NATURAL BONDED MOULDING SANDS OF CANADA

CAMPBELL H. BRENNAN

MINES BRANCH
DEPARTMENT OF MINES
OTTAWA
1916
NO. 767

CANADA
DEPARTMENT OF MINES
HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH
JOHN MCLEISH, DIRECTOR

Natural Bonded Moulding Sands of Canada

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INTRODUCTION

Moulding sands are mixtures of sand and clay or any material, which, when moist, can be formed into moulds from which usable metal castings may be made. When such suitable material occurs in nature it is called a natural bonded moulding sand. If the moulding sand is mechanically prepared by the addition of some form of bonding substance it is called artificially bonded moulding sand or synthetic moulding sand.

All natural bonded moulding sands possess in common a number of physical properties, the importance attached to the several properties being dependent on the type of work for which the sand is required. These sands are used by foundrymen to form the moulds into which molten metals are poured to make castings. To ensure good results such sands must satisfy certain specifications as to bond strength, permeability, durability, refractoriness, and fineness of grain, the specifications varying greatly for the various uses.

The natural bonded moulding sand industry of Canada is one that has been in existence since the first foundry was built in this country. Foundries in the early days depended almost entirely upon domestic resources of moulding sands; much more so than they have since the beginning of the twentieth century. At various times prior to 1900 Canada even exported moulding sands to the United States, from which country the larger percentage of her present requirements of such sand is being obtained.

PREVIOUS WORK

Little or no research work was done in Canada on foundry sands before 1914. In that year investigation, chiefly upon natural bonded moulding sands from Quebec, was started by the Mines Branch, Department of Mines, under the direction of L. Heber Cole, and by 1917 the work had been extended to include material from numerous localities in Ontario and the Maritimes.

Methods of testing foundry sands to determine their properties such as texture, refractoriness, bond strength, permeability, and durability were studied and applied in actual tests on samples of sands collected in the field. About 1915, Cole [1] devised a method for the determination of permeability of a sand that gives a measure of the time, recorded by a stop watch, of the first passage of gas through sand which has been uniformly rammed in a brass cylinder, small quantities being added at a

[1] Cole, L. H.: "Occurrence and Testing of Foundry Moulding Sands," Mines Branch, Dept. of Mines, Canada, Bull. No. 21, (Rept. 476); also Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1916, pp. 38-60.

time until it is filled. When the cylinder is filled it is struck off flush on the top with a straight edge. Illuminating gas, the pressure of which is determined by a water gauge, passes through the rammed specimen and the instant of complete passage is detected by ignition of this gas by a pilot light. It differs from the standard test of the American Foundrymen's Association mainly in the following respects: (a) that the measure of time refers to the first passage of gas and not a known volume of air, the greater part of which may pass more readily through channels enlarged by the initial passage of gas; (b) the ramming is done by pressing a 5-pound weight for 5 seconds on the several small additions of sand until the cylinder is full instead of impacting with a 14-pound weight, dropped three times a distance of 2 inches, a predetermined quantity of sand to make a specimen 2 inches high, with a tolerance allowance, plus or minus, $\frac{1}{16}$ of an inch.

For the purpose of this report all permeability tests were made by the standard method of the American Foundrymen's Association.

The British Cast Iron Research Association (B.C.I.R.A.) has adopted an adaptation of Cole's apparatus for determinations of permeability.

The first work of any particular importance concerning the methods of testing foundry sands in North America started about the beginning of the twentieth century. In 1904 Dr. Heinrich Ries published the results of tests on certain Michigan and Wisconsin sands. In 1908 the same author, with J. A. Rosen as co-author, published a further report on foundry sands in Michigan. In 1913 the late Dr. Richard Moldenke, then secretary of the American Foundrymen's Association, which sponsored the work, published the results of tests on various sands in the Transactions of that Association. In Great Britain interest in the study of foundry sands began about 1910 and research on testing of same followed along much the same general lines as on this continent. Important contributions to this work are credited among others to P. G. H. Boswell, A. L. Curtis, and J. G. A. Skerl. Also investigations along similar lines were made since about 1920 in France and Germany.

"In 1921, the American Foundrymen's Association with the co-operation of the Division of Engineering of the National Research Council organized the joint committee on moulding sand research. It was announced that the purposes of this committee would be:

1. To collect all the information available in technical literature on these subjects in this and foreign countries.

2. By field operations of a practical technical assistant to study and formulate the practice in the best foundries of this country.

3. To submit all the information so obtained to a committee composed of practical foundrymen and technical experts, this committee to formulate suggestions for promising lines of research that might be followed to attain the desired ends."[1]

The members of this committee in addition to the above-mentioned bodies were as follows:

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[1] "Testing and Grading Foundry Sands" (March 1931), page 12, American Foundrymen's Association, Chicago, 222 West Adams St.

The American Society for Testing Materials, the United States Bureau of Mines, the United States Bureau of Standards, the United States Geological Survey, Washington, and the Mines Branch, Department of Mines, Ottawa, Canada. The original personnel of the committee of 1922 included L. Heber Cole of the Mines Branch, Ottawa. Later on, Howells Fréchette, Chief of Ceramics and Road Materials Division, Mines Branch, became the Canadian representative on the committee and served for a number of years. At the present time the work is carried on by a committee of the American Foundrymen's Association.

SCOPE OF THE REPORT

The investigation of the occurrence of moulding sands throughout Canada, the results of which are embodied in this report, was made in order to supply foundrymen and others with data relative to available supplies and other related information in accordance with the policy of the Mines Branch in investigating our natural resources, and to correlate such work in Canada with similar work in the United States under the auspices of the committee referred to above. Deposits of moulding sand were examined by the writer in all provinces except Prince Edward Island. In this province questionnaires were sent to all known foundries. Samples were collected and forwarded to Ottawa for testing. The field work occupied the summer and autumn months of 1928, 1929, 1930, and 1931. The laboratory work of the testing of the samples collected was done from 1929 to 1934 and intermittently to the beginning of 1935.

The report discusses all known occurrences of natural bonded moulding sand in Canada suitable for making the moulds for non-ferrous castings and for ferrous castings other than steel.

The information regarding deposits visited and sampled was derived from the following sources:

1. The records and schedules of the Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa.

2. Reports of the Department of Mines, Ottawa, and the reports of the Provincial Bureaus of Mines.

3. Statements of foundrymen interviewed during the course of the field work.

4. Observations during the course of field work along the roads travelled, many deposits having been uncovered during recent years by the deep ditching along the main highways.

Systematic prospecting for moulding sand in Canada will probably reveal many new deposits in localities not touched on by this report, as it will be obvious in a report of this nature, that only the more prominent localities could be visited.

No deposits of sands or sandstones were examined that are, or might be, suitable for the production of moulding sands for the casting of steel, and very little information was gathered about sands used for cores to form the hollow parts in castings. Those for cores are easily obtainable, many foundries using nearby local supplies of clean sharp sand.

The results of the more important laboratory tests on the large-scale samples of moulding sand collected are presented in tabular form.

Maps are included showing the localities where the large-scale samples of moulding sand were collected, with their respective laboratory numbers.

ACKNOWLEDGMENTS

The writer wishes to acknowledge with thanks the assistance provided by two members of the Mines Branch: L. Heber Cole of the Mineral Resources Division and J. F. McMahon of the Ceramics and Road Materials Division, to the former for his guidance and criticism in the writing of this report and to the latter for his aid in the refractoriness tests on several of the moulding sand samples.

Thanks are extended to many foundrymen and producers of moulding sand, especially Mr. Wm. R. Barnes, 243 Cumberland Avenue, Hamilton, for assistance and helpful suggestions in the work.

CHAPTER I

MODE OF OCCURRENCE AND TECHNOLOGY

MODE OF OCCURRENCE OF NATURAL BONDED MOULDING SANDS

In Canada, so far as at present known, moulding sand occurs in comparatively thin beds, sometimes of fairly uniform thickness over a considerable area but in most cases of irregular thickness. Within distances up to 20 or 30 feet the thickness may change from 1 to 3 feet, or beds shade away to a thin edge or end entirely. This, in many cases, is due to the uneven surface upon which the moulding sand layer was deposited. Many moulding sands occur as rounded pockets or lenses instead of beds.

Some beds of moulding sand have interbedded thin layers of clay or free-running sharp sand, which is a drawback as they cannot be economically separated in digging, and an uneven product results unless the whole pit run is well blended, and this increases the cost of production.

Where a deposit occurs in rolling morainic country the beds are usually thicker at the bottoms and thinner on the flanks of the hill. Many beds pinch out entirely where they abut against a steep hillside.

Invariably, moulding sands, whether in beds, pockets, or lenses, lie directly below the top soil, generally with a well-defined line of demarcation. In many places the overburden is a dark-coloured loam, much darker than the light yellow, dark yellow, or red of the moulding sand. Moulding sand commonly rests upon free-running, sharp sand, but generally without any distinct line of demarcation; in fact, it is very difficult at times to determine the bottom of the usable moulding sand bed, as the amount of clay decreases gradually with depth. The colour also shades with depth from that common to moulding sand to that of clean, white sharp sand. In some places the moulding sand bed rests upon a bed of clay.

Origin

A short discussion of the probable origin of moulding sand deposits will be of assistance to prospectors.

All the moulding sand deposits in Canada are either closely associated with deposits laid down during the Pleistocene ice age or else are of more recent origin. Moraines left at every advance and retreat of the great ice-sheets are the chief sources of the sand and clay necessary for the production of moulding sand deposits. The sorting action of streams, wave action along the shores of glacial lakes, wind erosion, and the breaking down of some of the constituents of ordinary sand deposits, were responsible for the accumulation of the actual deposits in favourable spots, each agency producing a characteristic type of deposit. Some deposits are due to a combination of several agencies.

Classes of Moulding Sand Deposits

(1) Flood plain deposits of streams.
(2) Re-washed ancient beach sand deposits.
(3) Deposits partly changed chemically.
(4) Aeolian deposits.
(5) Delta deposits.

Flood Plain Deposits

Flood plain deposits are the commonest form of occurrence. Where a stream or river bed has the essential ingredients, sand and clay, in about the right proportion to form moulding sand, they will be intimately worked over by the currents, and may be deposited on the plains adjacent to the stream during flood periods as a layer of varying thickness, dependent on the velocity of the water and the amount of material in suspension. Such deposits are commonly uniform in composition, as the flowing water has a fairly regular sorting action. The excess clay and harmful silt, being more easily held in suspension, are carried away and deposited later in wider portions of the river or in lakes, where the velocity of the water has decreased. The deposition of moulding sand resulting from successive yearly flood periods may be of irregular thickness, the deposits adjacent to the St. Lawrence river being of this type. Deposits frequently occur on the terraces above the present level of streams and rivers, and were formed when the water level was higher. Deposits have also been formed along the terraces and flood plains of glacial streams now non-existent.

Re-washed Ancient Beach Sand Deposits

During the retreat of the glacial ice-sheets, lakes of increasing size were formed between the face of these ice-sheets and the divides to the south. The wave action along the shores of these lakes worked over the material in the moraines and other surface deposits to make moulding sand, which was deposited at varying distances from the shore lines. The coarser grained moulding sands would be deposited near the shore; whereas the finer grained ones, being held more easily in suspension, would be found farther out. The best district in Canada to illustrate this type of deposit is in the Niagara peninsula. Here a number of moraines have been worked over by the wave action of different glacial lakes. Some of the best deposits, now becoming depleted, undoubtedly were formed not far from the present shore line of Lake Ontario from material that originated chiefly from the Vinemount moraine. Figures 3 and 4[1], page 86, show the situation of the most important moraines and shore lines of the successive glacial lakes in the region from Niagara Falls to Brantford and north of Toronto. In Manitoba fairly similar conditions must have applied over wide areas along the shore lines of the glacial lakes Agassiz and Souris, particularly the former.

[1] Geologic Atlas of the United States, Niagara Folio, New York, by E. M. Kindle and Frank B. Taylor, pages 17 and 18, published by United States Geological Survey.

Deposits Partly Changed Chemically

In places deposits of moulding sand may be formed by a chemical change of some of the constituents of sand deposits, owing to weather acting over long periods of time and to descending waters carrying organic acids from overlying decaying vegetable matter. The ingredients most easily altered are feldspar and mica grains, which become changed to kaolin or clay. Hydrated iron oxide may also be formed from pyrite or magnetite particles in the sand and produce the yellow coating of limonite prevalent on the sand in such deposits. This coating of iron oxide is a bond in itself and greatly assists the clay, formed by the decomposition of feldspar and mica, in adhering to the quartz sand grains. Any moulding sand deposit is susceptible to chemical change during long periods of time, and the change is continuous. Moulding sand deposits are probably being formed at the present time and will continue to be, but no such deposit is known at present in Canada; the best example is in the Albany district in New York state.

Aeolian Deposits

Some deposits of moulding sand have been formed or altered by wind action. Wind has a sorting action somewhat akin to that of flowing water, and can induce great changes in any deposit of sand not anchored by vegetation. A prevailing wind has a more pronounced effect than one that is changeable, and its effect may be observed in many parts of the country where there are sand dunes. Dunes sometimes migrate long distances within a short time, and farms are overrun and partly or entirely ruined by such moving sand. In Canada no definite deposit of this type is known; some are worked in the state of Illinois.

Delta Deposits

Swift-flowing rivers or streams are prominent agents of erosion and frequently carry large quantities of sand and clay matter in suspension. Where these waters discharge into larger bodies of water such as lakes, inland seas, or oceans, the velocity of the water is rapidly decreased and in consequence the materials in suspension quickly settle out and are deposited in the shape of a fan spreading out from the mouth of the discharge. The coarser and heavier material is deposited near the mouth and the finer sand and suspended clay farther away. As years pass on the waves of the sea and the constantly recurring flood seasons of the rivers re-work and mix these deposits, and where conditions are favourable, suitable sand grains become intimately mixed and coated with clay substance to form moulding sand. Where such "delta" deposits have been formed, and later movements of the earth have made these areas dry land, moulding sand deposits are likely to be found and the district should be good for prospecting.

In Manitoba, in the area to the southwest of Portage la Prairie just to the east of where the Assiniboine river cuts through the Manitoba escarpment, such an area occurs and should be an excellent locality in which to carry out an intensive search for deposits of this nature.

THE TECHNOLOGY OF OPERATING A MOULDING SAND DEPOSIT

Proving a Deposit

Beds of regular thickness and continuity are the easiest to prove as fewer observations are needed.

The best way of proving a deposit is by drilling a series of auger holes at regular intervals to penetrate the moulding sand bed or beds. In deposits where little or no gravel is to be met, a 6-inch diameter auger is the best for the purpose, but where gravel is expected it is better to use an auger of 3-inch diameter. It is always advisable to have extension rods for the auger, so that any desired depth may be bored. When the log of each bore hole and the area of the deposit are known a reliable estimate of the tonnage may be made, but if the deposit is not uniform the estimate will be proportionately less accurate. If the deposit is pockety it is very difficult to ascertain the tonnage, unless many bore holes are made. Small producers sometimes do not prove their deposits as they consider ample supplies for their own business are available, but actually they then know very little about what grade of material lies beyond the face of their pits.

Stripping a Deposit

It is a simple operation to strip a moulding sand deposit as in most cases the overburden is less than three feet in thickness, and in Canada is generally between 1 and 2 feet. As most moulding sand deposits are in agricultural land the operator should try to develop a pit so that when it is exhausted the fertile soil is still available for use. The accepted way to work a fairly uniformly bedded deposit is first to dig a trench removing both the overburden and moulding sand, and then the overburden from the next block of the moulding sand bed, depositing it within the trench. By this method the moulding sand may be recovered step by step and the fertile soil will remain on top of the worked out area although at a slightly lower level. It is not advisable to use mechanical scrapers for the stripping, as no deposit is so uniform that such devices would neither leave any of the overburden nor rob some of the moulding sand layer. Men working with shovels do this work better, as they soon learn just what material to waste.

Excavating

All excavation of moulding sand from deposits in Canada is done by men working with shovels, and at present, owing to the beds being thin and the market limited, it is not economical to work a deposit by machinery, as is done at a few of the larger deposits in the United States. Machinery is applicable only in fairly uniform and thick deposits, unless the product is afterwards to be blended. Some deposits are irregular in quality and lean portions termed "islands" are usually left in place within the pits. A man skilled in the production of moulding sand can usually decide just what to take or leave behind in the pit. Moulding sand from a pit is sometimes condemned by foundrymen as of inferior quality, such as bond

or ability to withstand the heat of molten metals, when the fault may be that the operator had dug too deeply and included sharp sand, or had allowed overburden to get into the product. This may happen through unskilled workmen not knowing the grade of sand required by different foundrymen. Sand from a pit has sometimes been condemned by foundrymen when it may be useless only for the grade of casting they were attempting to make with it. Such criticism rarely comes from a skilled moulder who has had experience in making all grades or weights of casting.

Sand from different sections of a pit or from different pits may be blended by machinery to secure a uniform product. Thus one of a heavy clay content may be mixed with another of light clay content in proportions to yield a range of products. The adoption of scientific sand testing as described here and in reports published by the American Foundrymen's Association is of great value in maintaining a uniform grade. Above all, operators should keep in mind that blending must be well done, as moulders do not like an "uneven" moulding sand.

Loading and Transport

All loading is done by hand, the sand being sometimes loaded first on wheelbarrows or wagons and then transported to railway cars, or it may be loaded on wagons or trucks and conveyed direct to foundries if they are near. The transport of moulding sand has changed materially since the coming of the motor truck. Before trucks came into general use, and prior to the building of improved highways, many deposits too distant from railway or foundry for wagon transport could not be economically worked. Now it is a general practice for trucks to deliver supplies direct from the pit to the foundry over far greater distances than was thought possible a few years ago. For instance, from one place in western Ontario moulding sand is regularly trucked for a distance of 62 miles. One of the longest railway hauls is that given to an Ontario moulding sand which is freighted over 380 miles.

FACTORS BEARING ON LOCATION OF OPERATIONS

An ideal deposit of moulding sand, to be operated economically and at a profit, should be situated close to the markets, whether on or near a transportation system, railway, water or truck haulage, and in addition should be able to furnish a number of grades of sand in order to supply the various requirements of the several consumers.

Obviously, deposits meeting all the above conditions are rare, and it therefore becomes necessary to study carefully all factors with respect to any given deposit and to choose the one which most nearly fulfils the ideal conditions.

Where a deposit is opened up in a small way to furnish a supply of moulding sand for only one foundry, such a deposit should be within truck or wagon haulage distance of the foundry, and it rarely pays when this distance is greater than 10 miles. Such operations are invariably carried on only intermittently by local farmers who discover small patches of mould-

ing sand on their farms and, unless the greatest care is taken, they are likely to vary the grade of the material they produce. A preferable method of operating such deposits is for an operator, who has specialized on the production of moulding sand and who is thoroughly conversant with the requirements of the several foundries, to own a number of them, working each in rotation for only that length of time necessary to supply the local requirements. By such a system, men trained in the excavation of moulding sand could be moved from one deposit to another and the purchaser of the product from any particular deposit would be reasonably assured of obtaining sand of a uniform grade as long as it lasted.

Larger deposits, from which it is proposed to supply markets in different consuming centres with varying classes of sand, should be either on, or at least within 5 miles of a railroad or water transportation system. Where deposits are at a greater distance from the railway, the cost of hauling the material to the siding is generally prohibitive. A deposit situated within shipping distance of two or more systems of transportation has a distinct advantage, as in many cases the individual consumer is located on only one system and prefer shipments direct without the extra switching charges. Deposits within easy reach of main highways also have an added advantage, as increasing use is being made of truck haulage of moulding sand direct from pit to consumers' bins, haulage distances up to 62 miles being already made.

ECONOMICS OF OPERATING A MOULDING SAND DEPOSIT

Moulding sand is a low-priced commodity and it is, therefore, of the utmost importance to study carefully all aspects of the problem of opening up a deposit before any great expenditures are authorized.

After a deposit has been tested to determine, not only the character or classes of the moulding sand present, but also the tonnage of the several grades available, the markets for the class or classes of material which the deposit can furnish should be thoroughly canvassed and analysed. Freight rates to the various possible consuming centres have to be established and the outside limits of distance to which the sand can be shipped at a profit determined. This distance will vary greatly in different localities as it depends primarily on the cost of the product laid down in the several market centres, as compared with the cost of imported sand or of domestic sands from other sources. It is therefore vitally important to anyone opening up a new deposit, or contemplating operating one already producing, to study carefully all competitive sources of moulding sand when deciding what markets may reasonably be served.

Marketing of Moulding Sands

The marketing of moulding sands is of great importance. A competent sales staff is necessary in order to canvass thoroughly the whole available market. Each salesman should be able not only to talk intelligently about the products he is selling, but in addition he should be thoroughly conversant with the problems encountered in the foundry so that he may be

able to determine whether defects in castings are due to the type of sand used or to poor methods of using it. He should also be furnished with representative samples of different classes of sands which his company is prepared to supply and be competent to recommend a class suitable for the particular type of casting the purchaser is manufacturing.

The price of moulding sand at the larger pits fluctuates slowly and at the present time (1935) varies between $0.35 and $1.65, according to the grade. While, therefore, with many purchasers the cost delivered is a prime factor, the qualities of a sand are gradually being recognized to be of more importance, and the time is probably not far distant when standard specifications will be drawn up for the various grades of moulding sand and purchases will be made according to specification.

At the present time, each user has his own ideas as to the material best suited for his requirement, and purchases are customarily made on sample. The purchaser desires to be assured that, not only will the order be equal in quality to the sample, but that subsequent orders will be of the same standard. Uniformity of product is therefore not only highly desirable, but essential if customers once served are to be retained, and the salesman needs the results of standard tests on the various grades being marketed to furnish them to their customers.

Blending Plants

It is rarely possible to find a moulding sand deposit from which all grades of sand can be obtained. A sand suitable for one particular type of casting may be unsuitable for another. Again, for example, a sand may have too heavy or too light a bond, but by blending, a sand with the proper bond may be produced. It may therefore be necessary for a producer, or a group of producers, to establish blending plants at suitable spots with respect to the larger consuming centres, and to assemble a number of kinds of sand from which, by suitable blending, any desired grade may be produced to meet the requirements of consumers. Whether it is better to put such blending plants at consuming centres or with regard to their proximity to the greater number of the deposits from which the sands are supplied, can be determined only by a careful study of each case. It is, however, only by development along such lines that the Canadian producers can hope to supply the domestic markets with suitable material.

SYNTHETIC OR ARTIFICIAL MOULDING SANDS

Many of the better known deposits of natural bonded moulding sand are becoming depleted, and the day may not be far off when it will be impossible to obtain further supplies of the sands that have hitherto been used in some plants. The owners will then either have to accept similar sand from more distant points, be content with poorer quality sand, or use artificial sand made within their own foundry or purchased from manufacturers.

Synthetic moulding sand can be made of more uniform composition than natural bonded sand. Once the proper mixture has been determined by experiment it can be standardized. A great advantage of these sands is that none of the useless and often detrimental accessory minerals found

in natural bonded sands need be included, but only silica sand of certain screen mesh and plastic fireclay of required refractoriness. The sand grains may be of any shape, but sharp grain is usually preferred. It has been found that grains already coated with an iron stain enable the clay bond to adhere more strongly and give a stronger moulding sand than clean silica grains. The clay used should have high colloidal quality and be ground to a fine mesh, not coarser than 200 mesh.

Synthetic sands are usually prepared by putting the required amounts of sand and clay in a muller type of sand mixing machine, as illustrated in Plate IIA, and by thoroughly mixing them to give maximum bond strength. There is little danger of producing too close a sand by too much mulling because the silica sand chosen is nearly free from silt. Partly owing to this lack of silt, synthetic sands have not the same smoothness to the touch as the natural bonded moulding sands.

Many foundrymen accustomed to using natural bonded sand do not like artificial sand, as more care is said to be needed to produce good castings. The sand being more porous, allows the molten metal to penetrate farther past the surface of the mould and gives rougher surfaced castings; facing sand mixtures are therefore sometimes employed to give the required smooth surface. Another disadvantage is the rapid drying of the sand heaps upon the foundry floor.

As yet very little synthetic moulding sand is used in Canada, but its use is increasing in the United States.

RECLAIMING OF OLD OR PARTLY WORN-OUT MOULDING SANDS

Old or partly worn-out moulding sands may be reclaimed, as in most cases the silica content, by far the greater part of the original moulding sand, still remains in only slightly altered state, although the clay bond has been burned out. The addition of fresh clay will often allow the sand to be used for considerable additional periods.

Usually a good plastic fireclay of high refractory nature is chosen. There are also rebonding agents on the market under different trade names, consisting usually of fireclay or a mixture of fireclay and a very colloidal clay known as bentonite.

Sometimes the rebonding agent is simply worked into the old moulding sand, either by riddle or by shovel. A better method is by using a paddle-type sand mixer, as is illustrated in Plate II B, as a very thorough mixing results. The amount of clay added depends on the size and shape of casting being made but rarely exceeds five per cent.

The cost of rebonding agents is offset by the saving effected by purchasing smaller quantities of new moulding sand, with attendant reduction in freight charges and in cost of disposal of the lesser quantities of partly burnt out moulding sand.

It may be mentioned that extensive deposits of bentonite are known in the three western provinces, Saskatchewan, Alberta, and British Columbia. Spence[1] states that "So far, no attempt has been made to develop any of the Canadian bentonite deposits, and no supply of the material is immediately available."

[1] Spence, Hugh S.: "Bentonite," Mines Branch, Dept. of Mines, Canada, Rept. 626, p. 7.

CHAPTER II

PHYSICAL PROPERTIES AND METHODS OF TESTING

PHYSICAL PROPERTIES

Introductory

Natural bonded moulding sands are used by foundrymen to form the moulds into which molten metals are poured to make castings. To ensure good castings, sands must satisfy certain specifications as to bond strength, permeability, durability, refractoriness, and fineness of grain. Often a sand suitable for one class of casting is entirely unsuited for another. Weight, shape, and the metal from which the casting is made, are the deciding factors, and further, the procedures adopted in different foundries when making similar castings, may lead to the choice of moulding sands of divergent characteristics. A sand suitable to the requirements of one foundryman may be rejected as unfit by another, and so because a given sand is not used by some foundrymen does not prove it worthless for use in all foundries. Whether a particular moulding sand is used in a foundry depends often to a large extent on reports about it from other foundrymen. Local moulding sands often do not find favour, or may even not be tried, and some moulders seem to prefer imported sand or that from distant points. Consequently the range of sands used for moulding is wide and it is impossible to draw up a precise specification to which a sand must conform for it to be designated moulding sand. Simple tests as to the quality of a moulding sand, for use both in foundry practice and when prospecting, such as examination by the unaided eye and the compacting of a portion of the tempered sand in the hand to judge the amount of bond, are usually employed, but fall far short in accuracy of the methods being studied and advocated by the American Foundrymen's Association. The majority of moulding sands in general use are deficient in one or more of the requirements of a perfect sand. Moldenke[1] aptly defines an ideal moulding sand to be " a sand consisting of uniform-sized rounded grains of silica (quartz), each grain evenly coated with the thinnest necessary layer of the most refractory and fattest clay to be had."

Composition

Natural bonded moulding sands are intimate mixtures of quartz grains and clay, together with accessory minerals such as undecomposed feldspar, mica, hornblende, and magnetite, of which feldspar occurs most abundantly. Lime also is present, but not very frequently. The accessory minerals are unessential ingredients and are detrimental, as, under the high heat to which moulding sands are subjected, when they come in contact with the molten metal in the moulds, particularly if the castings being made are large, these deleterious ingredients break down and also form a flux with the quartz grains. If they were absent the sand grains would resist the heat far better.

[1] Moldenke, Richard: Principles of Iron Founding, p. 279.

Texture or Fineness

The texture or fineness of grain of a moulding sand has a direct bearing on the bond strength and the permeability of the sand and influences to some extent its refractoriness and durability.

Moulding sands must be chosen for the class of the work for which they are needed. Fine-grained moulding sands are used in the making of light weight or thin section castings, whereas the coarser grained are employed for manufacturing heavy castings. In light castings a smooth surface is generally demanded, which a coarse-grained sand could not produce unless a facing sand were also used.

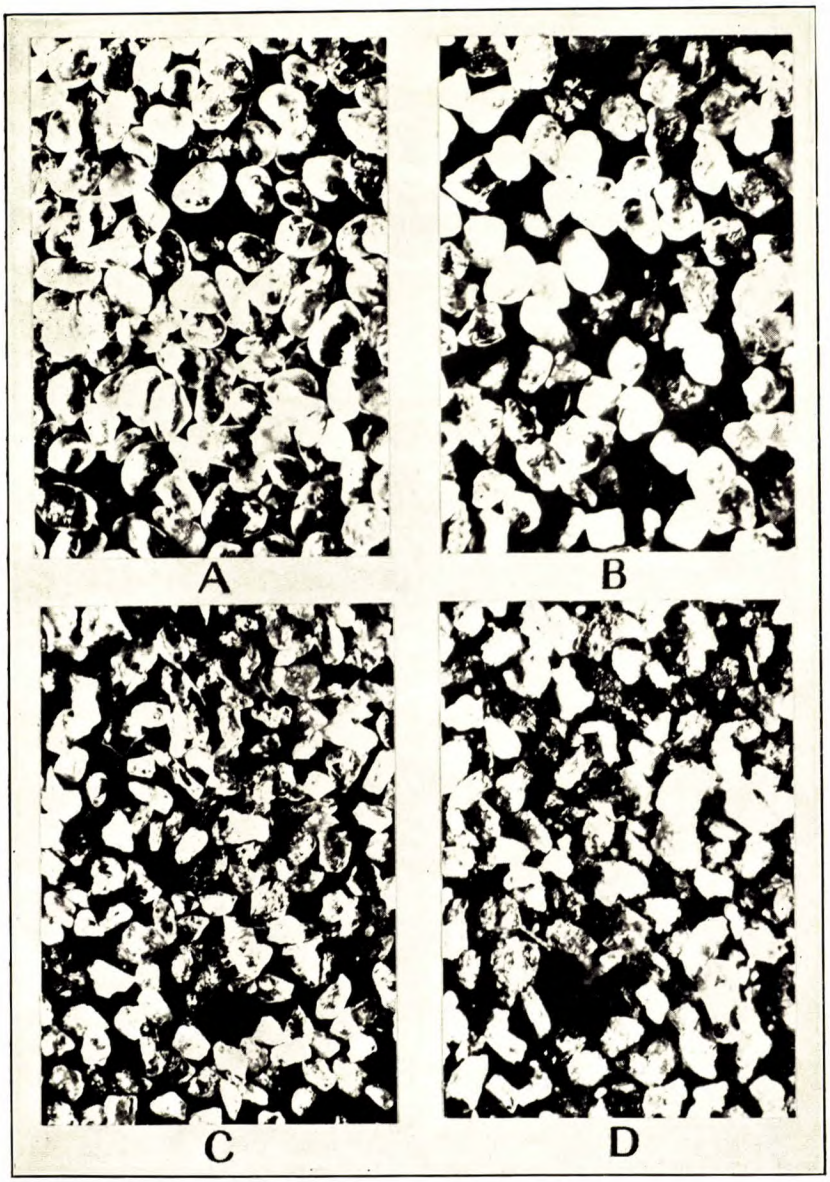
Sand grain shapes are described as rounded, angular, sub-angular, or compound. The first two need no description, the names being self-explanatory. A sub-angular sand is one having characteristics of both rounded and angular grains but generally is one with grains combining those of the first two types. A compound-grained sand has two or more grains bound together so firmly that they cannot readily be separated. A compound-grained sand may be further classified as rounded compound, angular compound, or sub-angular compound.

Plate I, A, B, C, D, photomicrographs of Canadian sands, shows grains of various types.

Bond Strength

The bond strength or cohesiveness of a moulding sand is the property causing it to hold together or resist rupture. It must be sufficient that, when the pattern is being withdrawn from the mould and the cope of the moulding flask returned to place, the rammed moulding sand will remain undisturbed and so preserve the shape and size of the cavity formed by the pattern. It must also be ample to resist the cutting action on the walls and sharp corners of the mould cavity, as well as the pressure caused by the inrush of the molten metal which tends to disrupt the mould.

The cohesiveness of a moulding sand is dependent on several factors, principally on the amount of clay contained, and its nature, and how it is disseminated throughout the sand or adheres to the individual sand grains. The amount of fat clay required to give a certain bonding strength is smaller than that of lean clay or one having low plasticity. A small amount of ferric oxide also increases bond strength, particularly if it occurs as a stain over the sand grains, for clay adheres more tenaciously to grains so coated. The shape and size of the sand grains also affect the bonding power; an angular-grained sand mass is more resistant to deformation than one composed of rounded sand grains owing to the interlocking of the sand particles. A coarse-grained sand has less bonding power than a fine-grained. The silt in many sands, being mainly the very fine particles of quartz and some other minerals that do not settle out in a clay substance determination test, provides some bond but is undesirable in that it lowers the permeability to some extent. The amount of water used for tempering the sand has a marked effect. Every moulding sand has a maximum bond strength with a definite amount of water, and even a small amount of water



Photomicrographs of Canadian sands showing grains of various types, magnification 30 X.

A. Rounded sand grains.
B. Sub-angular sand grains.
C. Angular sand grains.
D. Compound sand grains.

on clean sand grains induces some adhesion owing to surface tension. The amount of ramming to which a mould is subjected also is an important factor; greater strength is got by heavy ramming but this is detrimental as permeability is sacrificed. " Clay substance " is a generic term for the bonding substance, whether in the form of clay, hydrated iron oxide, or fine silt.

Bond strength is partly lost when the molten metal comes in contact with the moulding sand and the extreme heat causes the clay to lose some of its water of hydration. The effect is more marked when large castings are made, because of the greater soaking effect of the sustained heat than when small castings are produced. After being retempered, the clay will not have the capacity to take up the former amount of water. When the clay has become incapable of absorbing sufficient water, the material is no longer a moulding sand and is known as spent or burned out sand. It is owing to this loss of bond that new moulding sand is continually being added to the moulding sand heaps on foundry floors.

Permeability

Permeability is the property a sand possesses that permits the passage of gases through its pores. A sand of high permeability is one allowing gases to pass readily, and moulding sands of high permeability are desirable. The gases seeking exit from the mould include the air confined in the space formed by the pattern, that enclosed in the molten metal, the steam formed by the contact of the hot metal with the interior of the mould, and the volatile constituent from the sea-coal admixture. If the gases do not find easy exit the casting becomes defective through having "scabs" or "blows," or it is not an exact replica of the pattern because the metal chills before it can flow into recesses still retaining the gases. In large moulds most of the gases escape by means of " risers " in the cope of the moulding flask.

The rate at which the gases escape depends on different factors. The texture of the moulding sand is very important; rounded coarse-grained sands afford high permeability whereas angular fine-grained sand is conducive to low permeability.

The amount and nature of the bond is also important, for if there is too much clay the interstices in the sand are lessened, and the permeability decreased.

The water used in tempering the sand contributes to permeability for, contrary to what might be expected, the adding of a certain quantity of water to most moulding sands increases the permeability rather than decreases it, the amount of water so used depending on the sand. The water draws the clay up and around the sand grains, thus increasing the porosity of the sand. Any water in excess of the amount the clay can absorb and still retain its effectiveness, would then fill or partly fill up the voids and cause lower permeability.

Silt in the sand lowers the permeability by filling up the pore spaces. Moulding sands of high silt content are not desirable.

The ramming done in making the mould seriously affects the permeability. Ramming can be carried so far that it is very difficult for the enclosed gases to escape. This is counteracted to a marked extent by the foundryman venting the mould with vent wire.

The permeability of a too highly bonded moulding sand may often be increased by blending the sand with a sharp sand or another weaker bonded moulding sand; a more satisfactory blend is obtained by the use of a weakly bonded sand.

Refractoriness

Refractoriness is the property of a moulding sand that enables it to withstand the heat experienced when molten metal is poured into the moulds. The degree to which a moulding sand resists pyro-chemical changes is a measure of its refractoriness.

The refractoriness of a sand depends on several factors. The weakest link in the composition is the clay substance, because in it are the least refractory and most active fluxes in finely divided condition. The composition of clay substance varies in different moulding sands and tests on clay substance might be taken as an index of the refractoriness of the entire sand.

The texture of a sand plays a part in the refractoriness in that upon it will depend the surface area of the quartz grains exposed to the action of heat and fluxing ingredients. The finer the quartz grains, the more easily and more readily are they attacked.

The granular substance is the less affected portion. It is composed chiefly of quartz grains and may contain small percentages of such accessory minerals as feldspar, mica, hornblende, or magnetite. The quartz grains are highly infusible compared with those of the accessory minerals, but the latter are generally in such small amounts that they do not markedly affect the refractoriness. Calcium carbonate lowers the refractoriness.

The size of the casting being made is very important; for large castings a very refractory sand is required, because it is subject to the soaking action of sustained intense heat that penetrates some distance beyond the inner surfaces of the mould, whereas for light weight or thin section castings a much lower refractory sand may be used because the heat has little chance to pass beyond the immediate vicinity of the surface owing to the comparatively sudden chilling of the poured metal. Sustained heat is highly destructive of bonding substance.

Durability

Durability of a moulding sand is the power that it possesses to retain its original physical and chemical properties when subjected to the high heat of successive pourings of molten metals into moulds.

Durability in a moulding sand is a highly desirable property, a sand being preferred in practice that can be used repeatedly without the addition of much new sand. The need for continual addition of new sand to keep the heaps up to proper bond strength is often a reason for the abandonment of its use.

This durability or life depends on the quality of the clay, which provides by far the greatest part of the bond in all natural bonded moulding sands. Often after a few castings are made a sand is said to be "dead burned," owing to the inability of the clay to take up the former quantity of tempering water. The presence of such oxides as soda, potash, lime, and magnesia also reduces the durability owing to their fluxing property. The making of heavy castings is the severest test of the durability of any moulding sand.

THE TESTING OF NATURAL BONDED MOULDING SANDS

All laboratory tests on the samples collected and described below have been made as far as possible in accordance with the methods laid down in the American Foundrymen's Association (A.F.A.) booklets, viz., "Standard and Tentatively Adopted Methods of Testing and Grading Foundry Sands," published in July, 1928, and "Testing and Grading Foundry Sands," published in March, 1931. Tests for refractoriness were carried out according to the method followed by J. F. McMahon [1] in 1926.

Field Tests

For rapid field determination as to whether a sand had moulding properties very simple tests were made. These consisted in examination through a magnifying glass, the "squeeze and feel" test, or a quick adaptation of the vibratory test originated by Eugene W. Smith[2] of Chicago. The "squeeze and feel" test is commonly made by foundrymen for judging the amount of bond, and consists in compacting a quantity of moistened or tempered sand in the hand to see how it holds together or resists rupture. During the field work if a sand under consideration were too dry, sufficient water, about 4 to 8 per cent, was added to put it in approximate foundry working conditions before the test could be applied. Most good moulding sands have a smooth velvety feel in contrast to the harsh feel of a sharp sand. Generally the amount of bond is indicated by the degree of smoothness.

The lens used for examining the sand should not have too high a power of magnification; the writer used one of 8 power. Having previously examined typical moulding sands the essential features are easily recognizable in the field. The bond if present can be seen and the amount roughly estimated.

The adaptation of the Smith vibratory test consists in placing a small quantity of the sand into a stoppered graduate, the sand, if necessary, being crushed to free it from lumps. The graduate is then nearly filled with clear water, violently agitated for a few minutes, and the contents allowed to settle. The heavier and coarser silica quickly settles to the bottom, followed after a time by the separated clay bond. Usually a fairly clear line of demarcation is noted. By reading on the graduate the proportional height of the silica and bond, a rough percentage of each

[1] Mines Branch, Dept. of Mines, Canada, Invest. Ceramics and Road Materials 1926, Rept. 690, pp. 9-24; *also* Transactions of the American Foundrymen's Association, vol. XLII, pp, 501-525.

[2] Transactions of the American Foundrymen's Association, vol. XXXI, pp. 623-630.

is easily calculated. The main objection to this as a field test is that with most moulding sands considerable time must elapse before all, or nearly all, of the clay bond will settle.

Sampling

Most samples were collected from deposits that had been or were being worked, or considered commercially workable, only a few came from the bins of foundries. Before a sample was taken from an operated deposit the help of the owner or the pit foreman was sought if possible, so as to ensure that the sample represented the sand shipped.

The only tools used to obtain samples were a spade and a 6-inch post-hole auger. The spade was used mainly in open pits, where channel samples could easily be taken down the face. The auger was used in unopened deposits, or where a sample was desired behind the face of an open pit. As the auger was equipped with extension lengths it was easy to go beyond the depth of any deposit examined.

The final sample was obtained by quartering down several channel samples from the face of the pit, or the material from a number of auger holes. The smaller lots were placed upon a canvas sheet and thoroughly mixed to obtain a representative sample before the regular 50-pound sample was placed in a canvas sack. Occasionally, a wet sample had to be dried before shipment.

Laboratory Tests

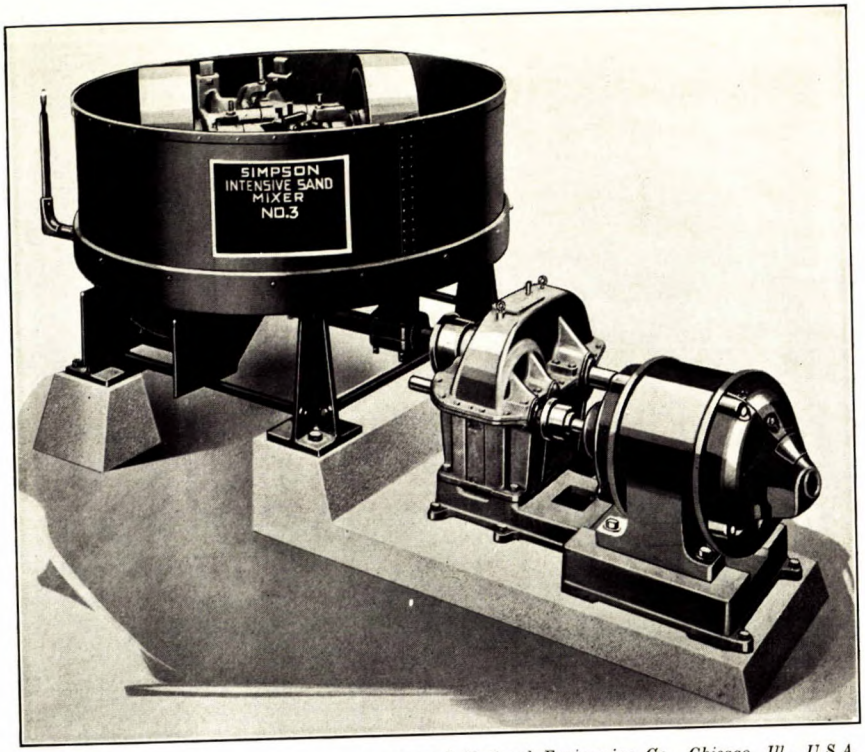
Chemical Analysis

The only chemical analysis made was the simple qualitative test for calcium carbonate. Every sample was tested with dilute hydrochloric acid and those showing effervescence were noted. As there is such a wide range in chemical composition in well known natural bonded moulding sands, no set specification can be given of what constitutes such a sand. Chemical analysis may enable the user to judge subsequent shipments once the usefulness of a sand has been proved. Chemical analysis would be the best method to test an unbonded steel-moulding sand, because its main constituent is silica.

For determining all properties, other than the presence of calcium carbonate, mechanical analyses were used as the information so gained is of more practical value to foundry owners.

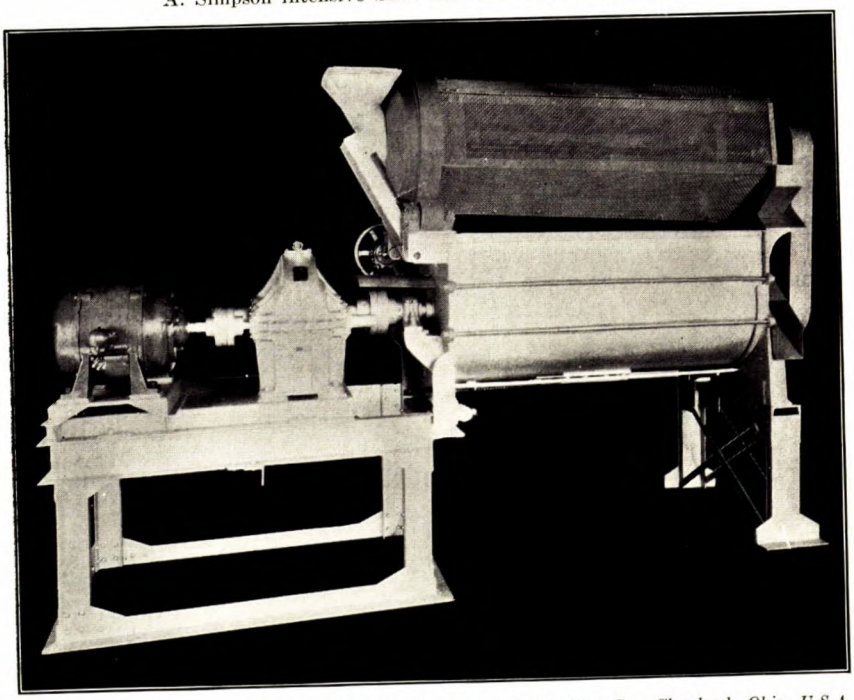
Mechanical Analysis

Preparation of Samples. For the purpose of carrying out the following test the field samples were prepared as follows: the field sample weighing approximately 50 pounds was quartered to obtain the working sample ranging from 10 to 15 pounds. From this working sample the small amount required for the clay substance and grain fineness test was obtained by further quartering, the remainder of the working sample being used for the other tests. The quartering was done by means of rifflers, the largest of which is illustrated in Plate III A. Many samples had to be crushed to break hard lumps before the rifflers could be used.



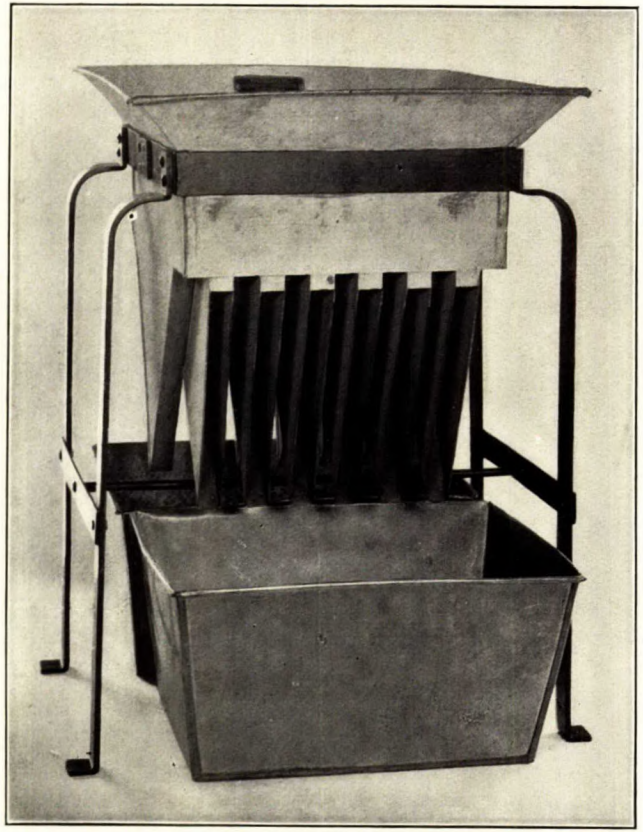
Courtesy of National Engineering Co., Chicago, Ill., U.S.A.

A. Simpson intensive Sand Mixer No. 3, muller type.

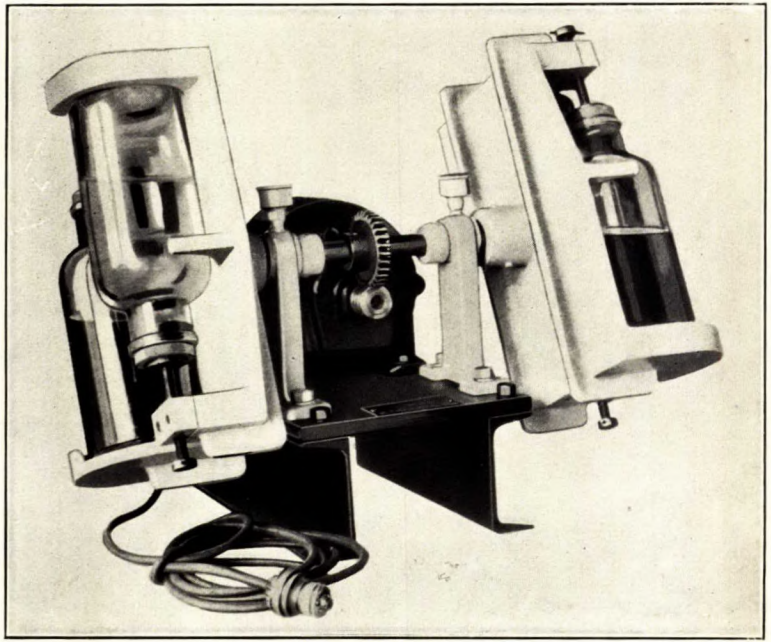


Courtesy of The Standard Sand & Machine Co., Cleveland, Ohio, U.S.A.

B. Paddle-type sand mixer with herring-bone speed reducer drive, direct from the motor.



A. Riffler used for obtaining laboratory-size samples from the large samples collected in the field.



Courtesy of Federal Foundry Supply Co., Cleveland, Ohio, U.S.A.

B. The Federal laboratory agitator, an apparatus useful for washing clay substance from samples of moulding sands.

Clay Substance Test. Fifty (50) grammes of moulding sand, previously dried for at least one hour in an oven at a temperature from 105°—110° C. (221° — 230° F.), is placed in a quart sealer. To this is added 475 c.c. of water and 25 c.c. of a one per cent standard solution of sodium hydroxide to assist the separation of the clay from the sand grains. The bottle is then securely sealed with a rubber stopper, placed in an agitator, and washed for at least one hour. In practice it is convenient to test four samples at the same time. The four quart sealers are securely fastened into two hinged-top wooden boxes and placed in the framework of an Abbé porcelain jar pebble mill as illustrated in Plate IV. The machine revolves, causing the sealers to be up-ended about 70 times per minute. The standard machine built for this test is the Federal laboratory agitator, illustrated in Plate III B.

After the agitation, the four sealers are removed from the frame boxes and filled with water up to the height of 6 inches and the contents well stirred with a spoon. Any swirling motion is stopped and the contents allowed to settle for 10 minutes. The clay-laden water is siphoned off down to one inch from the bottom of the sealer, leaving at least one-half inch of water over the layer of washed sand. To prevent deposited sand being carried over with the water, a right angle turn and a deflector is fixed at the end of the siphon. Water is again added to the same height, the contents stirred as before, and another 10 minutes allowed to elapse before a second siphoning. Washings from now on are repeated every five minutes until the water at the end of this time is clear. All the clay and fine silt that fails to settle and is carried off by the siphon is termed clay substance.

The clean sand remaining in the sealer is washed on to a filter paper in a Büchner filter, drained by means of a suction pump, and dried at a temperature 105°—110°C. (221°—230°F.), to bring to constant weight. The sand is now weighed and the difference in weight between it and the original 50-gramme sample represents clay substance. This is expressed as a percentage, and used for classifying moulding sand according to clay content as in the following table.

TABLE I*

Clay Content Classification

Clay Class	Clay content zone, in per cent of clay substance					
A	0·0	to but not including...				0·5
B	0·5	"	"	"	"	2·0
C	2·0	"	"	"	"	5·0
D	5·0	"	"	"	"	10·0
E	10·0	"	"	"	"	15·0
F	15·0	"	"	"	"	20·0
G	20·0	"	"	"	"	30·0
H	30·0	"	"	"	"	45·0
I	45·0	"	"	"	"	60·0
J	60·0	"	"	"	"	100·0

* Tables I to V are taken from "Testing and Grading Foundry Sands," March, 1921, published by the American Foundrymen's Association, 222 West Adams Street, Chicago, Ill.

In the table of results for each sand tested the percentage of clay substance and the clay content classification letter are given.

Grain Fineness Test. It is convenient to express the fineness of grain numerically, sands being graded according to a grain fineness number. This is the number of mesh per linear inch of the sieve that would just pass the sample if its component grains were of uniform size; that is, the average of the size of the grains in the sample. It is roughly proportional to the surface area per unit weight of the sand, exclusive of clay.

To obtain this grain fineness number a granulometric analysis is made of the grains remaining from the 50 grammes of moulding sand that were washed to determine the percentage of clay substance. A series of eleven sieves is used, each sieve being 8 inches in diameter and 1 inch deep. The mesh openings of the sieves for the Tyler and corresponding U. S. Bureau of Standard numbers are given in the following table.

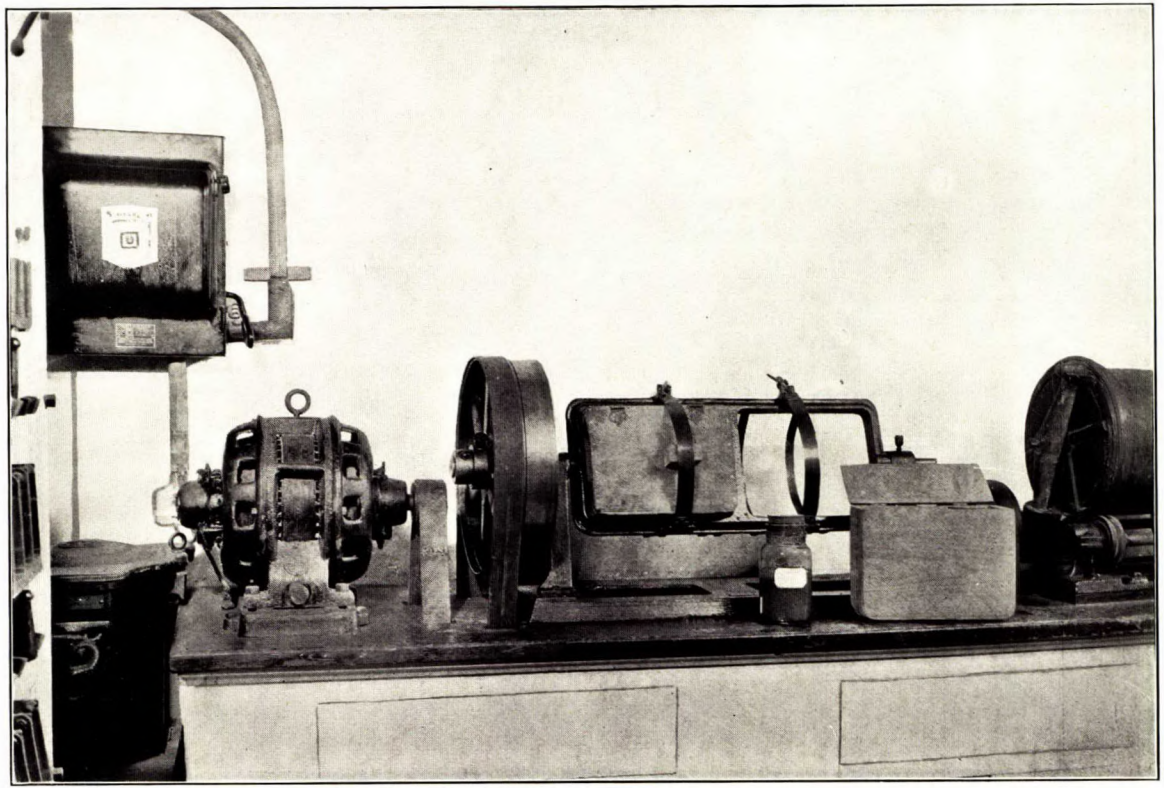
TABLE II

Mesh Openings of Standard Screens

Sieve Numbers		Opening		Sieve Numbers		Opening	
Tyler	U.S. Bureau of Standards	Inches	Millimetres	Tyler	U.S. Bureau of Standards	Inches	Millimetres
6	6	0·1310	3·327	65	70	0·0082	0·208
10	12	0·0650	1·651	100	100	0·0058	0·147
20	20	0·0328	0·833	150	140	0·0041	0·104
28	30	0·0232	0·589	200	200	0·0029	0·074
35	40	0·0164	0·417	270	270	0·0021	0·053
48	50	0·0116	0·295				

The sieves are nested together in the order of the sieve numbers indicated in the above table, the coarsest being at the top and the finest at the bottom, a cover being placed on the top sieve and a pan below the 270 sieve to catch the finest of the grains. With the sand grain sample in the top sieve the nest of sieves is placed in a Ro-Tap testing sieve shaker, or other mechanically agitated sieve shaker, and shaken for a definite length of time according to the type of machine used, being 15 minutes for the Ro-Tap. It is convenient to use a time switch to measure the time interval. The sieves and the sieve shaker, and the time switch, used in these tests are illustrated in Plate V A.

The percentage of sand on each sieve is multiplied by the mesh number of the sieve through which it has passed; the sum of the different products thus obtained is divided by the total percentages of sand remaining on the sieves and in the pan, exclusive of the clay substance. The quotient is the grain fineness number (G.F.N.) and in the tables is given to the nearest whole number. As mesh numbers of sieves manufactured by makers differ, the following multipliers have been chosen to be used in this calculation.



Device used for washing the clay substance from samples of moulding sands. It consists of framework of an Abbé porcelain jar pebble mill and two hinged-top wooden boxes, each capable of holding two one-quart size jars.

TABLE III

Multipliers to be Applied to Screen Numbers for Determining Grain Fineness Number

Sieve Numbers		Multipliers	Sieve Numbers		Multipliers
Tyler	U. S. Bureau of Standards		Tyler	U.S. Bureau of Standards	
On 6	On 6	3	On 65	On 70	50
" 10	" 12	5	" 100	" 100	70
" 20	" 20	10	" 150	" 140	100
" 28	" 30	20	" 200	" 200	140
" 35	" 40	30	" 270	" 270	200
" 48	" 50	40	" Pan	" Pan	300

To illustrate the above method, the calculation made for determining the grain fineness number for laboratory sand sample No. 18 is as follows:

On U.S. Bureau of Standards Sieve	Percentage of Sand	Multiplier	Product	On U.S. Bureau of Standards Sieve	Percentage of Sand	Multiplier	Product
6	0·25	3	·7	100	13·92	70	974·4
12	2·49	5	12·4	140	8·46	100	846·0
20	4·64	10	46·4	200	4·74	140	663·6
30	4·57	20	91·4	270	5·56	200	1112·0
40	7·35	30	220·5	Pan	12·07	300	3621·0
50	12·28	40	491·2				
70	15·46	50	773·0	Total.....	91·79		8852·6

$$\text{Grain Fineness Number} = \frac{8852 \cdot 6}{91 \cdot 79} = 96+$$

From the grain fineness number the grain fineness classification is obtained according to the following table.

TABLE IV

Grain Fineness Classification

Grain Class	Sands with grain fineness number
No. 1..	200 to and including 300
" 2..	140 to but not including 200
" 3..	100 " " " " 140
" 4..	70 " " " " 100
" 5..	50 " " " " 70
" 6..	40 " " " " 50
" 7..	30 " " " " 40
" 8..	20 " " " " 30
" 9..	15 " " " " 20
" 10..	10 " " " " 15

As an example, the grain classification number of the laboratory sand sample No. 18 is 4, because its grain fineness number 96 as calculated above, falls within the range of grain fineness numbers 70 and 100.

Tempering Water Test

The moisture content or the amount of tempering water that must be added to a moulding sand to produce the greatest permeability and bond strength is very important. For every sand there is a certain amount that gives best combined result. The amount of water needed

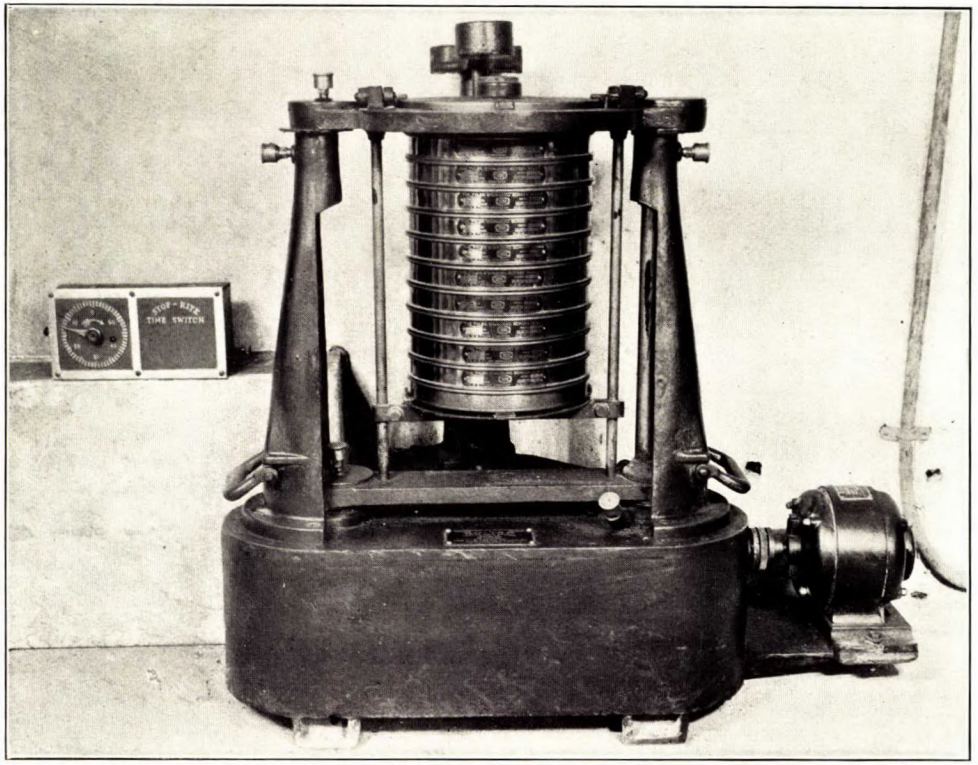
to produce maximum permeability is not necessarily that developing highest bond strength; in fact, these amounts are rarely the same. It is, however, an advantage to have a sand that develops the greatest degree of permeability and bond strength with the same percentage of water. In the foundry the amount of water added depends on whether it is desired to have a highly permeable sand or one having maximum power to hold together. In practice, maximum permeability and compressive strength generally occur when 4 to 8 per cent by weight of tempering water is used, although some sands take more or less than this amount. The testing of the sand samples for this report was all done at three water contents, namely 4, 6, and 8 per cent. If, during the tests for permeability and compressive strength on a sand, it appeared that better results might be obtained at lower or higher water content than any of these three, tests were made accordingly—in some cases as low as 3 per cent and as high as 10 and 12 per cent being used. Before a sand was tested for permeability or compressive strength it was allowed to remain at least 24 hours to become uniformly tempered. Also before testing, the sand was twice shaken rapidly through a coarse riddle and immediately returned to its humidor. This produced an intimate mixture with very little loss of moisture. Although in tempering the sand for permeability and compressive strength tests the amount of water added was calculated to give a definite percentage, a standard test for moisture content was always made, the results being recorded in the tables to the nearest one-tenth of one per cent.

Moisture Content Determination. The moisture content was determined as follows: One hundred grammes of tempered sand was dried for at least one hour at a temperature between 105°C—110°C. (221°F—230°F.) then cooled in a desiccator and re-weighed. The loss in grammes is the percentage of moisture content.

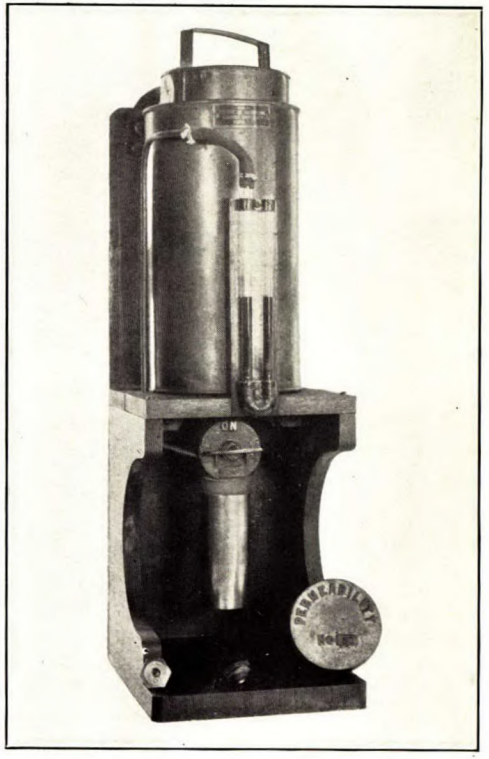
Permeability

The permeability of all moulding sand samples was determined by the use of the standard permeability machine, which is illustrated in Plate V B. A more recent model of this machine is shown in Plate VI A. Every sample specimen tested in this machine was compacted to within an allowable range of volume by means of a rammer as illustrated in Plate VI B. The ramming of the specimen is done as follows: Tempered sand is placed in the 2-inch diameter hollow brass cylinder, and subjected to three blows of a 14-pound weight falling through a distance of 2 inches, the amount being just sufficient to produce a specimen 2 inches in height with a tolerance of plus or minus one-sixteenth of an inch. In these tests this amount generally ranged from 150 to 175 grammes, and was fairly constant for each sand at the same moisture content. By trial and error the exact amount necessary was easily determined.

The brass cylinder containing the rammed specimen is placed on the standard permeability apparatus and 2,000 cubic centimetres of air are forced through it at a constant rate by the weight of the bell settling in

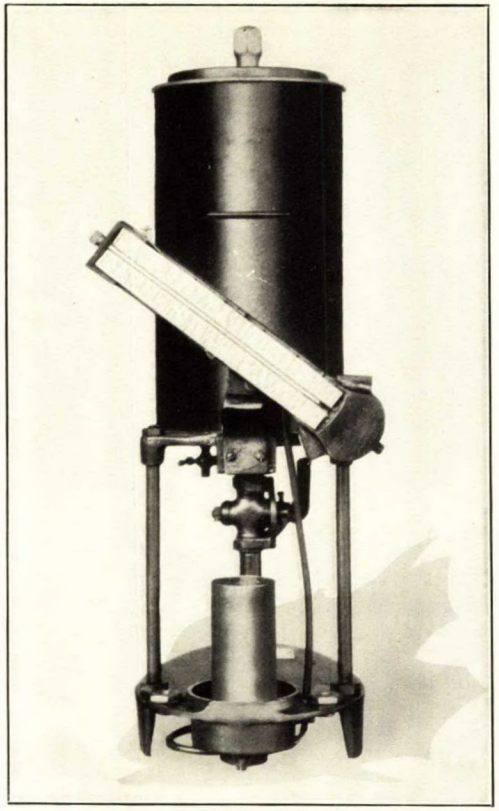


A. Ro-Tap testing sieve shaker with Stop-Rite time switch and eleven testing sieves used for making screen analyses of moulding sands.



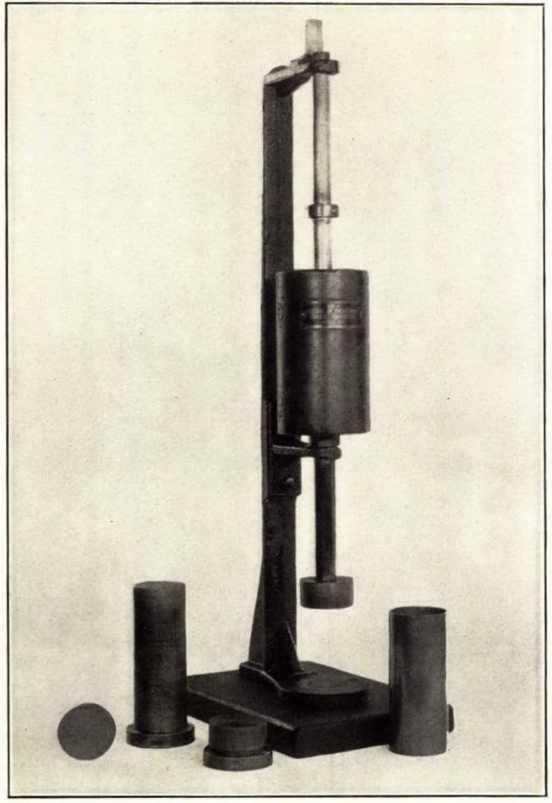
Courtesy, College of Engineering, Cornell University, Ithaca, N.Y.

B. Standard permeability machine used in securing the permeability of moulding sands.



Courtesy of Federal Foundry Supply Co., Cleveland, Ohio, U.S.A.

A. Standard permeability machine with mercury seal and direct reading gauge.



Courtesy, College of Engineering, Cornell University, Ithaca, N.Y.

B. Standard sand specimen rammer, apparatus used for moulding specimens of moulding sands for permeability and bond strength tests.

a tank of water. The rate at which the bell sinks is directly dependent on the time required to force the air through the sample specimen, this being recorded by a stop-watch. While the bell is sinking, the pressure in grammes per square centimetre when constant was recorded from the U-tube manometer scale. It is advisable to work with a pressure of about 5 grammes. If the bell alone does not give this pressure a weight is added.

The following form of calculation of the permeability by the above standard method is taken from "Testing and Grading Foundry Sands," edition of March 1931, subsections 67, 68, 69, and 70 on pages 40 and 41.

67. The degree of permeability as determined by this test is found by employing a formula. By its use, permeability is ascertained as the volume of air passing per minute, per gramme per square centimetre pressure, per unit volume in specimen.

68. Permeability equals the number of cubic centimetres of air forced through the sand specimen, multiplied by the height of the sand specimen in centimetres; whence, this product is divided by the product of the pressure in grammes times the area of the sand specimen in square centimetres and the time in minutes, thus

$$\text{Permeability} = \frac{\text{Cm}^3 \text{ of air} \times \text{Cm height of specimen}}{\text{Grammes pressure} \times \text{Cm}^2 \text{ area of specimen} \times \text{minutes}}$$

69. The general formula may be expressed as follows:

$$P = \frac{v \times h}{p \times a \times t} \text{ when}$$

P = permeability
v = volume of air passing through specimen
h = height of specimen
p = pressure of air
a = cross-sectional area of specimen
t = time

70. The method of conducting the permeability test herein described calls for 2,000 cubic centimetres (122 cubic inches) of air to be forced through the specimen; 5·08 centimetres (2 inches) to be the height of the specimen; and 20·268 square centimetres (3·1416 square inches) to be the area of specimen. These fixed quantities are therefore substituted as constants in the equation, as follows:

$$\text{Permeability} = \frac{2{,}000 \times 5{\cdot}08}{20{\cdot}268 \times \text{grammes pressure} \times \text{minutes}}$$

Reduced to its simplest terms this equation reads:

$$\text{Permeability} = \frac{501{\cdot}2}{\text{grammes pressure} \times \text{minutes}}$$

On each sand at each moisture content three determinations for permeability were made. If any determination varied more than 10 per cent from the average of the three, other determinations were made until the average of three were within this range. The permeability values given in the tables are always the average of at least three determinations and the greatest permeability is printed in bold type. Occasionally tests were made on sands at as many as 5 moisture contents, but only the results of the best 3 moisture contents are given in the tables. Usually sands were tested at 3 moisture contents.

The above standard method takes much time to perform, particularly if the sand is fine-grained or heavily bonded. A more rapid but less accurate method, more suitable for a determination in a foundry, is obtained by a slight change in the standard apparatus. By attaching one of two standardized orifice plates and adding an extra weight on the bell a permeability determination may be made directly by consulting a table, pro-

vided the pressure on the manometer U-tube has been read. The orifices and the extra weight necessary are shown in Plate V B. The smaller orifice is to be used for medium- to fine-grained sands and the larger for medium- to coarse-grained sands. The table used is taken from page 43 of "Testing and Grading Foundry Sands" and is as follows:

TABLE V

Permeability Test Pressures and Corresponding Values as Obtained With Orifice Plates

Pressure	Permeability		Pressure	Permeability	
	Small orifice 0·5 mm.	Large orifice 1·5 mm.		Small orifice 0·5 mm.	Large orifice 1·5 mm.
0·1	.....	....	5·1	14·3	134
0·1	.....	....	5·2	13·8	128
0·2	.....	....	5·3	13·4	126
0·3	.....		5·4	13·0	122
0·4	.....	2450	5·5	12·6	119
0·5	.....	2000	5·6	12·2	115
0·6	.....	1620	5·7	11·8	112
0·7	.....	1350	5·8	11·4	108
0·8	.....	1200	5·9	11·0	105
	.....	1060	6·0	10·7	102
1·0	.....	950	6·1	10·3	99
1·1	.....	850	6·2	10·0	96
1·2	.....	780	6·3	9·7	93
1·3	.....	710	6·4	9·4	90
1·4	.....	650	6·5	9·0	88
1·5	.....	610	6·6	8·8	85
1·6	.....	550	6·7	8·5	82
1·7	.....	525	6·8	8·2	80
1·8	.....	492	6·9	7·9	77
1·9	.....	467	7·0	7·7	75
2·0	49	440	7·1	7·5	73
2·1	47	417	7·2	7·2	70
2·2	44	398	7·3	7·0	67
2·3	42	376	7·4	6·7	65
2·4	40	358	7·5	6·5	63
2·5	38	341	7·6	6·3	61
2·6	36	326	7·7	6·0	58
2·7	34	313	7·8	5·8	56
2·8	33	300	7·9	5·6	54
2·9	31	287	8·0	5·3	52
3·0	30	275	8·1	5·1	50
3·1	29	264	8·2	4·9	48
3·2	28	253	8·3	4·7	46
3·3	27	243	8·4	4·4	44
3·4	25·8	235	8·5	4·2	42
3·5	24·2	226	8·6	4·0	40
3·6	23·4	219	8·7	3·7	38
3·7	22·7	212	8·8	3·5	36
3·8	21·8	205	8·9	3·3	....
3·9	21·0	198	9·0	3·1	....
4·0	20·0	193	9·1	2·9	....
4·1	19·5	185	9·2	2·6	....
4·2	19·0	178	9·3	2·4	....
4·3	18·4	173	9·4	2·2	....
4·4	17·8	167	9·5	1·9	....
4·5	17·3	163	9·6	1·7	....
4·6	16·7	156	9·7	1·4	....
4·7	16·2	151	9·8	1·1	....
4·8	15·7	146	....	....	....
4·9	15·2	142	....	....	....
5·0	14·7	138	....	....	....

Bond Strength

The standard test for the bond strength of a moulding sand is based on the sand's ability to resist compression, because most moulds are subjected to compression rather than tension or shear, and all strength tests on moulding sands quoted in this report refer to compression.

Any of four well-known machines may be used to determine the compressive strength of natural bonded moulding sands; viz., the Saeger, Adams, Dietert, and Federal Foundry Supply Company. All tests reported herein were made on the Federal Foundry Supply Company's machine, illustrated in Plate VII. The moulding sand test specimen is placed between two compression plates, the upper being then screwed down until the specimen fails. The amount of compression is registered on the dial in pounds per square inch of cross-sectional area.

The specimens used were those previously tested for permeability. After each permeability test the specimen is forced out of the 2-inch diameter brass cylinder by means of a stripping post and a one-half inch thick, 2-inch diameter steel disk. The specimen is supported on this steel disk while being subjected to the compression test. This hollow brass cylinder, stripping post, and steel disk are shown in Plate VI B, at the base of the sand specimen rammer.

On each sand, at each moisture content, 3 determinations for compressive strength were made. If one of such a group varied more than 10 per cent from the average of the three, other determinations were made until all three were within these limits. The compressive strength values given in the tables are always the average of at least 3 determinations. The maximum is printed in bold type. Occasionally tests were made on sands at as many as 5 moisture contents, but only the results of the best 3 are given in the tables. Usually sands were tested at 3 moisture contents.

Refractoriness

It is possible to obtain the comparative refractoriness of moulding sands by any one of several methods. A comprehensive study of the refractoriness of moulding sand was made by J. F. McMahon[1], in which seventeen typical moulding sands were tested by each of five different methods. There has been a good deal of discussion regarding the merits of the various tests and though the test outlined by C. M Saeger, Jr., of the U. S. Bureau of Standards of Washington, has been tentatively adopted by the A. F. A., it has not been to date accepted as a standard test.

Saeger's test is as follows: A platinum ribbon, heated by its resistance to the flow of electricity, is placed on the surface of a moulded test specimen. The temperature of the ribbon is controlled by decreasing or increasing the electric current passing through it. A carbon plate resistor is used for this purpose. The specimen is subjected in this manner to increasing temperature until the platinum ribbon adheres to the sand. The

[1] Mines Branch, Dept. of Mines, Canada. Invest. Ceramics and Road Materials, 1926, Rept. 690, pp. 9-24. *Also* Transactions of the American Foundrymen's Association, vol. 1, XXXVII, pp. 501-525.

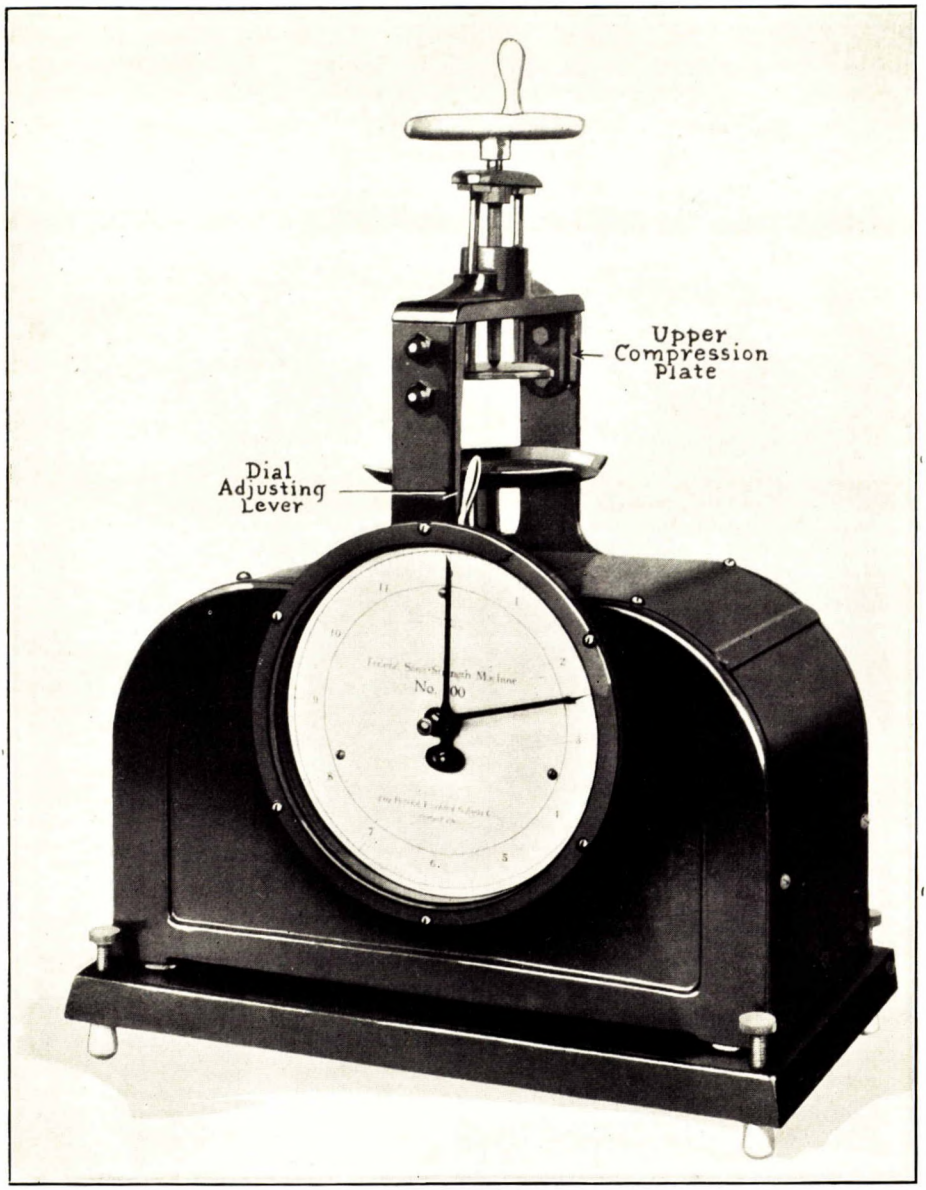
test is carried on in a dark cabinet and temperatures are taken by means of an optical pyrometer mounted outside the cabinet and focused upon the glowing ribbon.

Sufficient reports have not been published in which this test was mentioned, to permit one to judge from test results the comparative refractory value of sands studied in this manner. In order to be able to tie in the results of the work in this report with the result of previous work, it was decided to use the cone softening-point test that is used generally for the determination of refractoriness of non-metallic minerals. This test is described as follows: Small tetrahedra (cones) 7 cm. high and 15 mm. along the edges of the base, are made from the sands to be tested. The addition of an organic bond, such as gum tragacanth, dextrine, or the like, is permissible with sands that do not contain sufficient bond to permit of handling the cones after moulding. The specimens are dried and mounted on a suitable refractory plaque together with "Standard Cones" manufactured by the Standard Pyrometric Cone Co., Columbus, Ohio—the heat necessary to cause the standard cones to bend sufficiently to cause their tips to touch the plaque being known (*See* Table VI). The mounted cones are heated in a suitable furnace under oxidizing conditions at a definite rate and the time at which the sand specimen softens sufficiently to cause its tip to touch the plaque and the time at which the standard cones behave similarly are noted. The refractoriness is stated in terms of the standard cones and a sand whose tip touches the plaque at the same time, under the same conditions as cone 16, is said to have a refractoriness of cone 16.

Cone tests were made on sand representative of those being used by the foundries and on those samples whose other properties were satisfactory. Cone tests were also made of the "clay substance" of the various sands. The "clay substance" is less refractory than the coarser particles of a moulding sand. It contains the least refractory minerals in a very finely divided state. The results of the "clay substance" tests are not used to classify the sands but rather to learn the refractoriness of the bonds of the various sands tested.

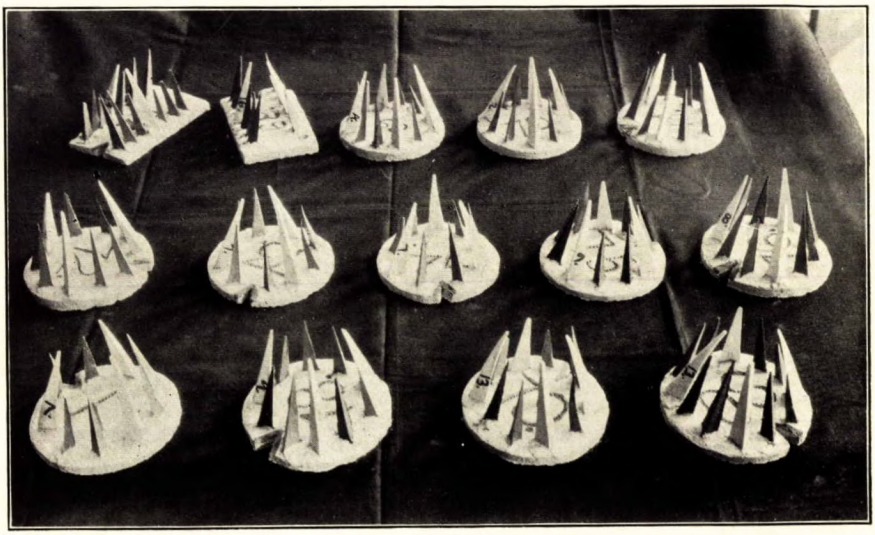
Cones representative of all the sands and "clay substances" to be listed were mounted on plaques in groups of 10 and placed in a down-draught, gas-fired kiln together with plaques containing standard cones, for a preliminary burn. The temperature was raised gradually to 1420° C. (2588° F.) in 9 hours. The kiln was cooled and plaques removed. By comparing the conditions of the test specimens with those of the various standard cones the pyrometric cone equivalents (P.C.E.) of the samples were estimated. By this means it was possible to group the sands generally as follows: first, those that had P.C.E. values below cone 15; second, those that had P.C.E. values between cones 15 and 20; and, third, those the P.C.E. values of which were above cone 20.

Having in mind the probable refractoriness of the sands when plaques were set up, three standard cones of consecutive order were placed on a plaque together with duplicate samples of three samples the P.C.E. value of which lay close to the intermediate cone. Determination on the sands of the first group (–15) were made in a down-draught, gas-fired kiln using air at atmospheric pressure; on the sands of the second group (+15 and –20) in a palo furnace; and those in the third group (+20) in a volcano furnace.

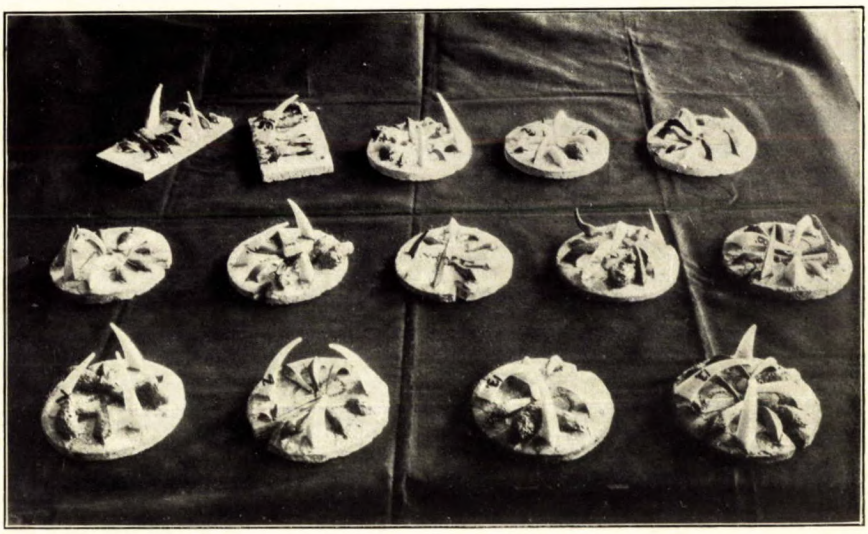


Courtesy of Federal Foundry Supply Co., Cleveland, Ohio, U.S.A.

Federal sand strength machine, apparatus used in testing the compressive green bond strength of moulding sands.



A. Moulding sand and clay substance cone specimens mounted on fireclay plaques prior to refractoriness tests.



B. The same moulding sand and clay substance cone specimens illustrated in Plate VIII A, after refractoriness tests were made.

The pyrometric cone equivalents of the sands and "clay substances" are included in the general table of results. A + sign after a P.C.E. value indicates that the refractoriness lies between the cone named and the next consecutive higher cone. A + sign before a P.C.E. value indicates that the refractoriness is above that cone but it has not been exactly determined.

Plate VIII A shows the cones mounted on the plaques for testing, and Plate VIII B shows the same specimens after the test.

TABLE VI

***End Points of Pyrometric Cones**

(Heated in air at the rate of 150°C. (270°F.) per hour)

Cone No.	Degrees Centigrade	Degrees Fahrenheit	Cone No.	Degrees Centigrade	Degrees Fahrenheit
1	1125	2057	15	1410	2570
2	1135	2073	16	1450	2642
3	1145	2093	17	1465	2669
4	1165	2129	18	1485	2705
5	1180	2156	19	1515	2759
6	1190	2174	20	1520	2768
7	1210	2210	23	1580	2876
8	1225	2237	26	1595	2903
9	1250	2282	27	1605	2921
10	1260	2300	28	1615	2939
11	1285	2345	29	1640	2984
12	1310	2390	30	1650	3002
13	1350	2462	31	1680	3056
14	1390	2534			

* Jour. Amer. Cer. Soc. 9, (11), 1926.

CHAPTER III

STATUS OF THE CANADIAN MOULDING SAND INDUSTRY

INTRODUCTORY

The natural bonded moulding sand industry of Canada has been in existence since the first foundry was built in the country. The early foundries depended almost entirely upon domestic sources for their supply of moulding sand, such foundries being small and their yearly requirements not being sufficient to warrant the extra cost entailed in the bringing into the country of foreign sands. The first producers of moulding sand were the foundrymen themselves, each foundry operator digging his own requirements from the nearest deposit or else contracting with some local farmer to bring in sand from his farm.

Moulding sand was produced in Ontario near Port Hope from about 1855, near Bolton from about 1870, and near Ridgetown from about 1895.

It was not until the sand requirements of the foundry industry had reached appreciable yearly tonnages that independent sand operators came into being. By the end of the last century producers of moulding sand in Canada were not only supplying the domestic market but were also exporting large quantities to the United States.

With the more intensive development of the large deposits of natural bonded moulding sand in the Albany district of New York state, in the United States, and the systematic methods of marketing such sands adopted by their producers, the Albany sands became well and favourably known not only in the eastern United States but in Canada as well, so that imports of moulding sand into Canada have steadily increased until at the present time (1935) there is no export of Canadian sand and imported sand has acquired a dominant position in the Canadian market. Modern foundry practice demands moulding sand complying more rigidly with specifications than would ordinarily be needed for a small foundry, and attention to this, coupled with prompt delivery of the full yearly requirements of a foundry have enabled the well-organized United States producers to maintain the position they at present hold. A foundryman accustomed to reliable service hesitates before making a change and experimenting with a comparatively unfamiliar sand lacking the appeal of a much advertised brand, and without the backing of an efficient organization for grading and prompt delivery.

In spite of this intensive competition and the fact that all sands, including foundry sand, are admitted into Canada duty free, some Canadian producers have held their markets. For example, the area between Hamilton and Niagara has maintained a steady moulding sand business for many years, and, to-day, still furnishes a number of consumers in the provinces of Ontario and Quebec.

From information obtained from the Dominion Bureau of Statistics and from personal visits to many foundrymen throughout Canada it is estimated that 55 to 60 per cent of our consumption of natural bonded moulding sands is imported, by far the greater part coming from the United States. The importation in years to come will probably be lessened because of the depletion of the nearby deposits in the United States, and this factor alone will compel development of more of our own deposits. On the other hand, consumption of the natural bonded moulding sands may be reduced by the more general use of synthetic moulding sands, or by the addition to partly spent moulding sand of re-bonding agents, the basis of which is fireclay or bentonite.

The Canadian deposits of moulding sand are widespread; of those in close proximity to markets the majority are small in extent, some having been worked, and are still being worked intermittently by farmers for use in local foundries. Such a method of production can hardly be expected to give the prompt service or to furnish the range of product suitable for specified conditions of work provided by the regular sand companies devoting their full time to the business and carrying adequate stocks of standard grades of material.

POSSIBLE FUTURE TREND OF THE INDUSTRY

A possibility worthy of consideration is the co-operative marketing in the large centres of consumption of the products from groups of moulding sand properties, either through the media of existing selling companies or by specially organized co-operative agencies. Moulding sand is a comparatively low-priced commodity that cannot bear the cost of repeated handling or long haulage, and for large-scale trading it will be necessary that properly graded material be available at strategic centres as required.

Probably the best method for a co-operative marketing association would be to erect blending and storage plants in centres of consumption or places possessing adequate railway facilities, and at the same time conveniently situated with respect to the several deposits from which the different types of sand for blending might be obtained. Grades of sand, which of themselves are without a ready market, or saleable locally only in small quantity, may, however, be suitable for blending and could be shipped into the blending plant for treatment. By carefully choosing a series of sands having complementary characteristics a number of desirable grades can be produced. For instance, the fine-grained moulding sand from L'Assomption county in Quebec, which has only slight use at present, could probably be blended advantageously with the coarse-grained sand from Drummond county, and the blended sand from the two areas would find a ready sale in the large market in Montreal and vicinity, a market supplied at present mainly by foreign sand.

Such a blending plant would have to be under strict technical control. Each sand used for blending would be tested by the methods advocated in this report, in order to determine the exact proportions required of each sand to form a proper blend.

An essential feature of such an organization would be the establishment of a series of standard grades, based on the present known requirements of the consumers, each with definite physical characteristics upon which the foundrymen could rely, not only in a first shipment but also in subsequent orders. This would also enable the preparation of adequate stocks of these standard grades in advance of requirements so that prompt delivery could be made on receipt of orders. At the same time the system would be flexible and when a purchaser desired a special grade, not covered by one of the standard grades already adopted, such a sand could, in short order, be prepared.

In the past, numerous complaints have been made by consumers using Canadian sands, some claiming them to be deficient in bonding substance, others that they contain too much; again, others state that the sand has less life than imported material, etc. Many of these complaints may be partly justified, as frequently Canadian sands have been purchased chiefly because of their availability and low cost, without due regard to their suitability for the particular type of work in hand.

By means of proper blending and strict control of the grade of the product being marketed, the Canadian producers would be able in a great measure to overcome such difficulties, and if this were done there is no reason why a growing and profitable moulding sand industry could not be rapidly built up throughout Canada.

STATISTICS

The consumption of natural bonded moulding sand in Canada is not definitely known. The statistics collected by the Dominion Bureau of Statistics regarding sand do not at present particularize; the import statistics for this commodity being combined with those of core sands, fire sands, blast sands, and facing sands, all of which are used in the same industries.

Exports

Canada does not export any natural bonded moulding sand, although for a period of 25 years, ending about 1907, large quantities were shipped by rail and boat from the districts around Leamington and Ruthven, in Essex county in Ontario, to United States' cities, including Cleveland, Detroit, Saginaw, Sandusky, and Toledo. The shipments ceased when the then known pits became exhausted. Shipments were also made about 1916 from a deposit near Metchosin on Vancouver island to three places in California. A shipment of 250 tons was made in 1866 to a foundry in Boston from Windsor, Hants county, Nova Scotia.[1]

Imports

The imports of natural bonded moulding sand into Canada exceed the domestic production. The bulk of the imports is from the United States, a small amount coming from Great Britain and France. It is

[1] Mineralogy of Nova Scotia, a report to the Provincial Government by Henry How, D.C.L., 1868, p. 162.

impossible to determine the amount imported because there is no special item for moulding sand in the tariff, but probably it comes in mostly under the classification of "sand and gravel, n.o.p." (not otherwise provided for). Some may be mistakenly included under the classification of "sand, silica, for glass and carborundum manufacture and for use in steel foundries, filtration plants and for sand blasting," owing to the belief that it is destined for steel foundries. No record is kept of the consumption of natural bonded moulding sand by Canadian foundries, as it is included by the Dominion Bureau of Statistics under the general classification of moulding and other sands used in the metallurgical industry in Canada. The writer estimates that the import of such sands is about 55 to 60 per cent of the consumption. All sands, including moulding sand, enter Canada duty free.

Domestic Production

Table VII gives the production of natural bonded moulding sand in Canada during the period since figures have been published. For the years 1912 to 1915 inclusive, the production of such sand is included with the production of "sands and gravel." From 1916 to 1920 inclusive, the production is taken from the annual reports of Mineral Production of Canada, published by the Mines Branch, Department of Mines, Ottawa. From 1921 to the present, the production is from the annual reports of Mineral Production of Canada, published by the Mining, Metallurgical and Chemical Branch, Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa.

TABLE VII

Production of Natural Bonded Moulding Sands in Canada for Calendar Years

Year	Tons	Value	Year	Tons	Value
1916	19,251	$ 16,726	1926	79,373	$ 62,151
1917	46,790	46,018	1927	86,541	56,017
1918	62,835	71,488	1928	42,060	46,404
1919	55,451	71,249	1929	64,457	50,308
1920	44,353	59,271	1930	43,642	31,768
1921	91,680	70,254	1931	13,921	10,031
1922	159,369	107,738	1932	8,493	5,355
1923	154,711	111,537	1933	7,717	9,635
1924	118,202	80,072	1934	13,229	13,415
1925	57,656	48,880			

CHAPTER IV

MOULDING SAND DEPOSITS OF CANADA

Natural bonded moulding sand deposits occur in numerous localities throughout Canada, and deposits are being worked or have been worked in every province.

At present with the exception of New Brunswick and Prince Edward Island, every province is producing some grade of moulding sand.

In Nova Scotia, deposits are being worked or have been worked in the following counties: Colchester, Cumberland, Hants, Inverness, Kings, and Pictou.

In New Brunswick, promising localities for moulding sand occur in Kent and Westmorland.

In Prince Edward Island, in Queens county, moulding sand was formerly produced for local use.

In Quebec, deposits are being worked or have been worked in the the following counties: Argenteuil, Brome, Joliette, L'Assomption, Missisquoi, Portneuf, and St. Hyacinthe.

Ontario is the leading province, at present, in this industry, with the greatest development in Welland and Wentworth counties from Niagara Falls to and around Hamilton. Deposits also occur in the following counties: Brant, Bruce, Durham, Essex, Grenville, Haldimand, Kent, Leeds, Lennox and Addington, Middlesex, Norfolk, Peterborough, Prince Edward and Stormont; and in Nipissing and Thunder Bay districts.

In Manitoba, deposits are being worked or have been worked at Brandon, Melbourne, St. Ouens, Mile 80 (Wye) on the Greater Winnipeg Water District railway.

In Saskatchewan, deposits of moulding sand occur at or near Humboldt, Langham, Moose Jaw, Pilot Butte, Prince Albert, and Saskatoon.

In Alberta, deposits are known at or near Calgary, Edmonton, Leduc, Lethbridge, and Medicine Hat.

In British Columbia, deposits occur at or near Cranbrook, Metchosin, Nanaimo, New Westminster, Penticton, and Victoria.

In addition to the above-mentioned localities, there are many districts in the various provinces where conditions are favourable for prospecting, judging from the results of the tests made on the many samples collected and the observations made in the field during the course of this investigation.

The chapters following give, by provinces, descriptions of the numerous deposits already being operated as well as many localities which may, on more detailed examination, prove potential sources of further supply.

The localities described include deposits in the following stages of development, namely:

(1) Those being worked fairly regularly.

(2) Those worked in the past, but which are now idle, and may or may not be depleted.

(3) All others, which may be classed as prospects. These include (*a*) deposits of sand sampled at the suggestion of foundrymen visited; (*b*) deposits of sand exposed to view along highways, ditches, etc., which from field tests gave promise of being of moulding sand quality.

Localities that may have deposits containing commercial quantities of sand, the laboratory tests or samples from which gave promise of being suitable for use in foundry work, are described in order to serve as a guide for future prospecting.

Counties in which occurrences have been noted are placed in alphabetical order. Preceding each detailed description will be found the laboratory number of the sample of moulding sand collected from that locality. Tables, giving the results of the laboratory tests on the samples collected, follow the descriptive section of the report. These tests were made where possible according to the standard methods recommended by the special committee of Moulding Sand Research of the American Foundrymen's Association. The tables are also in alphabetical order according to counties, and the laboratory number of each sample is found in the first vertical column of the table. By this method correlation of the descriptive text and the table is easily secured.

Provincial index maps show the localities from which laboratory samples of moulding sand were taken. The locality where each sample was collected is indicated by its laboratory number. On each map a ready reference of the localities designated by laboratory numbers is supplied.

In the course of the field work for this report over 200 samples were collected for examination in the laboratory. A number of these, after preliminary examination, proved to be lacking in some essential quality and in consequence were discarded without further testing. Tests on 191 samples were carried to completion and the data so obtained were tabulated. A detailed study of the results of these tests, taken in conjunction with the data obtained in the field relative to the size of the deposits, ease of working and proximity to transportation and markets, showed that 43 of these samples represented deposits probably unsuitable at present for exploitation on a commercial scale or else the sand was only suitable for blending purposes.

Descriptions and data are given in this report on 148 samples classified as follows:

Working deposits	72
Deposits formerly operated	31
Prospects	45

Of those formerly operated, by far the greater number of them still represent deposits of commercial bodies of usable sand, the few which come from localities that are known to be depleted nevertheless show the quality of sand formerly obtained and indicate the possibility of discovering other deposits in the district.

The localities from which the 43 samples, mentioned above, were obtained are indicated by numbers on index maps included in this report, but the detailed descriptions and results of tests are omitted. The locali-

ties with sample numbers are, however, tabulated at the end of this chapter and the detailed information regarding them is available on the files of the Department for anyone wishing it.

The samples and localities described in this report are divided among the provinces as follows:—

	Samples tested	Working deposits	Formerly operated	Prospects	Locality only tabulated
Nova Scotia	12	8	—	3	1
New Brunswick	4	—	3	1	—
Quebec	30	8	2	10	10
Ontario	90	36	18	13	23
Manitoba	23	4	4	7	8
Saskatchewan	12	5	—	6	1
Alberta	9	4	1	4	—
British Columbia	11	7	3	1	—
	191	72	31	45	43

The following tabulation of locations shows those from which samples were taken and tested, the results of which are not included in this report.

Nova Scotia

Laboratory Sample No.	
33	Kings co., ¾ mile of Avonport.

Quebec

Laboratory Sample No.	
88	Argenteuil co., Chatham tp., range VI, lot 2.
87	" " " range VIII, lot 6.
77	Bagot co., Acton tp., range IV, 32.
57	Joliette co., 2½ miles N. E. of St. Thomas de Joliette.
56	L'Assomption co., L'Assomption tp., 1 7/8 miles north of L'Epiphanie.
81	Megantic co., 1 mile N. W. of Thetford Mines.
60	Portneuf co., village of Deschambault.
82	Sherbrooke co., Ascot tp., range IX, lot 17.
51	Vaudreuil co., Newton tp., range VI, lot 2.
52	" " village of Ste. Justine.

MEMORANDUM

FROM [redacted]

TO [redacted]

Ontario

Laboratory Sample No.	
111	Essex co., Sandwich West tp., 2½ miles south of Ambassador Bridge.
50	Glengarry co., Lancaster tp., Con. II, lot 17.
47	Grenville co., Edwardsburg tp., Con. I, lot 16.
42	" " " " Con. II, lot 22.
69	" " " " Con. II, lot 22.
98	Grey co., St. Vincent tp., Con. VI, lots 18, 19.
135	Haldimand co., Canborough tp., 2 miles west of Dunnville.
91	Halton co., Trafalgar tp., Con. III, lot 20.
119	" " " Con. IV, lot 32.
65	Hastings co., Huntingdon tp., Con. VII, lot 10.
66	" " " Con. VIII, lot 6.
110	Kent co., Zone tp., Con. I, lot 1.
116	Norfolk co., Charlotteville tp., Con. IX, lot 19.
123	Northumberland co., Hamilton tp., Con. VII, lot 7.
94	Peel co., Albion tp., Con. VII, lots 16, 17.
93	" " Chinguacousy tp., Con. II, lot 7.
90	" " Toronto tp., ½ mile N. E. of Lorne Park.
122	Peterborough co., Monaghan North tp., Con. VIII, lot 1.
67	Prince Edward co., Ameliasburg tp., Con. II, lot 47.
97	Simcoe co., Medonte tp., Con. I, lot 49.
62	Stormont co., Osnabruck tp., Con. I, lot 14.
48	" " " Con. I, lot 37.
89	York co., north of Sammon Ave. and east of Coxwell Ave., North Toronto.

Manitoba

Laboratory Sample No.	
159	N. W. ¼ sec. 14, tp. 7, range XXV, west Prin. Mer.
157	N. E. ¼ " 15, " 9, " XIX, " " "
150	Parish Ste. Anne, river lot 9, 3 miles S. E. of Ste. Anne des Chênes.
151	" " " 9, " " " " " "
145	City of Winnipeg, Portage Ave. and Clifton Street.
146	S. W. ¼ sec. 33, tp. 12, range VIII, east Prin. Mer.
149	S. W. ¼ " 27, " 13, " IX, " " "
148	N. W. ¼ " 22, " 14, " X, " " "

Saskatchewan

Laboratory Sample No.	
163	City of Weyburn.

CHAPTER V

MOULDING SAND DEPOSITS OF THE MARITIME PROVINCES

NOVA SCOTIA

Colchester County

Laboratory Nos. 34, 35

Locality. On the Frank Whippy farm about three-quarters of a mile east of Belmont[1], N.S. The deposit is 300 feet distant from the owner's house.

Owner. Frank Whippy, Belmont, N.S.

Operator. Mrs. V. B. Moore, Prince St., Truro, N.S.

History. Moulding sand has been produced and sold from this farm since at least 1908. The late Mr. Melville Blair, of Truro, operated the deposit until about 1924. Since then it has been worked by the present operator.

Description. Moulding sand is now produced from an area on the farm that the previous owner worked in at least four different places. At present a cross-bedded deposit of sand, gravel, and interbedded layers of moulding sand is worked. Scattered throughout the beds are many large boulders. Owing to the beds of moulding sand not being continuous over any great length, being better described as lenses or large pockets, it is quite a difficult task to produce a uniform grade of material. This difficulty is increased by inclusions of free-running sand or gravel within the lenses of moulding sand that must be discarded as much as possible when loading. Owing to material from these inclusions becoming mixed with the moulding sand, the bond of the latter is lowered. Loading is done by hand shovels.

The deposit contains many grades of moulding sand but samples of only two were taken. By the blending of different grades, various products can be made. For instance, it has been a frequent practice to blend the sands represented by laboratory Nos. 34 and 35 in the proportion of 20 per cent of the former to 80 per cent of the latter. The sand represented by laboratory No. 35 is usually sold as it comes from the pit.

At the part of the pit where the moulding sand represented by laboratory No. 34 is dug it has a thickness of 15 feet. About 150 feet north of this spot, where the other sand, represented by laboratory No. 35, is obtained, the useful thickness is nearly 10 feet. The overburden over both of these is about the same, generally 1 to 2 feet thick, being slightly

[1] Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1918, p. 68.

less where sample No. 35 was taken; and as it is removed it is deposited in the exhausted part of the pit. The area occupied by the pit, or its probable extension, is cleared of timber or bush, part of it being cultivated land. The deposit is illustrated by Plate IXA. The samples were collected in August 1928.

Market. Moulding sand from here has been shipped to various places, the farthest being Sydney at a distance of 334 miles. Other places are Amherst, New Glasgow, Sackville, N.B., Trenton, and Truro, the last named being a market for this sand for over 20 years. The shipping point is Belmont on the Canadian National railway, 8 miles northwest of Truro. It is teamed to the station over good roads.

Remarks. For the greater part this sand is used just as it is produced from the pit. It has also been blended with imported moulding sand, such as that from New Jersey.

No doubt there are other deposits of similar moulding sand in this district that could be developed equally successfully.

From about 1901 to 1908 inclusive, moulding sand was also occasionally produced at Bible Hill near Truro in this county, and was used by a foundry in that city. The operator of this deposit was said to be Gardner Clish.

The following excerpt is taken from The Mineralogy of Nova Scotia, a report to the Provincial Government by Henry How, D.C.L. 1868, p. 162: "Promising beds of (moulding) sand are found at Onslow, Colchester County . . . ."

Cumberland County

Laboratory No. 36

Locality. On a ridge within 50 feet east of the road to Wallace on farm lands at North Middleboro, N.S.

Owner. Ira Henderson, North Middleboro, N.S., or Pittsburgh, Pa., U.S.A.

Operator. None at present. The only one was Frederick Deering, a citizen of the United States.

Description. Prospect sample. The deposit, which is in a gravelly ridge, has not been worked since about 1913, when it was not developed to any great extent because of difficulty in gaining the sand and trouble in marketing it. Owing to the heavy overburden of gravel, which at the point of development was nearly 5 feet, little profit could have been made. The overburden had slumped down the face of the old workings and had to be cleared away before the sample could be obtained. An effort was made to penetrate the gravel overburden with an auger, but this was found impossible. Mr. Wm. Canfield, who works the adjoining farm, stated that the thickness of the sand layer from which shipments were made was at least 20 feet. The sample, however, represents only the top 5 feet of it. Mr. Canfield stated that when he dug a well about 500 feet to the north on

his property, he struck a similar bed of moulding sand 25 feet thick after passing through over 20 feet of gravel. It was his belief that the moulding sand bed would come to or near the surface to the south, but this was not determined. The land under which the bed probably extends is cleared for cultivation. The sample was obtained in July 1928.

Market. The sand is said to have been shipped to Amherst and Oxford, N.S. It was teamed a distance of four miles to Fountain Road Station on the Canadian National railway.

Remarks. The sand resembles Windsor Locks Connecticut moulding sand which is used in this country to a very small extent in the making of light weight castings such as tablets, name plates, or statuary work in brass, bronze, or copper. Castings made in Windsor Locks moulding sand have a smooth finish owing to the velvety texture of that sand. This sand is considered the most expensive sand imported and closely resembles the famous French sands. Whereas ordinary kinds of moulding sand are ordered by the ton, such sands are ordered by the barrel lot. It could be used only for light weight castings.

Halifax County

Remarks. The following excerpt is taken from the Mineralogy of Nova Scotia, by Henry How, D.C.L., 1868, p. 162:—"Dartmouth affords beds of sand, one of which is used by the brass founders of Halifax."

Hants County

Laboratory Nos. 28, 29, 30

Locality. On the west bank of Ninemile river at the crossing known as the Red Bridge, $2\frac{3}{4}$ miles northwest from Elmsdale, N.S.

Owner. Walter Mosher, 307 Portland St., Dartmouth, N.S.

Operator. The same.

History. The deposit was opened up by the present owner about 1907.

Description. The deposit[1], which is comparatively level, is only a few feet above the mean level of the river; the area was most likely at one time a sand bar of this meandering stream. The deposit is very close to the present course of the river and has an area of 30 acres, of which the owner considers at least 8 to 10 acres are underlain by moulding sand, although not necessarily of one grade. After being worked periodically for over 21 years, only about one acre has been exhausted.

Of the three samples collected two were from the margin of the present workings. Sample No. 28 was from the north side of the area, nearest the

[1] Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1918, p. 68.

A. Face of portion of the moulding sand deposit on the Frank Whippy farm, near Belmont, Colchester county, Nova Scotia, showing cross-bedding of sand layers.

B. Moulding sand deposit on the west bank of the Ninemile river, $2\frac{3}{4}$ miles northwest of Elmsdale, Hants county, Nova Scotia.

river, and sample No. 29 from the east boundary, nearly 185 feet distant from the location of No. 28. Sample No. 30 was taken southeast from the location of No. 29 at a distance of 150 feet and was from an undeveloped part of the tract. Most of the area available for future use is free from woods.

The thickness of the moulding sand, which owing to iron stain is of reddish colour instead of the buff shade of most moulding sands, is sufficient to make exploitation an easy matter, and was 10 and 9½ feet, respectively, where samples Nos. 28 and 29 were taken. At the site of sample No. 30, although the thickness is about the same as at the other two places, the top 3½ feet is of a finer texture than the rest. Sample No. 30 represents only this 3½ feet. The overburden at all places is very light, being 6 inches in the case of Nos. 28 and 29, and about one foot of sample No. 30. The underlying material common to the whole area is a sharp sand, greyish in colour. There is no difficulty in determining when the bottom of the moulding sand has been reached as the colour changes from reddish to greyish. In most moulding sand deposits the loader has to judge by previous experience how far the excavation must be carried, and the irregular floor so exposed in this deposit is well illustrated by Plate IX B.

The samples were collected with the aid of the owner in August, 1928.

Market. The market is small for these sands, and the same may be said for all Maritime moulding sands owing to the preference of foundrymen for sands imported from Albany, N.Y., the competition from which became intensified about 1928 when foundrymen from different places in Nova Scotia began co-operative buying and importing by shipload. Prior to this they purchased individually and by railway.

These moulding sands, generally known by the name of Elmsdale, have been sold in Halifax, Liverpool, and Yarmouth; the latter place at a distance of 282 miles. They are usually trucked 2¾ miles over fair roads to Elmsdale on the Canadian National railway.

The sand was used to a small extent about 1928 for road material, as when mixed with gravel it acts as a bond owing to its clay content.

Remarks. The grade of sand represented by samples Nos. 28 and 29 is better suited for medium to heavy castings, that by sample No. 30 for light to medium weight castings. All these sands were free from organic matter such as roots, etc. Like other Nova Scotia moulding sands they have high refractoriness and should be durable.

The following excerpts are taken from The Mineralogy of Nova Scotia, by Henry How, D.C.L., 1868, p. 162:—

The foundry of Messrs. Dimock at Windsor, N.S., uses to some extent sand from near the railway depot about half a mile distant.

A shipment of 250 tons of sand was made in 1866 to a foundry in Boston from the property of Mr. Pellow at Windsor, Hants county. This proved to give satisfaction. The sand is red, it occurs in a bed some 8 feet thick, about three feet beneath the surface overlying a thin bed of grey sandstone which rests upon the great bed of gypsum. Mr. Pellow is now working in the Clifton quarry. Only 50 cents a ton was charged, but on another occasion it would be necessary to make the price 75 or 80 cents.

Inverness County

Laboratory Nos. 138, 139

Locality. Mainly on the north bank of Diogenes brook, 4 miles northwest from the village of Melford or 10 miles from River Denys on the Canadian National railway.

Owner. River Dennis Sand and Clay Company, Ltd., Melford, N.S.

Operator. The same. Manager, J. A. McLellan.

History. The deposit first became known about 1886, but no development was done until about 1911. In 1917 it was acquired by the present owners. By 1924 development was such that it was necessary to build the four-mile road connecting the deposit with the Victoria road at Melford. In 1928 the company was being reorganized, additional capital was sought, and it was hoped that in the not distant future a branch line of the railway would be built to save the excessive cost of hauling by one-ton trucks to River Denys Station.

Description. The property is described in detail by T. D. Guernsey[1]. An account also appears in a provincial report.[2] An earlier résumé is by Heinrich Ries and Joseph Keele.[3] Only a brief description is given here.

The deposit lies within the steep sides of the valley of Diogenes brook. Owing to the increase in the overburden of unstratified glacial drift from a minimum thickness of 3 or 4 feet near the brook level to a maximum of about 20 feet at the top of the slopes, development so far has been confined to the valley bottom. Of the 95 acres that the company owns outright, or adjoining property of which it holds leases, only a very small area has had any work done upon it. There are pits in at least seven places. Three adits have been driven through the top of the hillsides near the pits and a small tramway runs from one pit across the brook to the road. All excavation has been done by hand.

There are different grades of the sand, which occurs generally in cross-bedded layers, interspersed occasionally with irregular beds of creamy white clay, like kaolin. The property was not visited by the writer. Sample No. 138 was collected by E. H. Wait in 1929 and sample No. 139 by L. Heber Cole in 1930, both of the Mines Branch, Department of Mines.

Market. The sand, which is very suitable for the casting of steel products, has been sold in Sydney and New Glasgow replacing imported sands. The demand for it has grown since the first shipments were made about 1924. Some of the interbedded clay has found application in the pottery industry at St. John, N.B.

Remarks. The sand has extraordinary refractory power and the clay substance extracted from the sand shows equal refractoriness. The clay has little plasticity or bonding power while in a moist state, but moulds

[1] Geol. Surv., Dept. of Mines, Canada, Sum. Rept. 1926, Part C, pp. 110-124.
[2] Nova Scotia Mines Report, 1927, Part I, pp. 132-140.
[3] Geol. Surv., Dept. of Mines, Canada, Mem. 16-E, pp. 65-66.

made from the sand and dried have remarkable strength. The compressive strength of the sand as given in the tables is for dry sand moulds and not for those of the green sand, as given for other sands.

Kings County

Laboratory Nos. 31, 32

Locality. On a projection of land known locally as "Oak Island," 1½ miles north of Avonport. It is also ¾ of a mile north by private road from a crossing on the Dominion Atlantic railway.

Owner. Imrie J. Borden, Avonport, N.S.

Description. Prospect samples were collected on this peninsular-shaped piece of land jutting into Minas basin, at an approximate elevation of 25 feet. Most of the higher land is covered with bush; a little is cultivated, and that where the samples were dug was cleared. Two samples were taken at spots 265 feet apart, sample No. 31 being collected northeastward from where sample No. 32 was found. Sample No. 31 represents a layer of moulding sand 18 to 21 inches thick, and underlain by a coarser grained sharp sand. Sample No. 32 is from a bed of moulding sand 16 to 18 inches thick, and beneath this is a sharp sand finer grained than that below where sample No. 31 was taken. The overburden through this entire tract of land is uniform and of a thickness of only about 9 inches. Two or three acres is the area estimated as most likely possessing grades of moulding sand similar to the samples. Mr. Benton Borden was present when the samples were collected, in July, 1928.

Market. A trial shipment of the sand represented by sample No. 31 was submitted to a foundry in Nova Scotia about 1922, but as it apparently did not meet requirements no order was received. The nearest foundry to the deposit is at Windsor, N.S., a distance of 12 miles. Avonport Station on the Dominion Atlantic railway is distant 1¼ miles. Trucks could be used on the connecting road.

Remarks. The sand represented by sample No. 32 is considered the better of the two. Although, according to the mechanical analysis, it has less clay substance, what there is of it is of a more plastic nature and its refractoriness is high.

Laboratory No. 41

Locality. On the property of the owner in Kentville.

Owner. Lloyd Manufacturing Co., Ltd., Kentville.

Operator. The same.

History. This moulding sand deposit was discovered about 1898 while making excavations for the foundry buildings. It has been used ever since.

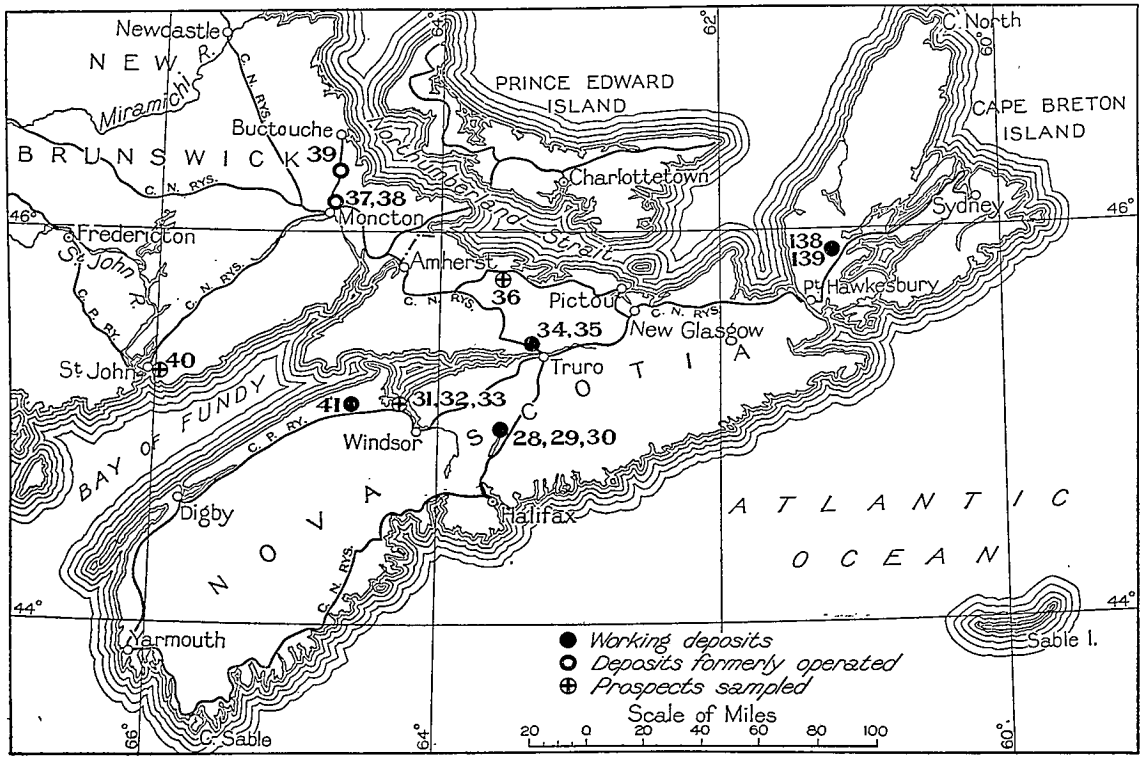


Figure 1. Index map of Nova Scotia and New Brunswick showing location of sand deposits sampled: **28, 29, 30**, near Elmsdale; **31, 32, 33**, near Avonport; **34, 35**, near Belmont; **36**, near North Middleton; **37, 38**, near Moncton; **39**, Notre Dame; **40**, near Red Head; **41**, Kentville; **138, 139**, near Melford.

Description. This is a flood plain deposit in the valley of the Cornwallis river and only a very small area has so far been developed, the owners of the foundry, after nearly 30 years' work, not having needed to go beyond the confines of their property for their requirements. The moulding sand bed has a thickness of 18 to 30 inches, but the quality is stated to differ within short distances. The sample taken represents the quality of sand generally used in the foundry. The thickness of overburden is not at all constant, ranging from 8 to 18 inches. The underlying material is fine sharp sand and clay.

Market. The sand has been used solely within the company's own plant.

Remarks. The sand has been successfully used for various shapes and weights of castings, and there has been no necessity to use any other grade of moulding sand. Of all moulding sands produced in Canada suitable for iron, brass, or aluminium, that have been tested to date, this has the highest refractoriness. It contains no organic matter such as roots or bark. Most of the adjoining flat land near the site of the foundry is cleared of bush, and undoubtedly a large tonnage of good sand is available.

It was reported by a foundryman in Kentville that moulding sand was once found on the farm of James Cochrane at Aylesford, 17 miles west of Kentville.

Lunenburg County

Remarks. The following excerpt is taken from The Mineralogy of Nova Scotia, by Henry How, D.C.L., 1868, p. 162: "Promising beds of (moulding) sand are found . . . . . at Chester Basin, Lunenberg county."

NEW BRUNSWICK

Kent County

Laboratory No. 39

Locality. Dundas township. Just within the property lines of the owner, adjacent to the main road in the village of Notre Dame, and at a distance of 50 feet from the hotel operated by the owner.

Owner. James Cobham, Notre Dame, N.B.

Operator. The same.

History. Mr. Cobham stated that he started shipping moulding sand from his deposits about 1918.

Description. The land from which the sample was obtained is cleared of bush but only a very small area had been excavated. The owner estimates that there is a large area available for development. The thickness of the moulding sand bed is not constant and is generally between

2 and 3 feet, whereas the overburden is fairly regular, ranging from 11 to 14 inches. The underlying material is of sharp sand of average size grain.

The sample was obtained in August 1928, with Mr. Cobham's assistance.

Market. The sand has been used with good results by a foundry in Moncton for the making of various shapes and weights of casting. It is said to have been shipped as far as St. John, N.B.

The shipping point is Notre Dame on the Canadian National railway, 19 miles from Moncton, less than one-quarter of a mile from the deposit.

Remarks. This is one of the few moulding sands analysed that required more than the average amount of water to be added in order to temper it to the best working condition. The compressive strength and the permeability were best when tempered to 10 per cent water content. It is free from organic matter such as roots but contains a few small pebbles, which can be discarded in the riddling.

St. John County

Laboratory No. 40

Locality. Simmons township. On the owner's farm at Red Head.

Owner. William McIlveen, Red Head.

Description. Prospect sample. Several places were examined on both sides of a small creek flowing through the farm towards Cranberry point. The land surface is very uneven and rises rapidly away from the coast line of the bay of Fundy. Near the farm buildings the rise is abrupt to rock formation.

The best ground was near the farm buildings, the sample collected coming from near the barn. The bed that appeared to give the best material is 3 feet thick and has an overburden averaging 6 inches. An extension of this bed may be found at or near the same elevation as the farm buildings, but from the pockety nature of the deposit it would be of small area. The sample was collected with the help of the owner, a patternmaker in a foundry in St. John in August 1928.

Market. Provided moulding sand were developed here the nearest market would be St. John, at a distance of 5 miles over good roads.

Remarks. It has a trace of organic matter and a few small pebbles, and is suited preferably for medium to heavy weight castings.

Westmorland County

Laboratory Nos. 37, 38

Locality. On the farm of the owner, east of the Irishtown road near the Moncton-Buctouche branch of the Canadian National railway and north of the Caledonia road.

Owner. Frank A. Seaman, R.R. No. 4, Moncton, N.B.

Operator. The same.

History. The deposit was opened up in 1921 and worked for two years. A small amount was also sold since 1928.

Description. The land surface in the vicinity of the deposit is gently rolling, partly covered with small bushes. At the time of the visit there was a pit of 25 to 30 feet having an average depth of 4 feet, but at no place was the bottom of the deposit reached. The deposit is fairly continuous, and the moulding sand ranges in thickness from 3 to 6 feet, but within this layer there is a narrow band of free-running sharp sand.

Sample No. 37 represented the moulding sand as shipped to Moncton. Sample No. 38 was taken 10 feet beyond the edge of the pit and 40 feet from where sample No. 37 was taken.

The samples were obtained with the help of the owner in August 1928.

Market. The sand has been shipped mainly to Moncton, a small amount going to St. John. That sold in Moncton was conveyed by wagon, and that to St. John was shipped from Humphrey on the Canadian National railway.

Remarks. The sand shipped gave excellent results on castings of various shape, weight, and material, particularly heavy castings made of brass. It contained a small amount of vegetable matter, which had to be removed by riddling.

Sample No. 38, being free from vegetable matter, represents what appears to be the better sand of the two, so in the event of the pit's being enlarged, better results ought to be obtained with this sand.

PRINCE EDWARD ISLAND

No field work was done in this province.

Questionnaires were sent to all foundries and from the answers it appears that there is little knowledge of any deposits in the province; but foundrymen expressed the belief that deposits of good moulding sands do exist.

Moulding sand was formerly used to a very small extent from a locality in Queens county, in the parish of Charlotte, near Charlottetown. This sand is said to be useful only for light weight castings.

TABLE VIII

Mechanical Analyses of Sands from Nova Scotia and New Brunswick

NOVA SCOTIA

Laboratory No.	Locality, county	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U. S. Bureau of Standards													Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), Percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent		Calcium carbonate
		On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance								Sand	Clay	
34	Colchester	.....	0·20	0·21	0·36	0·68	1·69	6·12	11·77	13·40	13·16	14·93	32·78	5·4	100·7	183	2	D	4·2 6·3 8·2	12·6 17·2 17·4	3·1 3·0 3·3	.....	.....	Nil
35	"	.....	1·09	2·06	3·33	5·13	6·59	8·07	9·67	9·38	7·14	7·58	23·28	16·6	99·9	144	2	F	4·0 6·1 8·1	4·2 6·4 8·1	7·0 7·5 7·6	15	11	Nil
36	Cumberland	.....	0·30	0·08	0·05	0·03	0·21	0·11	0·10	0·14	0·42	5·59	88·39	4·9	100·3	291	1	C	4·2 6·2 8·0	6·6 7·4 7·7	3·2 4·2 4·1	14	11	Nil
28	Hants	.....	.....	0·13	0·98	4·40	11·94	18·60	17·03	11·34	6·84	6·50	11·17	11·9	100·8	106	3	E	4·0 6·2 8·2	19·4 30·0 40·1	5·3 4·8 3·4	14	12+	Nil
29	"	.....	0·04	0·52	2·21	6·49	14·16	18·45	17·54	10·54	6·01	5·12	10·94	8·9	100·9	101	3	D	4·0 6·2 7·9	23·2 41·9 48·7	4·7 4·5 3·1	15	12+	Nil
30	"	.....	.....	0·48	0·51	0·66	1·40	3·04	7·20	11·12	11·14	12·60	32·50	18·9	99·6	195	2	F	6·1 8·0 9·9	3·1 5·6 5·3	11·8 11·3 10·4	13	12	Nil
138	Inverness	.....	0·14	1·28	5·74	16·86	30·18	17·08	12·98	6·00	1·56	0·78	1·20	6·2	100·0	53	5	D	3·8 5·8 7·8	245·0 216·2 192·7	5·9 8·8 11·1	30+	30+	Nil
139	"	.....	.....	0·10	1·14	5·46	21·96	31·76	17·52	5·32	1·92	1·14	2·40	11·3	100·0	64	5	E	3·9 6·5 7·8	133·3 172·2 167·0	3·9 10·3 7·9	30+	30+	Nil

31	Kings.....	.....	0 39	1·21	2·69	3·18	3·94	8·73	11·67	12·64	11·55	14·45	23·27	5·0	98·7	154	2	D	4·3 6·2 7·9	12·9 18·6 16·8	3·1 3·4 4·4	.....	.....	Nil
32	"	.....	0·39	0·69	0·82	1·12	1·62	3·06	6·26	9·44	11·91	18·67	39·99	7·3	101·3	162	2	D	4·2 6·1 8·1	8·1 10·6 **10·9**	4·4 4·9 4·8	16	14+	Nil
41	"	.....	0·18	0·36	0·52	1·02	2·64	8·34	16·53	17·94	12·91	11·87	17·82	9·5	99·6	145	2	D	4·0 5·9 8·2	8·3 13·8 **15·8**	5·3 6·5 5·0	16	15	Nil

NEW BRUNSWICK

39	Kent.....	.....	0·10	0·49	0·76	1·43	3·39	7·17	13·14	14·87	11·31	11·56	30·88	5·1	100·2	170	2	D	6·3 8·0 10·3	4·9 7·1 8·2	4·9 5·5 6·7	13+	11	Nil
40	St. John....	.....	0·23	0·41	2·08	10·33	29·56	36·30	6·00	1·60	1·63	6·25	5·4	99·8	80	4	D	4·0 6·0 8·4	21·3 24·0 **41·7**	3·6 **4·0** 3·7	.....	.....	Nil
37	Westmorland.....		0·39	1·04	0·94	1·54	3·12	5·61	16·69	22·57	14·87	11·72	20·36	2·3	101·1	146	2	C	5·9 7·8 10·0	12·8 15·8 **20·2**	3·4 4·2 4·1	.....	.....	Nil
38	"	.....	0·85	0·82	0·79	1·35	3·07	5·56	12·37	18·48	13·54	11·39	26·13	6·6	100·9	161	2	D	4·0 6·2 8·0	6·8 13·8 **16·6**	2·6 3·6 **4·3**	13	10+	Nil

CHAPTER VI

MOULDING SAND DEPOSITS OF QUEBEC

Berthier County

Laboratory No. 58

Locality. St. Pierre parish. The sample was obtained slightly more than 5 miles north of St. Gabriel de Brandon from the road allowance on the south side of a road and about 750 feet northeast from where it branches off the main road running on the east side of Maskinongé lake. The point where this road leaves the main road is about one mile north of the Maskinongé River crossing.

Description. Prospect sample. The sample was taken with the help of Mr. Jean Boisclair, a foundryman of St. Gabriel de Brandon. The layer claimed to be moulding sand is of uneven thickness, which ranges from 2 to 12 inches, and the overburden is 4 to 9 inches. Underlying is sharp sand. Other low rounded hills in the vicinity show signs of a similar formation. The sample was taken in September 1928.

Market. The nearest foundry to this deposit is located at St. Gabriel de Brandon. Joliette, the next nearest, with two foundries, is twenty-two miles by the Canadian Pacific railway.

Remarks. The sand could possibly be used, preferably for moulding light weight castings.

Champlain County

Laboratory No. 61

Locality. Ste. Marie parish. This sample was secured 3⅕ miles north of Ste. Anne de la Pérade towards St. Casimir west of the Ste. Anne river, within the property line, less than 30 feet west of the highway.

Description. Prospect sample. The part of the bluff resembling moulding sand is 12 to 16 inches thick, the overburden averaging 9 inches, and beneath is sharp sand. Other morainic hills having similar sections that might also supply moulding sand, lie only a short distance away. An appreciable amount of pebbles and much vegetation, such as roots, could be easily riddled out. The sample was taken in September 1928.

Market. The nearest foundry is at St. Casimir.

Remarks. A fair moulding sand deposit can probably be developed from this district. Along other terraced hills by the river and nearer to St. Casimir better places for moulding sand may perhaps be found.

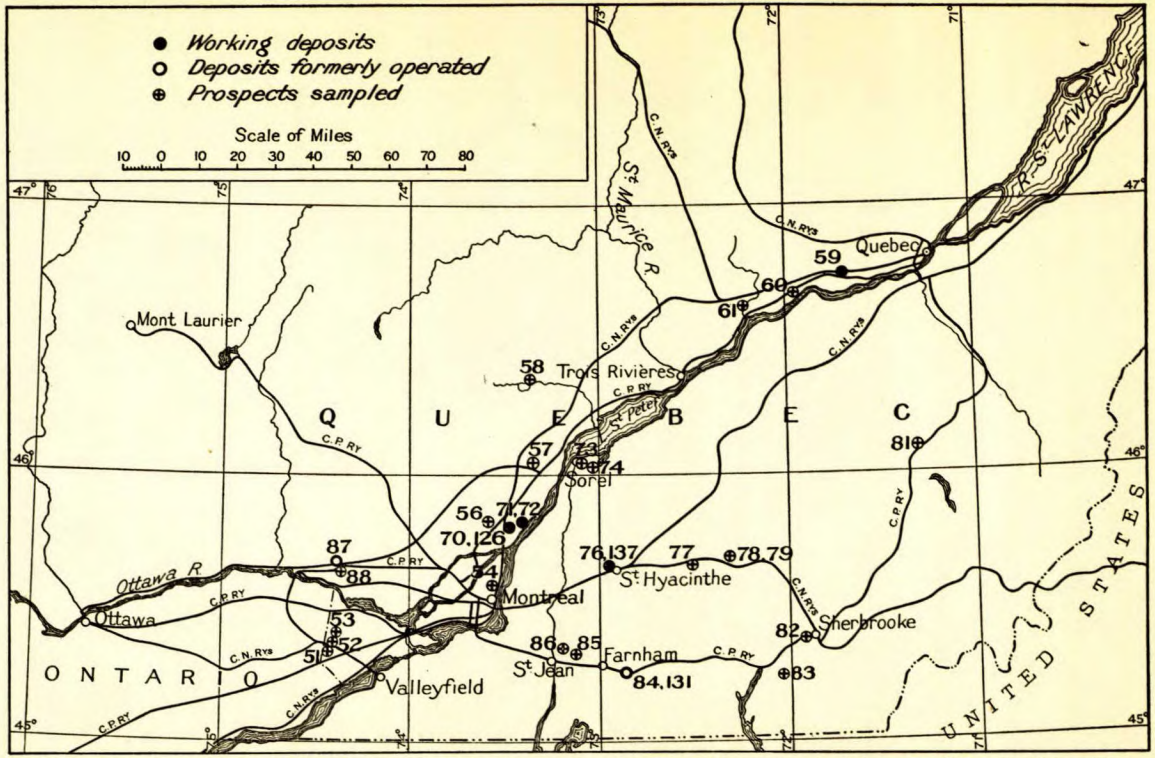


Figure 2. Index map of Quebec showing location of sand deposits sampled: **51**, near Ste. Justine; **52**, Ste. Justine; **53**, near Ste. Justine de Newton; **54**, Montreal; **56**, near L'Epiphanie; **57**, near St. Thomas de Joliette; **58**, near St. Gabriel de Brandon; **59**, Pont Rouge; **60**, Deschambault; **61**, near Ste. Anne de la Pérade; **70, 126**, near L'Assomption; **71, 72**, near St. Sulpice; **73**, Sorel; **74**, near Sorel; **76, 137**, St. Hyacinthe; **77**, near Acton Vale; **78, 79**, near South Durham; **81**, near Thetford Mines; **82**, near Sherbrooke; **83**, near Magog; **84, 131**, near Farnham; **85, 86**, near Mount Johnson village; **87**, near Brownsburg; **88**, near Lachute.

Drummond County

Laboratory Nos. 78, 79

Locality. Durham township, range IX, lot 15. The samples were taken from a sand and gravel deposit being worked about one mile north of South Durham. A spur from the Canadian National railway furnishes excellent transport.

Owners. Bonner Sand & Ballast Ltd., 1434 St. Catherine St. West, Montreal, Que. Manager, D. J. Foley.

Operator. The same.

History. The deposit has been worked for a number of years, producing graded sand and gravel, the greater part of which has found a market in Montreal, 66 miles distant.

Description. The formation is well exposed and a section over 100 feet in height has been opened up. Although most of the beds are nearly horizontal, a few are cross-bedded. Many different grades of material are available. At the top of the bluff, where the overburden averages only about 6 inches, is a layer of sand 4 feet thick that might be used for moulding. The bank is stated to extend back from the face of the pit in cleared ground and is represented by sample No. 79. Two other layers from 5 to 8 feet thick, represented by sample No. 78, that occur nearly half way up the face of the pit also have the appearance of moulding sand. These layers of clayey sand are an expense to the owners because they have to be sorted out from the ordinary product of the pit. Consumers of sand and gravel for concrete aggregates will not accept them mixed with clay.

The samples were taken in August 1929.

Market. Provided moulding sand were produced from here, Montreal would be the best market.

Remarks. The mechanical analysis suggests sample No. 79 would make the better moulding sand, particularly for medium to heavy weight castings. It has the further merit of being easier to recover.

Hochelaga County

Laboratory No. 54

Locality. City of Montreal. In a lot on the west side of Sherbrooke Street between Dezery and Prefontaine Streets.

History. According to foundrymen, moulding sand has been used from pits on Montreal island, some being obtained east of the Angus shops of the Canadian Pacific Railways and used for the casting of sewer pipe, and one foundryman, who had served his apprenticeship in Montreal, and was now in charge of a foundry outside of that city, said that a good grade of moulding sand was formerly worked near the railway station at Westmount.

Description. Prospect sample. This was taken from or near the place where the moulding sand used for casting sewer pipes is believed to have been obtained. There was an open pit covering about half an acre. The product must have been for other than foundry use, as the depth excavated was greater than that of any moulding sand now seen. Unevenly distributed narrow bands of sharp sand are interbedded with the layer of presumed moulding sand, which has a thickness of 12 to 18 inches and an overburden of 6 to 12 inches. It contains a slight amount of vegetable matter. The sample was obtained in September 1928.

Remarks. The mechanical analysis showed that it is a fair moulding sand for average weight castings. Across Sherbrooke St. from where this sample was obtained another pit was noticed having a similar section of sand. This was not sampled. There were not many buildings on the lots in this part of the city.

Iberville County

Laboratory No. 85

Locality. A sand and gravel pit on the south slope of mount Johnson, $1\frac{1}{4}$ miles northeast of Mount Johnson village. The pit is 200 feet northwest of the road.

Owner. J. A. Benoit, Mont St. Grégoire.

Operator. The same.

History. The deposit has been worked for many years for sand and gravel for building and road material, but no moulding sand has been produced.

Description. Prospect sample. The formation is well exposed, as a deep pit has been dug. An irregular band from 12 to 18 inches thick that may be used for moulding shows at various places along the crest of the pit, and has an overburden of 6 to 18 inches. The land back from the face of the pit is partly wooded.

The sample was taken in August 1929.

Market. The nearest foundries are at St. Jean at a distance of over seven miles.

Remarks. The mechanical analysis suggests that a fairly good sand, suitable preferably for heavy weight castings can be obtained from this pit. The difficulty would be to get a product of constant grade owing to the irregularity of the beds.

Laboratory No. 86

Locality. One-quarter of a mile northwest from the road intersection, $2\frac{1}{2}$ miles northwest from Mount Johnson village, is a sand and gravel pit.

Owner. Aldie Barrier, Mont St. Grégoire.

Operator. The same.

History. The deposit has been worked for over three years for sand and gravel, chiefly gravel, for road material. No moulding sand has been produced.

Description. Prospect sample. The formation is well exposed, as much gravel has been shipped. Near the top of the pit, gravel of different grades reaches to the surface and includes isolated small lenses of clayey sand or gravel. Some of these lenses are bigger and appear to be largely of moulding sand, and from such the sample was taken. This mode of occurrence is more marked in the small pits to the eastward. The moulding sand bands commonly have a thickness of 12 to 18 inches and an overburden of 6 to 8 inches. The land around these pits that is undeveloped is heavily wooded. In the sample there was no vegetable matter but a great number of pebbles.

The sample was taken in September 1929.

Remarks. The mechanical analysis shows that this would be a weak moulding sand because of the low amount of clay bond.

L'Assomption County

Laboratory Nos. 71, 72

Locality. Exactly one mile southwest along the river road from the right turn close to the St. Lawrence river, on No. 2 highway approximately 1½ miles southwest of St. Sulpice. The samples were obtained from the farm lands one-quarter mile northwest of the river road, at the rear of the owner's farm buildings. The distance between where the two samples were taken was 620 feet, sample No. 72 coming from southeast of No. 71.

Owner. Zorila Rivest, St. Sulpice.

Operator. The same.

Description. This is a typical flood plain deposit. The greater part of the land is cleared of bush. From where sample No. 72 was taken, only a small plot, 75 by 40 feet, has been worked, and the fairly uniform layer of moulding sand averages 12 inches thick, the overburden being about 10 inches. Nothing has been dug from where sample No. 71 was taken, the thickness of moulding sand being from 11 to 15 inches and the overburden 9 inches. Underlying the moulding sand at both places is sharp sand.

On an adjoining farm owned by Wilfrid Robitaille of St. Sulpice a similar moulding sand richer in bond has been produced and sold, but no sample was taken from the pit. One, represented by laboratory No. 55, which was claimed to have come from this farm, was obtained from a foundry in L'Assomption. It is evident that in this district along St. Lawrence river, and at an average elevation of 25 feet above the river, a very large tonnage of moulding sand is available. The samples were collected in August 1929.

Market. The moulding sand, generally known as that of St. Sulpice, has been used by a foundry in L'Assomption since 1924, prior to which the foundry was using Albany sand. The sand was taken by teams to

L'Assomption, a distance of 5 miles. Montreal, at a distance of 29 miles, could be supplied by either truck or rail transport; in this connexion it is interesting to note that in western Ontario moulding sand has been trucked from a pit to the consumer for a distance of at least 62 miles. If the railroad were chosen, it would be well to have the sand loaded on the Canadian National railway at L'Assomption.

Remarks. The mechanical analyses of the sands, represented by samples Nos. 71 and 72, indicate that they are suited preferably for light to medium weight castings. They are almost free from vegetable matter.

Over 3 miles west, on the west bank of the L'Assomption river, similar moulding sand has been produced and is described under laboratory Nos. 70 and 126. This is a good district in which to prospect for other deposits, some perhaps of a heavier grade, suitable for medium weight castings.

Laboratory Nos. 70, 126

Locality. Parish of L'Assomption, lot 416; 2 miles southwest from L'Assomption towards St. Paul l'Hermite on the No. 2 highway. Samples were taken from the farm lands half way between the highway and the west bank of L'Assomption river. The distance between the two samples was 230 feet, sample No. 126 being taken farther east and nearer the river.

Owner. Joseph Landry, L'Assomption, Que.

Operator. The same.

Description. This is a terrace deposit and the part of the farm from which sand is shipped is almost all cleared. Moulding sand has been dug where sample No. 126 was taken, but nothing as yet from the site of sample No. 70, the thickness of moulding sand in the former case ranging from 3 to 5 feet, and the overburden being 15 inches. Where sample No. 70 was taken the thickness of the moulding sand has decreased to about 15 inches, the overburden remaining fairly constant. The underlying bed is not quite the same in both cases. No clay was noticed with the sharp sand at the site of sample No. 126, whereas it was beneath No. 70. As the river is approached the bed of moulding sand appears to increase, but comes to an end at a slightly lower elevation than the site of sample No. 126. Lying between these two spots, and north and south of a line joining them, is an estimated area of about 2 acres available for development. The samples of these sands were collected in August 1929.

Market. The moulding sand was first used in 1929 by the same foundry in L'Assomption using the St. Sulpice sand to which it is said to be very similar. Teams were used in the transport. Should a market be found in Montreal, the distance over the highway is 22 miles. The nearest shipping point is at L'Assomption via the Canadian National railway.

Remarks. The mechanical analyses of these two sands show the bed changes little in quality between the sites of the samples. The sands would serve best for making light to medium weight castings. Very little vegetable matter was found. No more samples were taken along the terraces abutting the river, but other worthwhile deposits might be found in this area.

Missisquoi County

Laboratory Nos. 84, 131

Locality. Farnham West township, range III, lot 30. On the north bank of Yamaska river about one-quarter of a mile northwest from the owner's house.

Owner. Alfred Gordon, Brigham, Que.

Operator. The same.

History. According to the owner, in September 1929, moulding sand has been shipped from the deposit for at least 40 years.

Description. The deposit is in one of the terraces on the banks of Yamaska river. The worked part stretches along the river for over 190 feet and is within 5 to 10 feet of, and at an elevation of from 4 to 6 feet above, the average water level. The thickness of the material recognizable as moulding sand appears to be 12 to 15 inches. Below this the grade gradually changes into a sharp sand with little bond, although Mr. Gordon stated that he dug a seam from 3 to 5 feet thick. The underlying material is very fine sharp sand.

The farm lands around the deposit and on similar terraces were partly cleared of timber or bush. A considerable quantity of moulding sand could undoubtedly be produced from this area. There is a private wagon road to the deposit.

The samples were taken in September 1929.

Market. Shipments have gone to Cowansville, St. Johns, and St. Jerome. The last place is northwest of and farther away than Montreal, where it is believed no attempt has been made to use this moulding sand, most of it being used at St. Johns situated on Richelieu river. It has to suffer severe competition from the well-known Albany sands, which find entrance into Canada along Richelieu river.

Remarks. The writer took the sample without the help or guidance of the owner, and so a sample (No. 131) of the material said to have been shipped from here was obtained from a foundry in St. Johns. Sample No. 84 was that collected by the writer.

The sand has been used mainly in the making of light weight castings of brass and cast iron.

As the sand was collected along the same river as were samples Nos. 76 and 137 near St. Hyacinthe, any one interested in the deposit is referred to the remarks covering that locality.

Portneuf County

Laboratory No. 59

Locality. Neuville township. On the east bank of Jacques Cartier river, on the property of La Fonderie Suprême at Pont Rouge, within 100 feet of the foundry buildings.

Owner. La Fonderie Suprême, Pont Rouge.

Operator. The same.

History. The moulding sand has been used by the foundries in Pont Rouge for many years, the first user having been Chas. A. Julien, manufacturer of gasoline engines and other machinery, which business was taken over by La Fonderie Suprême, manufacturer of furnaces and stoves, about 1924. The Julien firm started using this moulding sand about 1884.

Description. At the rear of the foundry, where the excavation was made, the average thickness of the sand is nearly 2 feet, and it is capped with one foot of soil. Underlying was mainly loose and partly compacted sharp sand. The size of the deposit is shown by the fact that sufficient suitable sand has been produced within the area occupied by the foundry to supply its needs since 1884. The sample was collected in September 1928.

Market. The outlet for the product has always been for use in local foundries, of which there were two in 1928. It should find application in the foundries at Quebec and Three Rivers, distant 26 and 52 miles respectively over the Canadian Pacific railway. An alternative means of shipping is by truck over No. 2 and the adjoining highways.

Remarks. The moulding sand has been used for castings ranging from a few pounds up to a thousand pounds in weight. It contains no impurities, such as pebbles and vegetable material.

Richelieu County

Laboratory No. 73

Locality. Sorel township. At the southeast boundary of the cemetery, which is over one-quarter of a mile southeast of the Quebec, Montreal and Southern railway crossing on the No. 3 highway from Sorel to Yamaska. This is within the city limits of Sorel.

History. Foundrymen now operating in Sorel report that moulding sand was used from this neighbourhood by the early foundrymen of Sorel for over 40 years. The sand was produced by a Mr. Baxter who had a farm near the site of the present cemetery. It is said to have given satisfaction at that time. Most of the sand now used is imported from Albany.

Description. Prospect sample. There is little uniformity in the sand deposits around this locality. Anything that might be termed a moulding sand occurs in lenses or pockets, ranging in thickness from 1 to 14 inches. The overburden is light, being 2 to 6 inches thick. Underlying is sharp white sand. The exposed parts of the deposit were at or near the edge of timber-covered land. The area covered by bush that might contain a better grade of sand than that represented by the sample collected is fairly level. The sample was taken in August 1929.

Remarks. The mechanical analysis indicates that the material is deficient in bonding material (clay) for such a coarse-grained sand.

Laboratory No. 74

Locality. Sorel township. Along the banks of the Pot-au-beurre river at a right-angled left hand turn on the No. 3 highway distant 3½ miles from Sorel towards Yamaska.

Description. A section of the terrace along the river was visible in an excavation. A fairly uniform layer of moulding sand was seen, having a thickness of 6 to 13 inches, and the thickness of the overburden was 10 to 12 inches. For 3 feet below the moulding sand layer is a bed of sharp sand and immediately beneath this are cross-bedded layers of sand, clay, and fine gravel.

Similar formations occur along both banks up and down the stream from this exposed section that undoubtedly also have layers of moulding sand. Nearly all the adjoining land along the river was cleared of timber or bush. The deposit was sampled in August 1929.

Remarks. As foundrymen in Sorel said that moulding sand had once been worked southeast from that city near the present cemetery, this deposit was sampled as it is within 1¾ miles, and because tests gave promise of its being a better moulding sand than that from the cemetery. A local resident said that fine gravel for construction purposes and for foundries had been taken from this deposit some years ago. Neither of these statements was verified. Some of the fine sharp sand underlying the moulding sand may have been used for cores in foundries.

At any rate, the mechanical analysis shows that a good quality of moulding sand is found along the banks of the stream where the sample was taken, and would be suitable preferably for medium weight castings.

Stanstead County

Laboratory No. 83

Locality. Hatley township, range VIII, lot 13, approximately 2 miles west from Ayers Cliff, on the road allowance on the west side of the branch road of No. 50 highway between Ayers Cliff and Magog. It is also 6 miles from Magog or one mile south of the small settlement of Turnertown.

Description. Prospect sample. At several places along the road in question, north of the small settlement of McConnell, beds of sand and gravel had been opened up for road material. In most of these near the surface were exposures of short layers, pockets or lenses of sand having the appearance of moulding sand, some being 12 to 30 inches thick. In none of these pits were there beds of uniform thickness or fair continuity. The overburden covering these pockets, etc., ranges from 3 to 20 inches. Underlying is banded gravel and sharp sand. The road passes through fairly heavily wooded country.

The sample was collected in August 1929.

Remarks. The sample was taken not because of any likelihood of a workable deposit of moulding sand being developed but as a record that

at different places there were exposures of small amounts of such sand. Somewhere within the district a worthwhile deposit of moulding sand may exist.

In moulding sand noticed along this road, there are a few pebbles and some vegetable matter such as fine roots. The mechanical analysis indicates that the layer from which the sample was taken is at least a fair moulding sand, preferably for medium to heavy weight castings.

St. Hyacinthe County

Laboratory Nos. 76, 137

Locality. On the west bank of Yamaska river, 150 feet north of the Notre Dame cemetery in St. Hyacinthe and 40 feet above the water level of the river.

Owner. John Lavallée, St. Hyacinthe, Que.

Operator. The same.

History. Moulding sand has been produced from this deposit since 1909, when it was opened up by the present owner. The sand is now used in two foundries in St. Hyacinthe that formerly used Albany sands; it was also used in a foundry in St. Aimé since closed down.

Description. Moulding sand has been dug at different places along the property. It occurs generally in lenticular beds or pockets of uneven thickness that often pinch out entirely. They range in thickness from 2 to 18 inches, and the overburden from 6 to 10 inches. For at least 5 feet below the moulding sand lenses there is clean sharp sand.

Sample No. 76 was taken from the deposit in August 1929, whereas sample No. 137 was forwarded from the stock-piles of a foundry in St. Hyacinthe in September 1930, and is said to have been received from John Lavallée of St. Hyacinthe.

Market. From the latest information moulding sand from this locality is being used only by the foundries in St. Hyacinthe. As it has found favour there for making different shapes and weights of castings, a probable market would be Montreal only 36 miles distant by railway.

Remarks. In beds of moulding sand wide range in quality is known; but in these two samples obtained over a year apart, one by the writer while in the field and the other from the bins of a foundry, a fairly close similarity in the mechanical analyses is shown. A large tonnage could probably be developed from nearby property northward along the river. The samples showed no sign of vegetation.

As samples Nos. 84 and 131 came from farther south along Yamaska river, other places along the same valley are worth prospecting for such sands.

To the north and south of this deposit on both banks of the river the terraces may contain layers of moulding sand, but it would only be feasible to develop anything in a northerly direction, as encroachment on developed property would result to the south. The banks along the river are nearly all cleared of woods.

TABLE IX

Mechanical Analyses of Sands from Quebec

Laboratory No.	Locality, county	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards. On 6 6	On 10 12	On 20 20	On 28 30	On 35 40	On 48 50	On 65 70	On 100 100	On 150 140	On 200 200	On 270 270	Through 270 270	Clay substance	Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent: Sand	Refractoriness, Pyrometric cone equivalent: Clay	Calcium carbonate
58	Berthier	.....	.....	0·06	0·14	0·57	2·05	4·74	5·91	6·53	8·38	15·20	53·14	3·9	100·6	223	1	C	4·6 6·3 8·2	5·1 8·7 9·6	3·7 4·3 5·0	.....	.....	Nil
61	Champlain.	.....	0·21	1·62	2·78	3·74	5·00	6·60	10·85	13·33	10·29	10·82	29·64	5·2	100·1	161	2	D	4·0 6·0 8·1	10·4 10·8 12·3	6·9 7·3 5·8	.....	.....	Nil
78	Drummond	.....	0·25	0·98	1·90	3·50	7·53	12·36	18·82	19·42	12·18	8·81	11·96	2·3	100·0	117	2	C	4·0 6·1 8·1	33·1 35·1 33·5	2·2 2·1 2·0	.....	.....	Nil
79	"	.....	0·42	5·10	6·86	9·16	15·22	19·26	18·52	11·46	4·76	2·80	2·74	3·6	99·9	73	4	C	4·1 5·9 8·0	69·1 76·3 100·7	2·2 2·9 2·6	.....	.....	Nil
54	Hochelaga	.....	.....	0·28	0·32	1·36	6·65	16·58	20·69	19·08	9·54	6·16	11·41	8·0	100·1	127	3	D	4·1 6·1 7·9	13·6 20·7 33·1	3·7 3·9 4·4	7+	10+	Nil
85	Iberville	.....	1·30	14·01	24·00	22·84	14·91	5·78	2·26	1·14	0·66	0·78	3·28	8·7	99·7	41	6	D	4·1 5·9 8·0	22·1 58·9 299·0	3·7 4·7 2·6	9+	12+	Nil
86	"	.....	.....	0·16	0·64	3·60	19·91	46·08	21·92	3·42	0·51	0·31	0·81	2·2	99·6	56	5	C	4·0 6·0 7·9	98·5 149·0 175·2	2·6 1·8 1·2	.....	.....	Nil
55	L'Assomption	.....	0·11	0·16	0·24	0·38	0·70	2·13	9·76	18·28	22·71	32·49	13·3	100·3	196	2	E	6·0 7·9 9·8	6·4 8·6 8·5	9·7 8·1 7·3	6	6	Nil
71	"	.....	.....	.....	0·06	0·30	0·17	0·29	1·58	12·00	19·48	21·78	35·86	9·0	100·5	210	1	D	3·9 6·2 7·9	7·1 11·2 10·8	4·7 5·0 5·7	7+	8	

72	"	.....	.....	.....	0·40	0·04	0·32	0·78	5·56	15·12	20·23	20·10	28·66	8·8	100·2	192	2	D	4·0 5·9 8·0	8·8 11·5 12·9	4·8 5·6 5·1	8	8	Nil
70	"	.....	.....	0·13	0·17	0·16	0·44	0·98	7·11	17·78	18·04	16·74	29·14	9·5	100·2	187	2	D	4·0 5·9 7·9	7·9 12·1 13·8	3·5 3·7 4·7	8+	8	Nil
126	"	.....	.....	.....	0·01	0·03	0·25	0·72	5·44	16·46	18·38	19·26	30·94	9·0	100·5	194	2	D	4·0 6·1 8·0	9·3 12·8 14·1	4·6 4·9 5·6	9	8	Nil
84	Missisquoi....	.....	.....	0·02	0·04	0·10	0·70	3·80	11·06	17·16	14·18	13·18	30·12	9·8	100·2	181	2	D	4·1 6·1 8·0	2·8 4·0 5·4	5·5 5·8 7·1	9	12	Nil
131	"	.....	..0·22	0·28	0·34	0·78	2·24	6·34	12·18	15·78	12·00	10·74	24·74	14·5	100·1	165	2	E	4·1 6·1 8·0	4·9 7·3 9·7	6·5 7·0 6·7	9	11	Nil
59	Portneuf.....	.....	.....	0·58	0·38	0·45	1·88	2·33	7·48	12·32	14·79	17·00	37·67	4·4	99·3	198	2	C	4·0 6·0 8·1	4·2 6·1 8·4	5·3 6·3 7·9	7	8	Nil
73	Richelieu.....	.....	.....	.....	0·10	0·16	1·24	14·60	35·04	29·20	10·14	4·22	2·84	2·6	100·1	95	4	E	3·9 6·2 8·0	27·9 48·0 64·0	1·5 2·3 2·9	.....	.....	.....
74	"	.....	0·48	4·30	10·50	19·08	21·74	13·80	5·84	2·12	1·14	1·80	11·28	8·2	100·3	75	4	D	3·9 5·8 7·8	22·4 41·0 56·8	4·6 5·2 2·5	9+	12	Nil
83	Stanstead.....	.....	2·10	5·20	5·99	7·84	13·84	18·02	17·58	11·24	4·64	3·09	4·98	5·4	99·9	74	4	D	3·9 6·0 1·9	7·9 14·4 23·7	3·1 5·3 6·0	.....	.....	Nil
76	St. Hyacinthe	.....	.....	0·12	0·24	0·44	1·38	4·80	11·36	15·78	12·52	12·10	27·78	13·5	100·0	199	2	E	3·9 5·8 7·8	7·2 10·7 12·4	5·1 5·9 5·6	9+	7	Nil
137	"	.....	.....	.....	0·38	0·66	1·92	5·60	12·96	14·48	11·98	11·62	26·72	13·5	99·8	172	2	E	4·2 6·0 8·0	6·6 11·0 13·7	5·9 5·5 4·8	8	8	Nil

CHAPTER VII

MOULDING SAND DEPOSITS OF ONTARIO

Brant County

Laboratory Nos. 5, 6, 7

Locality. Brantford township. Within the property lines of the owner adjacent to the east side of highway No. 24, 2¼ miles south of Brantford. Three hundred feet north of the property is the Farrington school, and to the south a road branches off the highway to the east.

Owner. Wm. Brooks.

Operator. Secord File, 43 Port St., Brantford, Ont.

History. The property was opened by Mr. File in 1924 and by the end of 1928 it was nearly exhausted.

Description. The deposit is on the fairly level part of a piece of land recently cultivated, about two acres in extent. Directly east of the part worked for moulding sand, the surface changes abruptly, sloping towards Grand river. Only a small part of the field remained to be worked when the samples were collected in June 1928. Samples were chosen in this field at widely separated parts of the plot remaining undeveloped, No. 5 being collected within 10 feet of the highway allowance on the west side of the property about 490 feet from the school, and No. 6 at a distance of 210 feet in an E.N.E. direction from No. 5, and at a slightly lower elevation. Sample No. 7 was obtained at a distance of 185 feet in a N.N.E. direction from the same reference point.

At each spot the bed of moulding sand was from 12 to 15 inches thick, and the overburden averaged 6 inches. The producer said that the thickness was about the same over that part from which the moulding sand had been excavated. Beneath the layer of moulding sand is fine sharp sand.

One of Mr. File's assistants was present when the samples were taken.

Market. The sands were sold to at least three foundries in Brantford, transport being by truck.

Remarks. All the sands were of reddish brown colour. They contained no pebbles or organic matter such as roots, etc. The sand represented by sample No. 5 is more suitable for medium to heavy weight castings, whereas samples No. 6 and 7 are more suitable for light to medium weight castings.

Although this particular locality would be a producer of moulding sand for only a short time after the samples were collected, the pit was sampled for the purpose of record.

It is worth noting that any locality in this district at about the same elevation would be a good field for prospecting for similar deposits of moulding sand. To add weight to this supposition, samples Nos. 8 and 9 from the same county and samples Nos. 1, 2, 3, 4, 103, and 129 from Wentworth county came from localities at about the same elevation.

Laboratory No. 8

Locality. Brantford township. Within the property lines of the owner at a distance of 40 feet from the road, which has a southwest direction in the extreme southern part of concession II, lot 33.

Owner. McPherson farm, leased to James Maher.

Operator. W. J. Eisenbach, 64 Darling St., Brantford, Ont.

History. Mr. Eisenbach said that he opened up this property several years ago.

Description. The deposit lies in a cleared piece of ground having a gentle slope to the east. The elevation above sea-level is 770 feet. Only an irregular rectangular plot, 60 by 80 feet in dimension, has been excavated. The moulding sand bed, which has fair uniformity and continuity, averages 27 inches in thickness with an overburden of 10 inches. The underlying material is a lighter coloured sharp sand. There is no doubt that a large tonnage is still available here, particularly towards the east or northeast. The locality from which sample No. 9 was collected lies one-quarter of a mile in a northeast direction. The samples were collected in June 1928.

Market. Moulding sand from this deposit was sold only to the foundries in Brantford. Trucks were used in transporting it the $3\frac{1}{2}$ miles, the greater part being over paved road.

Remarks. The moulding sand is of a reddish brown colour, with a few small pebbles but no organic matter such as fine roots, etc. The sand would be quite suitable for medium to heavy weight castings. The deposit is thought to have been formed in the same manner as that occurring $2\frac{1}{4}$ miles south of Brantford described under sample Nos. 5, 6, and 7.

Laboratory Nos. 9, 10

Locality. Brantford township. Four hundred and fifty feet north of the road, which has a northwest direction in the extreme southern part of concession II, lot 34.

Owner. Wm. Cameron, R.R., Brantford, Ont.

Operator. The same.

History. Mr. Cameron opened up this property several years ago but has sold sand from it only intermittently.

Description. The deposit is situated in a cleared piece of ground having a gentle slope to the east. The height above sea-level is 765 feet.

Only a very small area has been developed, a few isolated patches of moulding sand having been excavated, but only two of the most promising were sampled. One part represented by sample No. 10 is 355 feet west of the other, represented by sample No. 9. Sample No. 10 came from a layer 18 inches thick, whereas sample No. 9 was from a bed 15 inches thick. Apparently the bed becomes thinner in an easterly direction. The overburden in both cases is from 8 to 10 inches thick, the underlying material being fine sharp sand. The moulding sand probably continues with increasing thickness in a southwest direction from where sample No. 10 was taken, because on the adjoining McPherson farm, from which sample No. 8 was collected, it is 27 inches thick. Probably for the entire intervening quarter mile the moulding sand bed continues uninterrupted.

The samples were obtained in June 1928; Mr. Cameron was present.

Market. The moulding sand from this deposit was sold in Brantford. There is paved road for the greater part of the 3½ miles to Brantford.

Remarks. The moulding sand is of a reddish brown colour, and has very few pebbles and no organic matter such as roots. Of the two samples No. 10 is the coarser grained, but both are suitable for light to medium weight castings. Of the two sands No. 10 is better for heavy castings.

The sands of both samples have greater fineness of grain than sample No. 8 collected on the adjoining McPherson farm to the west. These three sands as a group show that on going eastward the fineness of grain increases. The same gradual change is found in the deposit in this county represented by samples Nos. 5, 6, 7. This substantiates the belief that all these sands were formed by wave action along the western shore line of a glacial lake.

Laboratory No. 115

Locality. Burford township. South half of lot 14, concession IX. On the south side of the road allowance of the New Durham and Brantford road, ⅞ of a mile southwest from Harley on the New Durham and Brantford road.

Operator. None.

Description. Prospect sample. A cut-bank along the roadside showed a bed of sand that had the appearance of being usable for moulding. The bed is not of uniform thickness; it ranges from 12 to 18 inches. The thickness of the overburden is also uneven, ranging from 9 to 12 inches. There is no sharp line of demarcation from the underlying bed of fine sharp sand. There is cleared land on either side of the road to the extent of three or four acres from which moulding sand might be dug.

The sample was collected in October 1929.

Market. There are foundries within a fairly short radius at Brantford, Woodstock, Ingersoll, and Tillsonburg. The distance from Harley on the Canadian National railway to the nearest of these places, Brantford, is 14 miles. From the deposit to Harley, the shipping point, is nearly a mile, and the road is good. Trucks could be used, as excellent roads exist in this part of the province.

Remarks. From the mechanical analysis it appears that the sand is suitable for moulding, preferably for medium to heavy weight castings.

One reason for sampling the deposit was that it is close below the elevation where beach remains of the glacial lake Arkona may have been formed, some of the best deposits of moulding sand occurring on the offshore floor of glacial lakes. As this is only a prospect sample, taken from a very obvious and easily accessible place along the roadside, it is possible that elsewhere at the same elevation, 865 feet above sea-level, ponded morainic sand and clay was worked over by the waves of the ancient lake to form thicker and better deposits of moulding sand. Pockety deposits of moulding sand have been known for years several miles west of Brantford, and the sand found limited application in the foundries of that city.[1]

Bruce County

Laboratory No. 99

Locality. Brant township. On the south side of the road allowance along the north boundary of lot 24, concession B, west of the Laura road.

Operator. None.

Description. Prospect sample. This place was sampled on the suggestion and with the help of Mr. A. G. Hampson, proprietor of the Saugeen Foundry of Walkerton, Ont. Most of the surrounding country is fairly level and cleared of timber. A fairly good section of the surface deposits was observed in the ditch along the roadside. Where the sample was taken, the moulding sand layer is 2 to 3 feet thick, although at most other spots along the ditch it is less than 2 feet. The top soil is very shallow, ranging from 3 to 6 inches in thickness. Free-running sharp sand underlies the moulding sand.

The sample was obtained in October 1929.

Market. The nearest place with foundries that might use sand dug in this locality is Walkerton, 11½ miles south on the Laura road. The nearest shipping point is two miles south at Pinkerton, on the Canadian National railway.

Remarks. The results of the mechanical analysis suggest that the sand is more suitable for medium to heavy weight castings. Mr. Hampson has tested it in his foundry since the locality was sampled, and has found it very good for iron and for brass.

The district lying between Teeswater and Saugeen rivers is a promising place to prospect for moulding sand deposits, which were probably formed by the wave action of glacial lake Algonquin working over portions of the Goderich moraine.

Laboratory No. 140

Locality. Brant township, concession II, lot 18.

Owner. James Monahan, Walkerton, Ont.

Operator. The Saugeen Foundry, Walkerton, Ont.

[1] Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1918, p. 67.

History. The deposit was discovered by Mr. A. G. Hampson, proprietor of the Saugeen Foundry, who has worked it solely for his own use since about 1919.

Description. The sample was taken from the stock-pile of the Saugeen foundry. The land from which it is obtained is cleared of all bush or timber. The sand occurs at different places and not in any continuous layer. These lenses of sand, 8 to 10 inches thick, have an overburden generally from 10 to 12 inches. The underlying material is a mixture of sharp sand and fine gravel.

The deposit is not large but has supplied the requirements of the user and is now nearly exhausted. Other places in the near vicinity on the west of the Saugeen river may be found to contain moulding sand.

The sample was taken in October 1929.

Market. The only market for moulding sand from such a small deposit would be Walkerton, located 1¼ miles to the south.

Remarks. Although the sand has an undesirable ingredient, calcium carbonate, to a small extent, it has been possible to make excellent castings in it of various weights and shapes.

Durham County

Laboratory No. 132

Locality. Hope township. In the first concession, at two places north of Port Hope.

Operator. Thos. Hayden & Sons, Port Hope, Ont.

History. Moulding sand from various places north of Port Hope is said to have been used in the foundry of the present owners since 1855.

Description. The sample was obtained from the bins of the foundry of Thos. Hayden & Sons, Port Hope, in August 1930. The deposits from which it came are small and pockety, and the operator does not regard them as being of commercial value other than for local use. The lenses, which occur in undeveloped land outside the city, are very thin, being from 2 to 6 inches thick. The overburden that must be removed to recover this amount is excessive, being from 1 to 2 feet thick. The underlying material is sharp sand.

Market. Only one foundry in Port Hope is believed to have used local moulding sand. The proximity and the low cost of working it favour its use.

Remarks. The tests on this sand show that it would be suitable for medium to heavy weight castings. The sand has been found satisfactory in the foundry of the operator. No information was obtained that any prospecting for larger deposits had been done, all needs being amply satisfied from the present workings.

Laboratory No. 121

Locality. Hope township; 1,100 feet north from the No. 2 highway along the road allowance between lots 25 and 26, concession III. This is adjacent to the farm of Arthur Purcell, R.R. No. 3, Port Hope, Ont.

Description. Prospect sample. On the advice of Mr. Hayden, a foundryman from Port Hope, several places along the No. 2 highway, west of Port Hope, were examined, and the place sampled held out the best promise. A low ridge, cleared of bush or timber, with its axis in an east and west direction, crosses the road. Along the road allowance much of the crest of the ridge has been removed, providing a good section. On either flank of the ridge, which is about 300 feet wide at this point, a layer of sand is exposed having the characteristics of a moulding sand. The area on the south flank is more promising than that on the north.

The sand averages about one foot in thickness, under a shallow overburden of nearly 6 inches. It is underlain by free-running sharp sand. No effort was made to sample the continuation of the ridge either east or west of the road allowance; from its uniformity of shape it is probable that the layer extends in both directions.

The sample was obtained in November 1929.

Market. It might find slight application at Port Hope or Cobourg, 6 and 13 miles, respectively, east on the No. 2 highway.

Remarks. This sand should be more suitable for lighter weight castings than that used locally for so many years, which comes from north of Port Hope. It contains much vegetable matter.

Essex County

Laboratory No. 107

Locality. Colchester South township. East half of the south half of lot 18, concession III, 450 feet northeast of the farm house occupied by Peter Geauvreau.

Owner. Frederick A. Lee, 21 Laurel St., Kingsville, Ont.

Description. Prospect sample. This is from a level piece of cultivated land, which appears to be heavy clay but never holds water long even after a heavy rainfall as clay lands usually do. It produces exceptionally good crops, and the owner suspected the soil was more sandy than it looked. A bed of moulding sand 18 to 24 inches thick was discovered beneath an overburden 8 to 12 inches thick. White sharp sand underlies it. It appears to be an isolated bed in this field.

The sample was obtained in October 1929.

Market. The proper market would be Windsor and vicinity and Kingsville. Moulding sand that was once produced in Essex county found use at the latter place. The deposit represented by sample No. 107 is only 6 miles from Kingsville.

Remarks. The results of the mechanical analysis show that the sand would be very suitable for heavy to medium weight castings.

Laboratory No. 106

Locality. Gosfield South township, concession III, lot 10. About ½ mile east of No. 3 highway (Talbot road).

Owner. Zachariah Wigle, Ruthven, Ont.

History. Moulding sand was produced by the late Horatio Wigle for 25 years ending about 1907, William Fox being the manager of the pits for the whole time. The production came from parts of lots 10 and 11, near Ruthven, and from concession III near Leamington. An area of 20 acres in lot 10, and 30 acres in lot 11, near Ruthven, and 20 acres near Leamington was worked. The sand from the lots near Ruthven is said to have been used in the making of heavy weight castings, whereas that from Leamington was more suitable for lighter weight castings. It is estimated that 80 tons of moulding sand for each working day for 8 months of each year was excavated. By far the greater part of the sand was exported to American points, including Cleveland, Detroit, Saginaw, Sandusky, and Toledo, mostly by lake boats. Some was shipped to Canadian points including Walkerville and Windsor.

Description. This deposit is of historical interest but as no remnants of moulding sand could be found in the old workings, another place ¼ of a mile farther west which had not been worked was sampled. The land here and in the old pits was mostly cleared of timber and bush and has a gentle even slope to the west. At the place sampled, the sand occurred in pockets only, in contrast to the continuous bed that occupied the now depleted area. The pockets or lenses are only 12 inches thick, with an overburden of 15 inches, whereas in the old workings it is said that the average thickness of the moulding sand was over 18 inches. Underlying the moulding sand is fine sharp sand.

The sample was collected in October 1929, with the assistance of Mr. Zachariah Wigle and Mr. Rinaldo Wigle of Kingsville. The latter is a son of the former producer and most of the historical notes were secured from him.

Market. The nearest place where there is a foundry is Kingsville, 5 miles to the west. Walkerville and Windsor, two important foundry centres, are only 32 miles distant over the No. 3 highway.

Remarks. The mechanical analysis shows that the sand must be finer grained than that formerly produced. It would not be suitable for heavy weight castings as that formerly worked was claimed to be. Some moulding sand may still be recoverable from the old workings.

Other moulding sand deposits could probably be found in this district at or about the same general elevation of the deposit now worked out, which is nearly 720 feet above sea-level.

Laboratory No. 108

Locality. Gosfield South township, concession III, south ½ lot 8. About 10 feet north of the fence on the road allowance between concessions II and III.

Owner. Wm. Conklin, Kingsville, Ont.

Description. Prospect sample. Exposures of moulding sand appear in the ditch at intervals for some distance along the north side of the road allowance between concessions II and III, facing lot 8. The longest exposures lay along a field west of the house occupied by the lessee of the farm, Mr. Frederick Tapping, R.R. 2, Kingsville, Ont. In this field moulding sand probably extends over an area of 9 acres, the thickness ranging from 12 to 18 inches. The overburden is fairly light being from 4 to 6 inches. At the time the sample was collected, which was in October 1929, the field had recently been ploughed, and at several places the moulding sand had been turned up to the surface. Beneath the moulding sand is fine-grained sharp sand. The locality is roughly a mile west of the district from which moulding sand was exported to the United States for a period of at least 25 years.

Market. The sand could be shipped from Ruthven on the Père Marquette railway. Kingsville, the nearest place with a foundry, is 5 miles west.

Remarks. The mechanical analysis shows this is an ideal moulding sand for heavy to medium weight castings.

Grenville County

Laboratory Nos. 43, 44, 45, 46

Locality. Edwardsburg township, concession I, south half of lot 16. On the farm of the owner just north of the No. 2 highway. Samples Nos. 43 and 46 came from east of the private road from the highway to the farm, and samples Nos. 44 and 45 from the west. Samples Nos. 43 and 44 came from farther north of the highway and were from places 550 feet apart. Sample No. 45 was from directly west of the barn.

Owner. Alexander Patterson, R.R., Cardinal, Ont.

History. Moulding sand was produced from this farm prior to 1923 by William Lacey [1] of Prescott, Ont., and has been used in Brockville, Cardinal, Kingston, Morrisburg, and Ottawa. A Brockville foundry discontinued its use in favour of equally good moulding sand obtainable much nearer and west of the city.

Description. At several cultivated parts of the farm, moulding sand has been excavated from a terrace less than $\frac{1}{8}$ of a mile from the St. Lawrence river. The cross-section at places sampled is as follows:

	Overburden	Moulding sand
Sample No. 43..	8–10 inches	24 inches
" " 44..	12 "	24–26 "
" " 45..	12 "	20 "
" " 46..	12 "	26–28 "

As the thicknesses of the overburden and of the moulding sand are so nearly constant it is probable that the samples represent a continuous bed. Sharp sand underlies the moulding sand at each place. As the river is approached the amount of bond in the sand increases, samples Nos. 45 and 46 having much more than samples Nos. 43 and 44.

[1] Mines Branch, Dept. of Mines, Canada, Rept. No. 549, p. 102.

The samples were collected in August 1928, with the help of Mr. Patterson.

Market. The nearest shipping point is Cardinal on the Canadian National railway, 2½ miles eastward. Truck transport could be used to advantage owing to the proximity of the No. 2 highway.

Remarks. The mechanical analyses of the samples show that different grades of moulding sand can be obtained from the property, which may account for a difference of opinion prevalent regarding the use of the sand. Each grade should be suitable for a general weight or shape of casting.

Only one of the sands, represented by sample No. 43, had any organic matter such as roots.

Halton County

Laboratory No. 92

Locality. Esquesing township, concession II, southeast quarter of lot 10, on the farm of the owner, 30 feet southwest of the road from Milton to Speyside.

Owner. H. Smith, R.R. 3, Milton, Ont.

History. Moulding sand from this farm was used about the year 1920 in the foundry of David Anderson of Milton, 4¼ miles distant, but only for making light weight castings, and its use ceased with the closing of the foundry.

Description. Prospect sample. Much moulding sand has been dug from the deposit in a part of the lot covered with bush. The sand occurs in pockets ranging in thickness from 9 to 18 inches. The overburden is uneven, ranging in thickness from 2 to 9 inches. The underlying material is fine sharp sand. It is also reported that moulding sand was produced from the adjoining farm to the north, owned by W. Hampshire, but none was found worth sampling.

The sample was collected in September 1929.

Remarks. The mechanical analysis shows that the sand is suitable for light to medium weight castings. Owing to the irregular distribution of the pockets probably neither this deposit nor any nearby could be developed on a commercial basis for shipment to distant points. It might suffice for local foundries.

Laboratory No. 120

Locality. Trafalgar township, concession VIII, south half lot 6, ½ mile northeast from Drumquin. One hundred and seventy-five feet northwest of the road from Omagh to Streetsville.

Owner. J. E. Blackall, R.R. 2, Hornby, Ont.

Description. Prospect sample. Patches of yellowish sand were noticeable over nearly the entire area of a field having a gently rolling surface, in which recent ploughing had caused the upturning of the subsoil. The

sample was collected from that part of the field where most sand had been turned up. The overburden is very light, being 6 to 9 inches thick. The moulding sand layer ranges from 11 to 16 inches. In other parts of the field the moulding sand bed retains the same thickness, the overburden becoming greater.

In the adjoining lot 5, southeast of the road, similar patches of moulding sand were visible in the ploughed part but the showings were not so large or so numerous. No sample was obtained from this field.

The sample was collected in November 1929.

Remarks. The mechanical analysis indicates that the sand should be used preferably for medium weight castings. It contains much vegetable matter that could be riddled out.

The nearest market would be Toronto, 30 miles by highway. The nearest shipping point is Hornby on the Canadian National railway, 3 miles distant.

Kent County

Laboratory No. 109

Locality. Howard township, concession V, lot 10; and concession X, lot 10.

History. From about the year 1895, moulding sand dug in different places in Howard township was used for 30 to 35 years in a foundry in Ridgetown by Middleditch Bros. The greater part of this moulding sand was dug by Mr. David Turner, a retired moulder of the foundry, now living at Mull, Ontario. Most of the information concerning these deposits was given by him. The bulk of the sand used in the foundry came from these two places. Mr. Turner believes that moulding sand could also be obtained at the following places, namely: (1) the Whitman farm at the corner of Erie St. and the 7th concession; (2) farms located near lot 78 south of the Talbot road; and (3) other farms lying between Ridgetown and Thamesville.

Description. The sample of moulding sand was taken in October 1929, from the sand bins of the Universal Machine and Tool Works at Ridgetown by Mr. Dell Cole, the manager. It was laid in by Mr. Turner and presumably came from concession V or X, and is representative of the moulding sand regularly used in this foundry. The moulding sand beds are generally 12 inches thick and have a shallow overburden of about 6 inches. There is probably sufficient only for local needs.

Remarks. From the mechanical analysis it is evident that the sand would be best suited for light weight castings. This part of the country is a good field for prospecting.

Leeds County

Laboratory Nos. 63, 64

Locality. Elizabethtown township, concession I, east half lot 22. Sample No. 63 was collected at a distance of 2,630 feet north of the No. 2 highway and 430 feet west of the road between lots 21 and 22. Sample No. 64 was collected 2,930 feet north and 350 feet west of the same roads.

Owner. Arthur Paul, R.R. 3, Brockville.

Operator. The same.

History. Moulding sand from this farm was first used in a foundry in Brockville about 1898 and was produced by T. H. Bresee the owner at that time. The present owner has produced from it intermittently since 1923.

Description. The portion of the property[1] underlain by moulding sand has a rolling surface partly covered with a sparse growth of bush, and lies between outcrops of granite and sandstone. A large area has already been stripped of its moulding sand but some still remains workable. The beds extend into the adjoining lots 21 on the east and 23 on the west. The moulding sand layer is uniform in thickness, being about 30 inches. The thickness of the overburden is from 6 to 12 inches. The moulding sand is underlain by sharp or loamy sand.

The samples were collected with the help of the operator in September 1928.

Market. Most of the sand has been used in the foundries at Brockville, 2½ miles to the east. Transport is by truck over No. 2 highway.

Remarks. Moulding sands from the property have been used extensively in Brockville. Prior to their use this market was supplied almost solely from New York state.

Laboratory No. 125

Locality. Lansdowne township, concession I, east half of lot 9, 755 feet southeast from the owner's house.

Owner. Daniel Vanorman, R.R. 2, Lansdowne, Ont.

Description. Prospect sample. A ridge cleared of bush but uncultivated, its axis lying roughly northeast-southwest, is visible and is accessible from highway No. 2. About one-quarter acre has been removed, providing a good exposure of the deposit; pockets of moulding sand of irregular size and distribution are seen, having a thickness of 8 to 10 inches and an overburden of 6 to 9 inches. Underlying the moulding sand is sharp sand and some fine gravel. The sample was taken near the most northerly point of the ridge from a number of pockets. Other pockets were found southwestwards along the ridge in a few of the auger holes made. There seems to be little moulding sand in this ridge, and others near at hand were not examined.

The sample was obtained in November 1929.

Market. For the amount of moulding sand available the best market would be Gananoque, 7 miles to the west on highway No. 2.

Remarks. The mechanical analysis shows that this should be a good moulding sand for general purpose work. It contains a little vegetable matter but this could easily be removed in the foundry by riddling.

[1] Mines Branch, Dept. of Mines, Canada, Bull, No. 21, page 9; *also* Ont. Bureau of Mines, vol. XXVII, Part II, p. 62.

A good district for prospecting is in the southern part of the county towards the St. Lawrence river, between the localities described above and under laboratory Nos. 63 and 64, 2½ miles west of Brockville. J. F. Wright found a sand deposit under a clay bed near the Mallorytown Consolidated School that might be used for moulding, but at such a depth that it would be difficult to excavate at a profit. It lies 11 miles northeastward from the Vanorman property. In prospecting this district from 3 miles east of the Vanorman property to a point 2 miles east of Brockville, map publication No. 1964, prepared by Dr. Wright and included in his memoir [1], would be useful. Moulding sand, if present, would be found only in those parts marked on the map "post glacial and glacial."

Lennox and Addington County

Laboratory No. 124

Locality. Camden East township, concession I, north half of lot 23, one-half mile west of Camden East.

Description. Prospect sample. Patches of moulding sand are noticeable at a few places along either side of the road from Newburgh to Camden East. The sample was taken from the best exposure which is in a terrace along the south bank of Napanee river. For a distance of over 75 feet a bed 6 to 10 inches thick could be traced, although it may not be continuous. The underlying material is sharp sand. Auger holes were made as far as 100 feet south of the road and in most of these moulding sand was penetrated. Most of the land is free from bush or timber.

The sample was obtained in November 1929.

Market. The best market for production from this locality would be Napanee, 8 miles to the southwest over a good road. The foundry at Yarker, 5½ miles distant, would not be a market as it is supplied from a deposit of a good grade of moulding sand only 1½ miles to the north near Varty lake.

Remarks. The mechanical analysis shows that the deposit is of only a fair grade of moulding sand that possibly cannot be worked at a profit owing to the shallow thickness of the bed, but places might be found along the banks of the Napanee river where better beds exist.

Laboratory No. 68

Locality. Camden East township, concession III, south ½ of lot 42, 550 feet north of the road between concessions II and III, and 125 feet west of the Canadian National railway.

Owner. Seymour F. Ball, Colebrook, Ont.

Operator. Yarker Foundry Co. (A. A. Connoly, Manager), Yarker, Ont.

History. Moulding sand has been produced and used by the operator of the property in nearly every year since 1885.

[1] Wright, J. F,: Geol. Surv., Canada, Mem. 134 (Rept. 1986), p. 53.

Description. The deposit is on very even ground sloping gently to the west into marshy land near Varty lake. The moulding sand bed has been excavated from a wide area but is still far from depleted. A few trees are scattered over the undeveloped part. There is a private road from the owner's house parallel to the railway tracks. The moulding sand layer is uniform both in extent and thickness, the latter being 12 inches. The thickness of the overburden is only 6 inches. The underlying material is fine sharp sand.

The sample was collected in September 1928.

Market. The only market that has been supplied with moulding sand from this deposit is Yarker, 1½ miles to the south.

Remarks. The sand has been used for general purpose work on different sizes and shapes of castings and has given good results. The mechanical analysis shows it to be a good moulding sand. There is much vegetable matter in the form of fine roots but this would be removed in riddling.

Lincoln County

Laboratory No. 141

Locality. Niagara township, east half of lot 17. A short distance west of the road along the Niagara river, about half way between Queenston and Niagara-on-the-Lake.

Operator. None.

Description. The sample and most of the information concerning the neighbourhood were supplied by Mr. Wm. R. Barnes, 243 Cumberland Ave., Hamilton, in June, 1931. No sand was shipped from this area prior to that date. It is a highly bonded moulding sand but not uniform and the area is probably small. Railway shipping facilities are close at hand.

Remarks. The mechanical analysis confirms Mr. Barnes' view that the sand is heavily bonded. There is no doubt that it could be used as others from the Hamilton to Niagara district have been.

Mr. Barnes also pointed out six other places in this township where moulding sand occurs, as follows: Four places in the west half of lots 16 and 17, all within one-half mile of the locality where sample No. 141 was taken; one place in the east half of lot 39 about one-quarter mile west of Queenston station on the Michigan Central railway; one place in the east half of lot 14 about one-half mile north of Virgil.

No samples were obtained from these six localities.

Locality. Grantham township, north of St. Catharines.

Description. Mr. Wm. R. Barnes, 243 Cumberland Ave., Hamilton, Ont., stated [1] in June 1931:

[1] Personal communication.

"Moulding sand has been teamed into a St. Catharines foundry for the past few years. Believe this pit has been discontinued this year owing to deterioration in quality. Believe there is a certain amount of sand in this district; of good clay content and medium grain size; enough to supply local foundries."

No sample was taken from this district.

Middlesex County

Laboratory No. 112

Locality. London township. In the east section of London near Highbury and Brydges Streets.

Owner. E. Leonard & Sons, 351-381 York St., London, Ont.

Operator. The same.

Description. Moulding sand has been produced by the owners for their own use since about 1926 on the unbuilt lots. Sand was dug from a few selected spots. It is understood that the thickness is not uniform and the moulding sand bed lacks continuity. There is only a light overburden. The sample tested was taken from the storage bins of the owner's foundry in October 1929.

Remarks. It is said that the sand is always blended with a stronger bonded moulding sand, as it burns out quickly if used alone.

Moulding sand has also been dug on two other areas within a mile from where this sample is said to have been produced. Two other London firms produce and use it in their foundries in the same way as is done by the Leonard foundry. In one case the sand is blended with a highly bonded imported moulding sand.

By blending, the permeability of the stronger bonded moulding sand is much improved. One firm used equal quantities of local and imported moulding sand.

Nipissing District

Laboratory No. 203

Locality. Askin township, $\frac{3}{4}$ mile north of Rabbit Lake siding at mileage 58 on the Temiskaming and Northern Ontario railway.

Description. The following description is given by Messrs. Fidler and Nelson, 253 Victoria St., Toronto, who contemplate developing the property. The property consists of approximately 80 acres partly covered with second-growth timber and saplings. The moulding sand bed is from 2 to 10 feet deep with very little overburden. The underlying material is sand having less bond content. A road has been built into the property from the railway.

The sample was obtained from Messrs. Fidler and Nelson in January 1935.

Remarks. The mechanical analysis indicates that the sand would be suitable for medium to light weight castings. Another grade of moulding sand much heavier in clay substance is obtainable from the same locality. About one mile farther north there is another deposit from which a coarser grained moulding sand may be secured.

Norfolk County

Laboratory No. 117

Locality. The old Baker homestead, Charlotteville township, concession IX, east half of lot 24, 90 feet west of the Townline road between Woodhouse and Charlotteville townships.

History. Moulding sand was used from this farm for several years by the Polley foundry in Simcoe about 1880, in the making of all sizes and shapes of castings, and apparently was satisfactory. It was teamed to Simcoe, a distance of about 2 miles.

Description. The land in which the excavations were made has a gentle slope to the southeast. At present a new growth of bush covers part of the old workings, which extend over 2 acres and appear to have a depth of nearly two feet. In the small remnant from which the sample came, the top soil had a thickness of 10 inches, and the moulding sand was 12 inches. Below this was sharp sand.

The adjoining land to the north, west, and east was examined but no continuation of the bed was picked up.

The sample was obtained in October 1929, with the help of Robert Coates of Norfolk St., Simcoe, who is a moulder. He also supplied the historical data.

Remarks. This depleted deposit was sampled in order to determine the quality of the sand used by one of the old foundries of the province. According to the mechanical analyses of this and of the sand (No. 116 not tabulated), it is evident that this (No. 117) is the better of the two.

Moulding sand may possibly be found in the country between where these two sands were collected, as there is no change in the topography. If sand exists, that farther east should be the better.

Laboratory No. 118

Locality. Townsend township, concession VIII, east half of lot 4; 200 feet west of the Lake Erie and Northern Railway siding.

Operator. The most recent operator is Wm. R. Barnes, 243 Cumberland Ave., Hamilton, Ont.

History. A firm in Galt reports having bought moulding sand in 1923 and 1924 from this locality from John Seibert of Dunkirk, N.Y., and that it was satisfactory. From the office of the Lake Erie and Northern

Railway at Waterford it was learned that Mr. Seibert made shipments to several places in western Ontario. Mr. Barnes shipped both moulding and core sand in 1927 and 1928, some of it going as far east as Montreal.

Description. Most of the land from which the moulding sand has been recovered is partly covered with bush and is of a slightly rolling nature, and only the best sands have been excavated so far. From where the sample came the moulding sand layer has a thickness of 18 inches, the overburden only about 8 inches. The underlying material consists of layers of fine and coarse, clean, sharp sand, which has to some extent been utilized for core making. There is, probably, still a large supply of moulding and core sand in the locality.

The sample was obtained in November 1929.

Market. Shipping facilities from this locality are excellent, the deposit being less than $\frac{1}{8}$ of a mile from the Waterford siding of the Lake Erie and Northern railway, and two other railways, the Michigan Central and the Toronto, Hamilton and Buffalo, pass through Waterford. Highway No. 24 could be used if truck transport were desired. Many centres of consumption are within easy reach, the nearest important one being Brantford.

Remarks. The mechanical analysis shows that the sand would be best suited for average weight castings.

The cost of development would be lessened if a sale were found for the core sand exposed after the moulding sand has been stripped from the deposit.

The sand may have been formed by wave action along the shores of the same glacial lake that the writer believes was instrumental in the formation of other deposits, such as those in Brant county represented by samples Nos. 5, 6, 7, 8, 9, 10 and those in Wentworth county represented by samples Nos. 1, 2, 3, and 4.

Mr. Barnes, 243 Cumberland Ave., Hamilton, stated[1] that there was moulding sand south and southeast of Waterford, at the following localities:

Concession VIII, lot 7, east of the Fair grounds.
Concession VIII, lot 7, east of No. 24 highway.
Concession IX, lot 8, south of the cemetery.

Oxford County

Laboratory No. 104

Locality. Nissouri East township, concession XII, east half of lot 23, 370 feet northwest of the owner's house and 425 feet west of the road between concessions XII and XIII.

Owner. William Pickering, Lakeside, Ont.

[1] Personal communication.

History. According to Charles Mitchell of Lakeside in 1929, his uncle Marshall Mitchell sold moulding sand for a number of years around 1889 to foundries in St. Mary's, one of which is now owned by C. Richardson & Co. This moulding sand was excavated from the farm, then owned by James Fletcher but now by William Pickering, by whom, however, none has been produced.

Description. The topography of the surrounding country is typically morainic. Most of the farm is cleared of timber and some is cultivated. On the flank of a cultivated hill, northwest of the owner's house, the moulding sand is so near the surface that it is turned up by the plough and from a place thus exposed the sample was taken. Here the top soil had a thickness of 6 inches or more, whereas in most of the field it was 12 inches. The underlying material is fine, sharp sand. Apparently there is much moulding sand available for development on the flanks of other hills on this or adjoining farms. On the flank of the hill from which the sample came, at least two acres of moulding sand had been turned to the surface by the ploughing, and it can be expected at other places, for there were signs of it along the roadside one-quarter of a mile north of Mr. Pickering's house. Here the thickness is about 9 inches.

The exact spot where Mr. Mitchell dug his sand was not determined.

The sample was obtained in October 1929.

Market. The nearest market to this deposit is St. Mary's, 10 miles distant. Other cities and towns such as London, Stratford, Ingersoll and Woodstock could easily be supplied, either by highway or railroad. Lakeside on the Canadian Pacific railway is only slightly more than one mile distant.

Remarks. The results of the mechanical analysis were encouraging. The sand could be used for the general run of castings. Its analysis should be compared with that of sample No. 105, which follows.

Laboratory No. 105

Locality. Nissouri East township, concession XIII, west ½ lot 25. One-quarter of a mile northeast from the owner's house.

Owner. Christopher McLeod, Lakeside.

Description. Prospect sample. The deposit is similar to that described under laboratory No. 104, and is less than a mile north of it. Moulding sand had been turned to the surface by the plough on the flanks of several morainic hills of low relief. The thickness of the top soil is only 6 inches, but where the plough failed to disturb the moulding sand the depth is 9 inches or more. The thickness of the moulding sand layer ranges from 12 to 18 inches, most of it being at the lower figure. The underlying material is fine, sharp sand. The sample was taken where the moulding sand is nearest the surface. Mr. McLeod stated that much similar sand could be found one-eighth of a mile due east near a small lake. It should be possible to recover a large tonnage of moulding sand from this farm.

The sample was taken with the help of Mr. McLeod in October 1929.

Market. Moulding sand could be very conveniently shipped from here to many cities or towns such as St. Mary's, Stratford, London, Ingersoll, and Woodstock, because there are excellent highways. St. Mary's is only 9 miles distant. The nearest railway shipping point, Lakeside, on the Canadian Pacific railway is less than half a mile distant.

Remarks. The sand is of a slightly better grade than that represented by laboratory No. 104 which has been used in St. Mary's.

Laboratory No. 114

Locality. Oxford East township, concession VIII, south half of lot II, a quarter of a mile north of the road along the south of the above concession.

Owner. Estate of George H. Losee, Burgessville, Ont.

History. According to Mr. T. L. Lancaster, provincial immigration inspector, Mr. Losee produced moulding sand from the Losee farm for a number of years about 1890. Mr. Merville Griswold, living on the adjoining farm to the west, said Mr. Losee had sold moulding sand and teamed it for a distance of $6\frac{3}{4}$ miles to a foundry in Norwich, believed to have been owned by one William Avey, long out of business.

Description. The sample was taken from the east of the old workings easily noticeable on the north side of a prominent ridge with axis nearly due east and west crossing the farm. A large part of the ridge could still be worked; it is easy of access and entirely free from timber or bush. The moulding sand has a thickness of 9 to 15 inches and an overburden of 4 to 12 inches. The underlying material is medium sized, sharp sand. On the Griswold farm to the west is another ridge in which is a bed approaching moulding sand in quality, but with insufficient bond to serve while better sands are easily obtainable. The sample was taken in October 1929 with the help of Mr. Griswold.

Market. Moulding sand could easily be trucked to Woodstock, Ingersoll, or Tillsonburg. The nearest shipping point by rail, which is one and a half miles distant, is Burgessville on the Canadian National railway.

Remarks. This should be a good moulding sand for use in making average weight of castings. It has only a slight amount of vegetable matter. The intervening eight miles of country between here and the locality in Brant county to the east represented by laboratory sample No. 115 should be a promising field for prospecting.

Simcoe County

Laboratory No. 96

Locality. Innisfil township. Two miles east of Allandale on highway No. 11, on the property of the owner and about 75 feet southwest of that highway.

Owner. H. A. Wice, R.R. 1, Allandale, Ont.

Description. Prospect sample. A large excavation has been made into an Algonquin glacial lake beach deposit and a considerable quantity of gravel obtained for road building and other construction purposes. Above the gravel is an occasional lens of very coarse-grained moulding sand having a lateral extent of 2 to 8 feet and a thickness of 12 to 15 inches; the thickness of the overburden is usually 4 to 12 inches.

The sample was collected in October 1929.

Remarks. The mechanical analysis shows that the sand would be fair for heavy castings. Although the quantity is small, more extensive pockets or even beds may be found on the adjoining properties or in similar beach deposits along the south shore of Kempenfeldt bay.

Laboratory No. 95

Locality. Oro township, concession III. On the road allowance on the southeast side of highway No. 11, opposite the northwest quarter of lot 19, 2,100 feet northeast of the junction of the road between concessions II and III.

Description. Prospect sample. A good cross-section of part of the material forming the side of the highway was obtained from a ditch recently deepened for a length of 150 feet. A layer of moulding sand 6 to 18 inches thick has a very shallow overburden of only 2 to 5 inches. There is no definite demarcation from the underlying sharp sand for it also contains clay.

The land on lot 19 on the southeast and on lot 20 to the northwest is heavily timbered. Moulding sand was found on lot 19 by means of an auger, but it would be difficult to work moulding sand from these lots at a profit owing to the amount of bush.

The sample was obtained in October 1929.

Market. The obvious market for sand from this locality would be Barrie or Orillia at distances of 7 and 18 miles respectively over highway No. 11.

Remarks. Judging by the results of the mechanical analysis this sand would be serviceable for making medium to heavy weight castings.

Stormont County

Laboratory No. 49

Locality. Cornwall township, concession II, range 5. About 300 feet northwest of the barn on the property of the owner.

Owner. George Ray, Moulinette, Ont.

Operator. M. Lefevre, R.R. 1, Cornwall, Ont.

History. Moulding sand was first produced from this farm by John Mattice. Since 1915 the present operator has worked the deposit continuously.

Description. A large pit has been dug for the recovery of moulding sand in the crest of a ridge formed of boulders and gravel. The thickness of the moulding sand layer is 12 to 18 inches and of the overburden 6 to 12 inches. The underlying material is a mixture of boulder clay and fine gravel. A large area is still available for development. Most of the land has been cleared of timber or bush.

The sample was taken in September 1928.

Market. The moulding sand produced has been used by at least four foundries in Cornwall. Haulage is by truck, the distance being 9 miles, 7 of which are over highway No. 2. The nearest shipping point is 2 miles distant at Moulinette on the Canadian National railway.

Remarks. At the time the sample was taken the sand had superseded that formerly imported from New York state. It is very serviceable in the making of medium to light weight castings, and by diligent prospecting throughout the district similar deposits may be found. Particular attention should be given those parts where beds of sand and clay are associated.

Thunder Bay District

Laboratory No. 192

Locality. Neebing township N. R. (north of the river), lots 8, 9, 10, concessions A and B. A pit directly south of the west terminus of the owner's railway line, and about half way between it and the north bank of the big bend of the Kaministikwia river.

Owner. Mount McKay and Kakabeka Falls Railway Co., Fort William.

Operator. Same.

History. Moulding sand was discovered here about 1916.

Description. The deposit of moulding sand is on a terrace 60 feet above the water level of Kaministikwia river. The moulding sand ranges from 2 to 3 feet in thickness and its overburden from 6 to 12 inches. The material underlying the moulding sand layer is coarse, sharp sand. The area of the pit is from 30 to 50 acres and could easily be extended.

The sample was obtained from A. C. Adams, Superintendent of the Canada Iron Foundries, Fort William, Ont., in December, 1931. Mr. Adams and Mr. W. C. Lillie, Secretary, Mount McKay and Kakabeka Falls Railway Company, Fort William, gave the information with reference to the description and location of the deposit.

Market. The only foundry using this moulding sand is in Fort William, which is 5 miles distant. The proximity of the deposit to the owner's railway line makes the matter of shipment comparatively easy.

Waterloo County

Laboratory No. 101

Locality. Waterloo township, concession II, lot 2; 3,000 feet east of No. 24 highway. Locally known as "Sandy Knoll."

Owners. Cowan & Co., Ltd., Water St. North, Galt.

History. Cowan & Co., Ltd., produced moulding sand from this farm around the years 1888 to 1900 for use in their foundry in Galt. Some was also used in Preston.

Description. On a few well-rounded knolls the old moulding sand pits are easily recognizable. Mr. Thomas Cowan stated that the distribution of the beds is very irregular. Only a few knolls contain moulding sand capable of being developed at a profit. Elsewhere it would not pay to work the deposit owing to the beds being too thin or else they have been disturbed by ploughing. A short distance north of the old workings are beds still workable but undeveloped owing principally to the heavy growth of timber. The sample was taken from this wooded area where the top soil ranges from 2 to 12 inches and the moulding sand beds from 3 to 15 inches. The underlying material is either clay or sand or an uneven mixture of both.

The sample was obtained with the help of Mr. Thomas Cowan in October 1929.

Market. The nearest market for this sand would be in Galt, Guelph, Hespeler, Kitchener, Preston, and Waterloo.

Remarks. The mechanical analysis shows that the sand could be used for any average sized casting. It contains a few pebbles and some vegetable matter such as roots. There may be other good deposits in the lots to the north and south in the same concession. The deposit next to be described, represented by sample No. 102, occurs in lot 6 of this concession, one and a half miles to the north.

Laboratory No. 102

Locality. Waterloo township, concession II, east half of lot 6; 810 feet north of the road between lots 5 and 6 and 1,320 feet west of the road between concessions I and II.

Owner. Anson Groh, Preston, R.R. 2.

History. Mr. Groh, a farmer, discovered a layer of moulding sand by chance about the year 1904, that was later used successfully by two foundries in Preston for 5 years, almost depleting the deposit. Later on, another deposit was discovered 600 feet northeast of the old diggings, and it was from here, as described above, that the sample was taken. No sand has yet been sold from it.

Description. The new deposit is near the crest of a heavily timbered hill, the surface of which is very hummocky, and it was from one of these hummocks containing pockets of moulding sand that the sample was obtained. No continuous layer was found as is said to have been the case in the original discovery. The thickness of the moulding sand ranges from 6 to 10 inches, and the thickness of the overburden from 6 to 12 inches. The underlying material is sharp sand. The supply of moulding sand here is small and it would be impractical to try and recover it unless the timber growth had already been removed.

Mr. Anson Groh assisted in the collection of this sample in August 1929.

Market. Nearby markets might be obtained in Hespeler, Preston, Galt, Guelph, Kitchener, and Waterloo. The first two are not more than 2 miles distant.

Remarks. The sand has a peculiarity in that the colour is reddish brown. It contains many pebbles and a slight quantity of vegetable matter. The sand is very heavily bonded and in its present state would be difficult to use owing to its low permeability. It could be used better for the average weight of castings if it were blended with a low-bonded moulding sand, or if a certain amount of the underlying sharp sand were dug with it and the two well mixed.

Laboratory No. 100

Locality. Waterloo township; 275 feet southwest of a point on No. 8 highway, three-quarters of a mile west of the highway bridge over the Speed river.

Owner. Noah Schweitzer, Preston, Ont.

History. Moulding sand was produced from this farm for 5 years around 1904 by William Stengel, who was then the owner. The sand was sold to two foundries in Preston until it was thought that the deposit was exhausted.

Description. The old deposit was on the comparatively flat top of a ridge, part of a U-shaped piece of land formed by the junction of the Grand and Speed rivers. Most of the top of this ridge is cultivated, and only a small part of the rest is covered with bush. The part excavated for moulding sand is east of the timbered area in a field now cultivated. There was still a remnant of moulding sand and the sample was taken from it. The thickness of the moulding sand layer ranges from 8 to 12 inches and that of the overburden from 6 to 12 inches. The underlying material is sharp sand. Directly north of this old pit, patches of moulding sand also occur for a short distance in the ditch along the north side of the highway.

The sample was taken in October 1929, with the help of Mr. Wesley Stengel, who formerly loaded the sand for Mr. Wm. Stengel.

Remarks. The sample was collected so that the quality of the moulding sand formerly produced here could be determined. The mechanical analysis shows that it was of fair quality and was suitable preferably for the making of the average weight of castings. The owners of the two foundries that used it said that it had served their purpose.

As moulding sand has been produced from at least three localities in Waterloo township it is reasonable to suppose that there are others yet to be found.

Welland County

Laboratory Nos. 17, 18, 19, 20, 21

Locality. Pelham township, concessions VIII and IX, part of lots 6 and 7.

Owner. Capt. E. J. Lovelace, corner Ontario and Welland Avenues, St. Catharines.

Operator. The same.

History. The present owner opened up the deposit and has been producing from it continuously for a number of years.

Description. The deposit occurs in gently rolling land, sloping to the south and partly covered with bush. An area of 35 to 40 acres has already been worked, leaving a large area still available for development. Other moulding sand resources probably exist in the surrounding district, because traces are visible along the ditches of Canborough road at and near Ridgeville. The deposit is illustrated in Plate XA.

There is a railway siding into the property from Chantler on the Toronto, Hamilton and Buffalo railway. Trucks and teams are used for loading. Five samples were collected from representative places in the pit, the particulars of which are as follows:—

Sample No.	Thickness of overburden	Thickness of moulding sand	Position in pit
17	6 inches	5 feet	Southwest
18	6 "	2 "	Southwest
19	6 "	2 "	South
20	6 "	4 "	Centre.
21	12 to 18 inches	7 to 8 feet	Northeast

One foot of high-grade moulding sand had already been removed from above the place where sample No. 21 was taken.

The samples were collected in June 1928, with the help of Mr. George Hallett, pit foreman.

Market. Moulding sand of the different grades represented by these samples has been sold extensively throughout the province, principally in

A. Moulding sand deposit, Pelham township, concessions VIII and IX, lots 6 and 7, Welland county, Ontario (near Ridgeville).

B. Moulding sand deposit, Saltfleet township, concession II, lot 32, Wentworth county, Ontario (near Bartonville).

Ayr, Belleville, Chatham, Guelph, Hamilton, Harrison, Ingersoll, London, Oshawa, Owen Sound, St. Mary's, Tillsonburg, Toronto, Wallaceburg, and Walkerton, and also in Montreal.

Remarks. Table X shows that moulding sand of different grades as to grain fineness and clay content is available from this deposit. Nearly every foundry need for moulding sand can be satisfied.

Laboratory No. 22

Locality. Stamford township, parts of lots 17 to 24. North of the road joining the No. 8 highway and the Portage road from Stamford to Queenston. This is approximately ⅞ of a mile north of Stamford. [1]

Owners. Benson and Patterson, St. Paul Ave., Stamford, Ont.

Operators. The same.

History. The present owners have operated the deposit for many years.

Description. A very large excavation, made primarily for the production of building sand and gravel in cleared land, has a gentle slope to the southeast. Different grades of each of these products are available from this banded deposit, at present exposed to a depth of at least 20 feet in most places. While the pit was being enlarged lenses or layers of three different grades of moulding sand were found at many places, the overburden averaging about 6 inches. These lenses or layers are usually of a thickness of 30 to 36 inches.

A railway siding on the property connects with St. David's station on the Canadian National railway. Most of the products are shipped by train, the remainder by motor truck.

The sample was obtained in June 1928.

Market. Moulding sands from this pit have found a ready sale throughout the province wherever they have been tried, including Guelph, Hamilton, Hespeler, Kitchener, Lindsay, Orillia, Penetanguishene, Port Hope, Sarnia, and Toronto.

Remarks. The sample represents one of the finest grained moulding sands produced from the deposit, suitable preferably for light to medium weight castings. It contains very few pebbles and no vegetable matter. Other grades of moulding sand more suitable for heavy castings are also marketed.

Laboratory No. 23

Locality. Stamford township. On the fruit farm of the owner on the east of the Portage road from Stamford to Queenston, one-half mile north of Stamford.

[1] Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1918, p. 67.

Owner. J. E. Leviness, R.R. 3, Niagara Falls, Ont.

Operator. The same.

History. Moulding sand has been produced steadily for a number of years. Mr. Leviness is the original producer.

Description. The farm has a very gentle slope to the southeast. The sand has been removed from several places, mostly between the orchard trees, until now there remains an amount sufficient only perhaps to load 50 railway cars. The layers of sand have an average thickness of about 30 inches and an overburden generally of 7 inches. The underlying material is fine sharp sand.

The sample was obtained with the help of Mr. Leviness in June 1928.

Market. There has been a fairly regular demand for this moulding sand, like most of the other moulding sand produced in the county. Some of the places where it is marketed are, Bolton, Hamilton, Lindsay, Newmarket, Oshawa, Parkhill, Penetanguishene, Peterborough, Toronto, and Woodstock.

Remarks. Moulding sand from here is usually employed in the making of light to medium weight castings, and is highly recommended by foundrymen. Any vegetable matter such as fine roots and the few pebbles are easily removed in the foundry by riddling.

Laboratory Nos. 24, 25

Locality. Stamford township. On the old Douglas property, three-quarters of a mile north of Stamford.

Owners. N. L. Braas Hillcrest Sand Co., Niagara Falls, Ont., A. M. Staats, Manager.

Operator. The same.

History. Moulding sand was first produced by a Mr. Douglas and later on by Mr. J. E. Leviness of Niagara Falls. Neither of these did much more than prove the property. The present owners took control in 1928 and have since been producing regularly.

Description. The deposit is near the crest of a low, flat hill, about a half mile across and partly covered with bush and crops. Moulding sand has been removed from two places 850 feet apart. Sample No. 24 was taken from an excavation to the northwest of where sample No. 25 was taken.

Very little moulding sand has been removed from the excavation represented by sample No. 24. It occurs in a fairly continuous bed, ranging in thickness from 12 to 18 inches. The overburden is shallow in places, but generally the thickness is from 6 to 8 inches. This moulding sand is known as No. 3 to the trade.

Sample No. 25 represents the moulding sand from the other pit which is slightly more than an acre in extent. The thickness of the moulding

sand here is greater, ranging from 24 to 30 inches. The overburden is also greater being more than 12 inches thick. In both pits the underlying material is sharp sand, fine-grained under the No. 24 and medium-grained under the No. 25. The property is reached by a good road.

The samples were taken in June 1928.

Market. The moulding sand produced here since 1928 has been shipped to Welland and St. Catharines. The shipping point is Stamford, only one-quarter of a mile distant.

Remarks. The mechanical analyses show that the moulding sand represented by laboratory No. 24 is the coarser grained of the two and is preferable for medium to heavy weight castings. The other, represented by laboratory No. 25, is better for medium to light weight castings. It contains a slight amount of vegetable matter as fine roots.

The deposit is ½ mile north of that represented by sample No. 22.

Wentworth County

Laboratory No. 103

Locality. In the vicinity of Copetown, Ont.

Operator. Jefferson Stevens, P.O. Box 211, Stoney Creek, Ont.

Remarks. This sample was obtained in October 1929, from the storage bin of the P. Gies Foundry Co., 36 Water St., Kitchener, Ont. The sand it represents was said to have been shipped recently by Mr. Stevens. Good results have been obtained by its use.

The mechanical analysis shows that this moulding sand would be more suitable for light weight castings.

Laboratory No. 129

Locality. Ancaster township, concession I, north half of lot 31. This is within one-quarter of a mile south of Copetown.[1]

Operator. William R. Barnes, 243 Cumberland Ave., Hamilton.

Remarks. The sample was sent to the writer by Mr. Barnes in May 1931, as representing moulding sand produced from this locality.

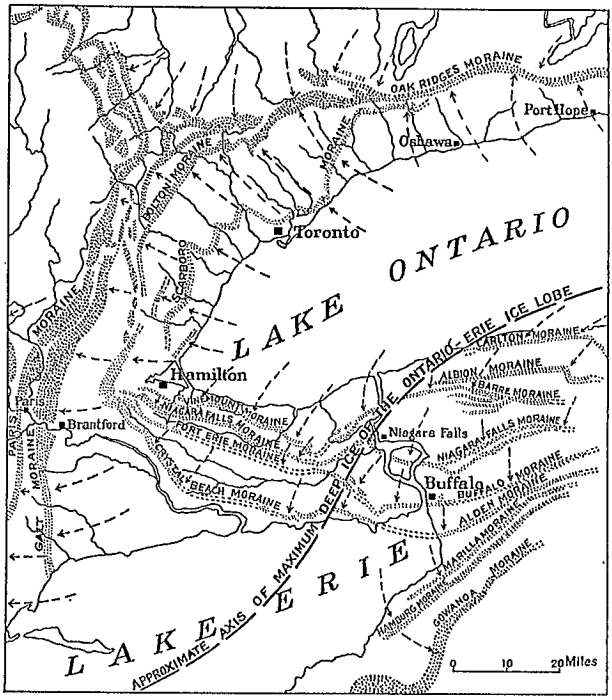
The mechanical analysis shows that it is more suitable for light weight castings. It compares favourably with a sample obtained from a foundry in eastern Ontario and said to be a No. 0 Albany moulding sand.

Mr. Barnes says that moulding sand has been exhausted from pits worked nearly half a mile south of Copetown in the north half of lot 30, and south of the Toronto, Hamilton and Buffalo railway, in the south half of lots 31 and 32 of concession I of Ancaster township.

Mr. Barnes makes the general statement[2] in reference to the Copetown district.

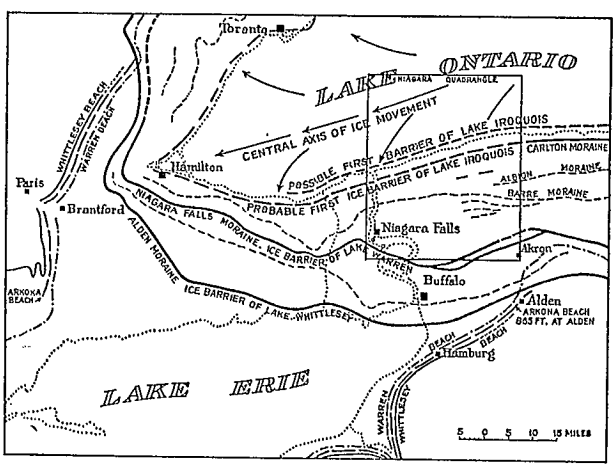
1 Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1918, p. 67.

2 Personal communication.



From U.S. Geol. Surv., Geologic Atlas of the United States, Niagara Folio, N.Y.

Figure 3. Sketch map showing moraines around the west end of Lake Ontario. Dense stipple pattern represents moraines formed on land; light pattern, moraines deposited in ponded water. Dashed lines indicate probable extension of known moraines. Arrows show general direction of ice movement.



From U. S. Geol. Surv., Geologic Atlas of the United States, Niagara Folio, N.Y.

Figure 4. Sketch map showing positions of ice barriers in Niagara region and shore lines of the better-known associated glacial lakes.

"A large quantity of sand has been shipped from this point to foundries all over Ontario since 1900. Particular deposits have been exhausted but believe this area has real possibilities. Sand of fine nature and good bond."

Laboratory Nos. 1, 2, 3, 4

Locality. Ancaster township, concession II, north half of lot 29.

Owner. E. L. Ward, Copetown, Ont.

History. Moulding sand was produced from this property by E. B. Radcliffe for a few years about 1913. Most was shipped from Summit Station on the Toronto, Hamilton and Buffalo railway, about one-quarter of a mile distant, and the remainder by truck. It was sold mostly in Hamilton. The property has been idle since Mr. Radcliffe sold it.

Description. This old working is situated on the north slope of a flat-topped hill devoid of bush or trees. A large quantity of building sand and gravel was also produced after the moulding sand bed had been removed. Fragments of the layer still remained and it was from these that the samples were taken. Owing to the varieties of moulding sand noted, four samples were taken at different points along the edge around the top of the pit and should give a fair approximation to the nature of the sands sold.

The following particulars show that the bed was not uniform.

Sample No.	Thickness of overburden	Thickness of moulding sand
1	2 inches	30 inches
2	4 "	20 to 24 inches
3	3 to 8 inches	16 " 27 "
4	4 " 9 "	15 " 22 "

Back from the edge of the pit over a width of about 50 feet an auger met very little moulding sand, therefore it is believed that the greater part of the moulding sand has been removed. As the topography of the country to the east of the old working is very similar, other layers or pockets may be discovered in that direction.

Remarks. The mechanical analysis of the sands shows that those represented by laboratory Nos. 1, 2, and 3 are suitable for light to medium weight castings and that by laboratory No. 4 for medium to heavy weight castings.

It is often remarked that Ontario has very little moulding sand suitable for light castings and that such sand must be imported. Evidently, in this locality at least, such sand did exist.

Laboratory Nos. 12, 13

Locality. Barton township. In the village of Bartonville, 50 feet east of Kenilworth Ave. and north of King St.

Operator. Mrs. B. C. Quigley, 317 Main St. E., Hamilton.

History. The property was opened up by Mrs. Quigley about 1925 and it has been worked until at least 1928.

Description. Most of the land in the vicinity has been subdivided into building lots; it has a gentle slope to the north, and a few houses have been built (1927-28) upon a number of the lots surrounding the deposits. The moulding sand may therefore never be worked where lots are built upon. An area of over an acre has already been developed.

A moulding sand bed represented by sample No. 12 has an average thickness of 21 inches. The overburden is shallow in places but the average thickness is 6 inches. At another part of the pit, represented by sample No. 13, the moulding sand bed has an average thickness of 18 inches with an overburden of 8 inches. Underlying both of these beds is coarse, sharp sand.

The samples were collected in June 1928 with the assistance of Mr. Jack Quigley, a son of the operator.

Market. Most of the sand represented by sample No. 12 is used locally in Hamilton and some is shipped to Toronto. All of the sand represented by sample No. 13 is said to be used in Hamilton as a core sand. The sands used in Hamilton are all trucked, the distance being 3 miles.

Remarks. The sand represented by sample No. 12 is said to be very serviceable for heavy weight castings. It is known to the trade as a No. 3 sand.

The sand represented by sample No. 13 is an example of a moulding sand having clay bond of low plasticity. Therefore, its compressive strength is low, in spite of the high clay content. It should be good for blending with moulding sand too rich in bond, as its low grain fineness would improve the permeability of the mixture.

Laboratory No. 14

Locality. Flamborough East township, concession IV, lot 4. On farm lands of the owner.

Owner. C. W. Drummond, Waterdown, Ont.

Operator. The same.

History. Mr. Drummond opened up this deposit in 1924 and he has been producing from it yearly up to the present time.

Description. The deposit occurs along the flank of a low ridge devoid of bush. From the large pit a good cross-section is easily obtained, the moulding sand forming a continuous bed averaging 12 inches thick. The overburden is only 6 inches and the underlying material is medium sized sharp sand. Much moulding sand has already been removed but from tests on adjacent land the owner believes that a large tonnage is still available.

The sample was collected with the assistance of the owner in June 1928.

Market. Most of the sand has been trucked to Hamilton and Guelph at respective distances of 6 and 23 miles. Some has been sold in Galt. Preston, and Toronto. The nearest shipping point, about one mile away, is Waterdown North on the Canadian Pacific railway.

Remarks. The mechanical analysis shows that the sand is suitable preferably for medium weight castings. It contains only a small amount of vegetable matter.

Mr. William R. Barnes, 243 Cumberland Ave., Hamilton, says that moulding sand was shipped at different times from a place one-half mile west of Waterdown, which would lie in concession III, about lots 7 and 8. This is one mile south from the Drummond deposit.

Laboratory No. 15

Locality. Flamborough West township, concession V, south half of lots 15 and 16. On the farm of the owner about one-quarter of a mile north of the road between concessions IV and V.

Owner. Gordon Goodbrand, Mill Grove, Ont.

Operator. The same.

History. Mr. Goodbrand opened up this deposit in 1927 and produced from it for two years.

Description. The deposit is in part of a cultivated field near the crest of a hill nearly a mile across, and the cross-section is easily seen in a small pit. A fairly continuous layer of moulding sand averages over 5 feet thick. The overburden is only about 6 inches. The moulding stratum is underlain by fine sharp sand. From test holes put down back from the edge of the pit it is evident that a large quantity is still available.

The sample was obtained in June 1928.

Market. All the sand was marketed in Hamilton, 8½ miles distant. The nearest shipping point is Mill Grove station on the Canadian Pacific railway about 3¼ miles distant.

Remarks. The mechanical analysis shows that the sand is good for medium to light weight castings. It contains coarse vegetable matter, such as thick roots, and small pebbles, but these can be removed by riddling.

The deposit is 3½ miles southwest from that described under laboratory No. 14.

It is reported that William Bolton also of Mill Grove has produced moulding sand from his farm.

Laboratory No. 16

Locality. Flamborough East township, concession IX, south half of lot 2, on farm land.

Owner. William Gray, Carlisle, Ont.

Operator. C. W. Drummond, Waterdown, Ont.

History. The deposit was opened up in 1924. Moulding sand has been produced from it occasionally up to the present time.

Description. This is a comparatively level deposit in flat-lying uncultivated land, partly covered with woods. The operator estimates that the bed of moulding sand is continuous over an area of at least 5 acres. When the sample was taken only one-half an acre of it had been developed. The bed is from 12 to 14 inches thick, the overburden from 8 to 12 inches. The underlying material is medium sized sharp sand.

The sample was obtained in June 1928.

Market. Most of the sand was sold to places north and west of Carlisle, principally to Guelph, Galt, and Mount Forest. It was trucked to all, Mount Forest, the farthest away, being over 62 miles distant. The nearest shipping point, only one-half mile distant, is Flamborough station on the Canadian Pacific railway.

Remarks. The mechanical analysis shows that the sand is suitable for medium to light weight castings. It is entirely free from vegetable matter. but contains a few pebbles.

Laboratory No. 113

Locality. Vicinity of Waterdown, Ont.

Remarks. The sample was obtained from Mr. A. O. Whitelaw of Whitelaw's foundry at Woodstock, Ont., on October 25, 1929. According to Mr. Whitelaw it was from a shipment of moulding sand received by him about October 18, 1929, through the Hamilton Facing Mill Co., Ltd., North Hess St., Hamilton. This company stated the sand was produced by C. W. Drummond of Waterdown from around the Waterdown district.

The sand is of much coarser grain than hitherto found in the district and suitable for medium to heavy weight castings.

Laboratory No. 11

Locality. Saltfleet township, concession II, near the centre of lot 32. Access to the deposit is from the road between concessions I and II.

Owner. Mrs. B. C. Quigley, 317 Main St. E., Hamilton, Ont.

Operator. The same.

History. The deposit was opened up and production started in 1926, and moulding sand was shipped until at least 1928. Recently this plot of land has been acquired for the Elliott airport.

Description. The deposit is on nearly level, uncultivated land, on which are a few trees and other brush. Moulding sand has been taken from several pits. When the sample was taken in June 1928, a considerable tonnage of moulding sand was still available. The bed, which is fairly continuous, has a thickness of 20 to 24 inches, and the overburden is 6 to 8 inches. The underlying material is chiefly clay. The pit from which the sample was taken is illustrated in Plate XB. The sharp line of

demarcation between the overburden and the moulding sand bed can be seen in the photograph, which also shows the method of production and how the overburden is deposited upon the underlying clay, from which the moulding sand has already been removed.

The sample was collected with the help of Mr. Jack Quigley, a son of the operator.

Market. Most of the sand was marketed in Hamilton, only 5 miles distant. Truck transport was used.

Remarks. The sand is best suited for making medium weight castings. It contained no pebbles nor vegetable matter, and is known to the trade as a No. 2 sand.

Laboratory No. 26

Locality. Saltfleet township, concession I, east half of lot 15. At distances of 400 feet west of the road between lots 14 and 15, and 900 feet north of the Canadian National railway tracks.

Owner. Jefferson Stevens, P. O. Box 211, Stoney Creek, Ont.

Operator. The same.

History. Mr. Stevens opened up the property about 1925 and produced from it until at least the summer of 1928.

Description. The deposit of moulding sand occurs in very flat, partly cultivated land, which has a very gentle slope towards Lake Ontario, less than one-half mile distant. A large pit has been made in which the formation of the deposit is easily observed. The moulding sand bed is fairly continuous and is from 12 to 15 inches thick, the overburden being generally about 6 inches. The moulding sand bed is underlain by sharp sand. A large area is still available for the production of similar moulding sand.

The sample was collected with the help of Mr. Stevens in June 1928.

Market. The moulding sand from this deposit has been used mostly in Galt, Hamilton, and Toronto, that sold in Hamilton being transported by truck a distance of about 12 miles over the No. 8 highway. The nearest shipping point is 3 miles distant at Stoney Creek on either the Canadian National railway or the Toronto, Hamilton and Buffalo railway.

Remarks. The sand has found successful application in the making of light weight castings such as stove plate and furnace parts. It contains no pebbles nor vegetable matter.

Laboratory No. 27

Locality. Saltfleet township, concession II, southwest quarter of lot 24. Three-quarters of a mile north of the village of Stoney Creek.[1]

Operator. Jefferson Stevens, P. O. Box 211, Stoney Creek, Ont.

[1] Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1918, p. 67.

History. The deposit was opened up in 1926 by Mr. Stevens who has produced from it until at least the summer of 1928.

Description. The deposit lies back from the banks of a small tributary to Stoney creek on fairly level ground, for the most part free from timber. Moulding sand has been removed from a long strip of land, leaving exposed the uneven thickness of the layer, which ranges at one place from 12 to 30 inches within a distance of 15 feet. The quality of the moulding sand also changes considerably. The sample consisted of the two grades, which are usually mixed to make the uniform product desired by most purchasers. The thickness of the overburden is generally about 8 inches, and the underlying material is sharp sand. At the time the sample was taken there was an area of over 2 acres left from which similar moulding sand could be obtained.

The sample was taken with the help of Mr. Stevens in June 1928.

Market. The moulding sand has been shipped to several places, the most important being Hamilton, Montreal, and Toronto. That sold in Montreal was in competition with sand imported from New York state having a shorter rail haul. The sand sold in Hamilton was transported by truck over the No. 8 highway, a distance of 9 miles. The nearest shipping point is 1½ miles distant at Stoney Creek on either the Canadian National railway or the Toronto, Hamilton and Buffalo railway.

Remarks. The blended sand is more suitable for light to medium weight castings. It contains only few pebbles and no vegetable matter.

General Remarks. Most of the moulding sand produced in this county came, or is coming, from the district near Gage Park in Hamilton and eastward to around Winona. All deposits lie between the Niagara escarpment and Lake Ontario.

Since about 1890 several grades of moulding sand have been taken from this district, some workings extending for nearly a mile at a stretch without much break, and the district is becoming exhausted. It was from some of the remaining localities that the five samples with laboratory Nos. 11, 12, 13, 26, 27, already described, were collected.

Moulding sands from this district are generally referred to by the trade as Hamilton sands. Occasionally too, sands like those described under laboratory Nos. 14 and 15, which come from the Flamborough townships, near Waterdown, and are usually designated as Waterdown sands, are referred to as Hamilton sands.

Hamilton sands have generally found province-wide acceptance in the foundry trade. The principal points to which they have been shipped are, Bolton, Brampton, Cobourg, Elora, Galt, Guelph, Hamilton, Kingston, Kitchener, Lindsay, London, Midland, Montreal, Orillia, Owen Sound, Parkhill, Preston, Sarnia, Stratford, St. Thomas, Teeswater, Toronto, and Woodstock.

Figure 5. Index map of Ontario showing location of sand deposits sampled.

1, 2, 3, 4, near Copetown
5, 6, 7, 8, 9, 10, near Brantford
11, Hamilton
12, 13, Bartonville
14, near Waterdown
15, near Mill Grove
16, near Carlisle
17, 18, 19, 20, 21, Ridgeville
22, 23, 24, 25, near Stamford
26, 27, near Stoney Creek
42, 43, 44, 45, 46, 47, near Cardinal
48, near Aultsville
49, near Moulinette
50, near Bainsville
62, near Farran's Point
63, 64, near Brockville
65, near Crookston
66, near Ivanhoe
67, near Belleville
68, near Colebrook
69, near Cardinal
89, Toronto
90, near Lorne Park
91, near Oakville
92, near Milton
93, near Brampton
94, near Bolton
95, near Barrie
96, near Allandale
97, near Barrie
98, near Meaford
99, near Walkerton
100, near Preston
101, near Galt
102, near Hespeler
103, near Copetown
104, near Lakeside
105, Lakeside
106, near Ruthven
107, near Arner
108, near Kingsville
109, near Ridgetown
110, near Thamesville
111, near Windsor
112, London
114, near Burgessville
115, near Harley
116, 117, near Simcoe
118, Waterford
119, near Bronte
120, near Drumquin
121, near Port Hope
122, near Peterborough
123, near Harwood
124, near Camden East
125, near Lansdowne
129, near Copetown
132, near Port Hope
133, 134, near Woodbridge
135, near Dunnville
140, near Walkerton
141, near Queenston

York County

Laboratory Nos. 133, 134

Locality. Vaughan township. On the farm of the owner 1½ miles south of Woodbridge on the main road to Weston and Toronto.

Owner. Robert Topper, Woodbridge, Ont.

History. Mr. Topper said that moulding sand from here was once used in a foundry, but not recently.

Description. The deposit was not visited. The samples were supplied by Mr. Topper in September 1930, who said that an area of 40 to 50 acres carries sands similar to the sample. The thickness of the bed is 24 to 36 inches, the overburden being generally 12 inches thick, and the underlying material is building sand and gravel.

Market. The locality is ideally situated with respect to the large consuming centres such as Toronto and Weston, which are at distances of 16 and 6½ miles respectively, and the most economical method of transport is by truck. The nearest shipping point is Woodbridge on the Canadian Pacific railway at a distance of 1½ miles.

Remarks. The mechanical analysis shows that the sand represented by laboratory No. 133 would be most suitable for the making of heavy weight castings. The other sand does not possess sufficient compressive strength but would be a good sand to blend with too highly bonded moulding sand.

TABLE X

Mechanical Analyses of Sands from Ontario

Laboratory No.	Locality, county	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards. On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent: Sand	Clay	Calcium carbonate
5	Brant	.....	0·58	2·23	4·43	7·22	9·53	9·86	10·36	9·88	6·72	6·59	21·52	10·8	99·7	131	3	E	4·2 6·2 7·9	13·4 19·3 20·5	5·6 4·9 3·8	10	9+	Nil
6	"	.....	.....	0·20	0·12	0·15	0·20	0·40	1·95	9·85	19·08	28·64	34·40	5·1	100·1	209	1	D	3·8 6·1 8·0	12·0 17·8 14·3	4·2 3·1 3·3	10+	10	Nil
7	"	.....	.....	0·02	0·02	0·03	0·08	0·12	0·47	4·13	14·20	27·06	50·53	3·2	99·9	238	1	C	4·1 6·1 8·1	10·9 11·8 13·0	4·0 3·6 3·0	9+	11	Nil
8	"	.....	.....	0·18	0·38	1·52	5·76	16·79	26·60	17·23	6·60	3·59	13·53	7·8	100·0	113	3	D	4·1 6·0 8·1	37·9 31·9 26·3	3·0 2·7 2·7	10+	10	Nil
9	"	.....	0·06	0·22	0·30	0·62	2·40	7·07	11·38	9·48	5·06	4·32	45·77	13·4	100·1	202	1	E	4·0 6·0 7·9	3·3 4·4 4·7	7·4 7·5 7·3	9+	9+	Nil
10	"	.....	.....	0·13	0·15	0·28	1·21	7·59	19·09	15·56	7·26	6·42	31·16	10·1	99·9	179	2	E	4·0 6·1 8·0	7·0 10·1 16·8	5·8 4·8 3·7	10	12	Nil
115	"	.....	0·16	0·20	0·41	0·94	3·41	5·30	5·72	10·50	16·64	19·58	32·65	4·7	100·2	188	2	C	4·1 6·0 7·9	7·4 10·9 12·4	4·0 4·4 4·7	.....	.....	Nil
99	Bruce	.....	.....	0·06	0·12	0·52	3·60	13·90	27·72	24·22	11·02	5·62	4·86	8·3	99·9	102	3	D	4·0 5·9 7·8	33·7 39·0 30·4	2·5 2·6 2·3	12	9+	Nil
140	"	.....	.....	.....	0·44	0·90	3·54	7·50	15·74	15·44	12·16	10·22	24·58	9·7	100·2	136	3	D	3·9 6·1 7·8	5·9 7·2 9·3	5·7 7·5 6·6	7+	7	Trace

132	Durham.....	.....	.....	.....	0·42	2·90	11·96	22·10	26·88	14·84	5·96	3·50	6·86	4·4	99·8	91	4	C	4·1 5·9 7·8	49·4 52·1 58·3	2·1 2·4 2·0	10+	9	Nil
121	"	.....	.....	0·21	0·30	0·59	1·30	3·42	14·06	24·55	22·48	16·66	14·37	2·2	100·1	148	2	C	4·0 6·1 8·0	16·7 24·2 29·1	1·5 2·5 2·6	.....	.....	Nil
107	Essex.....	.....	0·55	0·58	0·61	0·73	1·16	3·30	21·91	26·98	10·06	5·08	8·86	20·1	99·9	119	3	C	4·0 6·1 8·1	18·1 25·9 24·6	9·3 8·6 7·7	9	11	Nil
106	"	.....	0·89	0·87	0·78	1·11	2·46	6·39	7·38	7·00	7·09	10·25	38·35	17·4	100·0	197	2	F	4·0 6·1 8·1	3·3 5·1 5·8	8·1 8·2 7·6	9	11	Nil
108	"	.....	1·18	1·28	0·92	1·82	5·62	13·10	28·10	15·42	5·26	3·72	8·42	15·2	100·0	100	3	F	4·1 6·1 8·0	23·8 40·0 45·7	8·9 7·6 7·4	8	9	Nil
43	Grenville.....	.....	.....	0·04	0·07	0·11	0·55	0·66	1·72	17·53	27·12	26·46	22·63	3·2	100·1	184	2	C	4·0 5·9 7·8	23·6 22·9 22·4	2·6 2·4 2·4	.....	.....	Nil
44	"	.....	0·14	0·38	1·07	3·95	14·11	19·98	10·85	14·00	12·64	10·46	11·06	1·6	100·2	112	3	B	4·0 6·0 7·9	34·8 38·6 39·3	2·4 2·5 2·4	.....	.....	Nil
45	"	.....	.....	0·09	0·09	0·13	0·29	0·46	2·02	13·65	21·65	25·30	31·98	4·8	100·5	201	1	C	4·0 6·1 7·9	14·1 17·1 16·9	2·8 3·1 3·5	.....	.....	Nil
46	"	.....	0·11	0·07	0·08	0·12	0·31	0·36	1·35	9·78	18·28	24·97	38·19	6·8	100·4	215	1	D	4·1 5·9 8·0	12·6 12·7 12·4	3·8 4·5 3·7	7+	8	Nil
92	Halton.....	.....	0·22	0·36	0·38	0·32	0·52	0·90	7·90	20·26	18·88	15·18	26·76	8·6	100·3	179	2	D	4·1 6·1 8·0	4·6 6·9 8·4	3·9 4·9 5·9	.....	.....	Nil
120	"	.....	0·18	1·66	1·68	1·84	4·32	7·24	14·42	20·50	15·44	12·36	15·80	4·7	100·1	136	3	C	4·0 5·9 8·0	9·4 14·4 17·9	3·2 3·8 4·4	.....	.....	Nil
109	Kent.....	.....	0·11	0·60	0·60	0·72	1·34	1·60	3·45	5·50	10·02	20·52	47·58	8·9	100·9	214	1	D	4·0 6·1 7·9	4·4 5·2 5·8	2·5 3·8 5·2	11	11	Nil
63	Leeds.....	.....	.....	0·11	0·10	0·17	0·42	1·40	7·65	26·14	23·60	17·76	20·86	2·6	100·8	167	2	C	4·0 6·1 7·9	13·6 21·3 23·0	3·1 4·0 3·9	.....	.....	Nil
64	"	.....	0·05	0·10	0·05	0·06	0·37	0·37	3·06	18·94	23·90	21·50	29·05	3·0	100·5	172	2	C	4·1 6·1 7·9	8·4 11·4 15·4	4·3 5·0 5·5	8+	8+	Nil

TABLE X—*Continued*

Mechanical Analyses of Sands from Ontario

Laboratory No.	Locality, county	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards. On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent: Sand	Clay	Calcium carbonate
125	Leads,,.....	.....	0·82	1·60	2·90	5·92	11·08	10·90	8·61	8·19	7·08	8·82	25·72	8·2	99·8	144	2	D	4·0 6·1 8·0	4·1 7·2 **8·7**	5·3 6·3 **6·8**	10	11	Nil
124	Lennox & Addington.....	.....	.....	0·62	0·45	0·64	2·10	6·16	11·04	15·74	14·08	13·99	30·92	4·5	100·2	172	2	C	4·0 6·0 8·0	7·3 9·6 **10·1**	3·5 4·7 **5·1**	.....	.....	Nil
68	"	.....	0·11	0·26	0·22	0·71	2·76	8·16	16·73	20·51	14·78	12·86	19·24	3·8	100·1	147	2	C	4·0 6·1 8·1	14·1 21·1 **21·5**	2·3 3·5 **4·5**	8	8	Nil
141	Lincoln.....	.....	.....	0·34	0·46	0·48	0·88	2·50	7·06	14·18	13·38	14·50	28·76	17·2	99·7	187	2	F	6·0 8·0 10·0	5·3 7·5 **8·2**	8·2 7·9 6·6	.....	.....	Nil
112	Middlesex ..	.....	0·32	0·49	0·46	0·98	2·30	3·25	2·99	6·24	13·06	18·62	41·82	9·4	99·9	213	1	D	3·9 6·0 8·0	8·2 **9·6** 9·5	**5·9** 4·8 4·9	8	9	Nil
203	Nipissing (district).....	.....	.....	2·06	3·06	3·12	4·66	7·08	10·12	9·90	7·08	8·10	30·80	13·6	99·6	166	2	E	7·9 10·1 11·9	5·1 6·2 **7·1**	6·3 **6·8** 6·2	.....	.....	Nil
117	Norfolk	.....	.....	0·29	0·89	2·40	4·61	7·01	9·03	12·62	13·64	15·24	28·85	5·5	100·0	171	2	D	4·0 5·9 7·9	11·0 11·8 **12·1**	4·1 **4·6** 4·2	.....	.....	Nil
118	"	.....	0·42	0·26	0·72	2·48	6·34	8·86	11·94	13·98	12·48	13·12	24·50	4·9	100·1	155	2	C	4·1 6·0 7·8	12·9 13·8 **14·4**	4·0 **4·7** 4·3	.....	.....	Nil
104	Oxford.....	.....	0·45	0·98	1·60	3·51	8·70	14·92	17·24	12·39	6·64	5·11	16·95	11·2	99·7	121	3	E	3·9 5·9 7·9	3·8 7·5 8·7	5·3 5·4 **6·9**	10	11	Nil

105	"	0·10	0·41	0·44	0·64	1·72	6·19	14·82	17·86	13·12	7·65	7·09	20·45	9·3	99·8	135	3	D	4·0 6·1 8·1	2·7 5·7 **9·4**	3·7 **7·1** 6·6	11	11	Nil
114	"	.....	.....	0·28	0·84	2·74	8·62	12·94	14·39	15·11	11·90	10·16	14·78	8·2	100·0	128	3	D	4·1 6·1 8·1	8·6 13·7 **15·6**	**5·6** 4·4 4·8	10	11	Nil
96	Simcoe..	0·20	3·70	21·22	25·40	15·90	13·18	3·24	2·26	1·64	1·02	1·02	3·58	7·8	100·2	40	6	D	4·0 6·1 7·9	32·2 187·6 231·4	4·7 3·2 2·1	.....	.....	Present
95	"	.....	0·36	2·02	4·18	6·62	10·64	11·96	14·70	14·48	9·50	7·48	12·74	5·2	100·0	110	3	D	4·0 6·0 8·0	11·0 17·2 23·1	3·7 3·8 4·8	.....	.....	Nil
49	Stormont.....	.....	0·52	0·38	0·49	0·90	1·76	3·48	10·03	16·84	14·48	14·29	30·20	7·1	100·5	178	2	D	3·9 5·8 7·9	7·0 10·1 **11·9**	4·2 4·7 **4·9**	9	8	Nil
192	Thunder Bay. (district)	.....	1·92	3·02	2·24	3·26	7·70	15·54	23·58	18·88	8·74	3·78	4·50	6·8	100·0	87	4	D	4·2 6·1 8·1	33·4 48·7 **56·0**	3·1 **3·3** 2·5	7	4	Nil
101	Waterloo	.....	0·24	0·56	0·57	0·92	2·88	6·72	12·28	15·48	13·64	13·64	27·04	5·8	99·8	167	2	D	4·1 6·1 8·0	6·4 8·8 **9·4**	3·0 4·5 5·3	.....	.....	Nil
102	"	.....	1·98	2·81	2·49	2·62	4·28	5·76	7·05	7·47	5·92	6·19	26·28	27·1	100·0	162	2	C	4·1 5·9 8·0	1·2 1·4 2·3	8·8 9·8 **10·1**	10	11	Nil
100	"	0·20	0·34	1·10	1·70	3·96	8·65	11·83	12·66	10·14	6·82	6·92	24·20	11·7	100·2	142	2	E	4·1 6·1 7·9	3·8 5·9 7·2	6·5 **7·4** 6·4	8+	11	Nil
17	Welland..	.....	0·40	0·49	0·85	1·69	3·72	7·93	13·12	14·72	12·92	14·68	22·30	8·1	100·0	157	2	D	4·1 6·0 7·9	12·1 **16·6** 15·4	**4·9** 4·6 4·0	12	12	Nil
18	"	0·25	2·49	4·64	4·57	7·35	12·28	15·46	13·92	8·46	4·74	5·56	12·07	8·2	100·0	96	4	D	4·0 6·1 8·0	4·8 11·3 **17·6**	4·9 **5·9** 5·2	11	11	Nil
19	"	.....	0·48	1·57	2·45	4·58	9·96	16·35	20·12	14·76	7·73	6·23	11·25	4·6	100·1	105	3	C	4·1 6·1 7·9	16·2 24·4 **32·3**	4·0 4·5 4·0	.....	.....	Nil
20	"	.....	0·14	0·49	0·56	0·80	1·15	1·35	1·98	8·84	16·63	21·62	39·04	7·7	100·3	211	1	D	3·9 6·0 8·1	10·3 12·6 **13·1**	**4·9** 3·8 3·4	.....	.....	Nil
21	"	.....	.....	.....	0·02	0·02	0·25	0·28	3·03	13·54	16·62	18·94	44·70	2·7	100·1	217	1	C	4·1 6·0 8·0	13·2 **13·3** 13·2	3·0 **3·6** 3·4	.....	.....	Present

TABLE X—*Concluded*.

Mechanical Analyses of Sands from Ontario

Laboratory No.	Locality, county	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards. On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent: Sand	Clay	Calcium carbonate
22	Welland	.....	.....	0·15	0·13	0·14	0·29	0·35	1·51	3·99	6·36	12·43	64·29	10·5	100·1	259	1	E	4·1 6·0 8·0	4·9 5·5 5·8	5·4 5·6 4·8	12+	11	Nil
23	"	.....	.....	0·18	0·16	0·07	0·09	0·22	0·28	0·62	3·19	8·66	19·56	60·36	6·6	100·0	253	1	D	4·1 6·0 8·0	8·6 8·5 8·0	4·4 4·6 4·3	13	9+	Nil
24	"	.....	.....	0·20	0·11	0·22	0·63	2·83	11·73	20·23	15·78	13·15	12·90	13·53	8·5	99·8	132	3	D	3·9 6·0 7·9	29·5 34·4 30·4	3·0 2·6 2·1	13+	11	Nil
25	"	.....	.....	0·16	0·22	0·14	0·16	0·32	1·44	6·93	13·05	12·84	16·94	42·59	5·2	100·0	210	1	D	4·1 6·2 7·8	11·2 12·7 11·7	4·0 3·8 3·7	.....	.....	Nil
103	Wentworth	.....	.....	0·34	0·36	0·60	1·46	2·96	4·34	5·56	5·16	8·94	58·48	12·5	100·7	240	1	E	4·1 6·1 8·1	2·4 3·0 3·9	6·3 7·0 7·5	9	11	Nil
129	"	.....	.....	0·26	0·40	0·78	0·38	7·72	9·25	9·83	7·91	9·48	43·14	10·7	99·9	202	1	E	4·0 6·0 7·9	3·6 5·7 5·4	6·3 6·9 6·7	10	11	Nil
1	"	.....	.....	0·05	0·06	0·06	0·24	0·23	0·57	4·06	16·01	31·47	40·91	6·7	100·4	270	1	D	4·0 6·1 8·0	10·0 10·4 9·4	3·9 4·2 4·0	.....	.....	Nil
2	"	.....	.....	0·18	0·20	0·41	0·95	2·96	5·57	5·50	4·65	9·96	56·20	14·6	101·2	241	1	E	4·0 6·0 8·1	6·0 5·5 5·8	7·7 7·4 6·6	9	8	[illegible]
3	"	.....	.....	0·65	1·23	1·06	1·20	1·86	4·08	6·72	4·23	2·64	4·37	52·60	19·8	100·4	227	1	F	4·0 6·1 8·0	1·6 2·7 3·3	10·7 12·0 9·3	9+	10+	Nil

4	"	.....	.....	.....	0·02	0·07	0·41	2·12	9·34	20·74	18·40	9·62	7·50	20·25	11·6	100·1	144	2	E	4·0 6·0 8·0	18·0 20·8 26·6	6·6 5·7 3·6	.....	.....	Nil
12	"	.....	.....	0·58	0·79	1·54	5·96	18·54	27·73	8·95	2·62	1·78	2·66	14·80	13·9	99·9	98	4	E	4·1 6·0 8·0	16·7 33·5 50·4	5·9 6·7 5·9	10	10	Nil
13	"	.....	.....	0·85	1·62	3·58	10·65	23·35	29·63	11·09	2·23	1·07	1·39	7·06	7·5	100·1	58	5	D	4·1 6·0 8·0	77·8 145·3 123·8	4·0 3·3 2·8	10	11	Nil
14	"	.....	.....	0·36	0·60	0·69	1·26	4·60	13·18	23·76	20·20	10·63	7·89	12·59	4·0	99·8	120	3	C	4·0 6·0 8·0	8·7 15·7 19·5	4·9 4·2 5·4	9	12	Nil
15	"	.....	.....	.....	0·06	0·08	0·30	1·79	7·16	13·06	15·99	15·06	16·91	24·64	5·0	100·1	167	2	D	4·1 6·0 7·9	17·6 18·2 15·7	2·6 3·0 3·3	10	11+	Nil
16	"	.....	.....	.....	0·06	0·06	0·25	2·36	6·74	11·24	18·67	17·56	17·26	23·23	2·9	100·3	164	2	C	4·1 6·1 8·0	20·3 20·8 18·1	2·8 3·2 3·1	.....	.....	Nil
113	"	.....	.....	0·16	0·50	1·02	2·42	6·32	19·64	24·82	17·14	9·10	8·32	6·18	4·2	99·8	98	4	C	3·9 5·9 8·0	36·7 36·6 36·9	2·4 2·5 2·2	.....	.....	Nil
11	"	.....	.....	.....	0·11	0·25	0·40	1·05	4·04	26·31	26·51	11·98	7·02	8·91	13·3	99·9	121	3	E	4·0 6·1 8·0	23·4 32·4 38·7	6·1 5·1 7·5	9	9	Nil
26	"	.....	.....	0·08	1·42	2·21	2·54	3·17	4·44	9·92	18·03	13·04	10·55	19·08	15·4	99·9	150	2	F	4·1 6·0 8·1	6·2 8·5 12·6	7·6 8·0 7·3	10	12+	Nil
27	"	.....	.....	0·08	0·47	0·45	0·59	1·21	4·05	12·56	19·13	11·22	7·80	25·97	16·4	99·9	168	2	F	4·1 6·0 8·0	4·5 6·2 11·1	7·3 8·1 7·1	9+	9	Nil
133	York	.....	.....	1·50	5·24	9·19	14·94	18·70	12·40	7·51	4·37	2·38	2·12	5·46	16·3	100·1	65	5	F	4·0 6·0 8·0	60·4 74·0 65·3	7·2 9·5 8·1	10..	.....	Trace
134	"	.....	.....	0·76	1·48	1·76	3·72	11·80	20·82	21·84	15·02	6·54	3·82	5·78	6·0	99·3	87	4	D	3·9 6·0 8·0	55·5 57·9 57·8	2·2 1·9 1·5	10..	.....	Nil

CHAPTER VIII

MOULDING SAND DEPOSITS OF WESTERN CANADA

MANITOBA

Laboratory No. 155

Locality. Within the city limits of Brandon.

Operator. Archibald Millar, Foreman, Brandon Machine and Implement Works, 14th St. and Rosser Ave., Brandon.

History. Mr. Millar opened this deposit about 1924.

Description. According to Mr. Millar the deposit is easily accessible and a large tonnage of good moulding sand as represented by the sample is available. Although the moulding sand bed was little more than one foot thick, the deposit is economically worked because the overburden is only about 6 inches.

The sample was taken from the bins of the foundry in September 1931.

Market. During 1924 and 1925 large supplies of the sand were shipped to Winnipeg and St. Boniface, but this market was then lost owing to an increase in shipping costs.

The sand has been used continuously by the foundry in Brandon.

Remarks. This moulding sand is best suited for heavy to medium weight castings. One big advantage in its use is that maximum compressive strength and permeability are obtained with the same amount of tempering water.

Laboratory No. 154

Locality. On the north side of the road allowance, opposite mile post 84 on No. 2 highway, about one-half mile from Cypress River on the Canadian Pacific railway. This is on the southern edge of S.W. ¼ section 18, township 7, range 12, west Prin. Mer.

Description. Prospect sample. A good cross-section is exposed in a deep cutting along the highway, where a band of sand gives promise of being suitable for moulding. The thickness of the bed is 1 to 2 feet over the distance of 75 feet exposed. The overburden has an average thickness of 5 feet. Other good cross-sections were visible at intervals for about 2 miles east of here, where cutting had been done to keep the highway down to a reasonable grade. In all these, clayey sand was seen but the clay content is too great for such sand to be suitable for moulding. The land north of where the sample was taken was cultivated.

The sample was obtained in September 1931.

Moulding sand deposit near Melbourne, Manitoba, owned by the Canadian Pacific Railway Company, August, 1931.

Remarks. The sand is not very suitable for moulding because of its high clay content and very high grain fineness number, but it might serve for the making of light or thin section castings.

Laboratory Nos. 142, 143

Locality. About 750 feet west of Melbourne station on the Canadian Pacific railway, within the railway right of way and south of the tracks.

Owner. Canadian Pacific Railway Co., Winnipeg office.

Operator. The same.

History. Opened up by the Canadian Pacific Railway in 1925.

Description. A pit 185 feet long, 55 feet wide and from 7 to 10 feet deep had been developed by 1931. The largest dimension is parallel to the tracks. Two samples were taken; No. 142 in the east end of the pit and No. 143 in the southwest corner. Around the entire pit the bed of moulding sand is visible but it has varying thickness. There is no sharp line of demarcation between the moulding sand and the overburden. From where sample No. 142 was taken the moulding sand layer was from 2 to 2½ feet thick and its overburden from 15 to 18 inches. From where sample No. 143 was taken the bed was from 2½ to 3½ feet and its overburden from 12 to 20 inches. Beneath the entire moulding sand layer is sharp sand. The moulding sand bed extends from the pit in either direction along the railway tracks and southward into the cleared N.E. ¼ section 29, township 10, range 13 west Prin. Mer. No excavation has as yet been made other than in the railway right of way. Evidently a large quantity of moulding sand similar to that which has been shipped in the past is still available. The pit is illustrated in Plate XI.

The samples were taken in September 1931, with the help of Mr. D. Birse, assistant development engineer of the Canadian Pacific Railway.

Market. A large quantity of the moulding sand has been shipped, the greater part of which is used in Winnipeg, Calgary, Nelson, and Trail.

Remarks. Moulding sand from the deposit has given satisfactory service wherever tried. In one foundry it took the place of a sand imported from the United States hitherto extensively used. From the results of the mechanical analysis tests the sand as represented by the two samples is best suited for medium to heavy weight castings.

The moulding sand was loaded by shovel and wheelbarrows direct from the pit to railway cars by sectionmen of the railway.

Laboratory No. 156

Locality. About 3,400 feet west of Melbourne station on the Canadian Pacific railway, within the railway right of way and north of the tracks. The deposit is about 250 feet west of an abandoned crossing of No. 1 highway, and one-half mile west of the main moulding sand pit from which samples Nos. 142 and 143 were collected.

Owner. Canadian Pacific Railway Co., Winnipeg office.

Operator. Same.

Description. A cutting into the bank over 150 feet long gives a good section of the deposit. The moulding sand is 2 to 2½ feet thick and the overburden from 12 to 18 inches. The underlying material is clean sharp sand. The bed of moulding sand extends northwards beneath highway No. 1, which is about 150 feet distant, into the S.E. ¼ section 31, township 10, range 13, west Prin. Mer. On the side of the railway tracks opposite to this deposit is a cutting in which is a band of moulding sand but not so good or continuous as that on the north side.

The sample was obtained in September 1931, with the aid of Mr. Anthony Topolniski, a section foreman, who had at one time assisted in the loading of cars from the deposit.

Market. No definite record could be obtained as to where the moulding sand from this deposit was shipped, but it is thought most went to Winnipeg.

Remarks. The mechanical analysis shows that the sand is not so heavily bonded as that from the larger pit nearer Melbourne station. Apparently very little has been shipped from this working. It is possible that prospecting might locate a better grade of sand in this locality.

Laboratory Nos. 147, 153

Locality. In a sand and gravel pit about 1½ miles north of Molson.

Owner. W. J. Riley, Molson, Man.

Description. Several outliers of sand were left on the floor of the large sand and gravel pit. The material of these "island" masses is not suitable for any of the purposes for which the regular product is used owing to the high clay content. They were left in the pit where they did not interfere with the recovery of the regular product, but many had been removed and wasted, as no market was known for the material. Sample No. 147 was representative of several of these blocks, which are from 1½ to 2 feet thick. The underlying material is generally fine sharp sand. Sample No. 153 was said to be moulding sand from the pit and was collected from a brick plant in Portage la Prairie. Both samples were obtained in September 1931. Mr. Thos. Burns, superintendent of the pit, helped collect sample No. 147.

Market. The only market for the sand represented by No. 147 would be in the foundry trade in Winnipeg. There is a railway spur near the pit. At present the only known market for the sand represented by sample No. 153 is Portage la Prairie, where it is used blended with more heavily bonded sand from Ste. Rose du Lac, for mould dusting.

Remarks. According to the mechanical analysis the sand represented by No. 147 is suitable for only very light weight or thin section castings. Sample No. 153 is not suited for foundry casting.

Laboratory Nos. 152, 190

Locality. N.W. ¼ section 9, township 24, range XV. This is ⅛ of a mile east of No. 5 highway, which passes through Ste. Rose du Lac, and also 200 feet south of the Canadian National Railway tracks.

Owner. Snyder Brick Yards, Ltd., Portage la Prairie.

Operator. Same.

History. The pit was opened about 1913.

Description. A pit, 275 feet long, 150 feet wide, and 3 to 5 feet deep, was developed a few years prior to 1931 in fairly level cleared ground. The moulding sand bed is continuous, has a fairly uniform thickness of 18 inches, and its overburden is 12 inches. The moulding sand changes gradually in depth to sharp sand. The pit could be extended considerably, as auger holes put down around the pit penetrated the bed of moulding sand.

Sample No. 152 was received from the brick plant in September 1931, and No. 190 was obtained from the pit in November 1931.

Market. The only market for the sand has been the brick plant of the owner in Portage la Prairie, where it is used together with a low bonded sand from Molson for dusting brick moulds. The pit is in a very accessible place for loading direct onto railway cars. The rail haul from Ste. Rose to Portage la Prairie is 120 miles.

Remarks. The mechanical analysis shows that the sand could be used for moulding in foundries, preferably for making light weight or thin section castings.

Laboratory Nos. 188, 189

Locality. On the farm of the owner in the S.E. ¼ section 8, township 37, range 26, west Prin. Mer.

Owner. Alexander Fraser, P.O. Box 285, Swan River, Man.

Description. Between the prairie level and the water level of the north bank of Swan river, and within 200 feet and directly south of Mr. Fraser's house, is a slope 65 feet wide, partly covered with trees. A section of the slope shows overburden, beds of moulding sand, of very clean angular-grained silica sand, and of high-grade clay. The only bed of moulding sand thick enough to warrant sampling is 3½ to 5½ feet thick, and was exposed for over 100 feet along the slope. At each end of this exposure the slope was wooded. An unfavourable feature is the 25 to 30 feet of overburden. The bed of moulding sand is represented by sample No. 188. Another bed of moulding sand lies about 600 feet east of the Fraser house at the top of the slope to the river. This bed is at least 10 feet thick and has an overburden of only 2 to 3 feet. The land surface back from the slope rises only slightly from the river and is cleared of bush. This bed of moulding sand is represented by sample No. 189.

Mr. Fraser helped with the collection of the samples, which were taken in November 1931.

Market. Possibly the only market for moulding sand from the deposit would be Winnipeg. It would first have to be transported for 8 miles over a fair road to Swan River, on the Canadian National railway. The rail haul from here to Winnipeg is 292 miles.

Remarks. The mechanical analysis shows that both of the moulding sands are suitable only for light weight or thin section castings. The sand represented by laboratory No. 189 should be the better of the two, even if it is not so refractory as that represented by laboratory No. 188. At one time a small trial shipment of the latter sand was sent to Winnipeg, where the foundry reported that the bond was sufficient, but the sand was not permeable enough for mould gases to escape. If a coarser grained sand were well blended with either sand, greater permeability would be obtained, permitting the moulding of larger castings. Such a blended sand should be highly refractory, if the sand used were that represented by laboratory No. 188 as this was the most refractory of all sands collected and tested from the western provinces, it being the only one requiring the use of the volcano furnace to cause failure of the sand cone in the refractoriness test. These sands could also be used for blending with other coarser grained moulding sands. The blending could be done better by foundrymen, as the proportions depend on the use required of the product.

It would be difficult to excavate much of the moulding sand represented by laboratory No. 188 because of the removal of the excessive overburden, the cost of which would most likely be prohibitive, unless it could be wasted by gravity into the river bottom below, but dumping into a river bed might not be permitted. Whether moulding sand could be profitably developed here might depend on a market also being found for the associated high-grade silica sand and clay beds.

The development of the part of the deposit represented by laboratory No. 189 would be simple. The overburden being so shallow for such a thick bed, the cost would be proportionately low. No undue hoisting of the moulding sand such as would be required with the material represented by No. 188 would be a decided advantage.

Laboratory No. 160

Locality. On the east side of the road allowance of highway No. 1, 2 miles northwest from Virden. The land to the east of here lies in the S.W. $\frac{1}{4}$ section 34, township 10, range 26, west Prin. Mer., and is owned by John Glendenning of Virden, Man.

Description. Prospect sample. A bed of moulding sand can be traced over 200 feet in a ditch parallel to the highway. The thickness of the bed is 4 to $4\frac{1}{2}$ feet and that of the overburden 1 to $1\frac{1}{2}$ feet. Beneath the moulding sand bed is heavy clayey gravel. East of the ditch the land is cleared and slopes gently to a small stream bed. Auger holes were made over a width of 600 feet from the highway and the bed of moulding sand was penetrated in all. A large quantity of moulding sand is available. The sample was collected in September 1931.

Market. No moulding sand has ever been shipped from this spot. Possibly the only market is Winnipeg, which is 180 miles distant. Virden, which is conveniently situated on both railways, is the shipping point.

Remarks. The mechanical analysis shows that the moulding sand is best suited for light weight to medium weight castings. The sand is free from vegetable matter. It could also be used for blending with low bonded coarse-grained moulding sand to improve the latter's compressive strength.

Laboratory No. 161

Locality. On the west side of the road allowance of highway No. 1 about 3 miles northwest of Virden. A concrete bridge spans the highway about 200 feet south. The land to the west is S.E. ¼ section 3, township 11, range 26, west Prin. Mer.

Description. Prospect sample. Larger excavations than were necessary for draining the highway were made on each side of it. The excavated material was used together with the gravel for building part of the highway. In each of these excavations, cross-sections are available, the better of the two being on the west side, where the sample was collected. A band of material 4 to 5 feet thick, much resembling moulding sand is visible for a length of over 110 feet. The bed has an overburden the thickness of which is 1 to 2 feet. The underlying material is composed of layers of sand and clay, the latter predominating. The same bed of apparent moulding sand could be seen in the eastern excavation, but the surface material, which had slumped down, had hidden the greater part of it. The bed extends westwards and eastwards into cleared farming land, which slopes very gently to the south. The sample was collected in September 1931.

Remarks. The material from this bed should be classified as moulding loam instead of moulding sand on account of its very high clay substance content, and it is doubtful if it could be used in foundries, as its permeability is so low. The moulding loam is free from any vegetable matter. It might be used for blending with low bonded coarse-grained moulding sand, the compressive strength of such sand being thereby increased.

Laboratory No. 144

Locality. North of the tracks of the Greater Winnipeg Water District railway at Wye (Mile 80). This is in the S.E. ¼ of township 8, range 14, east Prin. Mer., and is a part of a reservation area of the water district.

Owner. Greater Winnipeg Water District, Civic Offices, Winnipeg.

Operator. Same.

History. This pit for the production of foundry sands was opened in 1923, about 5 years after the main project of building an aqueduct to supply water to the greater Winnipeg district had been completed.

Description. On fairly level cleared land, which has a gentle slope southwards to Birch river, a large size pit has been opened. In one section of the pit is a bed of moulding sand 4 to 6 feet thick, the overburden of which has a thickness of 3 to 3½ feet. The underlying material is mainly clay. In another part of the pit core sand is also produced. Apparently a large area is available for development.

The sample was collected in 1931.

Market. The only market for both the moulding and core sands is Winnipeg and St. Boniface, which are 80 miles distant. Shipments are made over the railway owned and operated by the Greater Winnipeg Water District.

Remarks. The moulding sand has been used chiefly for the making of light to medium weight castings. The sand is entirely free from vegetable matter.

Laboratory No. 158

Locality. N.W.¼ section 11, township 2, range 23, west Prin. Mer., on the property of the Deloraine Coal Mine, Ltd.

Owner. Deloraine Coal Mine, Ltd., 322 4th St., Brandon.

Description. An opening made 150 feet north of the coal mine tunnel to trace the coal seam, cut a bed of moulding sand having an average thickness of 3 feet and an overburden 3 to 4 feet thick. No effort had been made to trace the limits of this bed, but it probably extends for a considerable distance along the face of the slope. The overburden increases towards the hill.

Remarks. The mechanical analysis shows that this should be a good moulding sand for medium to heavy weight castings. There was no vegetable matter and only a trace of calcium carbonate.

Figure 6. Index map of Alberta, Saskatchewan, and Manitoba, showing location of sand deposits sampled.

ALBERTA

166, Medicine Hat
167, Lethbridge
168, Calgary
177, near Irricana
178, Leduc
179, Edmonton
180, near Oliver
193, 194, near Wimborne

SASKATCHEWAN

162, near Pilot Butte
163, Weyburn
164, near Milestone
165, Moose Jaw
182, near Langham
183, Saskatoon
184, near Duck Lake
185, Prince Albert
186, 187, Yorkton
195, near Trossachs

MANITOBA

142, 143, near Melbourne
144, Wye
145, Winnipeg
146, near St. Ouens
147, 153, near Molson
148, near Lac du Bonnet
149, near Smith's Siding
150, 151, near Ste. Anne des Chênes
152, 190, Ste. Rose du Lac
154, near Cypress River
155 Brandon
156, near Melbourne
157, near Brandon
158, near Deloraine
159, near Findlay
160, 161, near Virden
188, 189, near Swan River

TABLE XI

Mechanical Analyses of Sands from Manitoba

Laboratory No.	Locality	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards. On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent: Sand	Clay	Calcium carbonate
155	Brandon	....	1·06	1·68	2·54	4·88	9·68	15·56	15·28	11·34	7·34	5·16	9·22	16·3	100·0	101	3	F	4·1 6·1 8·0	36·9 31·7 25·3	**11·1** 9·9 8·6	10	5	Trace
154	Near Cypress River	....	....	0·12	0·06	0·04	0·06	0·10	0·24	0·44	1·04	4·58	57·06	36·5	100·2	286	1	H	8·1 10·1 12·0	3·0 3·6 4·0	**10·7** 9·8 8·6	....	.....	Present
142	Melbourne	....	....	.....	0·04	0·06	0·42	3·92	21·06	26·94	12·98	7·70	17·78	9·3	100·2	144	2	D	4·1 6·0 8·1	16·9 17·2 17·3	**9·5** 6·6 5·2	12+	4	Trace
143	"	....	....	.....	.....	0·10	0·38	4·64	25·98	33·20	15·02	6·88	6·00	7·9	100·1	116	3	D	4·0 6·0 8·1	35·7 37·8 39·7	**4·7** 2·7 2·0	14	4	Nil
156	Near Melbourne	....	....	0·04	0·04	0·06	0·52	5·42	31·34	27·58	13·42	7·08	9·42	5·0	99·9	120	3	D	4·1 6·0 8·1	34·2 37·3 37·8	**3·6** 2·5 2·0	....	.....	Trace
147	Near Molson	....	....	.....	.....	0·08	0·04	0·02	0·02	0·02	0·08	0·30	71·74	28·0	100·3	298	1	G	4·1 6·1 8·1	3·3 3·4 3·3	**5·0** 5·4 5·7	8+	5	Present
153	" "	....	....	.....	.....	0·04	0·06	0·06	1·10	13·30	24·92	25·72	33·36	1·3	99·9	203	1	B	4·1 6·0 7·9	2·6 2·5 2·4	**1·8** 2·0 1·9	....	.....	Present
152	Ste. Rose du Lac	....	....	0·14	0·12	0·12	0·18	0·18	0·22	0·30	0·70	7·60	82·70	7·9	100·2	287	1	D	4·1 6·0 8·1	9·4 9·6 9·2	**3·8** 3·9 3·7	12	11+	Present
190	"	....	....	.....	0·16	0·08	0·20	0·24	0·16	0·20	0·54	8·00	82·22	8·2	100·0	288	1	D	4·1 6·0 8·1	**9·1** 9·0 8·3	**4·5** 4·1 4·2	12	11+	Present

TABLE XI—*Concluded*

Mechanical Analyses of Sands from Manitoba

Laboratory No.	Locality	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards														Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent		Calcium carbonate
		On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total							Sand	Clay	
188	Near Swan River	....	....	.....	.....	.....	0·16	0·12	0·18	0·52	2·26	8·00	68·06	20·8	100·1	282	1	G	4·0 6·0 8·1	3·5 3·6 **3·9**	5·4 5·8 **5·9**	26+	7	Present
189	" "	....	....	0·10	0·12	0·08	0·18	0·22	0·38	0·60	1·26	5·16	72·80	19·2	100·1	286	1	F	6·0 8·0 10·0	4·1 5·2 4·9	**6·7** 6·4 6·1	8	6	Present
160	Near Virden	..	2·00	2·64	2·18	2·54	3·38	4·18	5·26	6·42	5·34	5·42	26·26	34·3	99·9	171	2	H	5·9 7·9 10·0	5·2 8·3 **21·7**	**12·6** 11·7 11·3	.....	.....	Present
161	"	....	....	0·26	0·24	0·48	0·88	0·88	1·06	1·26	1·24	2·18	24·12	67·5	100·1	250	1	J	8·0 10·1 12·1	1·8 2·0 3·4	**12·2** 11·5 11·3	.....	.....	Present
144	Wye (mile 80) G.W.W.D.Ry	....	....	0·12	0·12	0·10	0·14	0·14	0·42	12·52	44·56	26·48	11·66	3·9	100·2	170	2	C	3·9 6·0 8·0	**33·4** 30·8 27·7	**2·0** 1·9 1·8	12	3	Present
158	Tp.2, R. 23 W.P.M.	....	....	0·10	0·68	0·92	0·76	1·04	27·78	34·24	10·64	5·70	7·64	10·5	100·0	116	3	E	5·9 8·0 10·0	12·9 14·5 **16·2**	**11·4** 10·5 10·1	9	5	Trace

SASKATCHEWAN

Laboratory No. 164

Locality. On the east side of the road allowance of highway No. 6, about 450 feet north of the right angle turn in the highway at the southwest corner of section 13, township 12, range 20, west 2nd mer.

Description. Prospect sample. A bed of moulding sand is visible on both sides of the highway in a cut made in a terrace formation on the north bank of Moosejaw creek. The bed is 3 to 4½ feet thick and is exposed for about 140 feet on the east side of the highway; a nearly equal length is seen on the west side. The thickness of the overburden ranges from 1 to 1½ feet. There is no sharp line of demarcation from the underlying material, as the clay bond lessens gradually until finally sharp sand is reached. Test auger holes were put down over a distance of 300 to 400 feet east of here, in the cleared S.W.¼ section 13, on property owned by Emory P. Kuhns, and the moulding sand layer was penetrated in all. No test hole was put down in the S.E.¼ section west of the road, but the bed probably extends in that direction.

The sample was obtained in September 1931.

Remarks. The mechanical analysis shows that the sand should be used preferably for light weight or thin section castings. It is free from vegetable matter. It would require the experience of a foundryman to know the right depth to dig, on account of the lack of a parting plane between the moulding sand and the underlying sharp sand.

Laboratory No. 184

Locality. On the west side of the road allowance of highway No. 12 in township 44, range 2, west 3rd mer., ¾ of a mile northeast of Duck Lake on the Canadian National railway.

Description. Prospect sample. A bed of moulding sand occurs in a cut-bank for a distance of 40 feet parallel with the highway. The bed has a thickness of 3 to 4 feet and an overburden of 12 to 18 inches, which is comparatively light for such a useful thickness. The material beneath the moulding sand is the sharp sand generally found. The bed of moulding sand probably extends into the partly cleared ground east of the highway.

The sample was obtained in September 1931.

Market. The deposit of moulding sand is not well situated for a ready market, as both Saskatoon and Prince Albert use local supplies.

Remarks. From the mechanical analysis it is found that the sand should give best results when used for the making of medium to heavy weight castings. There is very little vegetable matter. Of the occurrences of moulding sand reported as lying between Duck Lake and Macdowall this has the best appearance.

Laboratory No. 182

Locality. S.E. ¼ section 16, township 39, range 7, west 3rd mer. within 20 feet of highway No. 5 and about 375 feet north of a wide curve in the highway at the southwest corner of section 15.

Owner. John Winisky, Nutana, Sask.

Description. Prospect sample. A very good bed of moulding sand is exposed in a shallow excavation, which stretches northwards for about 200 feet, and extends from the highway westwards into the owner's property. It is fairly continuous and is 12 to 15 inches thick, the overburden ranging from 12 to 18 inches. There is no distinct parting plane between the moulding sand and the underlying sharp sand. The bed of moulding sand was penetrated by auger holes in prairie land to a distance of over 250 feet from the highway. A slightly thinner band of moulding sand lies in the S.W. ¼ section 15 owned by Mr. Frederick E. Hanson, Langham, Sask., directly across the highway from the Winisky property.

The sample was collected in November 1931.

Market. No immediate market for this sand is available, as where foundries are operated in Saskatchewan local supplies are used. It might, however, be shipped to Winnipeg, a distance of 548 miles, for the same class of work for which the Kerrick, Minnesota, moulding sand is used. The nearest shipping point is 2 miles distant at Langham on the Canadian National railway. The distance from Kerrick to Winnipeg is about two-thirds that from Langham.

Remarks. The mechanical analysis shows that this would be a good moulding sand for heavy to medium weight castings. Foundrymen in Saskatoon believe that it should be very serviceable. It is entirely free from vegetable matter and calcium carbonate.

Laboratory No. 165

Locality. Across the road from the city limits of Moose Jaw in the southeasterly corner of the N.E. ¼ section 30, township 16, range 26, west 2nd mer.

Owner. J. H. Grayson, P.O. Box 789, Moose Jaw, Sask.

Operator. Moose Jaw Foundry Co., Moose Jaw, Sask.

History. Mr. H. Renshaw of the Moose Jaw foundry discovered this deposit of moulding sand about 1923 and has supervised its development.

Description. The deposit of moulding sand is on vacant land used for pasture and overlooking the Moosejaw creek to the east. Only a small excavation, about 50 by 60 feet, has been made but a large area is probably available for production. In this pit the moulding sand averages 24 inches in thickness and has 16 to 18 inches of overburden. The underlying material is clay.

The sample was obtained in September 1931.

Market. The only market so far has been local, the material being used in the company's foundry. The deposit is ideally situated for railway shipment, as it is only 1½ miles to the Moose Jaw station on either railway.

Remarks. The moulding sand has given satisfaction on all sorts and weights of castings, but is especially suitable for those of medium to heavy weight. In the opinion of Mr. Renshaw it is one of the best in western Canada. It is free from vegetable matter and calcium carbonate.

Laboratory Nos. 162, 209

Locality. S.E. ¼ section 32, township 17, range 18, west 2nd mer.

Owner. Mrs. John Betteridge, Pilot Butte, Sask.

Operator. The same.

History. The late Mr. John Betteridge started production of moulding sand from his farm about 1904.

Description. Beds of moulding sand have been discovered and worked in at least three different places on the owner's farm. The beds are 6 inches to 2 feet thick and are not continuous over any large area. The overburden was stated to have been 6 inches to 1 foot. There is no distinct plane of separation between the moulding sand and the underlying sharp sand owing to the clay bond decreasing in depth. The land is rolling prairie and is mainly free from timber or bush. Although the farm has not been thoroughly prospected sand is probably still undiscovered and available for development.

Sample No. 162 was obtained in September 1931, from the bins of a foundry in Regina where the moulding sand is regularly used. Sample No. 209 was collected from another location of the deposit by G. M. Hutt, Assistant Development Commissioner, Canadian Pacific Railway Company, Winnipeg, Man.

Market. The only market for the sand represented by sample No. 162 has been the foundry in Regina; it is trucked over No. 1 highway for a distance of about 10 miles. Rail shipments of sand represented by sample No. 209 have been made to Trail, B.C., from Pilot Butte on the Canadian Pacific railway which is about one mile distant.

Remarks. The mechanical tests show that the moulding sand represented by sample No. 162 is good for making heavy to medium weight castings. It is free from calcium carbonate and vegetable matter. Moulding sand represented by sample No. 209 is more suitable for medium to heavy weight castings; the sand contains some calcium carbonate but no vegetable matter. The permeability of the sand could be increased by blending it with clean sharp sand; the resultant compressive strength would not be much lessened owing to the amount of bond present. By this treatment heavier weight castings could be made.

Laboratory No. 185

Locality. In the city of Prince Albert, north of the Saskatchewan river, on the west side of the road allowance of highway No. 2, facing the rifle range. This is in the centre of the east ½ of section 8, township 49, range 26, west 2nd mer.

Owners. Rifle range portion owned by the Federal Government.

Operators. Prince Albert Foundry Co., Prince Albert, Sask.

History. Moulding sand was first obtained here by the present operators about 1911.

Description. A bed of moulding sand is exposed parallel to the highway in a cutting about 55 feet long, made to recover a part of the moulding sand. The bed, which is fairly continuous, has a thickness of about 12 to 15 inches. The underlying material is coarse, sharp sand. The bed extends westwards into the property of the rifle range for an indefinite distance, but as the deposit is in the flood plain of the Saskatchewan river it is most probably continuous.

The sample was collected with the help of Mr. J. C. McDonald, one of the partners of the foundry, in November 1931.

Market. The only market for the moulding sand has been local, in the Prince Albert foundry.

Remarks. The moulding sand has been found satisfactory for all shapes of casting especially those of large to medium weight. It contains no vegetable matter or calcium carbonate.

Laboratory No. 183

Locality. In the city of Saskatoon, beneath the floors of the owner's foundry.

Owner. John East Iron Works, Ltd., 121st Ave. C. N., Saskatoon.

Operator. The same.

History. When the owners built their foundry about 1909 they discovered a bed of moulding sand beneath the site chosen.

Description. The bed of moulding sand is fairly continuous over the property of the foundry and is 2 to 3 feet thick; the thickness of the overburden is about 18 inches. The moulding sand is underlain by medium-grained, sharp sand. A large quantity still remains for the future use of the foundry. The sample was taken in situ within the foundry walls with the help of Mr. John East in November 1931.

Market. The deposit is worked only for the use of the owners.

Remarks. The moulding sand has proved serviceable and has been used continuously for all sizes of castings from a few pounds to over a ton.

Mr. East stated that no vents or gaggers were used in the moulds and that the moulding sand does not blow with surplus water. It contains no vegetable matter.

Laboratory No. 195

Locality. S.W. ¼ section 4, township 8, range 17, west 2nd mer.

Owner. The Great West Life Assurance Co., Lombard St., Winnipeg.

Operator. Never operated for moulding sand.

Description. Prospect sample. A bed of moulding sand occurs on the flank of a grass- and weed-covered hill and was discovered by the previous owner of the property, Mr. A. W. Barnes, Box 22, Trossachs, Sask., when he sank a well. The well was 19 feet deep, but did not reach the bottom of the moulding sand bed, the top of which was about 4 feet from the surface. Mr. Barnes said that a previous owner also sank a well close to his, to a depth of at least 39 feet without reaching the bottom of the layer, which apparently is a bed 15 to 35 feet thick and judging by this extreme thickness it probably extends under the hillside for several acres. The sample that Mr. Barnes shipped to the writer in December 1931, represents only the 15-foot section as recovered from his well.

Market. No immediate market exists for moulding sand from this apparently large deposit. Trossachs on the Canadian Pacific railway, 2 miles distant, is the nearest shipping point.

Remarks. The mechanical analysis shows that the sand is very serviceable for making medium to heavy weight castings. It is free from calcium carbonate. It should be excavated economically because of the exceptionally large thickness.

Laboratory No. 186

Locality. In a sand pit about 300 feet south of the city water supply tank.

Owner. City of Yorkton, Sask.

Operator. The same, which uses it only as a source of sand.

History. Opened about 1911.

Description. Prospect sample. A bed of moulding sand 2 to 3 feet thick occurs in the west wall of the sand pit, about 18 to 20 feet below the surface. The overburden is mainly building sand, the top two feet or so being of a loamy nature.
The sample was taken in November 1931.

Remarks. This fine-grained sand would be suitable for only light weight castings. The bed could not be developed commercially unless use were made of the sand overburden. That part of the building sand over the moulding sand bed might be excavated instead of a very similar product elsewhere in the pit.

Laboratory No. 187

Locality. Clay pit in the northeast section of the city of Yorkton.

Owners. The Christian Community of Universal Brotherhood, Yorkton, Sask.

Operators. The same, but they work it only for the clay for making brick.

Description. Prospect sample. A bed of apparently fine moulding sand occurs in the east side of the clay pit, and is resistant to breaking down by weather, is fairly uniform, extends widely throughout the pit, and has a thickness of 18 to 24 inches. The bed is capped with about 24 inches of heavy clay. The underlying material is composed of beds of clay and a series of alternating layers of clay and sand. The sample was collected with the assistance of Mr. Michael Maloff, manager of the brickyard, in November 1931.

Remarks. The material is a moulding loam and its low permeability is due to the excessive amount of clay substance and silt. If the material could be used at all, it would be only for small weight or thin section castings, but it could be used advantageously for mixing with low-bonded, coarse- or medium-grained moulding sand to increase its bond.

TABLE XII

Mechanical Analyses of Sands from Saskatchewan

Laboratory No.	Locality	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards. On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent: Sand	Refractoriness, Pyrometric cone equivalent: Clay	Calcium carbonate
164	Near Corinne	....	0·02	0·12	0·06	0·12	0·24	0·30	0·64	5·38	12·28	16·72	40·60	23·6	100·1	233	1	G	6·1 8·1 10·1	4·8 5·7 5·8	9·5 8·4 8·0	6+	4+	Present
184	Near Duck Lake	....	....	.....	0·04	0·08	1·12	5·26	19·90	29·72	21·16	11·12	4·26	7·5	100·2	120	3	D	4·0 6·1 7·9	37·9 37·0 34·3	8·6 4·9 3·2	....	.....	Trace
182	Near Langham	....	....	0·50	2·36	14·00	32·20	16·56	6·62	3·10	2·58	3·02	6·58	12·5	100·0	72	4	E	4·0 6·1 8·1	114·4 82·3 97·3	9·0 7·5 4·5	13+	6	Nil
165	Moose Jaw	....	....	0·08	0·12	0·50	2·98	10·58	13·92	13·64	10·84	9·72	14·94	22·5	99·8	142	2	G	6·1 8·0 9·9	23·9 22·9 18·9	13·0 10·8 9·7	7+	4	Nil
162	Pilot Butte	....	0·06	0·52	1·66	4·06	9·88	15·74	16·62	11·54	5·92	4·78	9·20	19·9	99·9	103	3	F	4·0 6·0 8·0	27·3 25·3 21·5	12·1 10·9 9·0	12+	4	Nil
209	"	....	....	0·48	0·38	0·98	3·14	5·30	7·08	9·78	7·88	7·04	21·38	36·6	99·7	171	2	H	7·9 10·0 12·1	3·9 12·2 9·4	13·2 10·4 10·0	....	.....	Present
185	Prince Albert	....	....	0·02	0·50	1·70	7·02	14·84	22·12	17·58	10·48	6·62	7·22	11·6	99·7	106	3	E	3·9 6·0 8·0	43·1 32·7 36·0	10·7 7·1 4·8	13+	5	Nil
183	Saskatoon	....	0·18	0·40	0·32	0·92	5·12	18·38	25·94	14·34	6·42	5·38	7·68	14·7	99·8	102	3	E	4·0 6·0 8·1	20·7 32·1 35·1	10·4 9·8 8·3	9	6	Present
195	Near Trossachs	....	....	.....	.....	0·06	0·16	2·48	38·08	28·10	7·02	4·72	7·70	11·7	100·0	112	3	E	4·0 6·0 8·1	26·7 33·8 38·1	8·4 9·8 7·9	9	4+	Nil
186	Yorkton	....	....	.....	.....	.....	0·30	0·72	4·06	10·82	10·48	11·70	35·38	26·7	100·2	215	1	G	6·1 8·1 10·0	4·4 5·3 5·5	7·9 8·0 7·8	....	.....	Present
187	"	....	....	.....	.....	0·08	0·24	0·24	0·52	0·66	0·86	1·98	35·16	60·2	99·9	282	1	J	6·1 8·1 10·1	1·2 1·6 2·0	12·0 9·9 9·6	....	.....	Present

ALBERTA

Laboratory No. 168

Locality. On the north slope of Mission hill in the south section of the city of Calgary.

Owner. City of Calgary, Alta.

Operator. Calgary Iron and Foundry, Ltd., 410-418 9th Ave. East, Calgary, Alta.

Description. Moulding sand occurs about half way up the slope of Mission hill in a pockety formation. The bed, which is nowhere thicker than 1½ feet, dips inwards, and this causes the heavy overburden at the face to increase as the working extends inwards. The working, therefore, has been taken but a short way into the hill as this increasing overburden, being unsupported, slumps over the exposed face of the bed in proportionally greater amount.

The sample was collected in October 1931.

Market. The only market for this moulding sand has been for local use by the operator, Mr. C. J. Hoogveld, manager of the above foundry. It is trucked over No. 1 highway, a distance of about 1½ miles to the company's foundry.

Remarks. The moulding sand gives best results when used for the making of light to medium weight castings. It is free from vegetable matter. As the compressive strength and permeability of the sand remain nearly constant with a range of over 4 per cent in water content, the amount to be added for tempering is not very important.

Laboratory No. 179

Locality. Edmonton South, between Avenues Nos. 95 and 96 and Streets Nos. 91 to 93. This locality is locally known as Gallagher's Flats.

Owner. John O'Neill, 9737-96th St., Edmonton, Alta.

Operator. J. B. McDonald & Son, Excavating and Grading Contractors, 9924-102nd Avenue, Edmonton, Alta.

History. In 1931 the operator supplied to the Standard Iron Works Ltd., 121st Street and 106th Avenue, Edmonton, a quantity of good packing sand to make up a floor in the new foundry then being built. It had such excellent moulding quality that the foreman of the foundry started using it in place of an imported moulding sand suitable for heavy work used extensively in western Canada.

Description. A fairly continuous bed of moulding sand extends across the property, which is on the crest of the bluff overlooking the North Saskatchewan river on the south side. The property is all cleared of bush and is under cultivation. Mr. McDonald is of the opinion that equally good moulding sand could be dug on adjoining properties. The

bed occurs beneath black soil at depth of 18 inches and is 12 to 18 inches thick. Beneath the moulding sand bed is at least 20 feet of clay followed by about 55 feet of fine, sharp sand. Apparently a large tonnage of moulding sand is available here.

The sample was taken in October 1931.

Market. Moulding sand from this locality has been used, to date, only in Edmonton. The deposit is well situated for shipment by rail as both railways are available.

Remarks. The mechanical analysis shows the sand to be one of the best, in the writer's opinion, in western Canada for the making of large size castings. It is free from vegetable matter. Because of its high quality it could be used more advantageously through Alberta and British Columbia than any of the moulding sands imported for heavy work. The lower freight rates in effect throughout these provinces would be a considerable factor in favour of its adoption.

Laboratory No. 180

Locality. On the grounds of the Oliver Provincial Mental Institute in the N.E. $\frac{1}{4}$ section 6, township 54, range 23, west 4th mer.

Owner. Province of Alberta.

History. Mr. J. B. McDonald, 9924-102nd Ave., Edmonton, noticed that a layer of material exposed in a deep trench, made when an underground passage was being built between two buildings of the mental institute, had the same general characteristics as the bed of moulding sand at Gallagher's Flats in Edmonton South from which he had supplied a foundry in Edmonton.

Description. Prospect sample. The bed of moulding sand, from 18 to 24 inches thick, extends without a break along 400 feet of the trench. The overburden is 15 to 18 inches thick; the underlying material is sharp sand. No other exposure was observed in the grounds, but judging from the continuous bed visible and the even slope of the land surface the bed of moulding sand may extend into surrounding properties.

The sample was taken with the help of Dr. John A. Allan, Professor of Geology, Department of Geology and Mineralogy, University of Alberta, Edmonton, and Mr. J. B. McDonald, in October 1931.

Market. Moulding sand produced from this locality could be easily trucked over the highway into Edmonton, distant 9 miles to the southwest. The nearest railway station, half a mile distant, is Oliver on the Canadian National railway.

Remarks. The mechanical analysis was very encouraging. The moulding sand should be very serviceable in the making of large to medium weight castings. It is entirely free from calcium carbonate. Although the production of moulding sand would not be permitted on the institute grounds, it is probable that as good a bed may be found on adjoining properties.

Laboratory No. 177

Locality. About 20 feet east of highway No. 10 and 150 feet north of the Canadian Pacific railway tracks on the farm of the owner in the northwest ¼ section 22, township 27, range 26, west 4th mer., on the outskirts of Irricana.

Owner. A. C. Scratch, 2430 1-A St. E., Calgary, Alta.

Description. Prospect sample. Moulding sand was observed in shallow cuttings on the east side of the highway facing Mr. Scratch's property and along both sides of the railway tracks. The exposures along the north side of the tracks adjacent to the property were more marked than on the south side. Apparently the moulding sand occurs in pockets or lenticular formations rather than in an extensive bed. In the field, which was cleared of all bush or timber where the sample was taken, the moulding sand body is lenticular, is 24 to 27 inches thick and has an overburden of 12 inches. Below the moulding sand is sharp sand. The sample was taken in October 1931, and the owner was not present.

Markets. The market for moulding sand produced here would be Calgary, about 40 miles distant over highways No. 10 and No. 2. Excellent railway facilities are available as both railways pass through Irricana, which is only one mile distant.

Remarks. The mechanical analysis was encouraging. The sand is grey coloured, contains no vegetable matter, and is suitable preferably for heavy to medium weight castings. By careful prospecting larger and perhaps more continuous beds might be located on this or neighbouring properties.

Laboratory No. 178

Locality. In the sand pit of the owners on the east side of the village of Leduc, Alberta.

Owner. V. I. and R. MacLaren, P.O. Box 4090, Edmonton South, Alberta.

Operator. The same.

History. The pit was opened about the year 1900 for building and concrete sand.

Description. Under an overburden of 20 feet of building sand, lenses of moulding sand are exposed in the north and east faces, particularly in the latter, of the owner's sand pit. The lenses are 18 to 24 inches thick. The sample was taken from the best looking bed exposed in the east face of the pit, which was almost entirely obscured by the building sand above having slumped over it. The sample was taken with the help of Dr. John A. Allan, Professor of Geology, Department of Geology and Mineralogy, University of Alberta, Edmonton.

Market. Since the sample was taken the writer has been informed by the owners that moulding sand from the pit has been used by foundries in Edmonton. Leduc is on the Canadian Pacific railway, 20 miles south of Edmonton.

Remarks. The mechanical analysis suggests this is a very good moulding sand, useful preferably in the making of medium weight castings. It contains no vegetable matter and is practically free from calcium carbonate. The beds of moulding sand, however, could not be worked commercially unless there were a market for the building sand forming the heavy overburden. Special care would be needed in the removal of the lower part of this overburden, so as to prevent loss of the upper part of the moulding sand layer. It would also be necessary in the removal of the moulding sand bed to be sure that very little of the underlying building sand was included. As the moulding sand would be recovered as a by-product of the underlying building sand, it might become necessary to store it, pending its disposal.

Laboratory No. 167

Locality. On the north side of a deep coulée between the western limits of Lethbridge and the east bank of the Oldman river. This is about half way between the elevation of the city and that of the water in the river.

Operator. Lethbridge Iron Works Co., Ltd., Lethbridge, Alta.

History. The operator has dug moulding sand from this locality from about 1911 up to the present (1934).

Description. A good cross-section of an irregular bed of moulding sand from 15 to 24 inches thick is exposed in the face of the coulée. The deposit is very difficult to work because of the heavy overburden, at least 10 feet thick. No attempt has been made to follow the bed underground. The thickness of overburden would increase the farther the hill were penetrated. All moulding sand hitherto recovered was taken from or near the exposed face by working along the strike of the bed.

The sample was taken with the help of Mr. Wilcox, an employee of the Lethbridge Iron Works Co., Ltd., in September 1931.

Market. Moulding sand from the deposit was produced for the use of the operator only. There is a good wagon road in the coulée, although of very steep grade, and supplies may be teamed to the foundry, about 1 mile distant. Moulding sand will probably not be shipped from here for use in other places possessing nearer and sometimes better and more easily worked deposits.

Remarks. The use of this moulding sand has proved satisfactory particularly for the making of heavy to medium weight castings. It is free from vegetable matter and has only a trace of calcium carbonate.

Laboratory No. 166

Locality. On the banks of Seven Persons creek adjacent to Seventh Avenue in the city of Medicine Hat.

Owner. City of Medicine Hat.

Operator. Kinnaird Cartage Co., 513C North Railway St., Medicine Hat.

History. The deposit was opened about 1911.

Description. The deposit was not examined by the writer but it was reported that the bed of moulding sand is 4 feet thick, and the overburden 1 foot. The underlying material is clay. The bed was large enough to supply the requirements of a foundry for 20 years. The sample was obtained from the bins of Alberta Foundry and Machine Co., Ltd. in Medicine Hat in September 1931.

Market. The only market for this moulding sand has been local.

Remarks. The moulding sand has been used for making the general run of castings, but is particularly suitable for those of small to medium weight. It is entirely free from vegetable matter and has only a trace of calcium carbonate.

Although the deposit is reported as being largely depleted and the remainder as inaccessible, prospecting along Seven Persons creek might locate similar deposits.

Laboratory Nos. 193, 194

Locality. Near the farm house of the owner, which is in the N.W. ¼, section 14, township 34, range 26, west 4th mer.

Owner. G. W. Warren, Wimborne, Alta.

History. About 1923 a sample of moulding sand from near the pit was sent for trial to a foundry in Calgary.

Description. A large wedge-shaped bed of moulding sand underlies the cleared farming land near the house of the owner. Three hundred feet north of the house a pit about 15 feet across and 15 feet deep gives the best access to the bed. The overburden is 8 feet thick and 8 feet of moulding sand is exposed, the bottom not having been reached. Sample laboratory No. 193 represents the moulding sand from the pit. In the cellar of the house, beneath an overburden of about 5 feet there is at least 4 feet of a heavier bonded moulding sand than at the pit, the bottom again not being reached. Sample laboratory No. 194 represents the moulding sand from the cellar of the house. About 150 feet north of the pit or 450 feet north of the house the bed was exposed again when a radio pole was erected, but the thicknesses of overburden and moulding sand were not determined, nor a sample obtained. A very large tonnage of moulding

sand is undoubtedly available as the bed most likely extends south of the house, north of the radio pole, and east and west of a line joining the house and the radio pole.

The sample was taken in October 1931.

Market. No moulding sand has been sold from this deposit. Calgary is the most probable market, being 90 miles distant by rail. The nearest shipping point is Wimborne on the Canadian Pacific railway, which is 3½ miles distant.

Remarks. According to the mechanical analysis the moulding sand from the pit is better than that from the cellar of the house, but both would be suitable only for light to medium weight castings. No vegetable matter was contained in either sample. It would not be advisable to use moulding sand from the site of the house until the better sand from the pit or near the radio pole was exhausted. But it is doubtful if the deposit could be economically developed owing to the heavy overburden that would have to be removed.

TABLE XIII

Mechanical Analyses of Sands from Alberta

Laboratory No.	Locality	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards. On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent: Sand	Refractoriness, Pyrometric cone equivalent: Clay	Calcium carbonate
168	Calgary	....	....	0·10	0·10	0·12	0·34	0·44	0·86	1·88	5·64	19·78	62·26	8·9	100·4	259	1	D	4·0 6·1 8·0	6·1 10·9 10·7	4·4 4·0 3·6	9	8	Present
179	Edmonton	....	....	0·36	1·66	5·26	13·22	20·64	20·22	9·78	4·08	2·42	3·82	18·5	100·0	78	4	F	4·0 6·0 8·0	66·4 78·9 58·9	13·3 10·0 8·8	13+	6	Nil
180	Tp.54 R23 W. 4th M.	....	....	.....	0·28	1·70	9·30	23·10	25·24	12·90	5·70	2·92	2·22	16·5	99·9	104	3	F	4·0 6·1 8·0	84·3 59·8 45·7	14·2 11·0 8·3	13+	5	Nil
177	Irricana	....	0·04	0·46	1·63	7·02	22·54	25·10	11·86	4·20	2·82	2·68	6·16	15·5	100·0	76	4	F	6·1 8·1 10·0	33·0 46·9 61·6	11·1 9·3 7·6	13	5	Present
178	Leduc	....	....	0·04	0·12	0·26	0·54	1·50	11·52	23·98	16·16	10·48	13·50	22·0	100·1	150	2	G	3·9 6·0 8·0	21·6 23·0 17·2	8·4 9·2 8·6	14+	5	Trace
167	Lethbridge	....	0·34	0·20	0·22	1·10	7·36	24·14	28·08	17·28	7·80	3·26	2·20	8·0	100·0	83	4	D	4·1 6·0 8·1	73·6 62·4 54·8	6·6 3·9 2·1	13+	5	Trace
166	Medicine Hat	....	0·12	0·28	0·30	0·42	0·76	1·34	2·26	3·58	5·30	7·88	59·08	18·6	99·9	254	1	F	6·1 8·0 10·1	4·4 4·5 4·4	5·8 6·2 6·1	14+	9	Trace
193	Near Wimborne	....	....	.....	0·06	0·08	0·30	1·72	9·70	19·18	16·88	15·12	21·70	15·2	99·9	279	1	F	4·0 6·0 8·1	15·4 18·2 17·1	6·6 5·8 6·9	9	4	Present
194	" "	....	....	.....	0·12	0·06	0·12	0·32	0·56	1·84	3·96	8·42	46·20	38·5	100·1	265	1	H	6·1 8·1 10·0	3·1 4·3 6·2	12·7 10·2 10·8	....	.....	Trace

BRITISH COLUMBIA

Laboratory No. 176

Locality.—Fort Steele mining division. Part of lots 123, 124, and 125, northwest of Cobham St., Cranbrook, B.C.

Owners. City Transfer and Warehouse Co., P. O. Box 724, Cranbrook, B.C.

Operators. The same.

History. The deposit was opened up about 1908 and was stated to have been discovered by a foundryman from one of the foundries where the sand was later used.

Description. The deposit lies in a fairly flat piece of land sparsely covered with light timber and bush. The moulding sand occurs mainly in pockety or lenticular bodies, but beds of small extent have also been found. The thickness of the overburden is not uniform, only 2 or 3 inches was found in some pockets that have been worked, whereas generally it is one foot or more. Most of the moulding sand pockets or beds are 12 to 18 inches thick. Underlying the moulding sand is sharp sand. The deposit has been largely worked over, but a large area is still available for development.

The sample was taken with the help of one of the members of the operating company in October 1931.

Market. Most of the moulding sand produced has been used by Cranbrook Foundry and Machine Shop at Cranbrook. A considerable quantity has been shipped for more than 20 years a distance of 229 miles over the Canadian Pacific railway to the Boundary Iron Works at Grand Forks, B.C.

Remarks. The moulding sand has given satisfactory service on light to medium weight castings, but is likely to burn out or loose its bond when very heavy castings are made. It is entirely free from calcium carbonate.

Laboratory No. 169

Locality. Kamloops mining division. On the northeast road allowance of the main travelled highway to Kamloops, 1 mile northwest of Holmwood.

Operator. W. J. Ellis & Co., Kamloops, B.C.

History. The deposit was first worked about 1928.

Description. The deposit was not visited but the operator stated that it has a length parallel to the road of at least 300 feet. The thickness of the moulding sand is 4 to 5 feet and that of the overburden only about 1 foot. The moulding sand probably extends into the adjoining fields. The sample was taken from the bins of the foundry owned by W. J. Ellis & Co. in October 1931.

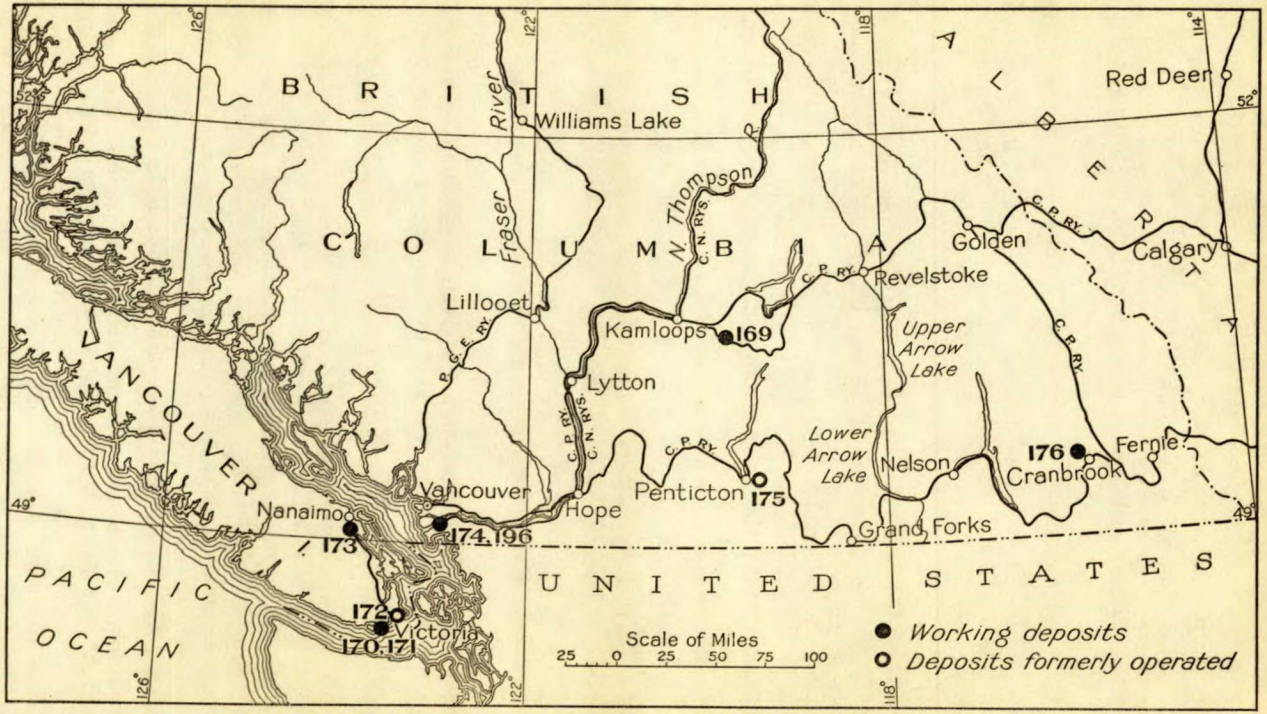


Figure 7. Index map of British Columbia, showing location of sand deposits sampled: **169,** near Holmwood; **170, 171,** Metchosin district; **172,** Victoria; **173,** near Nanaimo; **174, 196,** New Westminster; **175,** Penticton; **176,** Cranbrook.

Market. The moulding sand is produced by the company for its own use and is transported nearly 20 miles by truck.

Remarks. The moulding sand is useful for all weights and shapes of castings. It is entirely free from vegetable matter and calcium carbonate.

Laboratory No. 173

Locality. In the vicinity of Nanaimo.

Operator. Nanaimo Foundry Co., Nanaimo, B.C.

Description. No description could be obtained other than that in the past the deposit had been large enough to furnish supplies for many years and could continue to do so for many more.

The sample was taken in October 1931, from the bins of the foundry using the sand.

Market. The operator has kept this moulding sand deposit for his own use.

Remarks. The sand was said to be useful for making nearly all classes of casting. A moulder in the employ of the company believes that moulding sand could also be obtained northwest of Nanaimo towards Wellington.

Laboratory Nos. 170, 171

Locality. Victoria mining division, on the Whitty farm on lots 7, 8, 9, 10, and 10a, subdivision of lots 2 and 3, section 1, Metchosin district.

Owner. Swinerton & Musgrove Limited, P. O. Box 146, 602 Broughton St., Victoria, B.C.

Operator. The same.

History. The deposit was first worked about 1911.

Description. The deposit is in the face of a bluff on the coast line of Parry bay, having a height of over 75 feet and an approximate dip of 45 degrees. Two grades of moulding sand are recovered from separate beds near the middle section of the bluff. Of these, that nearer the surface is 20 feet thick, and from it comes the producer's grade No. 2 moulding sand, represented by laboratory No. 171. The overburden is 32 to 35 feet thick, the lower 30 feet being sharp sand, and the upper 2 to 5 feet being soil. The other bed, directly below, is also 20 feet thick, and the product, known as grade No. 1, is represented by laboratory No. 170. The underlying material down to sea-level is very fine-grained sand, which may be useful for moulding, but no sample was taken. To recover the sand an inclined skip driven by a gasoline hoist has been erected. Prior to the railroad being built from Victoria, the moulding sand was loaded on scows when weather permitted, but the wharf from which shipments were made is no longer in existence.

The samples were collected in October 1931, with the help of an employee of the company.

Market. The moulding sand is trucked about 14 miles to Victoria, where it is used locally or is shipped to Vancouver. In the past shipments have been made to Oakland, San Francisco, and Emoryville, California.

Remarks. Both moulding sands have given satisfaction; grade No. 1 is very good for making light weight castings of brass and iron such as stove plate work, and grade No. 2 is more suitable for heavier castings. Material from the 30 feet of sand immediately above the upper moulding sand bed has been used for core-making by a foundry in Vancouver.

Laboratory Nos. 174, 196

Locality. New Westminster mining division. On the south bank of the Fraser river, directly south of the east end of Annacis island.

Owners. Building & Moulding Sands, Ltd., 1111 Edinburgh St., New Westminster, B.C.

Operators. The same.

History. Mr. David Jennings of Vancouver became interested in this property about 1931 and induced the owners of several foundries in that city to test the sands.

Description. The property is half a mile square and lies beside the bank of the Fraser river. The land rises abruptly from the river as a bluff and is cut up by three gulches extending in a southeasterly direction towards the back of the property. The Great Northern Railway tracks lie between the river and the foot of the bluff. Good grade sand is well exposed along the face of the bluff between the outlets of the gulches and along their walls particularly those of the central gulch. The face exposed extends 75 feet from the surface down to a bed of blue clay near the river level. The beds of possible moulding sand in descending order have thicknesses of 5, 9½, and 8½ feet. The overburden is 16 feet, made up of 12 feet of gravel on top and 4 feet of coarse sharp sand next to the moulding sand. The middle bed, 9½ feet thick, supplies the best moulding sand, and from it is obtained the company's grade known as No. 3, represented by laboratory sample No. 174. The company has also made a blended sand from the three beds, known as No. 234, which is represented by laboratory sample No. 196. The samples were taken by Mr. Jennings from the walls of the middle gulch in 1932 and 1933.

Market. Since this deposit was opened in 1931 the company has supplied foundries in Vancouver. Excellent facilities for shipment are available by railway, steamboat, or truck; Townsend on the Great Northern railway is one mile distant.

Remarks. It is reported that both sands have given satisfaction in the foundries that tried them. The grade No. 3 is used chiefly for light to medium weight castings of iron, brass, and aluminium; grade No. 234 is more suitable for heavier weight of castings.

Laboratory No. 175

Locality. Within the town limits of Penticton and comprising a small part of an area 2 to 3 blocks east and west and 10 to 15 blocks north and south.

Owners. Several.

Operator. The L. L. Wilkins Machine Shop & Foundry, Penticton, B.C.

History. Moulding sand from within this area has been used for over 11 years, but by 1933 the lots having the best moulding sand had been built upon, so that they were no longer available for production.

Description. Small patches of moulding sand have been worked at several places in the area. These pocket-shaped deposits had a thickness of 24 to 30 inches; the overburden, largely coarse sand, gravel, and some boulders, had a thickness of about 36 inches. The underlying material is composed of sharp sand. The sample was taken in October 1931 from the bins of the foundry where the sand was used, a more general sample of the whole area being thus obtainable.

Market. The moulding sand has been used only in the one foundry in Penticton.

Remarks. The company states that the sand gave best results when making light weight castings, but that a smooth surface was always obtained. There is no vegetable matter or calcium carbonate.

Laboratory No. 197

Locality. On Crown land about four miles west of Telkwa, adjacent to the main road to Smithers.

Operator. Telkwa Transfer & Garage (per B. M. Hoops), Telkwa, B.C.

Description. The sample for testing and the information concerning the deposit was given by Mr. Hoops through Mr. Fred. V. Seibert, Superintendent, Department of Natural Resources, Canadian National Railways, Winnipeg, Man., about March 1934. The deposit is claimed to have an extent of at least 10 acres. The bed of moulding sand is from 6 to 8 feet thick and is underlain by gravel and covered by loam. It is claimed that other fairly similar deposits are present along the Canadian National railway and the railway station at Telkwa.

Market. About 1920, 300 tons of the moulding sand had been shipped to a foundry in Prince Rupert, 236 miles distant from Telkwa on the Canadian National railway.

Remarks. According to C. Stapleton, foundry superintendent, Prince Rupert Dry Dock & Engineering Co., Ltd., the sand was highly satisfactory. Owing to the high clay content it would be advisable to blend it with coarse-grained sharp sand for the making of large castings, so as to increase the permeability. Some compressive strength would be sacrificed by doing so, but this would not be detrimental as it would still retain greater strength than many less heavily bonded sands.

Laboratory No. 172

Locality. City of Victoria, near the corner of Bay and Blanshard Streets, and the corner of Douglas and Pembroke Streets.

Operator. Luney Bros., contractors, 508 Sayward Bldg., 1207 Douglas St., Victoria.

History. Moulding sand has been dug here for nearly 40 years. The deposits are now either exhausted or the land has been built upon.

Description. The actual thickness of moulding sand recovered from the district is unknown because of the lapse of time since most of the deposits were worked. The thickness of that dug in recent years was as great as 3 to 4 feet, and the overburden 1 to 1½ feet. The underlying material in most places is clay.

The sample was taken in October 1931 from the bins of one of the foundries in Victoria that had used the sand for years.

Market. Most of the moulding sand was used locally. At times some was shipped to Vancouver.

Remarks. The sand has given satisfaction for all classes of castings, being particularly suitable for those of medium weight. Moulders in Victoria expressed the opinion that, as so large an area had been underlain with moulding sand, other beds may lie outside the city limits, where building would not hinder development.

Laboratory No. 208

Locality. Cariboo mining division, lot 1757, near Bednesti at mileage 21·7, Nechako sub-division.

Owners. Land Settlement Board.

Description. Prospect sample. The following description of the property was given by R. A. Harlow, roadmaster, Canadian National Railways, at Prince George. The present known area underlain by moulding sand is about two acres, on land sparsely covered with poplar bush and spruce trees. The moulding sand bed has an exceptional thickness of about 15 feet with 1 foot of overburden and is underlain by clay.

The sample was sent in March 1935, by F. V. Seibert, Superintendent, Department of Natural Resources, Canadian National Railways, Winnipeg, Manitoba, who had received it from R. A. Harlow.

Remarks. This moulding sand should prove serviceable for light weight and thin section castings. The property has not been operated.

TABLE XIV

Mechanical Analyses of Sands from British Columbia

Laboratory No.	Locality	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards														Grain Fineness No.	Grain Class	Clay Class	Moisture (temporing), percentage	Permeability	Compressive strength lb. per sq. in.	Refractoriness, Pyrometric cone equivalent		Calcium carbonate	Trade designation
		On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total							Sand	Clay		
176	Cranbrook	....	0·42	5·44	7·78	9·66	11·42	10·96	9·86	8·42	5·90	5·48	14·70	9·9	99·9	104	3	D	3·9 6·0 7·9	10·6 18·2 **27·1**	**5·6** 5·2 4·2	13	5+	Nil	.....
169	Near Holmwood	....	0·98	3·16	4·10	5·36	7·82	9·40	11·32	11·90	8·88	7·66	14·84	14·4	99·8	120	3	E	4·0 6·0 8·1	7·2 8·4 **11·4**	**10·8** 10·2 9·9	5	4	Nil	.....
170	Near Metchosin	....	....	.....	.....	0·22	0·38	0·38	1·84	7·60	15·84	22·96	44·06	6·6	99·9	225	1	D	4·1 6·0 8·1	7·5 8·9 **9·6**	4·1 3·2 3·5	8	4	Nil	No. 1
171	" "	....	....	0·18	0·32	1·34	4·10	10·54	19·40	19·58	12·98	10·18	17·32	4·1	100·0	137	3	C	4·0 6·0 8·1	20·4 29·5 **30·8**	2·2 2·2 **2·6**	.....	.....	Nil	No. 2
173	Near Nanaimo	....	1·20	1·26	0·60	0·48	0·74	1·48	9·86	21·46	17·26	15·32	27·22	3·2	100·1	172	2	C	6·0 8·1 10·1	10·6 **15·2** 14·8	3·8 **4·4** 4·2	8+	4	Nil	.....
174	Near New Westminster	....	....	.....	0·04	0·04	0·22	0·24	0·52	3·26	9·04	18·20	59·98	8·4	99·9	254	1	D	6·0 8·0 9·9	7·9 8·7 **9·2**	3·7 4·5 3·7	8	5	Nil	No. 3
196	" "	....	....	.....	.....	.....	0·54	2·02	9·36	20·10	14·20	10·52	34·48	9·0	100·2	189	2	D	6·1 8·0 10·1	14·4 16·7 **18·5**	**4·1** 3·6 3·5	.....	.....	Nil	No. 234
175	Penticton	....	2·46	4·76	4·54	5·40	8·50	11·74	13·50	11·00	8·18	7·00	15·64	7·2	99·9	113	3	D	4·1 6·1 8·0	19·2 25·4 **30·2**	4·0 **4·1** 3·4	8	5	Nil	.....
197	Telkwa	....	....	0·44	0·64	0·90	1·08	1·84	4·60	6·80	6·02	6·88	28·62	42·3	100·1	207	1	H	8·0 10·1 11·9	3·1 5·6 **11·3**	**14·4** 13·3 10·7	9	12	Nil	.....
172	Victoria	....	1·44	1·10	0·74	1·08	2·58	5·74	17·98	22·24	14·32	10·12	12·64	10·0	100·0	131	3	E	4·0 6·1 8·1	16·0 22·4 **26·7**	**4·6** 4·4 3·3	8+	6	Nil	
208	Near Bednesti	....	....	.....	0·08	0·06	0·10	0·58	4·68	11·12	13·18	16·94	44·40	9·1	100·2	220	1	D	8·0 10·1 11·9	11·0 11·3 **12·7**	4·2 **4·3** 4·1			Trace	

APPENDIX I

IMPORTED SANDS

For many years, Canadian foundrymen have been large users of imported moulding sand, the greater bulk of the importations coming from the United States.

Sands from the Albany district, New York State; from Zanesville, Ohio; Millville, and Lumberton, New Jersey; and Kerrick, Minnesota, as well as many others, have become well and favourably known in many parts of Canada.

Special sands have also, from time to time, been imported from European sources where these sands were claimed to have peculiar qualities but such importations were small.

Since it is probable that imported sands will continue, for a time at least, to be important to the Canadian foundrymen it was thought advisable that information relative to their physical properties should be obtained. Samples were therefore collected of a number of the more representative imported sands now being used in Canadian foundries and the results of the tests on these samples are embodied in Table XV so that comparisons can be made with Canadian sands.

TABLE XV

Mechanical Analyses of some Imported Natural Bonded Moulding Sands

Laboratory No.	Locality	Screen Analysis, percentages. Screen numbers: top line, Tyler; bottom, U.S. Bureau of Standards. On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total	Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent: Sand	Refractoriness, Pyrometric cone equivalent: Clay	Calcium carbonate	Trade designation
A	Albany, N.Y.	....	0·08	0·10	0·09	0·15	0·66	2·29	4·26	6·75	13·99	22·96	38·02	10·9	100·3	217	1	E	4·2 6·1 10·2	7·9 10·2 **11·4**	**6·8** 5·7 5·1	13	13+	Nil	No. 0
B	"	....	0·11	0·18	0·29	0·40	0·82	0·84	2·24	8·78	15·73	24·67	38·72	7·7	100·5	214	1	D	4·1 6·0 8·1	12·7 **15·3** 14·3	4·2 3·2 3·1	13+	14	Nil	No. 1
C	"	0·20	0·14	0·06	0·18	0·54	2·36	13·97	30·89	17·70	7·32	5·90	10·86	9·9	100·0	113	3	D	4·0 6·1 8·0	34·3 40·5 **44·1**	**4·7** 3·2 2·7	14	14	Nil	No. 2
D	"	....	0·46	1·74	2·42	11·36	19·41	18·18	9·44	6·50	3·66	3·68	10·29	12·6	99·7	89	4	E	4·0 6·0 8·1	20·3 55·3 **77·3**	5·0 4·1 2·2	13	13	Nil	No. 3
E	"	0·26	0·35	1·33	2·65	4·89	10·56	13·09	9·34	15·21	10·99	8·09	12·65	10·6	100·0	117	3	E	4·0 6·1 8·0	19·1 22·0 **27·8**	**6·4** 5·4 3·5	14	14	Nil	No. 3
G	Zanesville, Ohio.	0·31	1·12	2·46	11·04	15·44	10·19	5·95	3·67	2·58	1·66	1·77	14·08	29·5	99·8	96	4	G	4·1 6·0 7·9	21·3 22·8 **32·6**	8·7 9·7 **11·1**	14	14	Nil	No. 5
I	"	....	0·15	1·16	7·12	15·94	14·93	8·49	4·21	2·57	1·48	1·48	13·95	27·9	99·4	96	4	G	3·9 6·1 8·0	18·8 22·8 33·4	9·2 **11·6** 10·2	....	.....	Nil	.....
H	Bidwell, Ohio.	....	0·07	0·40	0·78	1·44	2·19	13·73	18·47	13·32	6·16	4·54	10·63	28·2	99·9	103	3	G	4·1 6·1 8·1	7·2 12·6 **18·8**	12·4 **13·6** 11·3	14	15	Nil	No. 3
N	New Lexington, Ohio.	....	0·26	1·06	3·87	7·46	11·38	12·60	6·82	3·34	1·76	1·80	17·74	31·8	99·9	120	3	H	4·1 6·1 8·2	9·0 10·1 **13·3**	12·0 **12·9** 12·0	13+	14	Nil	.....

TABLE XV—*Concluded*

Mechanical Analyses of some Natural Bonded Moulding Sands

Laboratory No.	Locality	Screen Analysis, percentages. Screen numbers: top line Tyler; bottom, U. S. Bureau of Standards														Grain Fineness No.	Grain Class	Clay Class	Moisture (tempering), percentage	Permeability	Compressive strength, lb. per sq. in.	Refractoriness, Pyrometric cone equivalent		Calcium carbonate	Trade designation
		On 6 / 6	On 10 / 12	On 20 / 20	On 28 / 30	On 35 / 40	On 48 / 50	On 65 / 70	On 100 / 100	On 150 / 140	On 200 / 200	On 270 / 270	Through 270 / 270	Clay substance	Total							Sand	Clay		
K	Millville, N.Y....	7·83	9·35	20·72	16·96	12·33	7·12	3·18	1·33	0·63	0·39	0·35	1·87	17·8	99·9	28	8	F	4·1 5·9 7·9	72·6 143·5 249·0	9·1 14·4 8·8	16	.....	Nil	Gravel
L	Lumberton, N.J..	....	0·04	1·26	2·18	3·59	7·90	16·13	24·47	17·18	6·83	3·08	2·40	14·7	99·8	82	4	E	3·9 6·1 8·1	68·0 78·2 53·0	11·5 9·9 9·7	18	.....	Nil	.....
O	Windsor Locks, Conn.	....	0·30	0·14	0·16	0·14	0·40	0·34	0·52	1·32	2·71	5·72	59·74	28·9	100·4	275	1	G	.....	.....	.....	8	6	Nil	.....
U	"	....	0·30	0·38	0·44	0·54	0·94	1·32	1·62	2·76	4·24	7·58	64·38	15·4	99·9	260	1	F	4·1 6·0 8·1	2·0 2·5 2·7	6·4 6·8 7·0	8	6	Nil	.....
P	Nicols, Minn.....	....	....	0·10	0·06	0·10	0·56	2·08	3·84	7·98	13·18	17·42	40·60	13·9	99·8	218	1	E	4·0 6·0 8·1	6·1 8·0 7·9	7·4 6·4 6·2	8	5	Present	Fine
S	"	....	0·26	0·20	0·12	0·48	2·32	7·76	15·32	17·06	12·80	11·14	19·50	13·3	100·3	151	2	E	4·0 6·0 8·0	12·8 13·0 12·4	6·9 7·5 6·5	13	5	Trace	Medium
Q	Kerrick, Minn....	....	2·68	2·66	2·92	4·56	8·90	13·90	13·58	9·80	5·82	5·04	12·42	17·6	99·9	117	3	F	4·0 6·0 8·0	32·2 52·7 41·7	7·6 7·2 6·7	12+	6	Nil	.....
R	Ellensburg, Wash.	....	....	0·36	1·16	2·88	6·66	11·08	13·48	10·58	7·18	6·96	14·26	25·5	100·1	129	3	G	8·0 10·0 12·1	13·6 15·1 14·2	12·7 10·0 9·1	8	7	Trace	.....
T	France, district unknown.	....	....	0·08	0·04	0·06	0·20	0·42	1·77	5·62	8·80	13·88	61·98	7·3	100·2	252	1	D	4·1 6·0 8·1	8·6 9·4 8·8	3·5 3·8 4·0	8+	6	Nil	Fine

APPENDIX II

GLOSSARY OF FOUNDRY TERMS*

Blow-hole. A shiny, clean hole in a casting caused by air blowing into the metal from a core, or from the mould face, as the casting is solidifying.

Clay-wash. A thin emulsion of clay and water, sometimes used to strengthen the face of the mould.

Cold-shut. An imperfect junction line between two flows of metal in a mould.

Cope. The upper part or cover of a mould.

Core. A body of green or dry sand placed in the mould to form a corresponding cavity in the casting.

Drag. The lower part of a mould.

Dry sand. Green sand dried in an oven to remove moisture and strengthen it. (A dried-sand mould is a mould made of green sand which is treated as above.)

Facing sand. A fine-grained sand used for lining moulds which are made mainly from coarse-grained material in order that a smooth surface to castings may be obtained.

Feeding. Pouring additional molten metal into a freshly poured mould to care for volume shrinkage during progressive setting.

Fireclay brick. Brick made of highly refractory clay.

Fireclay. A clay comparatively free from iron and alkalies, not easily fusible.

Fire sand. A sand so free from fluxes that it is highly refractory.

Flask. Containers of wood or iron into which green sand is rammed about a pattern to make a mould, consisting of the cope and drag.

Foundry. An establishment in which moulds are made and metal melted to pour them, for the production of castings.

Gate. An opening cut into the cope through which the molten metal is poured into the mould.

Green sand. Moulding sand tempered with water. (A green sand mould is rammed up with properly tempered moulding sand.)

Hand moulding. The art of making moulds by manual operation.

Loam. A moulding sand rich in clay substance.

Machine moulding. The art of making moulds by mechanical operation.

Mould. A body of moulding sand or other heat-resisting material containing a cavity which when filled with molten metal yields a casting of the desired shape.

Moulding. The art of making moulds.

* Condensed from several sources including "The Principles of Iron Founding (1917)" by Richard Moldenke. McGraw-Hill Book Company, Inc., New York; "Foundry & Metallurgy, Vol. 1 (1932)" Edited by R. T. Rolfe. Sir Isaac Pitman & Sons, Ltd., London; "A Glossary of the Mining and Mineral Industry, (1920)" by Albert H. Fay, Department of the Interior, Bureau of Mines, Washington, D.C.

Moulding sand. Sand containing sufficient refractory clay substance to bond strongly without destroying the permeability to air and gases when rammed to the degree required.

Parting sand. A fine-grained bondless sand dusted on the joint of a mould to prevent the cope and drag from adhering to each other.

Pattern. A wooden or metal counterpart of a casting to be made.

Ramming. The packing of moulding sand around a pattern in a mould.

Riddle. A sieve for removing the coarser material while sifting sand.

Riser. An enlarged gate to act as a feeder for the casting. Also an outlet over a high part of the mould to indicate the level of the molten metal.

Runner. An enlarged pouring basin, or deep channel, connecting with the gates to bring metal to them.

Sea coal. A coal of high volatile matter added to moulding sand in dust form to facilitate easy stripping of castings from moulds.

Scab. Imperfection in the surface of a casting due to the breaking away of portions of the mould by the stream of molten metal.

Shrink-head. A very large riser intended to feed the casting as well as collect impurities. It is subsequently machined off the casting.

Skin-drying. The drying of the mould surface by direct application of heat. This drying should extend inward at least an inch.

Snap flask. A moulding box hinged at one corner, with a snap fastener at the opposite diagonal corner.

Vent. A small hole in the mould made with a wire to facilitate the escape of gases.

Vent wire. A wire used by foundrymen to make a hole in a sand mould for the escape of air or gases.

APPENDIX III

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