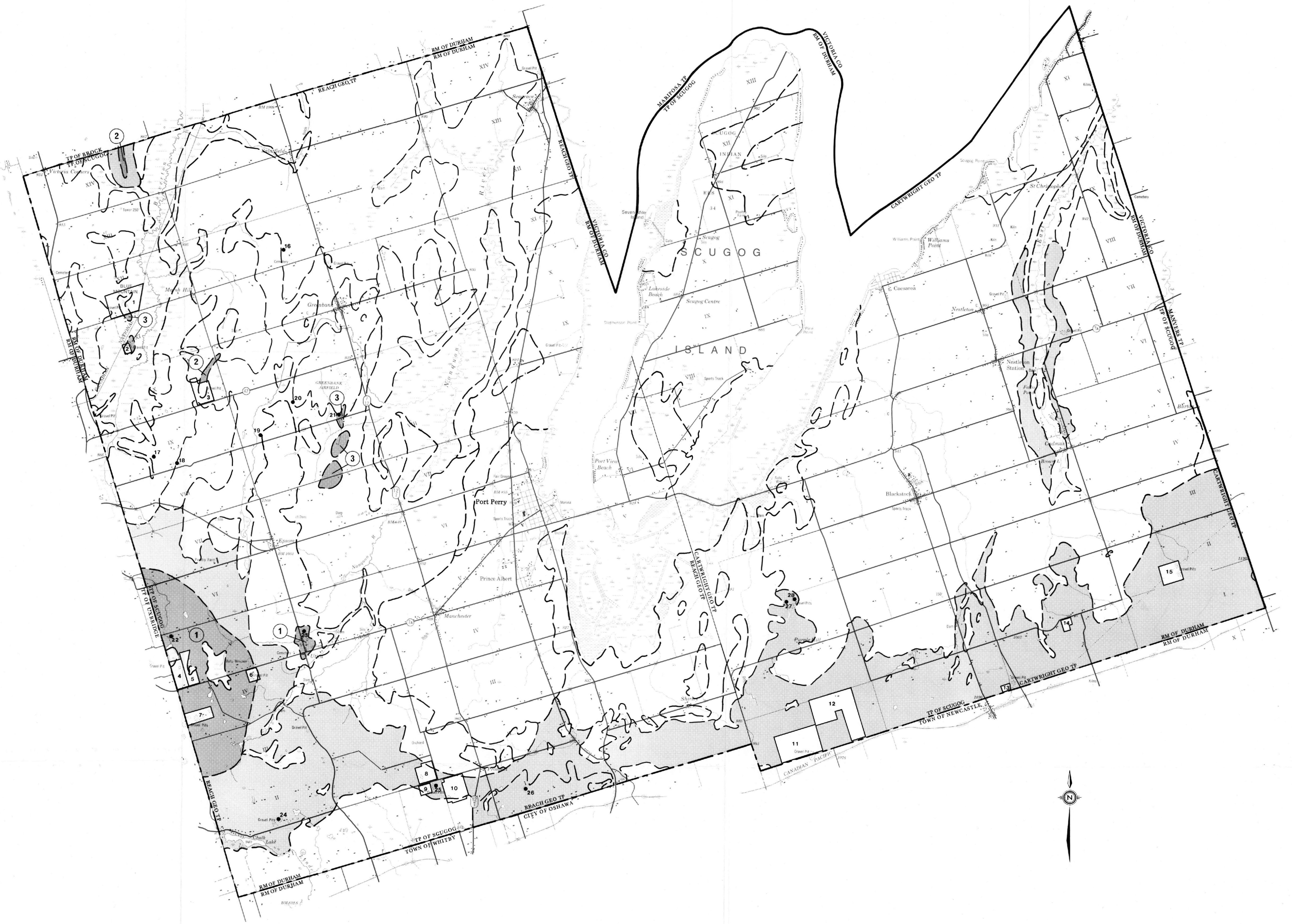
TEXTURE SYMBOL

(This symbol is used where sample analysis data are available.)



The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

(continued at left margin)



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ONTARIO GEOLOGICAL SURVEY

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TOWNSHIP OF SCUGOG

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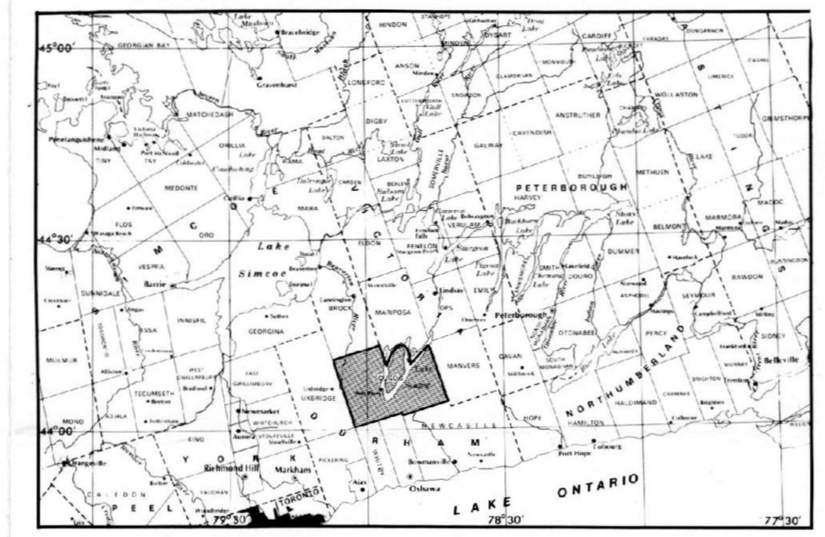
MAP 2
SELECTED SAND AND GRAVEL RESOURCE AREAS

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: **31 D/2, 31 D/3**



Location Map Scale: 1:1 800 000

LEGEND

(Some map units and symbols may not apply to this map.)

MAP UNITS

Selected sand and gravel resource area, primary significance; deposit number; see Table 3.

Selected sand and gravel resource area, secondary significance.

Selected sand and gravel resource area, tertiary significance.

SYMBOLS

Township boundary.

Project area boundary.

Geographic township within township boundary.

County, District, Regional or District Municipal boundary.

City or town limits.

Park, reserve boundary.

Geological and aggregate thickness boundary of sand and gravel deposits.

Buried geological and aggregate thickness boundary of sand and gravel deposits.

Licenced property boundary; Property number: see Table 2.

Unlicenced sand or gravel pit*; Property number: see Table 2.

*Abandoned pit or wayside pit operating on demand under authority of a permit.

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Geology by: **Gravenor, 1957.**
Gwyn, 1976 a,b.
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Compilation and Drafting by: Staff of the Aggregate Assessment Office.
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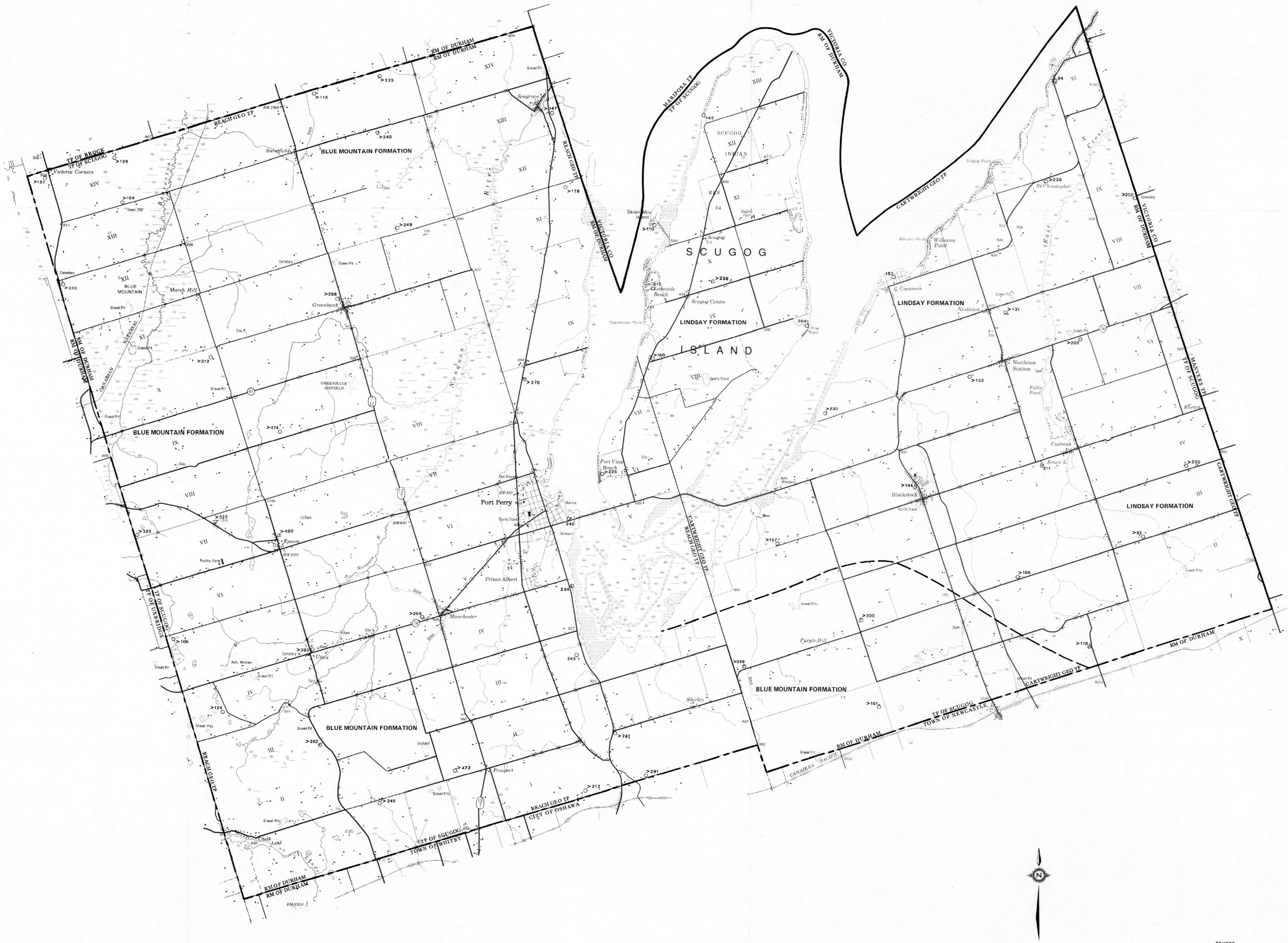
Issued **1986.**



Ministry of Northern Development and Mines
Ontario

ONTARIO GEOLOGICAL SURVEY
AGGREGATE RESOURCES INVENTORY

TOWNSHIP OF SCUGOG

REGIONAL MUNICIPALITY OF DURHAM

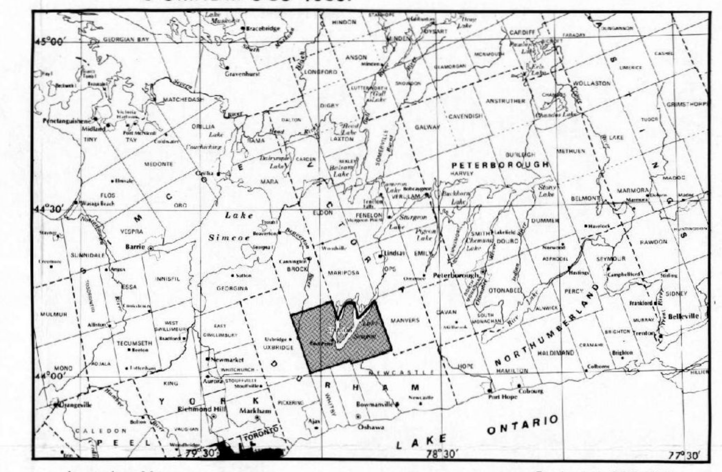
MAP 3
BEDROCK RESOURCES

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 31 D/2, 31 D/3



Location Map — Scale 1:1 800 000

LEGEND

[Some units and symbols may not apply to this map.]

BEDROCK UNITS

PALEOZOIC

ORDOVICIAN

UPPER ORDOVICIAN

BLUE MOUNTAIN FORMATION
Brown Fissile Shale

LINDSAY FORMATION
Limestone and Shale

DRIFT THICKNESS

- Bedrock outcrop (see Table 4); areas of exposed bedrock partially covered by a thin veneer drift. Drift thickness is generally less than 3 feet (1m).
- Bedrock covered by drift (see Table 4); drift thickness is generally 3 to 25 feet (1 to 8m). Bedrock outcrops may occur.
- Bedrock covered by drift (see Table 4); drift thickness is generally 25 to 50 feet (8 to 15m). Isolated bedrock outcrops may occur.
- Bedrock covered by drift; drift thickness is generally greater than 50 feet (15m).

SYMBOLS

- Township boundary.
- Project area boundary.
- Geographic township within township boundary.
- County, District, Regional or District Municipal boundary.
- City or town limits.
- Park, reserve boundary.
- Geological formation boundary.
- Geological formation member boundary.
- Formation thickness boundary (see text).
- 25 — Drift thickness contour. (3-foot, 25-foot and 50-foot contours are shown).
- 1 — Selected bedrock resource area; deposit number; see Table 6.
- Q2 — Licenced quarry boundary; Property number: see Table 5.
- Q3 — Unlicenced quarry*; Property number: see Table 5. *Abandoned quarry or wayside quarry operating on demand under authority of a permit.
- x — Isolated bedrock outcrop.
- 24 — Selected water well location; reported depth to bedrock (in feet).

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Selected water well data from the Ontario Ministry of the Environment.

Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: B.A. Liberty, 1969.
D.J. Russell and P.G. Telford, 1983.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

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