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BULLETIN No. 32

Report on Road Materials along the St. Lawrence River, from the Quebec Boundary Line to Cardinal, Ontario

BY

R. H. Picher.

OTTAWA
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1920

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No. 530

LETTER OF TRANSMITTAL.

DR. EUGENE HAANEL,
Director Mines Branch,
Department of Mines,
Ottawa.

Sir,—I beg to submit, herewith, a report, with maps, on the Road Materials along the St. Lawrence River from the Quebec boundary to Cardinal, Ont. This report has been prepared by Mr. R. H. Picher of the Road Materials Division.

I have the honour to be, Sir,
Your obedient servant,

(*Signed*) **K. A. Clark,**
Chief, Road Materials Division.

Ottawa,
Jan. 9, 1920.

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ROAD MATERIALS ALONG THE ST. LAWRENCE RIVER, FROM THE QUEBEC BOUNDARY LINE TO CARDINAL, ONTARIO.

INTRODUCTORY.

A road materials survey was made during the summer of 1917 over a strip of country 4 to 5 miles in width, along the St. Lawrence river, from the Quebec boundary line to Cardinal, Ontario. This area extends over a distance of 59 miles, and includes parts of Glengarry, Stormont, Dundas, and Grenville counties. The survey was undertaken in order to secure information regarding available road making materials, with a view to facilitating the planning of the proposed improved highway between Montreal and Toronto. The route of this highway will, presumably, follow the bank of the river.

The writer was assisted in his task by L. Clermont and E. Giguère, who performed their work in a thoroughly satisfactory manner.

GENERAL CHARACTER OF THE COUNTRY.

TOPOGRAPHY.

The country extending along the St. Lawrence river, between the border line of Quebec province, and Cardinal, Ont., and at right angle therefrom northward for 5 miles, is best described as a rather flat plain, sloping southeastwards to that river. Between Cornwall and Lancaster a characteristic feature is the occurrence of a series of ridges trending in a direction parallel to the St. Lawrence river. West of Cornwall, and as far as Aultsville, broad, low hills are commonly seen. Many of these hills have long, narrow ridges, running approximately north-south, bordering their western edge. At their south end the ridges rise a few feet over the hill with rather sharp western slope; but towards their north end they become gradually lower, and are not clearly distinct from the rest of the hill. Between Aultsville and Cardinal the same hills and ridges are found in smaller number, and rise only a few feet above the plain.

East of Cornwall, the plain lies only a few feet above the level of the St. Lawrence. It rises northward at a very low rate. The parallel ridges between Cornwall and Lancaster have elevations of from 25 to 50 feet above the flat. West of Cornwall the main flat is from 15 to 25 feet above the water-level of the St. Lawrence. The hills and ridges between Cardinal and Cornwall rise at elevations of from 5 to 30 feet above the plain, the highest being near Cornwall. The divide between the Ottawa and St. Lawrence River basins comes into the 5-mile belt north of Morrisburg; and near Cardinal it is only 2 miles from the shore of the St. Lawrence. At this point the northern side of the divide has a slope of only a few feet per mile, while the southern side slopes at a rate of about 25 feet per mile. The many small creeks emptying into the St. Lawrence river form gullies along the shore, these being particularly common between Cornwall and Morrisburg.

The Raisin river is the only important stream draining the country. It rises only a few miles from the St. Lawrence river, runs nearly parallel to it for over 20 miles, and empties into the main river at Lancaster, 9 miles west of the eastern border of Ontario. It flows through a flat channel, with an average fall of 3 feet per mile. The water-level of the St. Lawrence river above Cardinal and of Lake St. Francis near the Quebec line, is 242 feet and 153 feet, respectively, above sea-level. Many stretches of land, especially in the depressions between ridges, are marshy, and have remained uncleared.

GEOLOGY.

The rock outcrops consist of Beekmantown dolomites and Black River and Chazy limestones: all of the Palæozoic era. Dolomites of the Beekmantown are seen exposed at several places around Cardinal. The stone is generally dark grey in colour, and medium to fine-grained. All the outcrops are of rather small extent, and in nearly every case they lie in the north slope of flat hills 4 to 15 feet in height. The highest hill is found 1½ miles west of Cardinal, where a large excavation has exposed a section 23 feet in height above underground water-level. Exposures of Black River limestone occur at different points north and west of Cornwall. Only two are of real importance, one 4 miles north, and the other 5½ miles west, of that town. The stone is very dense, almost black in colour, and presents the same character in nearly every case. The stone occurrences lie in low places; and west of Cornwall most of it is covered with from 2 to 10 feet of drift, except where exposed by quarrying. One mile southeast of Summerstown station, limestone of the Chazy formation lies close to the surface, covering an area of about 2 acres. The rock is exposed in an old quarry, to a depth of 2 feet, but does not outcrop on the surface. The stone is light grey in colour, and of medium even grain.

The beds of the dolomites and limestones dip at very low angles with the horizon. The Beekmantown dolomites are thin-bedded, and Black River limestones thick-bedded, with many pencil-line partings. The joints are approximately at right angles to the bedding plane, but show no regularity in other ways.

Glacial striae were observed north and west of Cornwall, with direction varying from N. 12° W. to N. 20° W. Other striae, less commonly seen, had directions of N. 10° E., N. 18° E., and N. 55° W.

A large part of the country west of Cornwall is covered with boulder clay. To the east, the boulder clay is found more often on the higher lands, lying in the form of small ridges and hills. As seen from a few shallow sections, it is most frequently composed of rounded boulders and angular pebbles in a light bluish-grey matrix of fine sand, silt and some clay. The pebbles are largely limestone. The proportion of clay in the matrix seems to be higher west of Morrisburg than to the east. The most important gravel deposits lie in Cornwall and Osnabruck townships. Outside of this area thay are of less frequent occurrence. Between Cornwall and the Quebec border, the gravels lie in flat ridges on top of the boulder clay without any distinct outline between the two. West of Cornwall, most of them form small, well-marked ridges lying on the western slope of large boulder clay hills. They are in most places very bouldery on top, becoming finer and more markedly stratified below. The deposits contain marine shells, occurring in aggregations and layers in the boulders and

gravel to depths of 13 feet from the surface. The occurrence of collections of unbroken, fragile shells, in and under thick bouldery deposits, is of geological interest. Stratified blue marine clay occupies most of the country north and east of Cornwall. Much smaller strips of marine clay are seen west of Cornwall, and close to the river. A narrow belt of sand lies along the shore of the St. Lawrence river for 16 miles, from Cornwall west to Aultsville.

ROAD CONDITIONS.

The St. Lawrence River road is the most important line of travel through the area under consideration. It will probably be made part of the Montreal-Toronto trunk road. Most of the through traffic goes over it. This is not heavy at present, due to the bad condition of the road. Other lines run at right angles to this road from the principal towns along the river. Of these the Cornwall, Morrisburg, and Lancaster roads carry the heaviest traffic. The road from Lancaster northward, leads to Alexandria. The Morrisburg road goes through Winchester and Metcalfe, connecting with the Metcalfe road to Ottawa The road from Cornwall connects northward with the old King's road, which was the first opened by the early settlers in this part of the Province, and remained for a long time the main line of travel. The local traffic on the Morrisburg and Cornwall roads is nearly equivalent to that over the front road. The old King's road, although more extensively used than farm roads, is subjected to a light traffic.

Grades on the St. Lawrence road are flat, except from Mille Roches west to Cardinal, where many steep-sided gullies formed by streams flowing into the St. Lawrence are crossed. The Lancaster and Morrisburg roads run through perfectly level land. The country traversed by the Cornwall and the King's roads is slightly rolling, with long gentle grades.

Sections of the St. Lawrence road have been gravelled or macadamized at different times. As a whole, it is in bad condition, although the surface, for the most part, is still firm. This will undoubtedly help out in building a foundation for a new road. The soil along the front road consists of blue marine clay in the east part of the surveyed area, and boulder clay in the west part. A belt of sand stretches from Cornwall to Aultsville, but it is very thin towards the west, and only partly covers the underlying clay. Small isolated areas of sand are encountered between Morrisburg and Cardinal. In the high parts of the road in Charlottenburg township, the soil is largely made up of sand and boulders.

During the spring, the River road, where the swamps of Lancaster and eastern Charlottenburg townships are crossed, is said to be in very bad condition. Near the western border of the latter township, and in some of the gullies between Aultsville and Morrisburg, the stoned surfacing is completely gone, exposing the clay subsoil, which in wet weather is cut into deep ruts. East of Mille Roches, a section of road through heavy sand has given much trouble. The stoned surface on the Cornwall and Morrisburg roads is in good condition, except for one-half mile through a swamp north of Morrisburg. This section is cut by as many as 10 longitudinal ruts in the width of the travelled way. The Lancaster and King's roads have, at different times, been partly gravelled but are now hardly any more than good earth roads. The former is said to be badly drained in the spring.

ROAD MATERIALS

Bedrock, field stone, and gravel, are the only available road materials. Rock exposures are of small extent, and occur only in a few places. Boulder deposits, or field stone and gravel deposits, are most common between Cornwall and Aultsville, but everywhere else they are found only in isolated patches. From the Quebec border west, nearly as far as Lancaster, boulders and gravel are of very rare occurrence. The bedrock is probably the best road material, although the field stone in certain localities is nearly equivalent to it in durability. The proportion of durable material in the boulder deposits of field stone increases regularly from the east to the west end of the area. The boulder deposits are, with a few exceptions, of better quality than the gravel deposits of the same locality. The best gravels occur in Cornwall and Osnabruck townships. The bedrock, most of the field stone, and several gravel deposits, are suitable materials for broken stone or gravel roads under ordinary country traffic conditions, but none of them would be sufficiently durable to be used on roads subjected to fairly heavy traffic.

BEDROCK.

Twenty-five outcrop areas were mapped within the district surveyed; all of which were of small extent. Nine outcrops of Beekmantown dolomite occur around Cardinal, and west of Iroquois. Eleven exposures of Black River limestone are seen in two localities west and north of Cornwall respectively. Two small areas, one of Black River and the other of Chazy limestone, lie in the west end of Charlottenburg township. Southeast of Summerstown station, there is a small quarry of Chazy limestone.

Laboratory Tests.

Tests have been made on three samples of Beekmantown dolomite occurring north and west of Cardinal; and on four samples of Black River limestone exposed north and west of Cornwall; see Table II, page 6.

Recent standard recommendations on the per cent of wear and toughness of stone used in road surfaces are given in the following table[1]:—

TABLE I.

Limiting values of percentage of wear and toughness under varying traffic conditions.

Type of road surface.	Light traffic, up to about 100 vehicles per day.		Moderate traffic, 100 to 200 vehicles per day.		Heavy traffic, 250 vehicles per day and over.	
	Wear, per cent.	Toughness.	Wear, per cent.	Toughness.	Wear, per cent.	Toughness.
Water-bound macadam.....*a.*	5 to 8	5 to 9	2·7 to 5	10 to 18	0 to 2·7	over 18.
b.	5·7−	6+				
c.	5−	6+				
Bituminous broken stone with seal coat and broken stone with bituminous carpet.....*a.*	8−	5+	5·7−	10+	5·7−	10+
Bituminous concrete with or without seal coat.....*a.*	5·7−	7+	4−	13+	4−	13+
b.	3·5	13+	3·5−	13+	3·5−	13+
c.	3·5−	13+	3·5−	13+	3·5−	13+

a Recommended by the Office of Public Roads, Washington, 1916.
b Recommended by the American Society of Municipal Improvements, 1914.
c Recommended by the American Society of Civil Engineers, 1917.
\+ = "and over," that is, the figure is a minimum value.
− = "and under," that is, the figure is a maximum value.

[1] Reinecke, L., "Non-Bituminous Road Materials;" Economic Geology, Vol. XIII, No. 8, December, 1918.

According to aforementioned requirements, two of the seven samples tested, Nos. 17 and 22, are of sufficient durability for heavy traffic, if used on the road surface in connexion with a bituminous carpet, while the remaining five samples tested are only suitable for use in waterbound macadam roads subjected to light traffic.

TABLE II.

Results of Tests upon Bedrock.

Map No.	Location.	Rock Species.	Formation.	Percentage of wear.	French coefficient of wear.	Toughness.	Hardness.	Specific gravity.	Water absorbed per cubic foot.	Remarks
7	4 miles north of Cornwall.....	Limestone.....	Black River	3·5	11·4	6	16·6	2·71	0·27	
7a	4 miles north of Cornwall.....	Limestone.....	" ..	3·3	12·1	8	16·0	2·71	0·16	
10	5 miles west of Cornwall.....	Limestone.....	" ..	3·2	12·5	5	16·4	2·71	0·36	
13	5 miles west of Cornwall.....	Limestone.....	" ..	3·5	11·4	.....	.....	2·71	0·17	Sample taken from dump pile.
17	1 mile southwest of Iroquois...	Dolomite.....	Beekmantown.	2·7	14·8	10	16·5	2·82	0·97	Duplicate sample.
22	3 miles north of Cardinal.....	Dolomite.....	" ..	3·2	12·5	11	16·3	2·83	0·98	Duplicate sample.
25	1½ miles west of Cardinal.....	Dolomite.....	" ..	2·9	13·8	5	15·6	2·82	0·7	Toughness piece coarser grain than average in quarry.

Service Tests.

In only one instance has bedrock been used for road surfacing: at the time the Galop canal was dug—15 to 20 years ago—the canal road between Iroquois and rock outcrop No. 18 was surfaced with broken stone blasted out of the canal channel. No repair work has ever been done. When seen in the fall of 1917, it was worn out. As many as 12 longitudinal ruts, varying in depth from 1 to 3 inches, had been worn in the width of the travelled way. No deductions as to the quality of the stone can, of course, be drawn from this case.

Availability.

Exposures of Beekmantown dolomites occur in most cases on the north slope of low hills. The exposure west of Cardinal appears the most promising for future development. A large excavation has left exposed a 16-foot section of good stone above underground water-level, with from 1 to 4 feet of loamy silt and sand covering the rock. The overburden would probably be a serious obstacle to extensive quarrying, but several thousand cubic yards can be obtained without much stripping. The two dolomite exposures 3 miles north of Cardinal are covered, one by a few inches of boulder clay, and the other by from 4 to 12 inches of loam, except in the centre of the latter, where the thickness is unknown. Assuming that excavation is limited to thinly covered areas only, the two exposures should yield over 10,000 cubic yards of stone, taking $1\frac{1}{2}$ yards as the average depth of excavation. In case of deeper quarrying, the ground water would have to be taken into account. The hauling distance to the front road and canal from this place is not quite 3 miles. In outcrops Nos. 20 and 21, the stone splits readily in thin layers. It could be quarried to a depth of 2 yards without trouble arising from underground water, and very little stripping would be required. The deposit lies along the road, and three-fourths of a mile from the front road and canal. In the case of No. 19, the overburden is such a serious factor that further quarrying is out of the question. Exposures Nos. 17 and 18 lie in a low place surrounded by swamp. Over 2,000 cubic yards could probably be obtained without excavating below water-level. Deposit No. 16 lies at the foot of a low hill, and is covered with dark brown loam, up to 2 feet in thickness. Quarrying deeper than 2 feet would be hampered by ground-water. An excavation of that depth would yield over 5,000 cubic yards. The deposit lies $1\frac{3}{4}$ miles from the front road and canal.

No. 10, west of Cornwall, is an exposure of Black River limestone lying near the foot of a hill, with from $\frac{1}{2}$ to 2 feet of bouldery loam on top of it. About 30,000 cubic yards could probably be obtained by quarrying to a depth of $1\frac{1}{2}$ yards. It is situated within a hauling distance of $1\frac{1}{2}$ miles of the front road, canal, and railway siding. Other exposures in the same locality lie in a swamp, with from 2 to 8 feet of loamy clay covering the rock. The rock does not outcrop, but has been exposed in large openings, now nearly filled with water. The overburden is too heavy for further quarrying. Over 20,000 cubic yards of waste stone have been dumped in several big piles near the quarries. The stone is largely under 1 foot in size. Rock outcrops Nos. 6, 7, and 7a, north of Cornwall, have been extensively quarried. Over 100,000 cubic yards could be obtained, wit

average depth of excavation of 2 yards. The deposits lie at a hauling distance of 4½ miles from the front road. Nos. 4, 5, and 8 are too small to be considered for future development; Nos. 2 and 3 are doubtful outcrops. The Chazy limestone, southeast of Summerstown station, is covered by drift varying in thickness from a few inches to 2 feet. A few thousand cubic yards could be taken out, quarrying at an average depth of 1 yard. The material would have to be hauled nearly 3 miles to reach the front road.

BOULDER DEPOSITS OR FIELD STONE.

While an inspection of rock outcrops and gravels was made on a 5-mile belt along the St. Lawrence river, boulder deposits were examined and mapped only as far as 2 miles from the river. The field stone is of most frequent occurrence between Lancaster and Aultsville, and farther west between Iroquois and Cardinal. From Aultsville west to Iroquois it lies only in small detached areas, and is especially scarce around Morrisburg, and from Lancaster east to the Quebec border. Table III gives the yardage and composition of the field stone for each township, beginning at the east end of the district examined. There are separate amounts for the stone under 1 foot, and for that over 1 foot in size. The composition is in percentage of "Durable," "Intermediate," and "Soft." "Durable" includes granites, gneisses, syenites, gabbros, anorthosites. "Intermediate" includes partly weathered stones of the above-named types, much foliated gneisses; fine-grained Potsdam sandstone; Beekmantown dolomite; Chazy, Black River, and Trenton limestone; and Chazy sandstone. "Soft" includes coarse-grained Potsdam sandstone; soft or shaly limestones; soft Chazy sandstone; and weathered stone of all kinds.

TABLE III.

Amount and Composition of Field Stone.

Township.	Number of Cubic Yards.			Composition.					
				Under 1 ft.			Over 1 ft.		
	Total.	Under 1 ft.	Over 1 ft.	Durable.	Inter.	Soft.	Durable.	Inter.	Soft.
Lancaster	3,327	1,403	1,924	2	49	49	15	58	27
Charlottenburg	58,077	31,812	26,265	7	61	32	17	61	22
Cornwall	30,032	16,408	13,624	12	50	38	34	41	25
Osnabruck	19,610	11,716	7,894	22	49	29	51	35	14
Williamsburg	4,257	2,942	1,315	27	46	27	68	22	10
Matilda	14,092	6,728	7,364	37	41	22	77	14	9
Edwardsburg[1]	2,558	1,014	1,544	53	27	20	80	12	8

[1] Only a small part of this township was surveyed.

The proportion of stone under 1 foot in size varies for the different townships, from two-fifths to two-thirds of the total. The stone over 1 foot in size has everywhere a higher proportion of "Durable" than the smaller stone; and this proportion increases regularly for both sizes of stone, towards the west of the district. The types of stone classified as "Durable" are nearly the same all over the area, consisting mainly of gneisses, syenites and granites, with gabbros and anorthosites in smaller amounts. The constituents of "Intermediate" and "Soft" vary with the

locality, the type representing the underlying rock generally predominating. In Lancaster township the stone is largely Chazy limestone and sandstone: classified as "Intermediate," and, where partly weathered, as "Soft." The same kinds are found in Charlottenburg, with Potsdam sandstone and Beekmantown dolomite in smaller quantities. The deposits of eastern Cornwall are made up of Potsdam and Chazy sandstone, and, to a lesser extent, of Black River and Chazy limestone, and Beekmantown dolomite; while in western Cornwall and all of Osnabruck, Potsdam sandstone and Black River limestone are the two predominant types. In Williamsburg township the most common kind is Black River limestone; with Potsdam sandstone, Trenton and Chazy limestones in about equal proportions. The deposits in Matilda and Edwardsburg townships consist largely of Beekmantown dolomite, with soft gneisses and Potsdam sandstone in lower amounts. In the above enumeration by township, the "Intermediate" and "Soft" types only were considered; but in the western part of the district the "Durable" stones, such as granites, syenites, sound gneisses, gabbros, predominate over all other kinds.

Laboratory Tests.

The system adopted during 1917 for the sampling of field stone deposits was entirely different from the one in use during the past years. The old method, which consisted of sampling a fence within a certain area, and assuming this to represent the average in composition of the area, has proved to be wholly unsatisfactory. The relative proportions of the different types of rocks vary greatly, not only from farm to farm, but even a particular fence may be altogether different from its neighbour. After many experiments conducted by L. Reinecke and K. A. Clark[1], it was found that all the various kinds of stone occurring within a certain area could be classified into three or four main types, the components of the same type having a nearly equivalent durability. Tests were run on each type in the laboratory, and it was discovered that if tests are made on mixtures in various proportions of the several types, the results of the tests are nearly identical with those obtained by calculation. If we represent by $W_1, W_2 \ldots\ldots W_n$ the percentage of wear of the chief constituents, and by $C_1, C_2 \ldots\ldots C_n$ the percentage proportions in which they occur in the mixture, the percentage of wear W_m of the mixture is given by the formula:—

$$W_m = \frac{\Sigma CW}{100}$$

Knowing the percentage of wear of the main types, the percentage of wear of any mixture of them is, therefore, easily found by calculation.

[1] Reinecke, L., and Clark, K. A., "The Sampling of Deposits of Road Stone and Gravel in the Field;" Proceedings of the American Society for Testing Materials, Philadelphia, Pa., Vol. XVIII, Part II, 1918.

TABLE IV.

Results of Tests upon Field Stone.

Map No.	Location.	Type.	Wear, per cent.
43a	Lots 12, 19, Con. I, Charlottenburg....	Potsdam sandstone.....	2·7, 2·4, aver. 2·6
		Coarse-grained Chazy limestone.....	7·6, 8·4 " 8·0
		Chazy sandstone.....	3·7, 3·2, " 3·5
105	Lots 30, 31, Con. IV, Cornwall township	Igneous rock.....	2·8, 2·5, " 2·7
		Potsdam sandstone.....	2·4, 2·2, " 2·3
		Black River limestone.....	3·6, 3·6, " 3·6
131	Lots 13, 14, 15, Con. I, II, Osnabruck township.....	Chazy limestone.....	" 3·7

Service Tests.

For many years, crushed field stone has been extensively used for road surfacing in this district. Prior to 1914, all construction and maintenance work was done by statute labour, but in that year road work was taken up by the township council. The stone is laid in one layer, 8 to 12 inches in thickness, and 8 feet wide, without any rolling. The compacting is left to traffic, with the result that two deep ruts begin to form in the wheel tracks, and when these tracks have acquired a certain degree of smoothness, water is retained in the ruts, keeping them in a nearly constant moist condition. Bad drainage, whether due to ruts or insufficient grading, has been the most active cause of disintegration of road surfaces, since the few sections of road in good condition were found in places where the drainage was exceptionally good, either because of the relative elevation of the ground, or due to the firmness and porosity of the subsoil. For that reason, service tests do not give much information of value in regard to the durability of the stone in this district.

All roads surfaced in 1916 and 1917 were in bad shape, because of the stone not being sufficiently compacted. The best surfaces, found in the west end of the district examined, occurred in cases where old macadam or gravel roads had been resurfaced in 1914 and 1915. In the east end, old broken stone or gravel roads resurfaced in 1914, and under the same drainage and traffic conditions, were worn out after three years of service. All the country roads of this district are subjected to light traffic, rarely exceeding 100 vehicles per day.

Availability.

Boulder deposits are rare from Lancaster to the Quebec border, and the hauling distance from the nearest deposits to the front road is generally over one mile. Some other class of material will have to be used for the stoning of the river road. In Charlottenburg township, the amount of stone is sufficient to surface the road all along the shore, with a maximum hauling distance of 2 miles; except in the east end, where a longer haul is necessary. There may possibly be enough field stone in Cornwall and Osnabruck townships, figuring on a maximum hauling distance of $2\frac{1}{2}$ miles. Farther west, boulder deposits are of less frequent occurrence. The amount of stone within two miles of the shore is undoubtedly too small, so that some other kind of material will have to be employed for surfacing the front road. In the foregoing estimation, only the stone under 12 inches in size, is taken into account.

GRAVEL DEPOSITS.

The largest part of the gravel deposits lies between Cornwall and Aultsville. They occur less frequently east and west of this area. Most of the gravels east of Cornwall are found in the form of thin blankets, on top of boulder clay and closely associated with it. As far as could be ascertained from the few excavations, there is no distinct outline between the two kinds of deposits. West of Cornwall, in nearly every case, the gravels lie in the form of narrow ridges alongside the western edge of large boulder clay deposits. The gravels which are generally bouldery directly under the crest of the ridge, become finer and markedly stratified farther down. In many cases the extent of the gravel areas is uncertain, as surface indications were the only guide in determining the limits of the deposits.

Character.

All the information that could be obtained regarding the character of gravels is contained in Appendix III, page 34. The gravels are generally very coarse, and in several instances the deposits carry much more sand and boulders than gravel. Apart from a few exceptions, the gravels contain much stone of the same nature as the underlying rock. In Lancaster and Charlottenburg townships, the gravels carry much silt or fine sand, and a small proportion of pebbles. West of Cornwall, most of the gravel deposits are bouldery, but carry a sufficient proportion of stone of pebble size to differentiate them clearly from the boulder clay. In depth, the proportion of sand increases gradually as far as the underlying boulder clay.

TABLE V.

Tests made upon Gravels.

Map No.	Location.	Owners.	Impurities, clay, etc.	Composition percentage of.			Physical Characters.					
				Durable	Intermediate.	Soft.	Specific gravity.	Per cent wear.	French coefficient of wear.	Cementing value.	Per cent voids, material loose.	Per cent voids, material compacted.
5	Lot 36, Con. I, Lancaster.	D. M. McCuaig, Lancaster P.O.	Traces of iron oxide.	0	63	37	2·70	14·5	2·8	43	28·6	24·7
7	Lot 36, Con. I, Lancaster.	John Shanks, Lancaster P.O.	Little $CaCO_3$.....	0	70	30	2·70	8·6	4·6	67	25·2	22·2
13	Lots 4, 5, Con. III, Charlottenburg.	Charlottenburg Tp. Council.	Traces of $CaCO_3$....	1	35	64	2·67	11·1	3·6	291	38·4	36·2
18	Lots 1, 2, Con. I, Charlottenburg.	A. J. Fraser, R.R.I. Summerstown Sta.	Little $CaCO_3$ and iron oxide.	5	10	85	2·66	4·7	8·5	186	34·3	28·9
22	Lots 23, 24, Con. II, Charlottenburg.	T. Doherty, R. R. Summerstown.	Some $CaCO_3$.	3	50	47	2·68	8·3	4·8	186	28·5	24·7
24	Con. II, west end of Charlottenburg.	D. Richardson and L. Leroux, Cornwall. R.R. 1.	Little $CaCO_3$ and iron oxide.	2	26	72	2·71	9·1	4·4	95	29·8	25·6
27	Lots 7, 8, Con. II, Cornwall.	Manager C. L. Mongers, Cornwall P.O.	Some $CaCO_3$ traces of iron oxide.	3	57	40	2·73	11·6	3·5	61	27·7	24·2
31	Lot 11, Con. V, Cornwall	Father McRae, St. Andrews West P.O.	Some $CaCO_3$ several shells.	2	76	26	2·69	5·1	7·8	91	23·4	21·3
32	Lot 12, Con. V, Cornwall	John McIntosh, St. Andrews West P.O.	Traces of $CaCO_3$ many shells.	3	60	37	2·67	5·2	7·7	158	28·8	27·3
37	Lot 29, Con. IV, Cornwall.	Thomas Cleary, Mille Roches P.O.	Some $CaCO_3$ many shells, much clay in one place.	0	52	48	2·72	7·6	5·3	79	23·0	19·6
43	Lot 22, Con. V, Cornwall	H. Winters, Mille Roches R.R. 1.	Little $CaCO_3$ traces of iron oxide.	3	69	28	2·70	6·64	6·3	84	19·9	16·8
46	Lots 30, 31, Con. VI, Cornwall.	U. J. McQuillon, Harrison, R.R. 1.	Some $CaCO_3$ little iron oxide. Several shells.	0	75	25	2·70	9·6 5·6	4·2 7·1	82	21·6	18·5

49	Lots 33 to 36, Con. V, VI, Cornwall.	Geo. Losey, Harrison, R.R.1.	Some $CaCO_3$.....	0	80	20	2·67	12·5	3·2	148	30·6	26·5
50	Lots 33 to 36, Con. V, VI, Cornwall.	Wm. J. Murphy, Harrison, R.R. 1.	Traces of $CaCO_3$ and iron oxide.	0	80	20	2·69	4·0	10·0	111	21·1	20·0
			Many shells.				2·69	4·8	8·3	106	22·9	20·4
52	Lot 2, Con. II, Osnabruck.	J. G. Adams, Wales, R.R. 1.	Little $CaCO_3$ some iron oxide.	2	87	11	2·70	2·6	15·4	217	22·0	21·7
54	Lot 14, Con. I, Osnabruck.	James Miller, Wales, R. R. 1.	Little iron oxide; traces of $CaCO_3$. Some shells.	0	60	40	2·69	16·2	2·5	126	24·5	20·8
56	Lot 13, Con. III, Osnabruck.	Frank Smith, Lunenburg, P.O.	Lense of clay, a little iron oxide.	3	65	32	2·71	7·0	5·7	85	25·1	19·1
			Some shells.				2·70	7·9	5·1	86	24·6	22·0
63	Lots 24 to 27, Con. IV, Osnabruck.	Osnabruck tp. Council. Part owned by W. N. Hollister, Farran's Point, R.R. 1.	Traces of iron oxide.	0	60	40	2·69	5·3	7·6	80	23·5	19·0
			Many shells.				2·69	3·9	10·3	108	28·5	18·6
75	Lots 26, 27, Con. III, Williamsburg.	Malcolm A. Froats, Morrisburg, R.R. 1.	Traces of clay and iron oxide. Several shells.	1	64	35	2·70	13·2	3·0	89	26·8	22·1
79	Lot 35, Con. IV, Williamsburg.	A. Shannett, Williamsburg, R.R. 1.	Some $CaCO_3$. Organic matter.	7	43	50	2·72	8·1	4·9	74	29·2	26·2
80	Lot. 35, Con. III, Williamsburg.	Asa Cougler, Williamsburg, R.R. 1.	Some $CaCO_3$. Organic matter. Many shells.	6	42	52	2·71	5·8	6·9	47	29·0	24·6
83	Lot 1, Con. I, Matilda.	H. W. Doran, Morrisburg P.O.	Traces of iron oxide.	6	38	56	2·68	19·5	2·1	95	27·6	23·4
85	Lot 3, Con. I, Matilda...	A. Beekstead, Morrisburg P.O.	Much $CaCO_3$, a little clay.	6	50	44	2·71	6·3	6·4	59	27·6	24·4
86	Lot 5, Con. III, Matilda	W. Mullin, Iroquois, R.R. 1.	Some clay, a few shells.	0	64	36	2·71	9·7	4·1	95	29·8	24·5
87	Lot 19, Con. II, Matilda.	Edgar Shaver, Iroquois, R.R. 2.	Traces $CaCO_3$ and iron oxide. A few shells.	1	57	42	2·72	8·2	4·9	61	24·6	21·4
90	Lots 32, 33, Con. I, Matilda	Jay Maikley, Iroquois, R. R. 2.	Some $CaCO_3$, traces clay.	2	65	33	2·77	7·2	5·5	75	32·0	27·9
92	Lots 4, 5, Con. II, Edwardsburg.	Rufus Froom, Cardinal, R.R. 2.	Traces of iron oxide.	4	55	41	2·77	13·5	3·0	61	22·3	18·2

TABLE VI.

Mechanical Analysis of Gravels.

(Stone over 3 inch not included.)

Map No.	Percentages retained on Screens and Sieves.													Passing 200 mesh.	Total.
	2½ in.	2 in.	1½ in.	1 in.	¾ in.	½ in.	3 mesh.	8 mesh.	14 mesh.	28 mesh.	48 mesh.	100 mesh.	200 mesh.		
5	0·	5·3	10·1	14·6	8·2	10·5	16·1	14·1	10·0	4·5	1·2	1·0	1·1	3·3	100·0
7	4·3	9·0	14·4	14·1	7·3	8·1	9·8	8·2	9·6	8·5	2·4	1·0	1·0	2·3	100·0
13	0·	5·3	10·5	16·9	9·8	12·9	21·6	12·8	3·7	1·4	0·9	0·8	0·9	2·5	100·0
18	5·2	7·5	10·5	12·8	7·2	8·7	14·2	12·0	8·5	4·1	2·6	2·1	1·5	3·2	100·1
22	3·3	9·9	17·6	19·3	7·3	8·0	9·9	6·6	3·6	3·0	4·7	2·2	1·8	2·8	100·0
24	0·	2·1	7·4	12·3	7·1	10·6	15·9	14·2	11·3	8·0	4·2	2·5	1·5	2·9	100·0
27	2·0	5·4	10·1	12·1	6·7	8·3	13·8	11·3	10·1	8·7	6·9	2·2	0·9	1·5	100·0
31	5·9	11·1	11·9	13·2	6·4	6·7	8·5	5·3	5·2	7·0	12·4	4·1	0·8	1·5	100·0
32	2·7	2·6	2·2	5·0	4·1	6·2	20·1	26·3	15·8	4·2	4·0	3·7	1·4	1·7	100·0
37	0·	5·4	8·0	10·2	8·6	8·3	12·7	11·3	8·2	8·9	9·1	5·0	2·5	1·7	99·9
	0·	5·0	12·7	14·9	7·9	8·0	9·2	6·0	5·9	12·1	11·5	3·5	1·2	2·1	100·0
	0·	4·5	12·6	11·8	8·1	8·4	10·3	8·1	6·6	10·8	11·0	4·1	1·8	1·9	100·0
43	9·4	13·7	9·7	11·5	5·1	5·9	8·5	6·1	3·8	5·5	14·4	5·2	0·6	0·6	100·0
46	3·6	8·7	13·2	12·8	6·5	6·6	9·2	7·5	6·3	8·0	12·6	3·6	0·5	0·9	100·0
	0·	13·7	11·8	11·8	6·5	7·3	9·6	7·5	6·2	7·8	11·8	3·9	0·6	1·4	99·9
49	0·	12·8	12·9	13·7	10·7	13·9	11·1	11·1	5·5	3·6	1·2	0·9	0·5	2·1	100·0
50	4·0	8·8	8·1	12·7	7·6	9·2	13·5	8·6	5·0	3·9	8·7	8·4	0 8	0·6	99·9
	0·	7·3	12·1	15·3	8·9	10·6	12·6	8·5	4·5	3·8	9·7	5·0	0·8	0·9	100·0
52	4·8	13·1	15·7	15·9	7·7	7·3	7·3	7·0	5·7	4·3	6·7	3·5	0·7	0·3	100·0
54	5·7	9·8	12·5	14·6	6·1	7·0	9·4	7·9	6·3	5·9	10·1	3·3	0·5	0·8	99·9
56	3·9	11·8	11·7	13·5	6·6	9·5	12·2	7·6	5·3	4·6	8·2	3·8	0·9	0·6	100·2
	0·	3·5	7·4	14·6	6·6	9·3	13·4	11·6	7·9	8·1	11·4	4·8	0·8	0·6	100·0
63	3·1	8·5	14·3	12·5	5·7	7·5	8·7	6·2	6·0	8·3	13·7	4·4	0·7	0·5	100·1
	5·5	6·2	13·5	13·7	7·4	7·9	8·8	6·4	5·7	7·4	12·3	3·9	0·6	0·7	100·0
75	1·0	5·4	2·5	16·3	6·4	8·0	11·0	12·1	9·2	8·5	13·7	3·5	0·8	1·6	100·0
79	2·0	7·9	11·7	17·2	9·3	11·8	13·1	9·6	7·9	5·1	1·5	0·6	0·5	1·8	100·0
80	3·7	8·5	13·1	12·1	8·1	11·0	14·7	10·3	7·1	5·2	2·7	1·6	0·6	1·3	100·0
83	2·7	12·0	15·2	12·2	4·8	7·4	10·7	7·8	4·6	5·3	10·1	3·2	1·1	2·9	100·0
85	1·7	8·4	11·4	14·0	7·1	9·2	13·2	11·7	9·6	7·4	3·3	1·3	0·6	1·2	100·1
86	4·4	5·5	10·7	10·7	16·7	10·9	14·3	12·4	7·1	5·3	4·8	2·4	1·7	3·3	100·2
87	5·8	5·2	10·4	12·9	9·5	11·1	14·2	10·4	5·9	5·3	6·5	1·4	0·6	0·7	99·9
90	7·1	7·0	12·1	20·7	14·3	12·3	10·7	6·3	2·5	1·2	0·7	0·7	1·3	3·3	100·2
92	8·8	9·6	12·9	14·6	5·8	7·6	9·2	7·4	5·6	5·7	7·8	3·1	0·7	1·2	100·0

Service Tests.

Gravel has been used for over thirty years in the surfacing of roads in the area examined. No extensive gravelling has been done in the past few years. Most of the work consisted of surfacing short lengths of road each year, in places where it was badly needed. The same methods aer used as in the case of field stone; and, besides, fresh and weathered gravels are used indiscriminately, so that little information can be obtained from service tests in regard to the quality of gravels as road material. The following is a brief enumeration of the gravels which have been used for road surfacing during the past few years.

Lancaster township—Much gravel from deposit 5 was used long ago for road work. This deposit is nearly exhausted, and gravel is now taken from deposit 7. An old macadam or gravel road—resurfaced in 1915 with gravel from the latter deposit, and subjected to a traffic of a little over 100 vehicles per day—showed signs of wearing out after two years of service. Other old macadam roads resurfaced prior to 1915 with gravel from pits 5 and 7, were in very bad condition in the summer of 1917.

Charlottenburg township.—Gravel from deposit 24, used on a small piece of road subjected to light traffic, was completely worn out or sunk into the ground after three years. The subsoil at that place is rather unstable, and a larger amount of gravel should have been used, in order to obtain a hard and firm surface.

Cornwall township.—Gravel from pits 31, 40, 41, 43 and 49, has been extensively used in past years. More recently, much gravel has been taken out of pits 37, 45, 46 and 50, and laid on roads subjected to light traffic, with satisfactory results, in places where the subsoil was firm and well drained.

Osnabruck township.—Roads surfaced in 1913 and 1914 with gravel from pit 57 and with crushed boulders from pits 52 and 56 were in rather poor condition in 1917. A road surfaced in 1916 with crushed boulders from pit 63 showed signs of wearing out in 1917, but was in better condition than a part of the same road surfaced in 1916 with crushed field stone. Gravel from pits 65 and 66 was said to have been used in 1914 on a short length of the road from Aultsville to Gallingertown. It was in poor shape after three years service. Another part of the same road surfaced in 1915 with crushed field stone was in a much better condition. All the roads referred to in this township are submitted to a light traffic.

Williamsburg township.—Some of the main roads of this township were gravelled many years ago, and maintained with crushed field stone. Much material from pits 72, 73, and 80 has been used. In 1912 gravel from pit 79 was laid on the road nearby, which carries a very light traffic. It was in fair condition in the fall of 1917.

Matilda township.—Part of an old gravel road north of Iroquois was resurfaced a few years ago with gravel from pit 88. In well-drained places it is in fairly good condition, but very poor elsewhere.

Commercial Development.

All the information that could be obtained regarding the commercial development of gravels is contained in Appendix IV, page 50. No attempt has been made to estimate the quantity present in each deposit, because of the lack of reliable data.

The prices for gravel range from 10 to 50 cents, generally 25 cents per double load.

Lancaster township—Because of the great scarcity of field stone in this township, gravel will have to be used for surfacing the front road. Crushed gravel from deposit 7, which is the most important in this part of the district, could be advantageously used in the west half of the township. There is no good gravel available in the eastern half, but the large deposit of Riviere Baudet, which lies one mile outside of the Quebec border, could supply all the material necessary for this part of the township. The Riviere Baudet deposit is described in detail in the report "Road Materials in Soulanges and Vaudreuil Counties, Quebec," by L. Reinecke and R. H. Picher.

Charlottenburg township—The so-called gravel deposits of this township are closely related to boulder clay and sand, and are generally of poor quality. In the case of deposit 18, the per cent of "soft", which is marked as 85, and consists mainly of Chazy sandstone, is undoubtedly too high, as much of the Chazy sandstone should be more logically classified as "Intermediate", according to the results of laboratory tests made on that stone. Gravel from deposit 18 will have to be used in connexion with the stoning of the front road, as there is no other material available in the eastern part of this township. It is very bouldery, but once crushed should be a material of fair durability.

Cornwall township.—All the more important gravel deposits are located in the west half of the township. Most of them are very bouldery, and would have to be crushed. Deposits 31, 32, 33, 37, 40, 41, 43, 45, 46 and 50, are particularly suitable for road making, but, except in the case of 37, they all lie away from the front road, their hauling distance to that road varying from 2 to 6 miles.

Osnabruck township.—No large deposits are found near the shore. The best gravel areas of this township, Nos. 52, 56, 57, 59, and 63, lie at hauling distances varying from $2\frac{1}{2}$ to 5 miles from the front road. They are all very bouldery.

Williamsburg township.—Most of the deposits are of small extent, and several of them are nearly exhausted. Deposits 79 and 80, although inferior in quality to the Osnabruck and Cornwall townships deposits, are the best found in this locality. Both are bouldery. Because of the very small amount of stone available near the shore, especially so around Morrisburg, gravel from deposits 79 and 80 will probably have to be used, notwithstanding the long haul of $5\frac{1}{2}$ miles to the front road.

Matilda township.—There are no good gravels in this township. No. 85 in the east end, and 90 in the west end are of somewhat better quality than the rest. Both are bouldery. In order to provide a sufficient amount of stone for the front road in the east half of the township, it will be necessary to develop deposit 85, because of the scarcity of other kinds of material. In the west part, the necessary amount of stone can be taken out of the several bedrock exposures.

Edwardsburg township.—Only one large gravel deposit has been located in the small part of the township surveyed. It is of poor quality.

APPENDIX I.

Rock Outcrops.

(1) *1¼ miles southeast of Summerstown Station.* Chazy limestone formation. Limestone is light grey, slightly banded, medium to coarse-grained, thick-bedded, but splitting up easily in thin layers. Beds have a gentle dip northwest. The stone taken out of an old quarry, 250 cubic yards in size, was used by the Grand Trunk Company, over 50 years ago, for bridges and culverts. There are no outcrops, and the overburden varies from a few inches to 2 feet in thickness. A few thousand cubic yards could be taken out in dry season, assuming an average depth of 1 yard. Owner: D. Cattanach, Summerstown Station, R.R. 1.

(2) *2 miles west of Summerstown Station.* Doubtful outcrop of Black River limestone. The stone is dark, bluish-grey, fine-grained, with streaks of very dense stone, fossiliferous, breaking irregularly.

Flat blocks are seen on the surface of a small hill, in several parallel zones or ridges running approximately E. 7° N.

(3) *5 miles east of Cornwall.* Doubtful outcrop of Chazy limestone. The stone is light grey, medium-grained, fossiliferous, thick-bedded, with shaly partings, splitting easily in thin layers. Several large blocks of limestone are seen on a hill, nearly all dipping in the same direction, i.e., 5 degrees north. Stone used for building cellars.

(4) *3 miles north of Cornwall.* Black River formation. Dark, blackish-grey, very dense limestone, thick-bedded, with many shaly bands, splits up readily in thin layers. Beds apparently horizontal. Rock is seen at the bottom of a creek, and is overlain by 10 to 15 feet of boulder clay and sand. Quarrying here is out of the question.

(5) *3 miles north of Cornwall.* Black River formation. Dark, blackish-grey, very dense, thick-bedded limestone. Beds lie apparently horizontal. One set of joints trends N. 18° E., glacial striae, N. 17° W. to N. 21° W. Rock seen at the bottom of a creek, 12 to 18 inches above low water-level, and overlain by 4 to 9 feet of boulder clay, with loam on top. Very little stone available.

(6) *4 miles north of Cornwall.* Black River formation. In a large quarry, 59,000 cubic yards in size, 69 inches exposed of dark, blackish-grey, very dense limestone, massive, large number of small calcite streaks; many shaly partings. The beds have a very gentle dip to the north. Irregular joints. Glacial striae N. 15° W. A few fossils.

Stone used 15 to 20 years ago for building the Cornwall canal banks and locks. There are only a few outcrops along south edge. The thickness of overburden around the quarry varies from a few inches to 10 feet. There are probably over 30,000 cubic yards available, figuring on an average depth of 2 yards. If quarried deeper, there would not be any means of draining except by pumping. Over 1,000 cubic yards of large blocks piled in quarry. Hauling distance of 5 miles to the front road. Owner: James McLeod, Cornwall, R.R. 2.

(7) *4 miles north of Cornwall.* Black River formation. In a large opening over 50,000 cubic yards in size there are $8\frac{1}{2}$ feet exposed of limestone, same as in No. 6, and dipping very gently to the north, strike E. 22° N., irregular joints. Glacial striae N. 19° W. In one place two sets of striae observed: N. 17° W. and N. 54° W. respectively. Stone used 15 to 20 years ago in the building of the Cornwall canal banks and locks. Outcrops are plentiful in the south half. Overburden, 3 to 24 inches of clayey loam, possibly thicker along north edge. On an average depth of 2 yards, over 90,000 cubic yards could probably be quarried. Deeper quarrying would necessitate pumping for draining the excavation, as underground water-level is actually 7 feet below the top of the rock. Hauling distance of $4\frac{1}{2}$ miles to the front road. Owner: F. J. Friend, Cornwall, R. R. 2.

(7a) *4 miles north of Cornwall.* Black River formation. A small opening, 593 cubic yards in size, shows a 5-foot section of dark, blackish-grey, very fine-grained limestone, dense, especially at the foot of the section, massive, although in the upper part it splits easily in thin layers, along shaly partings. Beds have a slight dip north. Joints irregular. Glacial striae N. 17° W. Stone was used, 15 to 20 years ago, in the building of the Cornwall canal banks and locks. Very few outcrops seen. Overburden at the quarry, from 1 to 3 feet of clayey loam with limestone boulders. At the house, southeast of quarry, according to owner, the rock is 7 feet below the surface. A few hundred cubic yards could still be quarried. Owner: A. E. O. Clark, Cornwall, R. R. 2.

(8) *$3\frac{1}{2}$ miles north of Cornwall.* Black River formation. In the bottom of a shallow creek, a few inches exposed of very light bluish to greenish-grey, medium-grained limestone; the stone separates readily in thin layers along shaly partings. Weathers dark buff in colour and shows some silt. Beds apparently horizontal. Directions of joints: N. 49° E. and E. 2° N. No outcrops. Overburden, from 18 to 24 inches. At house near cheese factory the rock lies 9 feet below the surface. Bad drainage renders quarrying impracticable.

(9) *2 miles north of Mille Roches.* Black River formation. In the lower bank of a creek there is one bed, 13-inch thick, exposed, of blackish-grey, very dense limestone; large number of fossils. Beds apparently horizontal. The rock is 13 inches above low-water level, with a minimum thickness of 4 feet of overburden on top of the rock. There are no outcrops, and quarrying would be very difficult.

(10) *1 mile north of Mille Roches.* Black River formation. In a quarry of 5,580 cubic yards there are 6½ feet exposed of very dark, blackish-grey, very dense limestone, massive. Many shaly partings cause the stone to break irregularly; some fossils. Beds have a very gentle dip south. Joints irregular. Glacial striae N. 13° W. Stone used 15 to 20 years ago in the building of locks and part of bank of the Farren's Point, Morrisburg and Cardinal canals. Owners received 10 cents per yard unquarried. Outcrops are plentiful within the east half of the mapped area. Overburden, ½ to 3 feet of bouldery loam, probably over 3 feet to the west. There would probably be about 30,000 cubic yards of rock available, quarrying at an average depth of 1½ yards, and with not over 2 feet of overburden. If quarried deeper, provision would have to be made for drainage. Hauling distance: 1½ miles to the front road, canal, and railway siding. Owner: Philip T. Empey, Mille Roches, R. R. 1.

(11) *1½ miles north of Mille Roches.* Black River formation. Large opening, full of water, the top of the rock being a few inches below water-level. Blackish-grey, very dense limestone, massive. Beds nearly flat. The opening has an area of 12,000 square yards. Stone used for building canal banks. No outcrops. Overburden, over 3 feet of loamy clay. No more stone available. Owner: James Henderson, Mille Roches, P.O.

(12) *1½ miles north of Mille Roches.* Black River formation. Large opening nearly full of water. The rock is under water-level, except in the south end, where at one place a 6-foot exposure is seen. Dark, blackish-grey, very dense, massive limestone, with many shaly partings, causing the stone to break irregularly. Beds have a gentle dip to the north. The opening has an area of 16,000 square yards. Stone used for building canal banks. No outcrops. Overburden, a few inches of loam and black muck in the south end, 8 feet of loamy clay in the north end. Quarrying would be very expensive. Over 10,000 cubic yards of waste stone have been dumped in big piles around the quarry, the largest part is under 1 foot in size. Owner: U. E. Thompson, Moulinette, P.O.

(13) *1½ miles north of Mille Roches.* Black River formation. In the south end of a large excavation, 12,000 square yards in extent, and nearly full of water, there is a 3-foot section above water-level of limestone of same character as No. 12. Beds nearly horizontal. Stone used for building canal banks. Overburden, over 5 feet of loamy clay. Quarrying would be very expensive. Over 1,000 cubic yards of waste stone dumped in 2 piles west of quarry, largely under 1 foot in size. Hauling distance of 2 miles from the front road, canal and railway siding. Owner: William Manson, Mille Roches, P.O.

(14) *1½ miles north of Mille Roches.* Black River formation. Old quarry, nearly full of water. Rock above water-level in the southwest end only. Dark, blackish-grey, very dense limestone, massive, with a few shaly partings. Beds lie nearly horizontal. Stone used for building canal banks. The quarry occupies an area of 5,250 square yards. Overburden, a little over 2 feet in the southwest end of quarry, and goes over 4 feet everywhere else. Quarrying would be expensive. Hauling distance of 2⅓ miles to the front road, canal and railway siding. Owner: G. Brooks, Mille Roches, P.O.

(15) *1½ miles northwest of Mille Roches.* Black River formation. Large quarry nearly full of water. All rock is under water-level, except in the east end, where it is 63 inches above water-level. Dark, blackish-grey, very dense, massive limestone; small streaks of calcite crystals; fossils. Stone splits irregularly in thin layers along shaly partings. Beds have a very gentle dip north or northwest. Glacial striae: N. 13° W. and N. 9° E. The opening covers an area of about 24,000 square yards. Stone used in the building of the locks and parts of the banks of the Cornwall, Farran's Point, Morrisburg and Cardinal canals, 15 to 20 years ago. No outcrops. Overburden, 3 feet of clayey and silty loam in the east end of the quarry, and over 6 feet everywhere else. Quarrying would be very expensive. Over 10,000 cubic yards of waste stone dumped in 3 piles south of the quarry. Hauling distance of a little over 2 miles to the front road, canal, and railway siding. Owner: Miss Copeland, Cornwall, P.O.

(16) *1½ miles northwest of Iroquois.* Beekmantown formation. Light steel grey, fine-grained, thin-bedded dolomite, weathering to light buff colour. Beds appear to lie flat. Stone used for making lime many years ago. Outcrops plentiful and overburden, apparently not over 2 feet, consists of dark brown loam. The rock lies in a low place. Over 5,000 cubic yards available without much stripping. Hauling distance, 1¾ miles to the front road and canal. Owner: R. A. Carman, Iroquois, P.O.

(17) *1 mile west of Iroquois.* Beekmantown formation. In an opening, 3,170 cubic yards in size, there are 3½ feet exposed of rather dark earth-grey, fine-grained, thick-bedded dolomite, with a few shaly partings; splits in thin layers. Slight amount of silt in the weathering. Beds have a very gentle dip west. Strike N. 9° E. One direction of joints trends N. 29° E.

Stone used as back filling for the canal locks at Iroquois, 15 to 20 years ago. The stone has not been used on roads, but the canal road from the quarry east to Iroquois is said to be surfaced with stone blasted out of the canal, 15 to 20 years ago, and has never been repaired since. In the fall of 1917, the road was in very bad condition, full of ruts, and many large stones exposed. No more stone can possibly be quarried because of the limited area, and of the difficulty of draining. The rock lies within 250 yards of the front road and canal. Stone sells at 50 cents a cord, unquarried. Owner: William Fisher, Iroquois, P.O.

(18) *1 mile west of Iroquois.* Beekmantown formation. In small quarry, 320 cubic yards in size, there are 2 feet exposed of dark grey, fine-grained, thin-bedded dolomite. Slight amount of silt in weathering. Beds have a very gentle dip to the west or southwest. Stone said to have been used as back filling for the canal locks at Iroquois, 15 to 20 years ago.

Very few outcrops seen north of the quarry. Overburden, a few inches to 2½ feet of clayey loam. Over 2,000 cubic yards could probably be obtained. The rock is right along the front road and canal. Owner A. H. Hutchison, Iroquois, R. R. 2.

(19) *3 miles northeast of Cardinal.* Beekmantown formation. Light clay-grey, finely grained, rather brittle, thick-bedded dolomite, slightly

weathered with silt in the weathering. Beds have a very gentle dip to the southwest. Irregular joints. Stone used for building the Methodist Church in Iroquois, and the owner's house, 35 years ago. The overburden consists of from 2 to 4½ feet of boulder silt and clay. Further quarrying would be expensive, because of the great thickness of drift. The hauling distance is half a mile to the front road and canal. Owner: J. T. Liezert, Iroquois, R. R. 2.

(20) *3 miles northeast of Cardinal.* Beekmantown formation. About 1 foot exposed of dark brownish-grey, medium to fine-grained, banded dolomite, partly weathered with silt in the weathering. Beds lie horizontally. For future development see No. 21.

(21) *3 miles northeast of Cardinal.* Beekmantown formation. A 2-foot bed exposed of rather dark grey, finely grained, dolomite, with several shaly partings. Splits readily in thin slabs, 1 to 4 inches thick. Beds have a very gentle dip west. Irregular joints. Outcrops are plentiful, with overburden of from 2 to 12 inches of bouldery sand in west part and clayey loam in east end. The stone is easy to quarry, but could not be excavated farther down than 2 yards, on account of the difficulty of draining. Hauling distance of ¾ mile to the front road and canal. Stone sells at 50 cents per cord (128 cu. ft.) unquarried. Owner: J. T. Liezert, Iroquois, R. R. 2.

(22) *3 miles north of Cardinal.* Beekmantown formation. Thin-bedded, rather light grey, fine, even-grained dolomite, weathering to a dark grey and buff colour, with silt in the weathering. Beds have a very slight dip northwest; striae N. 24° E. One direction of joints trends E. 1° S. Two series of glacial striae: N. 18° E. and N. 12° W. respectively. Stone used for building houses in the vicinity 40 to 60 years ago. Outcrops are numerous, with a few inches of boulder clay as overburden, excepting a small sand ridge 5 feet in height, which partly covers the northern part of the area. Several thousand cubic yards of stone can be easily obtained. Hauling distance of 2½ miles to the front road and canal. Owner: William Warren, Iroquois, R. R. 2.

(23) *3 miles north of Cardinal.* Beekmantown formation. In shallow quarry, a 2-foot section of thin-bedded, fine-grained, rather dark grey dolomite, with a few shaly partings; splits up readily in thin slabs. The dolomite weathers to a dark grey, with spots of buff colour, small amount of silt in the weathering. In the east end of the deposit, in a small quarry about 50 cubic yards in size, there is a 2½ - foot section of very light, reddish-grey, finely grained, thin-bedded, dolomite, with a few calcite crystals and nodules of quartz. Very gentle dip northwest, increasing to nearly 5 degrees farther down the slope. Striae N. 44° E. One direction of joints runs N. 24° E. Stone used for building cellars. It sells at $3.50 per cord (128 cu. ft.) quarried, or 50 cents unquarried. Outcrops are seen along the west and east edges, but none in the centre of the area. The overburden on both edges consists of from 4 to 12 inches of loam. Its thickness at the centre is unknown. The stone is easy to quarry, and over 10,000 cubic yards could be obtained along the east and west edges. Hauling distance of 3 miles, of which half a mile is through fields, to the front road and canal. Owner: John Bueley, Iroquois, R. R. 2.

(24) *3 miles north of Cardinal.* Beekmantown formation. About 2 feet exposed of same dark grey dolomite as seen in No. 23. Outcrops on top and northwest slope of a low hill. Very gentle dip to the northwest, increasing to 5 degrees farther down the slope. Striae N. 34° E. One direction of joints runs N. 16° E. Stone sells at $3.50 per cord quarried, or 50 cents per cord unquarried. Owner: William Shaver, Iroquois, R. R. 2 For future development see No. 23.

(25) *1½ miles west of Cardinal.* Beekmantown formation. In a large quarry, over 70,000 cubic yards in size, 23-foot section exposed above ground water-level. In the 16 feet immediately above water-level, the stone is dark brownish-grey, medium to fine-grained, thin-bedded dolomite. On the top a 7-foot section of intensely weathered dolomite is seen only at one place in the quarry. Beds have a very slight tip to the northwest. Striae N. 44° E. Irregular joints. Stone used many years ago for building houses, and later in the building of the Cardinal canal. Overburden, from 1 to 4 feet of loamy silt and sand. Outcrops around a flat-topped hill in the lower part of the slope. The thickness of drift on top of the hill is not known. Several thousand cubic yards can be obtained in the old excavation and from the belt of outcrops around the hill. The deposit is close to the front road and canal. Caretaker: F. F. Adams, Cardinal, P.O. (See Plate VI).

APPENDIX II.

Character of Boulder Deposits or Field Stone.

Explanation of Table. Glacial boulders, strewn over the land which has been cleared, have, for the most part, been piled in fences or heaps. The composition of the boulder aggregates has been estimated, and the amount of stone present measured, fence by fence, and pile by pile. The amount under and over 1 foot has also been estimated fence by fence. Groups of fences and piles were combined into areas, and the total yardage and the average composition for the areas compiled and calculated from the results obtained on each fence. Each area is numbered on the map, and the information regarding it will be found accompanying this number in the table. Durable boulders in this classification represent igneous rocks, hard gneisses and quartzites; intermediate represent limestones, dolomites, dense and hard sandstones, softer gneisses and partly weathered durable rocks; soft boulders represent sandstones, shales and much weathered rocks.

Abbreviations used in column for remarks.

anor	anorthosite.
Beekman	Beekmantown.
Blk. R	Black River.
Ch	Chazy.
dol	dolomite.
gb	gabbro.
gn	gneiss.
gr	granite.
gr.-gn	granite-gneiss.
lst., limest	limestone.
Pot	Potsdam.
ss., sandst	sandstone.
sy	syenite.
Tr	Trenton.

CHARACTER OF DEPOSITS OF FIELD STONE.

Lancaster Township.

Map No.	Location.	Field estimate of composition. Average of whole deposit. Material under 1 ft.; per cent of. Durable.	Intermediate.	Soft.	Material over 1 ft.; per cent of. Durable.	Intermediate.	Soft.	Cu. yds. of stone, diameter. Under 1 ft.	Over 1 ft.	Total.	Remarks.
1	Con II, lot 8	11	59	30	18	48	34	41	111	152	
2	Con II, lot 10	20	40	40	30	25	45	21	86	107	
3	Con II, lot 12							302	497	799	Chazy limestone, Beekmantown dolomite, weathered sandstone
4	Con II, lot 17							8	34	42	Mostly dolomite and limestone
5	Con. I, lot 17	0	35	65	0	73	27	48	85	133	
6	Con. II, lots 19, 20	0	37	63	0	62	38	168	257	425	
7	Con. II, lot 20	0	30	70	0	60	40	65	28	93	
8	Con. II, lots 21, 22	2	48	50	4	68	28	228	144	372	
9	Con. II, lot 24	0	40	60	30	60	10	9	19	28	
10	Con II, lot 24	4	53	43	11	73	16	142	111	253	
11	Con II, lot 25	0	74	26	0	86	14	72	62	134	*Inter.*—Mostly Chazy limestone; few sandstone *Soft.* Sandstone.
12	Con. II, lot 27	0	75	25	0	85	15	10	35	45	
13	Con. II, lots 28, 29	1	53	46	38	48	14	117	252	369	*Dur.*—Sy. gr. gn.
14	Con. II, lot 28	0	50	50	0	50	50	36	48	84	*Inter.*—Chazy limestone and sandstone.
15	Con. I, lot 29	0	60	40	0	80	20	7	7	14	*Soft.*—Weathered Chazy sandstone.
16	Con. I, lot 25	0	41	59	0	60	40	35	23	58	
17	Con. I, lot 27	0	80	20	0	90	10	49	13	62	*Inter.*—Chazy limestone and sandstone. *Soft.*—Weathered Chazy sandstone.
18	Con. I, lot 32								75	75	Chazy sandstone, boulders, scattered on hill, partly buried in the ground.
19	Con. II, lot 38	6	54	40	56	36	8	45	37	82	*Dur.*—Sy. gr. gn. *Inter.*—Chazy limestone and sandstone *Soft.*—Weathered lst. and sandstone.
								1403	1924	3327	

Charlottenburg Township.

20	Con. I, lots 58, 59	25	70	5	25	70	5	59	147	206	
21	Con. I, lot 58							155	155	310	Mostly limestone, a few gr. and gn
22	Con. III, lot 1	30	60	10	30	60	10	53	124	177	Impracticable to draw out, on account of the swampy character of the soil and the very poor condition of roads.
23	Con. IV, lot 2				25	60	15	18	54	72	

24	Con. III, lots 3, 4	27	49	24	26	52	22	593	905	14084	Can be drawn out only in very dry weather, because of the soft soil between ridges. In No. 24 mostly limestone, with a few gn. In No. 26, a few hundred cu. yds. of boulders scattered over the area and partly buried in the ground. No variation in composition.
25	Con. II, lot 5	5	70	25	10	65	25	175	248	423	
26	Con. II, lots 5, 6, 7	5	65	30	10	65	25	2061	2318	4379	
27	Con. II, lot 7	3	60	37	2	67	31	46	79	125	
28	Con. I, lot 8								100	100	A few hundred cu. yds. of boulders scattered over the surface of hill.
29	Con. I, lot 6	5	65	30	8	55	37	323	182	505	
30	Con. I, lot 4	5	70	25	15	65	20	164	245	409	
31	Con. I, lots 2, 3	13	72	15	28	60	12	251	575	826	*Inter.* is largely limestone. Higher amount of *Soft* in west than east.
32	Con. I, lot 5	5	70	25	5	65	30	45	141	186	
33	Con. I, lots, 7, 8, 9, 10	9	72	19	23	65	12	6597	5211	11808	Fairly uniform in composition *Inter.* a little higher, *Soft* a little lower in the west than in the east.
34	Con. I, lot 12	25	65	10	30	60	10	10	92	102	
35	Con. II, lots 9, 10, 11, 12, 13	5	67	28	9	66	25	1,456	2,247	3,703	No variation in composition.
36	Con. II, lot 14	3	51	46	31	55	14	7.	205	281	*Dur.*—Gn. a few anor.
37	Con. II, lots 15, 16	0	61	39	1	82	17	333	149	482	*Inter.* Pot. and Chazy sandstone.
38	Con. II, lot 17	5	60	35	3	84	13	299	153	452	Chazy limestone. Beekmantown dolomite. *Soft.* Sandstone and limestone.
39	Con. II, lots, 18, 19	5	60	35	17	70	13	3o1	148	509	Very hard to draw out, because of bad condition of side road.
40	Con. II, lots 17, 18, 19	3	62	35	13	74	13	575	409	1,084	*Dur.*—Gn, a few anor.
41	Con. I, lots 19, 20	0	60	40	10	70	20	51	6	57	*Inter.*—Pot. and Chazy sandstone, some Ch. lst., a few Beekmantown dolomite. *Soft.*—Chazy sandstone and lst. weathered stones.
42	Con. I, lot 16	10	60	30	25	50	25	22	8	30	Impracticable to draw out.
43a	Con. I, lots 13, 14	2	48	50	25	57	18	492	303	795	
43b	Con. I, lots 13, 14	8	60	32	25	65	10	321	396	717	
44	Con. I, lots 14, 15	4	60	36	22	67	11	450	356	806	*Dur.*—Gn., a few anor.
45	Con. I, lots 14, 15	8	58	34	14	75	11	868	477	1,345	*Inter.*—Pot. and Chazy sandstone some Ch. lst. and a few Beekmantown dolomites.
4o	Con. I, lots 16, 17, 18, 19	3	60	37	13	74	13	1,145	703	2,348	
47	Con. I, lot 17	0	61	39	3	77	20	281	57	338	*Soft.*—Chazy sandstone and lst. weathered stones. In No. 50, 100 cu. yds. of boulders scattered over the surface of the ground, same in No. 51.
48	Con. I, lots 17, 18, 19	6	62	32	13	76	11	1,185	524	1,709	
49	Con. I, lots 19, 20	3	64	33	26	60	14	825	278	1,103	
50	Con. I, lots 21, 22	0	65	35	26	62	12	345	156	501	
51	Con. I, lots 19, 20, 21, 22	3	52	45	13	65	22	1,218	308	1,526	
52	Con. II, lots 20, 21	3	56	41	10	67	23	730	189	919	Can be drawn out only in very dry weather, because of bad roads. *Dur.*—Gn. gr.
53	Con. II, lots 22,23	1	51	48	14	56	30	979	248	1,227	
54	Con. II, lots 24, 25, 26	2	60	38	13	66	21	1,661	436	2,097	
55	Con. I, lot 26	10	65	25				50		50	*Inter.*—Pot. ss., Ch. lst. a few Blk. River lst. and Beekmantown dolomite. *Soft.* Ch. lst., a few Pot. ss. weathered stones.

Charlottenburg Township—(Concluded).

Map No.	Location.	Field estimate of composition						Cu. yds. of stone, diameter.			Remarks.
		Average of whole deposit									
		Material under 1 ft ; per cent of			Material over 1 ft.; per cent of.						
		Durable	Inter-mediate	Soft	Durable	Inter-mediate.	So't	Under 1 ft	Over 1 ft	Total	
											In No. 55, about 200 cu. yds. of scattered boulders.
56	Con. I, lot 26	14	60	26	60	30	10	43	47	90	About 200 cu. yds. of scattered boulders.
57	Con. I, West end	7	66	27	15	65	20	1,275	2,064	3,339	
58	Con. I, West end	25	40	35	20	45	35	135	284	419	
59	Con. I, West end	10	40	50	10	55	35	68	103	171	
60	Con. I, West end	15	55	30	24	44	32	629	627	1,256	Can be drawn out only in dry season on account of soft soil and bad roads.
61	Con. II, West end				45	40	15	3	55	58	
62	Con. II, West end	28	47	25	27	43	30	227	291	528	
63	Con. II, West end	10	35	55	25	45	30	364	282	646	*Dur.*—Gn. gr.-gn. gr.
64	Con. I, II, West end	10	46	44	10	57	33	241	258	499	*Inter.*—Pot. and Chazy ss., Beekmantown dol. *Soft.*—Chazy lst. and Potsdam sandstone.
65	Con. I, West end	10	47	43	18	42	39	3,482	3,621	7,103	Can be drawn out only in dry season Uniform in composition.
66	Con. I, West end	5	65	30	10	60	30	462	301	763	
								31,812	26,265	58,077	

Cornwall Township.

67	Con. I, lot B	25	50	25	40	50	10	71	32	103	Impracticable to draw out. About 400 c. y. of scattered boulders.
68	Con. I, lots C, D	23	54	23	62	30	8	182	130	312	Can be drawn out only in dry season. About 400 c. y. of scattered boulders.
69	Con. I, lot D	0	60	40	10	70	20	12	38	50	
70	Con. I, lots B, C, D	1	62	37	30	55	15	960	236	1,196	*Dur.*—Gn.
71	Con. I, lots A, B	5	70	25	20	70	10	151	30	181	*Inter*-Ch. & Pot. sandstone; some Beekmantown dolomite and Chazy lst. *Soft.* Chazy shales and weathered stones.
72	Con. I, lots A, 1	5	69	26	35	55	10	53	37	90	
73	Con. I, lots 1, 2, 3	23	54	23	61	31	8	265	402	667	*Dur.*—Gr. gn. sy.
74	Con. I, lots 3, 4	31	48	21	65	26	9	88	124	212	*Inter.*—Pot & Ch. sandstone, Black River & Chazy limest. Beckmantown dolomite.
75	Con. I, lot 6	5	60	35	41	45	14	80	102	182	
76	Con. II, lots 7, 8	9	61	30	66	26	8	69	149	218	

77	Con. II, lots 10, 11	19	47	34	48	37	15	148	447	595	*Soft.*—Sandstone and limest., weathered stones. In No. 74, about 50 cu. yd. of scattered boulders. In No. 76; about 200 cu. yd. in piles in gravel pit.
78	Con. II, lot 12	5	60	35	5	55	40	4	17	21	
79	Con. III, lot 13	15	60	25	57	33	10	318	73	391	*Dur.*—Gn. gr. sy. a few gabbros.
80	Con. III, lot 16	9	68	23	42	48	10	790	253	1,043	*Inter.*—Pot. sandstone, Black River & Chazy lst.
81	Con. III, lots 16, 17, 18	7	72	21	47	43	10	492	116	608	*Soft.*—Lst. and sandstone, weathered stones. In No. 81 about 300 cu. yd. of scattered boulders.
82	Con. III, IV, lot 19	6	65	29	20	60	20	173	125	298	
83	Con. III, lots 19, 20	1	71	28	41	49	10	321	220	541	Besides, 500 cu. yd. of boulders scattered on hill.
84	Con. III, lots 19, 20	2	63	35	59	29	12	47	142	189	*Dur.*—Gr. gn.
85	Con. II, lots 18, 19, 20	9	65	26	26	56	18	166	218	384	*Inter.*—Lst., Pot. sandstone.
86	Con. III, lot 18	6	64	30	53	37	10	121	75	196	*Soft.*—Weathered stones. Hard to draw out, because of sand. In No. 84, 200 cu. yd. of scattered boulders.
87	Con. III, lots 15, 16	4	68	28	38	52	10	464	384	848	Hard to draw out because of sand. *Dur.* Gr. gn. sy.
88	Con. II, lots 15, 16	18	53	29	31	47	22	408	705	1,113	*Inter.*—Black River lst. Potsdam sandstone.
											Soft.—Black River lst. Pot. sandstone.
89	Con. I, lots 12, 13	15	35	50	40	53	7	22	123	145	
90	Con. I, lot 18 (along canal)	10	50	40	15	55	30	14	40	54	
91	Con. I, lots 18, 19	65	30	5	80	15	5	79	54	133	
92	Con. II, lot 21	17	49	34	27	44	29	103	170	273	*Dur.*—Gn. gr.-gn.
93	Con. III, lots 22, 23	5	59	36	63	27	10	288	320	608	*Dur.*—Gr., gn., sy., a few gabbros.
94	Con. III, lot 23	0	63	37	25	54	21	329	211	540	*Inter.*—Pot. ss., Blk. River lst., some Chazy lst. *Soft.*—Pot. ss. some Chazy lst., weathered stones. In No. 97, a few hundred cu. yd. of scattered boulders, mostly Black River lst., with a few sandstone and gn.
95	Con. III, lots 24, 25	5	53	42	17	40	43	227	222	449	
96	Con. III, lots 24, 25	0	64	36	22	56	22	574	262	836	
97	Con. III, IV, lots 21, 22, 23	5	65	30	30	50	20	767	857	1,624	
98	Con. IV, lots 24, 25	10	40	50	15	55	30	37	34	71	
99	Con. IV, lots 24, 25	5	30	65	30	25	45	59	20	79	Over 20,000 cu. yd. of Black River lst. in huge piles near quarries. Over 75% of the stone is under 1 foot in size.
100	Con. IV, lots 22, 23	21	50	29	26	51	23	53	35	88	Pile of 15 cu. yd. of Black River limestone.
101	Con. IV, lot 19	16	57	27	12	60	28	156	82	238	Hard to draw out.
102	Con. V, lot 25	9	17	74	17	22	61	871	338	1,209	
103	Con. V, lots 25 to 29	14	25	61	30	20	50	3,080	1,628	4,708	Variation from fence to fence. *Dur.* from 5 to 40; *Inter.* from 15 to 60; *Soft* from 30 to 75%; 20 cu. yds. in piles and a few hundred cu. yd. of scattered boulders
104	Con. V, lots 29, 30	17	62	21	16	51	33	108	160	268	Besides, pile of 36 cu. yd. all Chazy lst., 12 cu. yd. of boulders scattered along a fence.
105	Con. IV, lots 30, 31	20	49	31	43	31	26	188	490	678	
106	Con. III, lot 29	15	50	35	45	35	20	26	59	85	
107	Con. IV, lot 29	7	60	33	40	45	15	210	419	629	
108	Con. III, lots 26 to 28	12	50	38	8	46	46	105	362	467	24 cu. yd. in small piles.

Cornwall Township—(Concluded).

Map No.	Location.	Field estimate of composition. Average of whole deposit. Material under 1 ft.; per cent of. Durable.	Inter-mediate.	Soft.	Material over 1 ft.; per cent of. Durable.	Inter-mediate.	Soft.	Cu. yds. of stone, diameter. Under 1 ft.	Over 1 ft.	Total.	Remarks.
109	Con. V, lots 31 to 34	16	55	29	23	54	23	1,331	1,411	2,742	60 cu. yd. in piles. A few hundred cu. yd. of boulders scattered on hill.
110	Con. IV, lot 33	15	60	25	26	40	34	102	107	209	
111	Con. V, lots 34, 35	15	52	33	36	39	25	1,075	833	1,908	25 cu. yd. in piles. A few hundred cu. yd. of scattered boulders.
112	Con. V, lots 35, 36	10	50	40	38	48	14	207	89	296	30 cu. yd. in piles.
113	Con. V, lots 36, 37	38	40	22	24	45	31	375	381	756	About 100 cu. yd. of scattered boulders.
114	Con. V, lots 36, 37	12	52	36	31	50	19	444	414	858	30 cu. yd. in piles.
115	Con. III, lots 36, 37, 38	10	60	30	40	40	20	103	115	218	
116	Con. IV, lot 34	25	45	30	47	38	15	92	333	425	100 cu. yd. of scattered boulders.
								16,408	13,624	30,032	

Osnabruck Township.

117	Con. I, lot 1, part in Cornwall tp	10	65	25	20	65	15	602	403	1,005	15 cu. yds. in piles.
118	Con. I, lots 1, 2, 3	16	50	34	50	40	10	97	5	102	*Dur.*—Gn. gr. a few gabbros.
119	Con. I, lot 2	38	40	22	63	27	10	122	72	194	*Inter.*—Pot. sandstone, limestone. *Soft.*—Weathered stones.
120	Con. I, lots 2, 3	5	60	35	15	55	30	11	93	104	Hard to draw out on account of sand.
121	Con. I, lots 1, 2, 3	21	50	29	32	42	26	614	1,108	1,722	*Dur.*—Gr. gr.-gn. sy. *Inter.*—Black River and Beckmantown limestone. Potsdam and Chazy sandstone. *Soft.*—Potsdam sandstone, weathered stones. About 225 cu. yd. of boulders piled and scattered.
122	Con. I, lot 4	20	50	30	60	31	9	35	76	111	
123	Con. I, lot 5	.....	.....	.....	70	20	10	.....	56	56	*Dur.*—Sy. gr.-gn., a few anor.
124	Con. I, lot 6	.....	.....	.....	80	10	10	.....	159	159	*Int.*—Potsdam sandstone. *Soft.*—Weathered stones.
125	Con. I, lot 7	35	40	25	65	25	10	117	111	228	*Dur.*—Gr. gn., a few gabbros. *Int.*—Potsdam sandstone. Black River lst., and some Chazy. *Soft.*—Weathered stone.
126	Con. I, lot 10	19	49	32	72	22	6	77	53	130	
127	Con. I, lots 6, 7, 8	38	39	23	62	28	10	1,147	546	1,693	*Dur.*—Gr. gn. sy. gabbros, a few anor. *Inter.*—Potsdam sandstone, gn., a few limestone.

128	Con. I, lot 9	52	30	18	80	14	6	40	45	85	*Soft.*—Potsdam sandstone, weathered Chazy limestone. Little variation in composition.
129	Con. I, lots 10, 11	19	50	31	44	42	14	826	248	1,074	*Dur.*—Gr. gn. sy., a few gabbros & anor.
130	Con. II, lots 10, 11, 12	16	52	32	47	40	13	1,300	1,161	2,461	*Int.*—Black River and Chazy lst., a
131	Con. II, lots 13, 14, 15	19	49	32	50	36	14	1,369	761	2,130	few Potsdam sandstone. *Soft.*—Chazy and some Black River lst., weathered stones. In No. 131, *Durable* is in higher proportion in the north part, *Inter.* varying inversely.
132	Con. I, lots 15, 16	0	66	34	20	62	18	274	147	421	*Dur.*—Gn. gr. a few gabbros. *Inter.*—Black River lst. *Soft.*—Chazy and Potsdam sandstone.
133	Con. I, lots 11, 12	40	38	22	68	22	10	899	670	1,569	*Dur.*—Gr. sy. gn., a few anor.
134	Con. I, lot 11	38	36	26	55	30	15	47	37	84	*Int.*—Potsdam sandstone, few Black River and Chazy lst. *Soft.*—Potsdam sandstone, , weathered stones.
135	Con. I, lots 13, 14	42	30	28	74	17	9	434	311	745	*Dur.*—Gr. gr.-gn. sy. gabbro.
136	Con. I, lots 13, 14	39	25	36	63	23	14	158	83	241	*Inter.*—Potsdam sandstone, Black River and Chazy lst. *Soft.*—Chazy lst., weathered stones.
137	Con. I, lot 16	25	40	35	60	35	5	21	31	52	
138	Con. I, lot 18	50	21	29	65	25	10	70	26	96	
139	Con. I, lots 17, 18	5	65	30	43	46	11	74	171	245	
140	Con. II, lots 16, 17	15	58	27	26	58	16	177	43	220	
141	Con. II, lots 18, 19, 20	13	59	28	56	35	9	1,131	520	1,651	*Dur.*—Gr. gn. sy. few anor. *Inter.*—Black River and Chazy lst., Potsdam sandstone. *Soft.*—Pot. ss., weathered stones. About 250 cu. yds. of scattered boulders. In the stone under 1 ft. there is no *Durable* east of the road, while there is as much as 35 per cent west of road.
142	Con. II, lot 20	0	82	18	13	82	5	43	25	68	
143	Con. II, lots 18 to 23	25	52	23	63	28	9	384	394	778	*Dur.*—Gr. sy. gn. gabbro, a few felsites.
144	Con. I, lot 19	50	30	20	65	30	5	35	11	46	*Inter.*—Black River lst. Potsdam sandstone. *Soft.*—Sandstones, weathered stones. 300 cu. yd. of scattered boulders.
145	Con. I, lot 23	50	30	20	80	15	5	7	40	47	*Dur.*—Gr. gn. gabbro.
146	Con. II, lot 24	41	39	20	67	28	5	71	17	88	
147	Con. II, lot 24	42	38	20	70	25	5	28	46	74	
148	Con. II, lots 25, 26	17	53	30	34	50	16	84	8	92	
149	Con. II, lots 28 to 31	19	49	32	47	43	10	296	26	322	In con. II, from lots 24 to 31, there are about 100 cu. yd. of scattered boulders.
150	Con. I, lot 27				60	30	10		19	19	

Osnabruck Township—(Concluded).

Map No.	Location.	Field estimate of composition. Average of whole deposit. Material under 1 ft.; per cent of. Durable.	Inter-mediate	Soft	Material over 1 ft.; per cent of. Durable	Inter-mediate.	Soft	Cu. yds. of stone, diameter. Under 1 ft.	Over 1 ft.	Total.	Remarks.
151	Con. I, lot 29	20	50	30	50	40	10	720	80	800	*Dur.*—Gr.-gn. sy., a few gabbro & anor. *Inter.*—Potsdam sandst., Black River & Chazy lst., some gn. *Soft.*—Chazy lst., Potsdam sandstone, weathered stones. Stock pile owned by Dept. of Public Works.
152	Con. I, lots 28, 29, 30	26	44	30	58	32	10	54	171	225	
153	Con. I, lot 31	5	51	44	45	43	12	231	95	326	*Dur.*—Gr.-gn. gr. a few sy. *Inter.*—Chazy & Black River lst. *Soft.*—Chazy lst., weathered stones.
154	Con. I, lots 33, 34	20	50	30	80	10	10	5	12	17	
155	Con. II, lots 33, 34	10	43	47	60	30	10	104	6	110	
156	Con. I, lot 37	30	40	30	60	30	10	12	8	20	
								11,716	7,894	19,610	

Williamsburg Township.

157	Con. I, lots 1, 2	13	53	34	62	28	10	32	10	42	
158	Con. I, lot 6	20	50	30	.....	.....	.....	22	.....	22	
159	Con. I, lot 8	24	41	35	60	30	10	122	9	131	*Dur.*—Gr., gr.-gn., sy., few gabbros. *Inter.*—Black River and Chazy limestone, some Potsdam sandstone. *Soft.*—Chazy limestone, some weathered stones.
160	Con. II, lot 12	20	50	30	.....	.....	.....	15	.....	15	
161	Con. I, lots 3, 4	26	44	30	65	24	11	275	361	636	*Dur.*—Sy. gn. gr., gabbros. *Inter.*—Limestone, Potsdam sandstone. *Soft.*—Chazy limestone, weathered stones. Can be drawn out only in dry season.
162	Con. I, lot 6	20	50	30	.....	.....	.....	11	.....	11	
163	Con. I, lot 10	25	45	30	.....	.....	.....	213	.....	213	Stock pile owned by township.
164	Con. II, lot 13	25	48	27	66	24	10	105	57	162	Several hundred cu. yds. of piled stone, east of side road.
165	Con. II, lots 15 16	35	42	23	67	23	10	200	38	238	*Dur.*—Gr., sy., gr.-gn., few gabbros.

166	Con. II, lots 16, 17	32	44	24	67	23	10	525	125	650	*Inter.*—Black River and Trenton limestone, few Potsdam sandstone.
167	Con. II, lots 17, 18	29	45	26	70	21	9	596	191	787	*Soft.*—Chazy limestone, weathered stone Composition very uniform.
168	Con. II, lots 19, 20	19	55	26	60	30	10	344	41	385	*Dur.*—Gr., sy., gr.-gn. *Inter.*—Black River and Trenton limestone few Chazy limestone. *Soft.*—Chazy limestone and weathered stones.
169	Con. I, lot 19	21	50	29	51	39	10	73	28	101	
170	Con. I, lots 20, 21	10	60	30	.....	.....	.....	64	.....	64	
171	Con. I, lot 16	50	30	20	.....	.....	.....	13	.....	13	
172	Con. I, lot 20	30	40	30	.....	.....	.....	112	.....	112	Stock piles owned by county.
173	Con. I, lot 27	25	50	25	.....	.....	.....	133	.....	133	*Dur.*—Gr., gr.-gn., few sy. and gabbros. *Inter.*—Black River and Chazy limestone, a few Potsdam sandstones and gn. *Soft.*—Chazy limestones, sandstones, weathered stones.
174	Con. I, lot 26	25	45	30	70	20	10	26	4	30	
175	Con. II, lot 26	.....	.....	.....	70	20	10	.....	100	100	Gr.-gn., gabbros, limestone. Hard to draw out, because of the soft, swampy soil.
176	Con. II, lot 31	40	40	20	.....	.....	.....	17	.....	17	
177	Con. II, lot 35	25	50	25	.....	.....	.....	14	.....	14	
178	Con. I, lot 37	43	37	20	78	12	10	30	117	147	*Dur.*—Gr.-gn., gr., sy., gabbros, anor. *Inter.*—Potsdam sandstones, few limestones. *Soft.*—Weathered stones.
179	Con. I, lot 35	.....	.....	.....	70	20	10	.....	66	66	About 500 cu. yd. of boulders scattered in bush.
180	Con. I, lot 36	.....	.....	.....	70	20	10	.....	168	168	
								2,942	1,315	4,257	

Matilda Township.

181	Con. I, lot 6	50	30	20	73	17	10	24	124	148	*Dur.*—Gr.-gn. gr. sy., gabbro, anor. *Inter.*—Potsdam sandstone, few limestone. *Soft.*—Weathered stones.
182	Con. I, lots 8, 9	60	20	20	85	10	5	17	15	32	
183	Con. I, lots 11, 12	53	27	20	79	13	8	188	459	647	*Dur.*—Gr. gr.-gn., sy., gabbro, anor.
184	Con. I, lot 7	40	45	15	.....	.....	.....	27	.....	27	*Inter.*—Potsdam sandstone and gn.
185	Con. I, lots 9, 10	62	24	14	80	11	9	43	481	524	*Soft.*—Weathered stones, Most of the stone under 1 ft. in size has been drawn out for the canal.
186	Con. I, lots 11, 12	52	32	16	77	13	10	131	575	706	*Dur.*—Gr. gr.-gn., gabbro, anor.
187	Con. I, lots 13, 14, 15	55	26	19	80	11	9	128	534	662	*Inter.*—Potsdam sandstone, limestone. *Soft.*—Weathered stones.
188	Con. I, lot 18	20	50	30	60	30	10	34	8	42	

(Matilda Township—Concluded).

Map No.	Location.	Field estimate of composition: Average of whole deposit. Material under 1 ft; per cent of: Durable.	Intermediate.	Soft.	Material over 1 ft; per cent of: Durable.	Intermediate.	Soft.	Cu. yds. of stone, diameter.: Under 1 ft.	Over 1 ft.	Total.	Remarks.
189	Con. I, lot 19	10	60	30	.....	.....	.....	200	.....	200	*Dur.*—Gr. gr.-gn., a few sy., gabbros.
190	Con. I, lot 19	5	76	19	23	62	15	138	89	227	*Inter.*—Beekmantown dolomite and few sandstones.
191	Con. I, lots 20, 21	6	67	27	53	36	11	182	173	355	*Soft.*—Weathered Beekmantown dolomite and other stones.
192	Con. I, lots 21,22	10	66	24	65	25	10	146	94	240	
193	Con. I, lot 23	8	68	24	62	28	10	95	55	150	
194	Con. I, lots 24, A	17	60	23	80	10	10	32	16	48	
195	Con. I, lot 21	0	80	20	80	10	10	93	58	151	*Dur.*—Gr. gr.-gn., gabbros.
196	Con. I, lot 22	40	40	20	70	20	10	14	22	36	*Inter.*—Beekmantown dolomite, few sandstone. *Soft.*—Weathered Beekmantown dolomite and other stones.
197	Con. I, lots 25, A	7	67	26	67	22	11	175	102	277	
198	Con. I, lot 25	47	35	18	78	12	10	491	353	844	*Dur.*—Gr. sy. gr.-gn, gabbro, anor.
199	Con. I, lot 26	55	27	18	85	9	6	915	1,243	2,158	*Inter.*—Gr., Potsdam sandstone, few Beekmantown dolomite,
200	Con. I, lot 27	60	27	13	84	10	6	277	366	643	*Soft.*—Weathered stones.
201	Con. I, lot 30	67	17	16	85	9	6	127	279	406	*Dur.*—Gr. gr.-gn., sy., gabbros, few anor.
202	Con. I, lots 31, 32	50	28	22	77	13	10	264	202	466	
203	Con. I, lot 32	58	22	20	76	14	10	413	100	513	*Inter.*—Gr. gn., some Beekmantown dolomite, few Potsdam sandstones.
204	Con. I, lots 32, 33	30	48	22	70	20	10	413	132	545	*Soft.*—Weathered dolomite and other stones. Hard to draw out to the front on account of sand and bad roads.
205	Con. I, lot 34	26	49	25	70	20	10	167	87	254	*Dur.*—Gr. gr.-gn., sy. gabbro, few anor.
206	Con. I, lots 33, 34	39	41	20	74	16	10	282	76	358	*Inter.*—Gr.-gn., gn., some dolomite, few sandstone.
207	Con. I, lots 34, 35	33	43	24	77	13	10	105	128	233	*Soft.*—Weathered dolomite and other stones. Hard to draw out to the front on account of sand and bad roads.
208	Con. I, lot 34	44	36	20	70	20	10	110	96	206	
209	Con. I, lot 29	50	30	20	70	20	10	55	28	83	
210	Con. I, lots 30, 31	26	48	26	70	20	10	157	164	321	*Dur.*—Gr. sy. gr.-gn. gabbro, anor. *Inter.*—Gn., Potsdam sandstone, few Beekmantown dolomite. *Soft.*—Weathered stones.
211	Con. I, lot 31	20	45	35	60	30	10	12	28	40	
212	Con. I, lot 32	20	50	30	63	27	10	210	60	270	*Dur.*—Gr. sy. gr.-gn., gabbro.
213	Con. I, lots 31, 32, 33	31	43	26	74	16	10	797	602	1,399	*Inter.*—Beekmantown dolomite, few Potsdam sandstone.
214	Con. I, lot 32	55	25	20	74	16	10	44	111	155	*Soft.*—Weathered stones.
215	Con. I, lot 35	29	44	27	77	13	10	140	425	565	*Dur.*—Gr. gr.-gn., sy., gabbro, few anor.
216	Con. I, lots 35, 36	25	42	33	69	21	10	82	79	161	*Inter.*—Gr.-gn., some dolomite, few Potsdam sandstone. *Soft.*—Weathered dolomite and other stones.
								6,728	7,364	14,092	

Edwardsburg Township.

217	Con. I, lot 1	52	25	23	84	10	6	52	226	278	*Dur.*—Gr.-sy. gr.-gn., gabbros, anor. *Inter.*—Gr.-gn., Potsdam sandstone, Beekmantown dolomite. In No. 218, only a few Beekmantown dolomite. *Soft.*—Weathered stones. Hard to draw out to the front in rainy season, on account of soft soil and poor roads.
218	Con. II, lot 2	60	21	19	82	10	8	381	491	872	
219	Con. II, lot 1	45	30	25	70	20	10	26	48	74	
220	Con. II, lot 2	48	32	20	75	15	10	187	206	393	
221	Con. II, lots 2, 3	48	31	21	80	13	7	199	318	517	
222	Con. I, lots 3, 4	51	27	22	76	14	10	169	255	424	Same composition as above, with only a few Beekmantown dolomite.
								1,014	1,544	2,558	

APPENDIX III.

Character of Deposits of Gravel.

Explanation of Table. The estimates of the character of the gravels were made in such excavations as could be found in the deposits, or from surface indications where there were no excavations. Since parts of the walls in nearly all the pits are talus-covered, and the pits are usually small in proportion to the deposit, the estimates are only an approximation to the true character of the deposit. This is especially so in the proportion of boulders, gravel and sand, which nearly everywhere vary greatly from place to place in a body of gravel. The compositions of the pebbles also vary, but not as a rule to so great an extent. The impurities mentioned include the clay, iron oxide, lime carbonate ($CaCO_3$), organic matter, etc., found below the zone of weathering; except in cases where practically all of the gravel is weathered. The pebbles have been classified according to composition into three classes, durable, intermediate, and soft. The average results of laboratory tests made upon many samples of rock have been tabulated by Lord.[1]

Durable pebbles in the following table are those made up of rocks averaging from 2·2 to 3·9 per cent of wear, and 12 to 25 in toughness; intermediate 4 to 5·6 per cent of wear, and toughness 5 to 12; soft, per cent of wear 5·6 and over.

The mechanical analysis covers only the material under 3 inches in size.

[1]Lord, E. C. E., "Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials." U.S. Dept. Agric., Bull. 348, p. 2, Washington, D.C., 1916.

Lancaster Township.

Map No.	Depth of Weath.	Percentage.			Impurities.	Shape of Pebbles.	Percentage.			Remarks.
		Boulders over 3 in.	Gravel ¼ to 3 in.	Sand under ¼ in.	$CaCO_3$, Fe_2O_3, Clay, etc.		Dur.	Int.	Soft.	
1	4	25	50	25	Small amount of clay and $CaCO_3$.	Angular to sub-angular.....	5	35	60	Estimates made in the northeast bank on a depth of 4 feet. Coarse, unstratified gravel. The pebbles are mostly Chazy limestone and sandstone.
2	.....	.....	.....	.....	.....	Angular.....	10	10	80	Estimates from surface indications. Medium coarse gravel. The pebbles consist of limestone, dolomite, sandstone (all weathered).
3	2 to 2½	25	24	51	Traces of $CaCO_3$. Traces of Fe_2O_3.	Angular and sub-angular.....	3	54	43	Depth of pit: 7 feet, nearly all uncovered; pit walls stand up well. Estimates made in the east bank. No variation as to size. Rather sharp outline between weathered and fresh part, with a layer, ⅛ to 1/16 in. thick of $CaCO_3$ between the two parts. The material under ¼-inch consists of limestone particles in a matrix of silt grading into fine sand. Looks much like a boulder clay deposit. 80% of pebbles is Chazy limestone, part being shaly. Mechanical analysis:— Retained on 5 mesh sieve...32% " " 8 " " ..13 " " 20 " " .. 6 " " 48 " " ..23 Passing 48 " " ..26
4	2	5	40	55	.....	Angular.....	0	84	16	Two feet weathered gravel exposed in road cut Largest part is Chazy limestone.
5	3	0	53	47	Traces of Fe_2O_3.....	Sub-angular.....	0	63	37	Six and a half feet of face seen in south part of the pit. Fine gravel and coarse sand, with some clay in the upper 3½ feet. (No clay in unweathered gravel). More sandy everywhere else in the pit. The sand is medium to coarse-grained. The pebbles are mostly Chazy limestone. Sample tested. Mechanical analysis:— Retained on 3 mesh sieve.....53% " " 8 " " ..18 " " 20 " " ..20·5 " " 48 " " ..7 Passing 48 " " ..1·5

Lancaster Township—(Continued.)

Map No.	Depth of Weath. in feet).	Percentage. Boulders over 3 in.	Gravel ¼ to 3 in.	Sand under ¼ in.	Impurities. $CaCO_3$, Fe_2O_3, Clay, etc.	Shape of Pebbles.	Percentage. Dur.	Int.	Soft.	Remarks.
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	Small pit showing loam with a streak of gravel, 6 ft. wide in the north bank. About the same character as No. 5.
7	5	35	38	27	Small amount of $CaCO_3$.	Sub-angular.....	0	70	30	Estimates made in the north bank. Looks somewhat coarser in the southeast bank. Over 90% of the pebbles is Chazy limestone. Sample tested.

Charlottenburg Township.

8	2	10	49	41	Traces of $CaCO_3$, traces of Fe_2O_3	Angular to sub-angular.	0	47	53	Over 6 feet of face seen in east part. The lower part of the face is less bouldery and shows a no well-marked stratification. Large number o shells up to 1½ inch in size. Gravel uniform in size. 75 % of pebbles is limestone. Mechanical analysis.— Retained on 3 mesh sieve...54% " " 8 " " ..11 " " 20 " " ..10 " " 48 " " ..18 Passing 48 " " .. 7
9	2+	.....	.....	.....	.....	Angular to sub-angular.	.....	.....	.....	Estimates made from what seen in two test pits on top of ridge; the test pits are 2 feet deep. Over 90% of Black River limestone, rather soft in the upper 2 feet. Coarse gravel.
10	.....	.....	.....	.....	.....	Angular to sub-angular.	.....	.....	.....	Estimates made from what seen in several test pits, 2 to 3 feet in depth. Many shells seen in the holes. Over 90% of Black River limestone. Medium coarse gravel, fairly regular in size. Matrix of fine sand and silt in the upper 3 feet.
11	2+	.....	.....	.....	.....	Angular and sub-angular.	.....	.....	.....	Only 2 upper feet seen in bank; dirty and partly weathered gravel. Over 90% of the pebbles is Chazy limestone and shale, the limestone predominating. Very bouldery gravel, some boulders 6 feet in size. Matrix of grey sand and silt.
12	2+	40	.....	.....	Traces of $CaCO_3$....	Sub-angular.....	0	68	32	Greatest depth of bank 3 feet. Estimates made in the north bank, where uncovered to a depth of 2 feet. No stratification observed. Pebbles are largely Chazy and Black River limestone.

13	2 to 2·5	25	32	38	Traces of $CaCO_3$....	Sub-angular.....	1	35	64	Cut on both sides of road; greatest height of bank 5 feet. No stratification observed. Pebbles are largely limestone. Sample tested. Estimates made in weathered part. Dirty gravel in matrix of silt and loam.
14	.....	.....	.....	.....	.....	Sub-angular.....	.....	.....	.....	Old pit, bank all covered with talus; a few broken pieces of shells seen in the talus. Rather coarse gravel with much silt. Pebbles are mostly Black River limestone.
15	3+	30	45	25	Traces of $CaCO_3$. Dirty gravel. Roots all through.	Sub-angular.....	1	48	51	Small cut north side of road; bank uncovered to a depth of 3 feet. Estimates made in more or less weathered gravel. No stratification. A few broken pieces of shells seen. Pebbles are mostly limestone.
16	1¼+	25	55	20	.....	Sub-angular and flat angular.	0	56	44	Small pit, 4 cu. yd. in size. Estimates made in weathered part. No stratification observed. Pebbles are mostly Chazy limestone.
17	1½+	.....	.....	.....	Many traces of Fe_2O_3.	Sub-angular.....	.....	.....	.....	Old pit. Estimate made in a fresh cut, 1 foot deep, in the bottom of the pit. Fine gravel with high amount of fine sand and silt. Over 90% of the pebbles is Chazy limestone, a small proportion being shaly. No stratification observed.
18	4	40	30	30	A little Fe_2O_3 and $CaCO_3$.	Angular to sub-angular.	5	10	85	Pit wall talus-covered except upper 4 feet. Estimates refer to weathered part in north bank. The pebbles are mostly Chazy sandstone and shale. No stratification seen. Sample tested.
19	.....	.....	.....	.....	.....	Sub-angular.....	0	70	30	Bouldery gravel. The largest part of the pebbles are Chazy limestone and Beekmantown dolomite. Estimates made from woodchuck hole indications No pit opened.
20	½+	.....	.....	.....	Moderate amount of $CaCO_3$ (weathered part).	Sub-angular.....	2	65	33	Small hole, 18 inches deep, along the road. Only 8 inches of bank seen. Estimates refer to weathered part. A few broken pieces of shells seen in the bank. Coarse gravel with many boulders. Pebbles are mostly limestone.
21	2+	50	.....	.....	Traces of $CaCO_3$....	Sub-angular.....	.....	.....	.....	Estimates made in east bank; depth of pit at that place 5½ feet; covered 3½ feet. Broken pieces of shells seen in the bank. Pebbles are mostly limestone with a large proportion of them weathered. All estimates refer to weathered gravel.
22	1 to 1½	5	67	28	Some $CaCO_3$.....	Sub-angular.....	3	50	47	Face of 3½ feet in the west part of the pit, shows a coarse gravel and fine sand. The pebbles are mostly Chazy limestone and sandstone.

Charlottenburg Township—(Continued).

Map No.	Depth of Weath. (in ft.)	Percentage.			Impurities.	Shape of Pebbles.	Percentage.			Remarks.
		Boulders over 3 in.	Gravel ¼ to 3 in.	Sand under ¼ in.	$CaCO_3$, Fe_2O_3, Clay, etc.		Dur.	Int.	Soft.	
										Mechanical analysis:— Retained on 3 mesh sieve...70 % " " 8 " " .. 7·5 " " 20 " " .. 5·0 " " 48 " " ..10·0 Passing 48 " " .. 7·5 Sample tested.
23	.....	.....	.....	.....	.....	Sub-angular.....	5	25	70	No pit. Estimates made from surface indications. The pebbles are mostly Chazy limestone and sandstone, the limestone being in higher proportion.
24	3	17	50	33	A little $CaCO_3$ and Fe_2O_3.	Sub-angular.....	2	26	72	Estimates refer to upper 3 feet of northwest bank of the pit (weathered part). Pebbles are, in order of decreasing proportions, Black River limestone. Beekmantown dolomite, Potsdam sandstone. Chazy sandstone and shale. Mechanical analysis:— Retained on 3 mesh sieve..50·0% " " 8 " " ..13·3 " " 20 " " ..19·6 " " 48 " " .. 8·3 Passing 48 " " .. 8·8 Sample tested.
25	.....	.....	.....	.....	.....	Sub-angular.....	.....	.....	.....	No gravel seen on surface, probably on account of the loam (unplowed field). Estimates made from woodchuck hole indication. Bouldery gravel. Over 90% of the pebbles is Black River limestone, with a fairly high amount of fresh pebbles.

Cornwall Township

26	2	50	40	10	Traces of Fe_2O_3. Moderate amount of $CaCO_3$.	Sub-angular.....	1	41	58	Mechanical analysis:— Retained on 3 mesh sieve...80.0% " " 8 " " .. 7·5 " " 20 " " .. 5·0 " " 48 " " .. 2·5 Rest, 5% yellowish-brown loam. The pebbles are largely Black River and Chazy limestone.

27	2 to 2½	70	16	14	Angular to sub-Some $CaCO_3$.	Angular to sub-angular.	2½	57	40½	Pit wall stands up well. Face 9½ feet deep in south-east part of pit, showing boulder sand with low percentage of gravel. Sample tested. Unstratified gravel. About 70% of the pebbles is lime-stone. Mechanical analysis:— Retained on 3 mesh sieve...52·5% " " 8 " " ..15 " " 20 " " ..20 " " 48 " " ..10 Passing 48 " " .. 2·5
28	3	33	37	30	A little $CaCO_3$.....	Sub-angular.....	2	26	72	Estimates made in weathered part, on a depth of 2 feet. Rest talus-covered. The talus is very bouldery all around, except in the north part where only sand and loam are seen. No strati-fication seen. The pebbles are largely Black River limestone, the remainder being mostly Potsdam and Chazy sandstone.
29	.....	.....	.....	.....	.....	Angular.....	.....	.....	.....	Small pit. Estimates refer to upper 18 in. of bank, the lower part being talus-covered. Bouldery gravel, high amount of silt and fine sand. Over 90% of the pebbles is limestone, some being shaly.
30	.....	.....	.....	.....	.....	Flat and sub-angular	.....	.....	.....	Road cut 1 foot deep. Very bouldery gravel. Over 90% of pebbles is limestone, mostly Trenton; small proportion being shaly.
31	2	35	33	32	Some $CaCO_3$.....	Sub-angular.....	2	76	26	Pit cut along the west slope of a ridge. Estimates made in 3 ft. of bank, south end, the lower part being talus-covered. Looks more bouldery in other parts of pit, but only the top of bank could be seen. Several shells. 80% of pebbles is Trenton limestone. Mechanical analysis:— Retained on 3 mesh sieve....50% " " 8 " " ..10 " " 20 " " ..15 " " 48 " " ..20 Passing 48 " " .. 5 Sample tested.
32	3	1	57	42	Traces of $CaCO_3$....	Sub-angular.....	3	60	37	Small pit, 5 ft. face in north bank. Very fine, clean, stratified gravel, with many shells; south bank talus-covered, said to be largely sand. Sample tested.
33	2	0	60	40	.....	Sub-angular.....	.....	.....	.....	Stratified gravel. Very large number of shells. Pebbles are mostly limestone.
34	.....	.....	.....	.....	.....	.....	.....	.....	.....	No pit opened, and surface indications are meagre. Looks rather coarse gravel. Deposit covered with clear bush.

Cornwall Township—Continued.

Map No.	Depth of Weath. (in feet).	Percentage. Boulders over 3 in.	Percentage. Gravel ¼ to 3 in.	Percentage. Sand under ¼ in.	Impurities. $CaCO_3$, Fe_2O_3, Clay, etc.	Shape of Pebbles.	Percentage. Dur.	Int.	Soft.	Remarks.
35	2 to 3	60	.....	.....	Large amount of clay. Traces of $CaCO_3$.	Angular.....	.....	.....	.....	Pit walls talus-covered. Small amount of gravel; pebbles are mostly Black River limestone. Apparently a boulder clay deposit.
36	.....	.....	.....	.....	.....	.....	.....	.....	.....	The gravel deposit forms part of a long boulder clay ridge. There is no pit opened, and judging from surface indications, it might possibly be all boulder clay, being a little more gravelly than the rest of the ridge. Limestone boulders of the Black River type, scattered over the surface.
										a—South bank.
37	3	14	42	44	Much clay and $CaCO_3$.	Sub-angular.....	.....	.....	.....	Depth of bank 7 feet; estimates made on lower 4 feet. Large amount of shells. Stratification well shown.
										b—Southeast bank.
.....	2	40	35	25	Some $CaCO_3$.....	Sub-angular.....	.....	.....	.....	Uncovered depth of bank 5½ feet. Lower 3½ feet very bouldery. Some shells. Stratification visible but not well marked.
										c—West bank.
.....	.....	15	47	38	Some $CaCO_3$.....	Sub-angular.....	0	52	48	No stratification seen. Some shells. Over 50% of pebbles is Black River limestone, the remainder being Potsdam sandstone, Chazy shales and weathered stones. East bank more bouldery than other parts. The pit walls stand up well. Samples tested from *a* and *b* parts of the pit.
38	2	10	30	60	A little $CaCO_3$.....	Angular to sub-angular.	3	60	37	Estimates made in the northeast bank. Sand only is seen in the other pit faces. The pebbles are largely limestone and dolomite, the latter being in much smaller amount. A few shells in the bank.
39	4	15	65	20	Traces of $CaCO_3$....	Sub-angular.....	.....	.....	.....	Pit on the east slope and near top of a sma West bank all boulder clay and silt. In north bank, a streak of gravel, 4 feet thick, runs through boulder clay and silt. Estimates refer to gravel streak only. Pebbles are largely Trenton limestone.
40	3	15	55	30	A little $CaCO_3$.....	Sub-angular.....	3	57	30	No stratification seen. Pebbles are limestone for the largest part; Trenton, Black River and Chazy.

41	4	15 25	55 35	30 40	Large amount of $CaCO_3$.	Angular to sub-angular.	3 2	49 55	48 43	Bottom of pit almost covered with boulders. Estimates made in the upper 3½ feet of the face, and in weathered part. No clean face seen farther down. Estimates made in two different places. No stratification seen. The pebbles are largely Black River and Chazy limestone, the former being predominant. Sample tested.
42	4	30	33	37	A little $CaCO_3$ and clay.	Sub-angular to angular.	5	25	70	Railroad cut 30 feet in depth; the upper part only is not talus-covered. Apparently unstratified.
43	1½ to 2	5	60	35	Traces of Fe_2O_3, some pebbles coated with $CaCO_3$	Sub-angular.....	3	69	28	No boulders over 5 inches in size. Finer gravel toward the bottom. Estimates made in west bank, uncovered to a depth of from 4 to 5 feet, the wall standing up well. Pit walls talus-covered everywhere else. No stratification seen. Many small shells in gravel, sand is bluish-grey. Mechanical analysis:— Retained on 3 mesh sieve ..60·0% " " 8 " " .. 7·5 " " 20 " " .. 7·5 " " 48 " " ..23·8 Passing " 48 " " .. 1·2 Pebbles are mostly limestone. Sample tested.
44	2 to 3	2	63	35	.....	Sub-angular.....	.....	.....	.....	Pit walls talus-covered. Estimates made in 1 foot of bank seen at only one place in the pit. Some shells.
45	2	20	55	25	Traces of $CaCO_3$....	Sub-angular.....	5	59	36	Pit on the west slope of flat hill. Estimates made on upper 3 feet of north bank. Gravel regular in size, and no boulders over 8 in. Some shells. 75% of the pebbles is limestone, largely Trenton; 13% is Potsdam sandstone.
46	4	30	45	25	Traces of $CaCO_3$, a little Fe_2O_3.	Sub-angular	5	71	24	*a*—East bank. 5-foot face shows coarse, stratified gravel. Pebbles mostly Trenton.
	3	25	55	20	Some $CaCO_3$.....	Sub-angular.....	4	78	18	*b*—North bank. 5½-foot face. Coarse stratified gravel. Several shells. Over 85% of pebbles is limestone, largely Trenton. Mechanical analysis:— Retained on 3 mesh sieve 60 % " 8 " " 7·5 " 20 " " 10·0 " 48 " " 20·0 Passing 48 " " 2·5 Pit walls stand up well. Pit on west slope and near top of gravel ridge. Samples tested.
47	.....	.....	.....	.....	.....	Rounded and sub-angular.	.....	.....	.....	No pit opened. Estimates made from surface indications and from woodchuck hole. Fine gravel; over 75% of the pebbles is Trenton limestone.

Cornwall Township—(Continued).

Map No.	Depth of Weath. (in ft.)	Percentage.			Impurities.	Shape of Pebbles.	Percentage.			Remarks.
		Boulders over 3 in.	Gravel ¼ to 3 in.	Sand under ¼ in.	$CaCO_3$, Fe_2O_3, Clay, etc.		Dur.	Int.	Soft.	
48	.....	2	.....	Over 50	Traces of $CaCO_3$....	Angular; some sub-angular.	.....	.....	.....	Small pit on top of hill; 2-foot face shows a fine stratified gravel with much sand and large number of shells. Pebbles are largely limestone. At southwest end of deposit, coarse gravel and coarse sand seen in the bottom of ditches, under 1½ to 2 feet of loam (swampy soil).
49	1½	15 20	61 60	24 20	Some $CaCO_3$	Flat rounded and sub-angular, more angular in west bank.	0	77	23	Pit near top of a ridge running east-west. The upper 3½ fest in east bank show a coarser, stratified gravel, voids being only partially filled with a fine, loamy sand. Second size estimates refer to west bank, 200 yards from east bank. Stratification not well shown in west hank. Over 95% of pebbles is Trenton limestone, part being shaly. Sample tested. Mechanical analysis:— Retained on 3 mesh sieve 71·3 % " 8 " " 15·0 " 20 " " 7·5 " 48 " " 2·8 Passing 48 " " 2·8
50	3½	15	60	25	Traces of Fe_2O_3.....	Angular.....	.....	.....	.....	*a*—East bank. Uncovered: 7 ft. stratified, coarse, clean gravel. Many shells.
	2	10	65	25	A little Fe_2O_3.....	Angular and sub-angular.	1	81	18	*b*—North bank. Uncovered: 5½ ft., coarse stratified gravel. Several shells. 90% of pebbles is limestone, largely Black River; some Trenton.
		50	.....	.....	Traces of $CaCO_3$....	Sub-angular.....	.....	.....	.....	*c*—East bank, 200 ft. south of *a*. (*c* is closer to crest of ridge than *a*.) Uncovered: 5½ ft. Very bouldery, stratified gravel. Large number of shells in the upper part.
	4	5	50	45	.....	Sub-angular.....	0	82	18	*d*—South bank, 300 ft. from north bank. 11½ ft. of face seen. Fine, stratified gravel, with large amount of sand and some silt. Large number of shells in the upper part; several shells seen down to the bottom. Over 90% of pebbles is limestone. Mechanical analysis:— Retained on 3 mesh sieve 55·0 % " 8 " " 12·5 " 20 " " 8·8 " 48 " " 16·2 Passing 48 " " 7·5

										e—West bank.
50					Traces of $CaCO_3$	.....	.....	.....	.....	Uncovered in a few places only. Same as south bank, but more sandy. Stratification well shown. Large number of shells. Pit on west slope of north-south ridge. Gravel said to be very coarse and bouldery under crest of ridge. (Test pits dug.) Pit walls stand up well. Samples tested. (See Plate II.)
51	2½	5	55	40	.....	Angular.....	1	90	9	Small pit in the lower part of west slope of gravel ridge. 5½-foot face seen on east bank. Fine, stratified gravel with much sand. Many shells. Over 85% of pebbles is Trenton limestone.

Osnabruck Township.

52	1	40	47	13	Some Fe_2O_3, in layer 4 to 6 inches thick. Some $CaCO_3$ in north bank.	Angular to sub-angular.	2	87	11	North bank—Depth 14 feet, covered 7 feet. Bouldery gravel, stratified. South bank—Depth 17 feet, only the lower 4 feet being uncovered. Much sand and gravel. Per cent of boulders much less than table indicates. Stratified. Over 95% of pebbles is Trenton and Black River limestone. Mechanical analysis:— Retained on 3 mesh sieve 79·0% " 8 " " 7·9 " 20 " " 7·9 " 48 " " 3·9 Passing 48 " " 1·3 Sample tested.
53	1½	0	52	48	A little $CaCO_3$ and Fe_2O_3. Several thin lenses of clay.	Sub-angular.....	3	49	48	Old railroad pit along west slope of gravel ridge. The east and south walls only remain. They are talus-covered, except the upper part, which shows a bouldery gravel or rather bouldery sand with low percentage of gravel. South face less bouldery and more sandy than east face. Small pit recently dug in the bottom and north end of the old pit, shows a clean face, 4 ft. in depth. Table estimates refer to the latter pit. High amount of coarse sand. Stratification visible. Fifty per cent of pebbles are Black River limestone, the remainder being largely Potsdam sandstone, Chazy limestone, sandstone, and shale.
54	2 to 2½	25	40	35	Fe_2O_3. Traces of $CaCO_3$.	Angular to sub-angular.	0	60	40	Pit on west slope and near top of hill. Face of 6½ feet in depth seen in south bank. Coarse, stratified gravel; boulders not over 6 in. in size. Some shells. More sandy in west bank. Pit walls stand up well. 90% of pebbles is limestone, mostly Black River. Mechanical analysis:—

Osnabruck Township—(Continued).

Map No.	Depth of Weath. in (ft.)	Percentage. Boulders over 3 in.	Gravel ¼ to 3 in.	Sand under ¼ in.	Impurities. $CaCO_3$ Fe_2O_3 Clay, etc.	Shape of Pebbles.	Percentage. Dur.	Int.	Soft.	Remarks.
										Retained on 3 mesh sieve 52·5 % " 8 " " 10·0 " 20 " " 12·5 " 48 " " 20·0 Passing 48 " " 5·0 Sample tested.
55	.....	.....	.....	.....	.....	.....	.....	.....	.....	A few woodchuck holes reveal gravel and sand. No other evidence of gravel.
56	1 to 2½	40	40	20	Lens of clay, a little Fe_2O_3, much $CaCO_3$.	Sub-angular.....	3	65	32	Pit dug on top of ridge. 15-ft. face in east bank—9 ft. of very coarse and bouldery gravel over 6 ft. of fine, stratified gravel and sand with a few boulders. A few feet east, a pit shows boulder sand with a very high amount of boulders, and 25 ft. west in the west slope of the ridge, the gravel is fine and stratified, mixed with high amount of sand and some shells. 80% of the pebbles is Black River limestone. Pit walls stand up well. Mechanical analysis:— Retained on 3 mesh sieve...67·5% " " 8 " " ..10·0 " " 20 " " .. 7·5 " " 48 " " ..10·0 Passing 48 " " .. 5·0 Samples tested. (See Plate III).
57	4½	40	30	30	A little $CaCO_3$.....	Angular and sub-angular.	3	86	11	Pit on top of small ridge. South bank shows 10-ft. face, lower 4 ft. being talus-covered. Very bouldery gravel. Stratification not well marked Fine stratified gravel in the upper 2 ft. Over 90% of pebbles is Trenton limestone.
58	.....	.....	.....	.....	.....	Angular.....	.....	.....	.....	Old pit, bank all covered with talus. Several shells seen in talus. Coarse gravel with much sand; pebbles are largely Trenton limestone.
59	5	35	40	25	Traces of Fe_2O_3....	Angular.....	2	82	16	Pit dug on top of small ridge, walls mostly talus-covered. Estimates made on 2½-foot face, 5 feet below top of east bank. A few broken shells in the bank. Much variation as to size. Parts of sections seen in west bank reveal as high as 50% of boulders. Over 80% of the pebbles is limestone, largely Trenton.

60	1½ to 2	10	40	50	Traces of $CaCO_3$.... Some Fe_2O_3.	Sub-angular.....	4	79	17	Ditch cut showing 3-foot face. Fine, stratified gravel with much sand and a few shells. Over 80% of the pebbles is limestone, largely Trenton. The cut is in the lower part of west slope of ridge.
61	.....	.....	.....	.....	.....	Sub-angular.....	.....	.....	.....	Small pit on top of same ridge as No. 62. Bank mostly covered with talus. Rather coarse gravel. Pebbles are mostly limestone.
62	1½	30	40	30	Traces of $CaCO_3$.... Traces of Fe_2O_3.	Sub-angular.....	0	71	29	Pit on top of a flat ridge; 5-foot section seen in south bank; walls talus-covered everywhere else. 90% of the pebbles is limestone, Trenton and Black River.
63	2 to 3	20	50	30	A little Fe_2O_3.....	Angular.....	0	60	40	*a*—East bank 250 ft. from north end. 7-foot face. Coarse and bouldery, stratified gravel; carrying large number of shells. Over 90% of the pebbles is limestone, Black River and Trenton. Mechanical analysis:— Retained on 3 mesh sieve...59% " " 8 " " .. 9 " " 20 " " ..10 " " 48 " " ..18 Passing 48 " " .. 4
	2½ to 3½	50	35	15	Traces of Fe_2O_3.....	Angular.....	.....	.....	.....	*b*—East bank, 100 ft. south of *a*. 7-foot face. Very bouldery, stratified gravel; colonies of shells to a depth of 13 feet. 4½ feet below top, same coarseness as in *a*.
	2 to 3	50	20	20	Traces of Fe_2O_3.....	Angular.....	.....	.....	.....	*c*—East bank, near south end. 8-foot face. Very bouldery, stratified gravel; a few shells. Stratification better shown in the lower parts of the sections, the gravel being less bouldery. West bank, where seen, shows a little gravel and a high amount of sand, all well stratified; large number of shells. Samples tested. (See Plate IV).
64	.....	.....	.....	.....	.....	Angular and flat,...	.....	.....	.....	Old pit; walls talus-covered. Estimates made from surface indications and from two woodchuck holes. Bouldery gravel on top. Pebbles are largely Trenton limestone; some Black River.
65	2½	15	45	40	Traces of Fe_2O_3.....	Sub-angular.....	7	69	24	Large shallow pit on west slope of a flat hill, 2 yds in height. 3-foot face seen in north bank. Stratified. Several shells. A little coarser, apparently in east and south banks. Over 80% of the pebbles is limestone.
66	.....	.....	.....	.....	.....	.....	.....	.....	.....	Old pit; bank all covered with talus, except the upper foot; average depth of pit, 1 yd. Looks much the same as No. 65.

Osnabruck Township—(Continued.)

Map No.	Depth of Weath. (in feet.)	Percentage.			Impurities.	Shape of Pebbles.	Percentage.			Remarks.
		Boulders over 3 in.	Gravel ¼ to 3 in.	Sand under ¼ in.	$CaCO_3$, Fe_2O_3, Clay, etc.		Dur.	Int.	Soft.	
67	.....	20	.....	.....	.....	Sub-angular.....	.....	.....	.....	Old pit; 1-foot face seen at one place. Stratified gravel. Many broken shells. Over 80% of the pebbles is limestone, Black River and Trenton.
68	1½ to 2	30	50	20	Traces of Fe_2O_3.....	Angular to sub-angular.	0	50	50	Small pit, 3 feet deep. Gravel uniform in size. Unstratified. Pebbles are largely limestone.

Williamsburg Township.

69	1½	5	50	45	Traces of Fe_2O_3.....	Sub-angular.....	2	87	11	Old pit; 2½-foot face seen in northeast bank. Stratified gravel. Over 85% of the pebbles is Trenton limestone.
70	1½	1	19	80	A little clay and Fe_2O_3.	Sub-angular.....	.....	.....	.....	Small pit, 3 feet deep. Stratification not well shown. Pebbles largely limestone.
71	2	1	59	40	.....	Sub-angular.....	2	89	9	Pit walls talus-covered, except in west bank, where there is a 3-foot face. Fine, stratified gravel, with high amount of sand, and many shells. 70% of pebbles is Trenton limestone, 20% Black River limestone.
72	.....	.....	.....	.....	.....	.....	.....	.....	.....	Old pit, very little gravel seen; apparently nearly all worked out. Pebbles are largely limestone.
73	.....	.....	.....	.....	.....	Sub-angular.....	7	67	26	Three old pits; pit walls talus-covered. Estimates made from surface indications. Coarse gravel. Over 50% of limestone, Black River and Trenton.
74	3	10	45	45	Traces of Fe_2O_3.....	Sub-angular.....	.....	.....	.....	Four-foot face seen in east bank. Fine, gravel; much sand, not well stratified; a few shells. Pebbles are mostly Black River limestone, generally soft.
75	2½ to 3½	15	40	45	Traces of clay.....	Sub-angular.....	1	64	35	*a*—North bank. Four-foot face. Coarse, stratified gravel with silt and loam in the upper part, and much sand with several shells in the lower part. 80% of the pebbles is limestone.

										b—East bank.
75	3	25	40	35	Traces of Fe_2O_3.....	Sub-angular.....	.....	.....	.....	4½-foot face. Very coarse, stratified gravel with much sand and several shells. Mechanical analysis:— Retained on 3 mesh sieve...53·5% " " 8 " " ..13·5 " " 20 " " ..13·5 " " 48 " " ..16·5 Passing 48 " " .. 3·1 Pit on top and west slope of a ridge. Pit walls stand up well. Sample tested.
76	.....	25	.....	.....	.....	Sub-angular and flat	.....	.....	.....	Old pit on top of ridge; pit walls talus-covered. Pebbles are largely Black River limestone, part being soft and shaly.
77	.....	.....	.....	.....	.....	Sub-angular and angular.	.....	.....	.....	No pit. Estimates from surface indications and small hole, 1 foot deep on top of ridge. Probably very bouldery gravel. Over 50% of pebbles is limestone.
78	.....	.....	.....	.....	.....	.....	.....	.....	.....	No pit. Medium coarse gravel seen at foot of fence posts near brick house and along the crest of a ridge. Many large igneous boulders on both slopes of the ridge.
79	2 to 3½	25	47	28	Some $CaCO_3$..... Organic matter.	Sub-angular.....	7	43	50	Pit cutting through the top of a ridge; 5-foot face seen in north bank. Bouldery stratified gravel. Uniform in size all around the pit. 70% of the pebbles is limestone, more than half being soft. Mechanical analysis:— Retained on 3-mesh sieve 59·0% " 8 " 15·1 " 20 " 3·9 " 48 " 20·2 Passing 48 " 1·8 Sample tested.
										a—South bank.
80	2½	10	60	30	Some $CaCO_3$.....	Sub-angular.....	6	42	52	8½-foot section, 3 ft. being talus-covered. Medium coarse stratified gravel, with very large number of shells. Over 90% of the pebbles is limestone. Mechanical analysis:— Retained on 3 mesh sieve 65·0% " 8 " 17·5 " 20 " 12·5 " 48 " 3·7 Passing 48 " 1·3
										b. South bank, east of section *a*.
	2 to 4	30	45	25	Some $CaCO_3$..... Organic matter.	Sub-angular.....	.....	.....	.....	10-foot face, 1 ft. being talus-covered. Generally coarse, stratified gravel, with very large number of shells found to a depth of 9 feet. Pit cutting through top and west slope of ridge. Pit walls stand up well. Sample tested.

Williamsburg Township—(Continued).

Map No.	Depth of Weath. (in feet).	Percentage. Boulders over 3 in.	Gravel ¼ to 3 in.	Sand under ¼ in.	Impurities. $CaCO_3$, Fe_2O_3, Clay,	Shape of Pebbles.	Percentage. Dur.	Int.	Soft.	Remarks.
81	.....	.....	.....	.....	A little clay.....	Sub-angular.....	.....	.....	.....	Old road cut, talus-covered. Estimates made from surface indications and from two woodchuck holes. Very coarse gravel. High amount of fresh limestone pebbles.
82	.....	10	60	30	.....	Sub-angular.....	.....	.....	.....	Gravel seen in the bottom of creek. It is said that about 100 cu. yds. are carried there by the creek every spring. About 90% of the pebbles is limestone.

Matilda Township.

83	1½ to 3	70	18	12	Traces of Fe_2O_3.....	Sub-angular	6	38	56	Pit on top of a ridge. 6-foot face seen in south bank. Very bouldery gravel or boulder sand. Pit walls stand up well. 90% of the pebbles is dolomite and limestone. Sample tested.
84	1½	25	50	25	Traces of Fe_2O_3.....	Sub-angular.....	2	58	40	Pit walls talus-covered. Estimates made on a 2½-foot face in a small hole, bottom of pit 4 feet from top of bank. 90% of the pebbles is dolomite and limestone.
85	1½ to 2	25	47	28	Much $CaCO_3$..... A little clay.	Sub-angular.....	6	50	44	South bank shows 5½-foot face. Pit walls stand up well. Over 90% of the pebbles is limestone and dolomite. Mechanical analysis:— Retained on 3 mesh sieve 62·3% " 8 " 15·0 " 20 " 16·0 " 48 " 5·3 Passing 48 " 1·3 Sample tested.
86	6	60	25	15	Some clay.....	Sub-angular.....	0	64	36	Pit on top and west slope of a ridge. 10-foot section in north bank, 1 foot being talus-covered. Very bouldery, unstratified gravel. A few shells. Less bouldery in northwest and northeast parts. Over 85% of the pebbles is limestone. Pit walls stand up well.

86	.....	.....	.....	.....	.....	.....	.....	.....	.....	Mechanical analysis:— Retained on 3 mesh sieve 63·7% " 8 " 19·7 " 20 " 5·9 " 48 " 6·1 Passing 48 " 4·6 Sample tested.
87	2	5	55	45	Traces of $CaCO_3$ and Fe_2O_3.	Sub-angular.....	1	57	42	7-foot section seen in soutb bank. Pit walls stand up well. A few sbells. Stratified gravel. 60% of the pebbles are dolomite and 30% is limestone. Sample tested.
88	1	20	50	30	Traces of Fe_2O_3 and $CaCO_3$.	Sub-angular.....	2	56	43	4-foot section in east bank. Wall stands up well. Stratified.
89	1½	0	5	95	.....	Sub-angular.....	56	18	26	Unstratified gravel. *Dur.*—Quartz, granite, gabbro. *Inter.*—Potsdam sandstone, gneiss. *Soft.*—Potsdam sandstone, weatbered igneous stones.
90	5+	25	50	25	Some $CaCO_3$..... Traces of clay.	Sub-angular.....	2	65	33	Pit on top of a ridge. 8-foot section under ridge crest, 3½ feet being talus-covered. Pit walls stand up well. All gravel more or less weathered. Stratified. Mucb variation in size between the different strata. Table estimates give average. 90% of tbe pebbles is dolomite and limestone. Sample tested.

Edwardsburg Township.

91	.....	.....	.....	.....	.....	Sub-angular.....	16	48	36	Pit walls talus-covered. Pit on west slope of a ridge. Looks rather like boulder sand. No stratification seen. *Dur.*—Granite, granite-gneiss. *Int.*—Dolomite. *Soft.*—Weatbered dolomite.
92	2 to 2½	5	70	25	Traces of Fe_2O_3.....	Sub-angular.....	4	55	41	Estimates made in soutbeast bank, 11½ feet in depth, 5 ft. being talus-covered. Stratified gravel, uniform in size. 85% of tbe pebbles is dolomite, some limestone. Pit walls stand up well. In nortb bank, coarser, unstratified gravel. Sample tested. (See Plate V).

APPENDIX IV.

Commercial Development.

Lancaster Township.

Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
1	Con. II, lots 8, 9.....	Archie Currie, Bainsville P.O.	104	Used on roads.....	Well dug 9 feet deep. Gravel still found at that depth but coarser than on top. The deposit forms a rounded ridge, covering an area of 25 acres.	Overburden—18 in. Bouldery loam. Drainage good. Gravel sells 50 cents a load. Hauling distance to the front road 1¼ miles.
2	Con. I, lot 12.....	George Helps, Bainsville P.O.	None.....	.....	The deposit forms a flat ridge, covering an area of 20 acres.	Drainage good. Deposit along Grand Trunk Railway main line. Hauling distance to front road ¼ mile by lane and 2 miles by side road.
3	Con. IV, lot 23.....	John McCabe, Bainsville R.R.I.	121	Used for concrete. One neighbour made a concrete cistern. Proportion: one cement, 6 gravel—1 month old, concrete very poor.	Well dug by owner on deposit 65 feet deep: 46 feet of boulder clay similar to that seen in the pit, and 19 feet of rock. The deposit covers an area of 8 acres.	Overburden 12 in. Loam. Drainage good. Gravel sells 50 cents a load. The deposit forms a small rounded knoll rising to a height of about 4 yards above the flat. Several other hills, of similar character apparently, are found in the vicinity, but were not mapped, as very little gravel is seen on surface. Hauling distance of 4¾ miles to front road.
4	Con. II, lot 28.....	D. C. Morrison, Lancaster P.O	12	Used to repair the road in Con. II.	Depth of pit, 1 yard. The pit is located on a small flat hill. The deposit occupies an area of 1½ acres.	Good drainage. Overburden 2 feet of loam. Haul of 2¼ miles to front road.
5	Con. I, lot 36.....	D. M. McCuaig, Lancaster P.O.	4,848	Used to repair roads for many years. For concrete sidewalks in Lancaster and other concrete works.	Depth of pit 7 feet. The deposit forms a flat ridge, a few feet above flat, and covers an area of 9 acres.	Drainage good. Overburden 2 to 3 feet. Loam. It cannot be developed much more owing to thickness of overburden. Gravel sells 50 cents a load. Deposit ¼ mile from front road.

6	Con. I, lot 36	D. M. McCuaig, Lancaster, P.O.	107	To repair roads	Depth of pit 4 feet. Very small deposit.	Good drainage. Overburden 1 foot. Deposit ¾ mile from front road.
7	Con. I, lot 36	John Shanks, Lancaster, P.O.	1900	Recently used in piece of road between pit and Lancaster. Good condition where sufficiently rolled by traffic.	Depth of pit 2 yards. More gravel farther down. Area of deposit 2½ acres.	Drainage good. Gravel sells 50 cents a load. Surface of deposit at same level as the surrounding ground. Deposit 200 yards from front road.

Charlottenburg Township.

8	Con. V, lot 55	John Keir, Williamstown, R.R.	2,500	Used for making concrete. The owner made a concrete floor for stable—1 year old, satisfactory condition. Proportion: 1 cement, 6 gravel. Used on spots on the road nearby. The parts recently gravelled are in poor condition, due mostly to the soft underlying soil. Ruts 2 inches deep all along. Too coarse gravel used, resulting in a rough surface.	At the pit, clay found 10 feet from top of ridge (from owner's information). At owner's house, north side of road (outside of the mapped area), well dug by owner 45 feet deep: 16 feet of hard pan, 1½ feet of sand, 23·5 feet hard pan, 4 feet of sand (bottom). The deposit occupies an area of 5 acres.	Drainage. Stagnant water in bottom of pit, 9 feet from highest point of bank. Could be easily drained down the ridge. Gravel sold 10 cents a load run of the bank and 25 cents a load, taken in the bank. Over burden: 9 to 12 inches. Gravelly and sandy loam. The deposit forms a flat ridge on top of a boulder clay or sand hill. The whole hill is more or less gravelly on surface. Haul of 4¾ miles to front road and two miles to railway siding.
9	Con. V, lot 52	O. Major, Williamstown, P.O.	Over 1,000	Largely used to repair bad spots on main road leading to Williamstown. The gravelled parts have a very unstable subsoil. Rough and uneven where recently gravelled. Very few traces of gravel in some parts.	The deposit forms a flat ridge on the west slope or top of a boulder hill. One hundred yards east of the mapped gravel area, clay was found under 18 inches of gravel. The deposit extends over an area of 20 acres.	Good drainage. Gravel sells 25 cts. a load. Overburden 3 to 9 inches of gravelly loam. The deposit is right along the road, and 5 miles from the front road. Haul of 5½ miles to the front road, and 1¾ miles to railway siding.
10	Con. V, lot 52	.....	None	.....	The C.P.R. Co. is said to have dug several test pits 5 feet deep and found gravel all through but did not buy any; on account of the small extent of the deposit.	Good drainage. The deposit is the same as No. 9.
11	Con. IV, lot 5	J. A. McDonald, Jr., Williamstown, P.O.	80	Used to repair parts of road now covered with broken stone.	The deposit forms a flat knoll only 2 to 3 yards above the flat. Probably the amount available is very small. The deposit covers an area of 8 acres.	Good drainage. Overburden: 9 to 18 inches of gravelly and sandy loam. Sells 25 cts. a load. Haul of 3¾ miles to front road (through bad roads).

Charlottenburg Township—(Continued).

Map No.	Location.	Owners and Addresses.	Amount Excavated in cu. yds.	Uses.	Amount Available.	Remarks.
12	Con. III, lot 4	Alex. Shetlah, Summerstown Sta., R. R. 1.	56	Used to gravel 1,000 feet of the side road nearby, at the south foot of the ridge, about 900 feet north of the G.T.R. track. The subsoil is a soft clay in a badly drained area. Owner of pit said big stones were put in the bottom and 9 to 10 inches of gravel on top: 7 to 8 feet wide. Work done in June, 1917. Many loose stones and ruts 1 to 1½ inch. deep all along. Weathered and unweathered gravel used overburden included. Very light traffic.	The deposit forms a flat ridge on top of a boulder hill. The ridge of gravel is from 2 to 3 yds. over the surface of the boulder hill. No sharp outline between the two. The deposit lies over an area of 45 acres.	Good drainage. Gravel sells 25 cts. a load. Overburden: 6 to 12 inches of gravelly loam. Several boulders up to 5 feet in size seen. Hauling distance to front road 2¾ miles (through bad roads).
13	Con. III, lots 4, 5	Charlottenburg township council.	154	Used to gravel same part of road as in the case of No. 12.	Same deposit as No. 12	Good drainage. Overburden: 12 to 18 inches of gravelly loam.
14	Con. III, lot 8	Charlottenburg township council.	1,600	Unknown. Probably all for roads, many years ago.	The deposit forms a small irregular ridge, rising to a height of 2½ yards above the flat and covering an area of over 2 acres.	Good drainage. Hauling distance of 4 miles to the front road.
15	Con. II, lot 12		A few.		The deposit forms a small irregular ridge rising to a height of 2 yds. above a wide boulder clay hill; no clear outline between the gravel and the boulder clay. The gravel deposit extends over an area of 5 acres.	Overburden: 12 to 18 inches of loam. Haul of 3¼ miles to front road, and one-half mile to railway siding.
16	Con. II, lot 9	J. Handy, Summerstown Sta., R.R. 1.	4	Used in lawns.	Small ridge, rising to heights of 2 and 2½ yds. above a boulder clay hill, and occupying an area of 5 acres.	Good drainage. Overburden: 3 inches gravelly loam. Haul of 2¾ miles to front road.

17	Con. II, lot 9.....	Charlottenburg township council.	1,100	Used a few years ago to repair bad spots in the road in front and side road east of the deposit. Very few traces of gravel seen on the road. The surface of the road is fairly even, but has no crown. Sandy loam as subsoil.	Flat hill rising to height of 2½ to 3 yds. above the flat, and occupying an area of 5 acres. From information received, coarse grey sand was found in the pits at depths of 7 and 8 feet.	Overburden: 6 inches of loam. Haul of 2 miles to the front road.
18	Con. I, lots 1, 2.....	A. J. Fraser, Summerstown Station, R. R. 1.	222	Used on private road; 25 loads used on front road nearby to repair bad spots. Marshy subsoil. Road well graded and surface in fair condition during dry season. Maintained by dragging.	The mapped deposit covers an area of 23 acres and is rather a boulder clay or sand deposit.	Overburden: 15 inches. Good drainage. Deposit within one-half mile of front road.
19	Con. I, lots 9, 10.....	H. A. Craig, and C. McDonald, Summerstown, P.O.	None.	.....	The deposit as mapped includes probably much more boulder clay than gravel.	Many boulders scattered over the surface. The deposit is within one-half mile of the front road and ¾ miles from wharf on the river.
20	Con. IV, lot 19.....	.....	A few.	.....	Small gravelly area in the highest part of a boulder clay ridge. The outlines of the gravel area are not well-defined.	Overburden: over 8 inches of bouldery loam. Drainage good. Haul of 5½ miles to front road, and 1 mile to a railway siding.
21	Con. III, lot 25.....	Alex. A. McDougall, Williamstown, R. R. 1.	148	Used by owner for making concrete. Concrete stable floor, 14 yrs. old, looks in good condition. Proportion: 1 cement, 5 gravel. (Boulders taken out.)	Small gravelly ridge on the top of a wide boulder clay hill, but there is no clear outline between the gravel and the boulder clay. From surface indications the gravel area would be about 3 acres, with a depth of 7 feet at the pit (highest point of the deposit), according to owner.	Good drainage. Sells 25 cts. a load. Overburden: 8 to 15 inches of sandy loam with boulders. Hauling distance of 3½ miles to the front road.
22	Con. II, lots 23, 24.....	T. Doherty, Summerstown, R. R.	9	Used for a concrete stable floor	The deposit forms a small rounded ridge on top of a much larger boulder clay or sand ridge. The gravel deposit extends over an area of 23 acres, but there is no sharp outline between the gravel and the boulder sand. Well dug 10 feet deep on top of deposit and gravel still found at that depth.	Gravelly loam. Gravel sells 25 cts. a load. Hauling distance of 2 miles to the front road. Drainage good.

Charlottenburg Township—(Continued).

Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
23	Con. II, west end of tp.....	Allan Loney, Cornwall, R.R. 1	None.	.....	The deposit lies on top of a wide boulder clay hill, and occupies an area of 19 acres.	Drainage good. Hauling distance of 2 miles to the front road.
24	Con. II, west end of tp.....	D. Richardson and L. Leroux, Cornwall, R. R. 1.	156	Used in 1914 on last one-half mile of front road, west end of township. Very bad condition, much clay on surface. Clay subsoil. Used for concrete.	The deposit forms a flat ridge, extending over an area of 90 acres; it probably includes much boulder clay.	Overburden: 1 foot. Drainage good. Gravel sells 50 cts. a load. Hauling distance of 3¼ miles to the front road.
25	Con. IV, west end of tp.....	.....	None.	.....	Small ridge on a wide boulder clay hill; very few indications of gravel on the ridge, which covers an area of about 6 acres; the amount of gravel is uncertain.	Large number of limestone boulders scattered all over the surface of the deposit. Hauling distance to front road 4½ miles (through bad roads).

Cornwall Township.

26	Con. III, lot 7.....	Dan. McCabe, Cornwall, R.R. 2.	10	For roads and concrete.....	Small pit on north slope of same ridge as No. 27.	Drainage good. Overburden: 1 to 1½ feet. Loam. Gravel sells 25 cts. a load. Same hauls as for No. 27.
27	Con. II, lots 7, 8.....	Manager: C. L. Mongers, Cornwall P.O.	10,000	Run of the bank used to gravel roads and some streets in Cornwall. None in fair condition. Crushed boulders used for stoning roads and streets in Cornwall. Stoned roads are in good condition in places, but streets are generally in bad state. Screened gravel used for concrete. Pumphouse in Cornwall made of concrete. Proportions: 1 cement, 3 screened gravel.	The gravelly parts form a ridge running approximately north-south, on top of a much wider boulder clay or sand hill. The ridge covers an area of 28 acres, but no sharp outline between the gravel and boulder clay or sand judging from surface indications. 100 yds. south of road, the gravel is said to be 12 feet deep.	Drainage good. Overburden, 1 to 2 feet. Loam and a few boulders. Two loads of bank gravel have to be screened in order to have 1 load of concrete gravel. Hauling distance of 2¼ miles to the front road and canal, and 2 miles to a railway siding.

28	Con. IV, lots 10, 11, 12.....	T. J. McLennan, Cornwall P.O.	1,991	Unknown; probably used long ago on road nearby, now surfaced with broken stone. Fair condition.	The deposit as mapped covers an area of 50 acres, but only a small part in the west end is of gravel size, the main part carrying a very large amount of boulders.	Overburden: 18 inches. Drainage good. West face of pit has reached limit of deposit; to the east the deposit is not promising, being too bouldery. Haul of 4½ miles to front road and canal, and 3¾ miles to railway siding.
29	Con. IV, lot 11.....	William J. Robertson, Mille Roches, R.R. 1.	115	Said to have been all used by township council to put in a bad place on concession road nearby. This was gravelled several years ago. Some gravel seen on that part of road, but the road is in bad condition, owing chiefly to softness of subsoil (swamp.)	Small irregular ridge extending over an area of 8 acres. No sharp outline between the gravel ridge and the boulder clay hill underneath. Amount available uncertain.	Good drainage. Overburden 3 inches of bouldery loam. Hauling distance of 5 miles to the front road and canal and 4 miles to a railway siding.
30	Con. IV, lot 10.....	.....	None.	.....	Extent of deposit uncertain. The gravel deposit forms a small ridge on top of a wide boulder clay hill and covers an area of 12 acres. Evidence of gravel was shown by a road-cut, but none is seen from surface indications. Farther east, on the same boulder clay hill, several other ridges or knolls are seen.	Good drainage. Overburden: 3 to 9 inches of loam and boulders. Apparently poor gravel. Hauling distance of 5 miles to the front road and canal, and 4 miles to a railway siding.
31	Con. V, lot 11.....	Father McRae, St. Andrews West P.O.	2,979	Used by the township council to gravel roads many years ago. The roads have been since stoned with broken stone, and are in satisfactory condition.	In its north end the gravel deposit forms a sharp ridge on the west slope of a boulder clay hill. Toward the south it seems to occupy a depression between boulder clay hills. It is not sharply outlined from the boulder clay. It extends over an area of 28 acres. At pit No. 32 boulder clay is found at depth of 5 feet, but at pit 31 the depth of gravel underneath the crest of the ridge is greater.	Good drainage. Gravel sold 10 cts. a load. Overburden, 6 inches of sandy loam with small boulders. Hauling distance of 6¼ miles to the front road and canal, and 5½ miles to a railway siding.
32	Con. V, lot 12.....	John McIntosh, St. Andrews West P.O.	62	Used only for concrete. Used by owner 7 years ago to make a concrete pump base (proportion: 1 cement to 4 gravel). Good condition.	*See* No. 31.....	Good drainage. Overburden: 3 to 6 inches of loam (north bank). Gravel sold 50 cts. a load. Same haul as for No. 31.
33	Con. V, lot 12.....	John McIntosh, St. Andrews West P.O.	7	.....	*See* No. 31.....	Overburden: 6 inches loam. Good drainage.

Cornwall Township—(Continued).

Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
34	Con. IV, lot 15	John Pierce, Mille Roches P.O.	None		The mapped deposit occupies an area of 37 acres, but being covered with brush, surface indications furnish very little information as to the extent of the deposit, so the amount available is uncertain.	Drainage good. Haul of 4½ miles to front road, cana and railway siding.
35	Con. III, lot 20	Levi Groves, Mille Roches, R.R. 1.	33	To repair roads and for concrete. Stable floor made 4 years ago. Proportion: 1 cement, 8 gravel. Surface not sound.	Small ridge of boulder clay and gravel, 6 acres in extent, at the east end of a larger boulder clay ridge. As seen from pit, at depth of 8 feet, boulder clay only is found.	Good drainage. Overburden 2 to 3 ft. of loam. Haul of 2 miles to front road, canal, and railway siding.
36	Con. IV, lots 25, 26	John Manson, Mille Roches. P.O.	None		Flat gravelly ridge extending over an area of 30 acres. May possibly include much boulder clay.	Drainage good. Haul of one-half mile to front road, canal and railway siding.
37	Con. IV, lot 29	Thomas Cleary, Mille Roches P.O.	3,825	Used on King's road and front road, east of Mille Roches. For concrete.	The deposit as mapped includes much boulder clay, and only a small part in the north end near pit, is good gravel. The extent of deposit is not probably over 10 acres, with average depth of 3 yards as seen from pit.	Overburden: 10 inches. Drainage good. Gravel sells 25 cts. a load. Deposit close to front road and canal and three-fourths of a mile from railway siding.
38	Con. V, lot 30	Jay Moss, Mille Roches P.O.	667	Used by owner for concrete.	The deposit occupies the western slope of a boulder clay hill and covers an area of 22 acres.	Overburden: 1 foot. Drainage good. Very large number of limestone boulders along eastern edge of deposit and farther east. Haul of 1¼ miles to front road, canal and railway siding.
39	Con. V, lot 29	C. H. Wood, Moulinette P.O.	544	Used four years ago for concrete at foot of canal bank at Moulinette.	The deposit forms a flat knoll at the south extremity of a wide boulder hill. Owner said clay was found in pit at a depth of 15 feet. Amount available uncertain and probably very small, on account of large proportion of boulder clay.	Good drainage. Gravel sells 20 cts. a load. Overburden: 9 to 12 inches. Silty loam. Hauling distance of 2 miles to front road, canal, and railway siding.

40	Con. V, lot 28.....	A. E. Annable, Moulinette P.O	2,963	Used a few years ago for roads and concrete.	The deposit as mapped includes much boulder clay; judging from surface indications only small areas in the north and west parts are real gravel. At pit 40 the deposit has the shape of a ridge running along the west edge of the boulder clay hill.	Overburden: 8 inches. Drainage good. Gravel sells 25 cts. a load. Hauling distance of 2 miles to front road, canal, and railway siding.
41	Con. V, lot 27.....	Alex. Day, Moulinette P. O...	2,778	Same uses as for No. 40.....	Small knoll on top of a boulder clay hill. Greatest depth of gravel in pit, 15 feet.	Overburden: 6 inches. Drainage good. Gravel sells 25 cts. a load; needs screening. Same haul as for No. 40.
42	Con. V lot 23.....	J. E. Runions, Mille Roches P.O.	278	Used for railroad embankment by the New York Central company.	The deposit covers an area of 25 acres and looks more like boulder clay than gravel.	Overburden: 1 foot. Drainage good. Haul of 2¾ miles to front road and canal.
43	Con. V, lot 22.....	H. Winters, Mille Roches R.R 1.	9,240	Used for many years to repair roads in vicinity. In 1915, 2,000 yds. used by the Public Works Dept. for a concrete pier at Moulinette.	The gravel deposit occupies part of the northwestern slope of a boulder clay hill, and covers an area of 19 acres. According to owner, the thickness of gravel at the pit is 12 feet, with boulder clay underneath. Farther up the slope the deposit is probably much more houldery as a very large number of boulders is seen on surface between the eastern edge of the deposit and the road.	Drainage good. Overburden at pit: north bank 2 feet; south bank, 1 foot. Loam. Gravel sells 10 cts. a load for road work, and 25 cts. for concrete work. Two years ago some test pits dug by N. Y. Central Railway Company. No land bought. Price asked for by owner, $200 per acre. Hauling distance of 3 miles to front road, canal and railway siding.
44	Con. V, lot 19.....	Cyril Meek, Mille Roches, R.R.1.	300	To repair roads and for concrete.	Very small ridge; no gravel seen on surface, because of the thick overburden. Amount available uncertain, looks very small.	Drainage good. Gravel sells 25 cents a load. Overburden: 2 to 3 feet of loam. Haul of 3 miles to the front road, canal and railway siding.
45	Con. VI, lots 23, 24.....	J. H. Beattie, Harrison, R.R.1.	3,867	Used by people to gravel side road nearby and road along Raisin river. Both generally in good condition but, dusty (dry weather). Small ruts all along. Where recently gravelled, the stone is all loose. No rolling done.	The deposit is on western slope of a boulder hill, and extends over an area of 10 acres, but it is not sharply outlined especially towards the north. According to the owner there is a depth of 14 feet of gravel at the pit. Over 150,000 cu. yds. available at an average depth of 9 feet.	Good drainage. Gravel sold 25 cents a load. Overburden: 8 to 12 inches. Gravelly and sandy loam. Hauling distance of 4½ miles to the front road and canal (2 miles of bad roads) and 1½ miles to a railway siding.

Cornwall Township—(Continued).

Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
46	Con. VI, lots 30, 31.....	U. J. McQuillon, Harrison, R.R.I.	4,000	Mostly used on roads by township council. The side road nearby has been gravelled on a long distance. It is in satisfactory condition except where recently gravelled, the material is all loose. No rolling done.	The deposit occupies the west slope of a boulder hill. Towards the north, very little gravel is seen and deposit has no definite limits. Area of deposit 25 acres; taking an average depth of 2 yards of gravel over the sand, there would be about 240,000 cubic yards available.	Good drainage. Gravel sold 25 cents a load. Overburden: 12 inches. Gravelly loam. Stratified sand seen in the lowest part of south bank and bottom of pit, 8 feet from top of bank. Hauling distance of 3½ miles to the front road and canal, and ¾ miles to a railway siding.
47	Con. V, lot 30.....	Jay Moss, Mille Roches, P.O..	None.....	.....	Small knoll on top of a boulder hill. Greatest height above boulder hill 2½ yards. Supposing the whole knoll gravelly, there would be 5,000 cubic yards available.	The deposit is entirely covered with brush. Hauling distance of 2¾ miles to front road, canal and railway siding.
48	Con. VI, lots 30, 31, 32.....	Edgar Pryer, Moulinette, P.O.	18	Small part of side road nearby (500 feet south of corners) recently gravelled. Gravel all loose; too fine and too much sand. Not rolled.	The deposit covers an area of 85 acres, but its limits are not definite. In the northeast end, it seems to lie over the west slope and part of the top of a boulder clay hill, while in the southwest, it occupies only the lower part of the same slope, and extends for an indefinite distance in a swamp under 2 feet of loam, and muck.	Good drainage. Overburden at pit: a few inches of sandy loam. Grows thicker toward west. Fine gravel sells 50 cents and coarser gravel 25 cents a load. Hauling distance of three miles to front road, canal and railway siding.
49	Con. V, VI, lots 33,34,35,36...	Geo. Losey, Harrison, R.R.I.	Approx. 6,000	The greatest part has been used on roads many years ago; the con. road to the east has been gravelled with the gravel. It is in fairly good condition in dry weather. When wet, low spots are very muddy because of bad drainage. Used by owner 7 years ago to make a concrete cistern. Proportion: 1 cement, 7 gravel. Good condition.	At pit 49, the deposit forms a ridge running east-west, the gravel in the ridge is quite different in character from the one in the rest of the deposit, and seems to lie on top of the latter. For the whole deposit, see No. 50.	Good drainage. Gravel sells 10 cents a load. Overburden: 2 to 6 inches of loam. About 100 cubic yards of boulders (over 5 inch.) piled in pit and around pit. Very few boulders over 18 inches in size. Largely Trenton limestone. Same hauls as for No. 50.

50	Con. V, VI, lots 33, 34, 35, 36..	William J. Murphy, Harrison, R.R.I.	8,125	Used on all roads around, *i.e.*, the roads have been gravelled on short lengths here and there at different times. Good condition only on small elevations with gravelly subsoil, and very poor in low places where the subsoil is soft and unstable. Owner made a concrete cistern four years ago. Proportion: 1 cement, 7 gravel. Good condition.	The whole of the deposit covers an area of 280 acres and lies in the form of ridges, some running north-south, others east-west. While the north and west slopes are rather steep, the east and south slopes have a very gentle dip, and along the east and south edges of the different spurs, boulder clay is probably very close to the surface.	Overburden: 9 to 24 inches. Loam with small amount of boulders. Drainage good. Gravel sells 15 cents a load run of the bank and 25 cents in the bank. Test pits dug two years ago by the Grand Trunk Company. Three test pits dug along the crest of the ridge between pits 50 and 51, one said to have been dug 30 feet deep. Very bouldery gravel found all through. Another test pit dug 200 yards north of brick house north of road. Fairly coarse gravel found, with boulder clay at depth of 12 feet. Hauling distance of 4 miles to front road, canal, and railway siding.
51	Con. V, VI, lots 33, 34, 35, 36..	Geo. C. Winters, Moulinette, R.R.	113	Gravel from pit 51 was used in 1917 on road from school, going west as far as township limits. The subsoil is soft clayey loam and muck (swamp). The gravel was not rolled. It is all loose, with ruts 2 to 3 inch deep in wheel tracks. Used by neighbour for concrete.	Same deposit as for No. 50....	Good drainage. Overburden: 3 to 18 inches. Gravelly loam. Gravel sells 25 cents a load for concrete and 15 cents for roads. Hauling distance of 5½ miles to front road and canal, and 4 miles to railway siding. Haul 2 miles shorter to front road and canal, passing through very bad roads.

Osnabruck Township.

52	Con. II, lot 2.....	J. G. Adams, Wales, R.R.I...	9,462	Largely used to repair roads. In 1913, 3,000 yards crushed in pit and used to stone parts of con. road nearby and side road to Lunenburg. Fair condition after being sufficiently rolled by traffic. Owner received 25 cents per yard. A little used for concrete.	Rounded ridge with a general east-west direction, and extending over an area of 20 acres. Average depth 3 yards.	Overburden: 4 to 6 inches. Loam with a few boulders. Drainage good. Gravel sells 25 cents a load; needs to be screened. Hauling distance of 3½ miles to front road and canal, and 2 miles to railway siding.

Osnabruck Township—(Continued).

Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
53	Con I, lot 2.....	James Anderson, Dickinson's Landing P.O.	130,000	Used many years ago by the Grand Trunk Company for railroad ballast. Recently used on short pieces of the front road. Gravel all loose; large proportion of sand.	The deposit forms a wide ridge running in a north-south direction, covering an area of 40 acres. The east and south parts are largely boulder sand. Boulder clay over 20 feet in depth from top of ridge.	Drainage good. A large part of the west slope has been excavated by the Grand Trunk Company, and very little good gravel remains now. Deposit within one mile of the road, with no road leading to it.
54	Con. I, lot 14.....	James Miller, Wales, R.R1....	18,632	Largest part used by the Grand Trunk Company in 1907 for ballast. Used for concrete, such as sidewalks in Farran's Point and Dickinson's Landing, bridge at Farran's Point. Used for repairing front road, west of pit. Poor condition in 1917.	Small rounded ridge running approximately north-south and covering an area of 8 acres. Boulder clay found in pit at depth of 6 feet from top of bank, but this is the greatest depth, and the deposit is apparently nearly exhausted.	Overburden: 1 to 2 feet. Loam. Drainage good. Gravel sells 20 cents a load. Deposit within one-half mile of the front road.
55	Con. I, lot 15.....	James Miller, Wales, R.R1....	None.....	.....	Small rounded ridge running approximately north-south and occupying an area of 7 acres. Similar ridge to No. 54, and amount available looks about the same.	Deposit within one-half mile of the front road.
56	Con. III, lot 13.....	Frank Smith, Lunenburg P.O.	5,105	Greatest part used to repair roads in con. III and IV. Three years ago a crusher was installed in pit and 2,000 cubic yards of crushed boulders used to stone side road nearby. Rather poor condition in 1917. Used for concrete sidewalks, foundations, stable floors, etc., in and around Lunenburg.	The deposit forms a sharp ridge along the west slope of a boulder clay and sand hill and extends over an area of 9 acres. Gravel seen to a depth of 15 feet in pit. The north end looks more like boulder sand.	Good drainage. Overburden: 1 to 2 feet. Gravelly loam. Gravel sells 25 cents a load. Much of the gravel would need to be screened. Hauling distance of 4 miles to the front road.
57	Con. IV, lot 11.....	Edgar S. Shaver, Wales, R.R. 2.	1,400	Largely used on roads. The con. road between con. III and IV was gravelled several years ago. Satisfactory, but many large stones exposed; very dusty in dry weather.	Sharp ridge along the west slope of a boulder clay hill, and covering an area of 5 acres. Depth of gravel in pit, underneath the crest of the ridge 12 feet.	Good drainage. Gravel sells 20 cents a load. Overburden: 3 to 6 inches of loam. Gravel needs to be screened. Hauling distance of 5 miles to the front road.

58	Con. IV, lot 15	Preston Rombough, Wales, R.R. 2	95	Unknown	The deposit forms a flat ridge on top of a boulder hill. It is probably all a boulder hill, the top being more gravelly than the rest. Many boulders seen on top. Amount available probably very small.	Good drainage. Overburden: 4 inches. Gravelly loam, with many boulders. Hauling distance of 4⅓ miles to the front road.
59	Con. IV, lots 17, 18	Hermann Alguire, Osnabruck Centre P.O.	400	Used to gravel roads many years ago, before present owner had the property.	The deposit covers an area of 39 acres, and rises only a few feet above the flat, the highest point being at pit No. 59, where a sharp sloped ridge runs in a north and south direction, its crest being 4 yards above the flat. Along east and south edge, boulder clay is probably close to surface.	Overburden 3 to 4 inches. Sandy loam. Good drainage. Gravel needs to be screened. Hauling distance of 4¼ miles to the front road.
60	Con. IV, lots 17, 18	Silas Cook, Osnabruck Centre P.O.	17	Unknown	Same deposit as for No. 59	Good drainage. Overburden: 7 to 10 inches. Gravelly sand, with thin layers of loam on top. Same haul as for No. 59.
61	Con. IV, lots 24, 25, 26, 27		48	Unknown	Same deposit as for No. 63	Good drainage. Overburden: 6 inches. Gravelly sand and loam. Pit 2 yards in depth, on top of same ridge as for No. 62. See No. 63.
62	Con. IV, lots 24, 25, 26, 27	Zack Hart, Porcupine	7,035	None used for 8 years. Used by people around for repairing roads. All gravel used for roads for the past 8 years was taken from pit No. 63.	Same deposit as for 63	Good drainage. Overburden: 8 to 12 inches. Loam and sand. Gravel needs to be screened. Same haul as for No. 63.
63	Con. IV, lots 24, 25, 26, 27	Osnabruck Township Council. North part owned by W. N. Hollister, Farran's Point, R. R. 1.	14,731	The largest part of gravel was used for roads. The road south of pit, from lot 25 to lot 30, was stoned with crushed gravel in 1916. No rolling done. In 1917, it was in fairly good condition, but apparently is wearing out rapidly.	The deposit extends over an area of 145 acres; it forms two ridges, one at pits 61 and 62, the other one at pit 63, but the rest of the deposit rises only a few feet above boulder clay. At brick house, northeast end of deposit, depth of gravel 7 feet, from well records; at pit 62, boulder clay found 9 feet below top of ridge, and at pit 63, 20 feet below top of the other ridge. Very little gravel seen along south edge of deposit, and boulder clay is probably very close to surface.	Good drainage. Gravel sells 10 cts. a load. A few years ago, a crusher was installed in the pit by the council, and great part of boulders crushed, to be used for roads. Nearly all boulders are limestone which split easily on account of many shaly partings. Soft stone. Overburden, 6 to 12 inches loam and sand. Gravel needs to be screened. Hauling distance of 6½ miles to the front road (haul of 4¾ miles through very bad roads).

Osnabruck Township—(Continued).

Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
64	Con. III, lot 33.....	.....	50	Unknown.	Very small ridge, 1 yd. above the flat. Amount available apparently very small.	Good drainage. Overburden: (estimated at one place only) 8 inches. Loam and boulders.
65	Con. III, lot 32.....	Chas. F. Dafoe, Aultsville, R. R. 1.	1,527	The greatest part of the gravel (overburden included) was used to repair the road nearby. Too high proportion of sand. Very poor condition. No rolling.	Very small ridge, 5 acres in extent, along the west side of a boulder clay deposit. Boulder clay found in pit at depth of 4 feet below the top of the ridge. Small amount.	Good drainage. Overburden: 12 to 18 inches of sandy loam. Gravel sells 50 cents a load in the bank, and 30 cts. run of the bank. Hauling distance of 4 miles to front road and 3½ miles to railway siding.
66	Con. III, lot 32.....	Wm. T. Dafoe, Aultsville, R. R. 1.	1,500	Used 5 to 8 years ago on roads. Side road west of deposit in con. II, gravelled in places, stoned in others. Good condition, much better where stoned than where gravelled. Stoned in 1915; gravelled before.	Same deposit as for No. 65....	Boulder clay 4 feet from top of ridge.
67	Con. II, lot 33.....	.....	15	Unknown.....	Very flat deposit and amount available apparently very small.	Overburden, 12 inches. Gravelly and sandy loam. Drainage good.
68	Con. I, lot 31.....	Willie Denson, Aultsville.....	400	Used to repair front road. For concrete sidewalks in Aultsville.	Very small layer of gravel on top of boulder clay. Thickness varies from 1½ to 5 feet, including overburden. Very small amount available.	Drainage good Overburden: 1½ to 2 feet. Gravel sells 15 cts. a load for roads, and 25 cts. for concrete.

Williamsburg Township.

69	Con. III, lot 1.....	George Williams, Williamsburg, R. R. 1.	3,392	Said to have been used largely on the concession road nearby. Road in very poor shape. All along, except at the pit the subsoil of the road is a soft loam with muck in places.	Flat ridge covering an area of 12 acres. The west end is now exhausted. Boulder clay seen in pit, 3½ feet below top of ridge. In the east end, surface indications show very little gravel, and the amount now available is very small.	Bad drainage and could not be easily drained. Probably dry during the summer. Gravel sells 25 cts. a load. Overburden: 14 inches. Sand and loam. Hauling distance of 4¾ miles to the front road.

70	Con. III, lot 3.....	Thomas Manion, Williamsburg P.O.	30	To be used for concrete.....	Apparently a pocket of gravelly sand.	Bad drainage. Could not be easily drained. Overburden: 14 inches—8 inches of muck on top of 6-inch of fine sand.
71	Con. II, lot 4.....	Rubin Pruner, Aultsville, R. R. 1.	620	Used for concrete. In 1916 owner built a stable floor and cistern in concrete. Proportion: 1 cement, 5 gravel. Very good condition in 1917.	Thin layer of gravel on top of boulder clay; greatest thickness 3 feet. Of no value for future development.	Bad drainage. Diffieult to drain. Gravel sells 50 cts. a load. Overburden: 8 to 18 inches. Loam, sandy in places. Hauling distance o f 3½ miles to the front road.
72	Con. II, lot 5.....	W. K. Farlinger, Morrisburg, P.O.	2,269	Said to have been all used on roads many years ago.	None.	Deposit exhausted.
73	Con. IV, lots 14, 15.....	Malcolm Beckstead, Williamsburg, R. R. 2.	5,700	No gravel used for twenty years. The side road north of Morrisburg was gravelled long ago with gravel from the deposit. Broken stone put on since.	Narrow ridge, covering an area of 10 acres; height above the flat; north end 3 feet; south end 10 feet. Depth at south end 10 feet. The best part of the deposit, the south end, is nearly all worked out. From surface indications there would be a large proportion of boulder clay or sand in the north end.	Drainage good. Hauling distance of 4½ miles to front road.
74	Con. III, lot 27.....	.....	44	Unknown.	The deposit occupies part of the west slope of a boulder hill. Height 2 yds. Apparently very small amount of gravel.	Drainage good. Overburden: 18 to 24 inches. Gravelly and sandy loam. Haul of 4½ miles to front road and canal.

Matilda Township.

83	Con. I, lot 1.....	H. W. Doran, Morrisburg.....	3,382	For repairing roads in vicinity, and for concrete works in Morrisburg.	Narrow ridge having a general southwest and northeast direction, and occupying an area of 20 acres. Boulder clay found at several places at depth of 8 feet below the crest of the ridge.	Overburden: 2 feet of loam on top of 1 foot of bouldery loam. Drainage good. Gravel sells 25 cts. a load. Looks more like boulder sand. Bottom of pit covered with boulders. Hauling distance of 1½ miles to the front road and canal.
84	Con. I, lot 3.....	George Larmer, Morrishurg...	32	Used locally for concrete.....	Same deposit as for No. 83...	Good drainage. About 800 cu. yds. of boulders scattered along the ridge, between pits Nos. 83 nnd 84. Pit less than 1 mile from the front road and canal.

Matilda Township—(Continued).

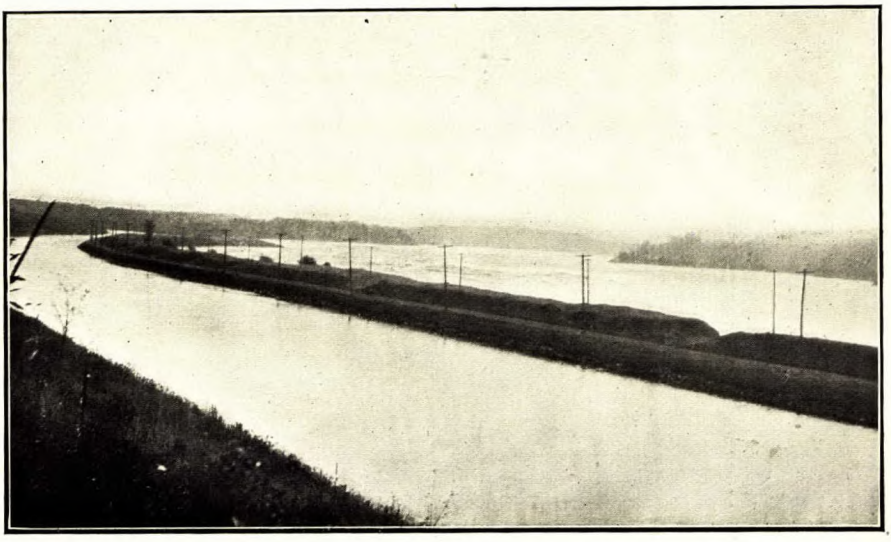
Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
85	Con. I, lot 3	Albert Beckstead, Morrisburg.	2,420	Used locally for concrete; for pier at Morrisburg.	Same deposit as for No. 83.	Overburden: 1 to 1½ feet of loam. Drainage good. Gravel sells 50 cts. a load. Pit within one mile of the front road and canal.
86	Con. III, lot 5	William Mullin, Iroquois, R.R. 1.	3,600	Used in July, 1917, on concession road nearby as far as the east end of Matilda township. Gravel dumped on the road, without rolling. Very bad condition. Underlying soil: loam and muck (swamp) Ruts all along. Much muddy muck on surface. Weather—rainy. Was used a long time ago on the side road between lots 17, 18 and 19, con. II and III, which has since been stoned with broken stone.	Small ridge, 4 acres in area, along west edge of boulder clay deposit. The ridge is 4 yards in height at the south end and 2 yards at the north end. At pit in south end boulder clay is found 10 feet from top of ridge; probably closer to surface in north end.	Bad drainage. Could be easily drained by proper ditching. Gravel sells 25 cts. a load. Overburden: 15 to 24 inches. Sandy loam. In the bottom of the pit there is a pile containing about 400 cu. yds. of boulders (from 5 to 24 inches in size). Gravel is poor on account of its coarseness and great depth of weathering. Should be crushed to be used on roads. This ridge is part of the divide between the St. Lawrence and Ottawa valleys. Haul of 3½ miles to front road and canal, through 1½ miles of bad roads, in rainy weather.
87	Con. II, lot 19	Edgar Shaver, Iroquois. R.R. 2.	907	Used for concrete culvert in Iroquois, and other concrete works. Used on a side road nearby. Fair condition.	Small ridge, covering an extent of 4 acres. Gravel seen at depths of 6 feet in pit 88 and 8 feet in pit 87. Less than one-third of the deposit now worked out.	Overburden: 1 to 2 feet. Loam. Between pits Nos. 87 and 88 there is a heap of sand which increases the overburden to over 2 yards. Drainage good. Gravel sells 50 cts. a load. for roads and 75 cts. for concrete. The deposit is on the divide between the St. Lawrence and Ottawa valleys. Hauling distance of 2 miles to the front road.
88	Con. II, lot 20	James Brouse, Iroquois, R.R.2	7,268	Used for concrete in Iroquois. Used on front road and side road east of Iroquois. This last road is in fair condition in places, very poor in others. Fairly good in concession II.	Same deposit as for No. 87.	Same remarks as for No. 87, but no more gravel sold now.

89	Con. I, lot 31.....	J. H. Binion, Iroquois.....	600	To repair front road. None used for a few years.	Small ridge, 2½ acres in extent. Depth of 3 feet of gravel seen in pit; more gravel farther down.	Good drainage. Overburden: 1 foot of loam, with coarse sand. No gravel sold for a few years. Deposit within 250 yds. of the front road and canal.
90	Con. I, lots 32, 33.....	Jay. Maikley, Iroquois, R.R. 2	487	Used by owner 4 years ago to make a concrete stable floor. Proportion: 1 cement, 9 gravel. Good condition. Never used on roads.	The mapped deposit forms a small flat ridge, 10 acres in area. It runs parallel to the shore of the river nearby and lies on the southeast slope of a boulder ridge. In pit, southwest end of deposit, boulder clay is found 12 feet below the crest of the ridge.	Drainage good. Overburden: 8 inches. Gravelly loam. Gravel sells 50 cts. a load. Nine test pits dug by the G. T. Co. four years ago. Pits dug on both slopes of ridge; none on top. According to owner, gravel was found to depths of 10 to 14 feet. However, that portion only was marked which showed gravel on surface. Deposit within 200 yards of the main road and canal.

Edwardsburg Township.

91	Con. II, lots 2, 3.....	George Stethem, Cardinal, R.R. 2,	96	Used locally for concrete.....	The deposit occupies an area of 3 acres on part of the west slope of a boulder ridge. A depth of 6 feet is seen in pit: total depth said to be 10 feet. Looks more like boulder sand.	Overburden: 2 feet of loam. Drainage good. Gravel sells 25 cts. a load. Hauling distance of over 2 miles to front road and canal.
92	Con. II, lots 4, 5.....	Rufus Froom, Cardinal, R.R. 2,	17,644	For locks and concrete works in Cardinal by Public Works Dept. Used on front road around Cardinal, and side road west of that town. Surfaced later with broken stone. Both have hard but rough surfaces, due to fine material being partially worn out.	Flat rounded ridge, covering an area of 45 acres. Fifteen feet of gravel as seen from pit, in the southwest end of deposit, near the crest of the ridge, and probably some more gravel farther down. All of the eastern slope contains probably much boulder clay or sand.	Overburden: 1½ to 2 feet. Sandy loam. West face of pit: 3 feet of loam on top of loamy clay. Drainage good. Gravel sells 25 cts. a load. Test pits dug by G. T. Co. a few years ago, and it is said that gravel was found all over the ridge. Probably much boulder clay or sand in the east slope, judging from similar deposits found farther east. Hauling distance of 1½ miles to the front road and canal.

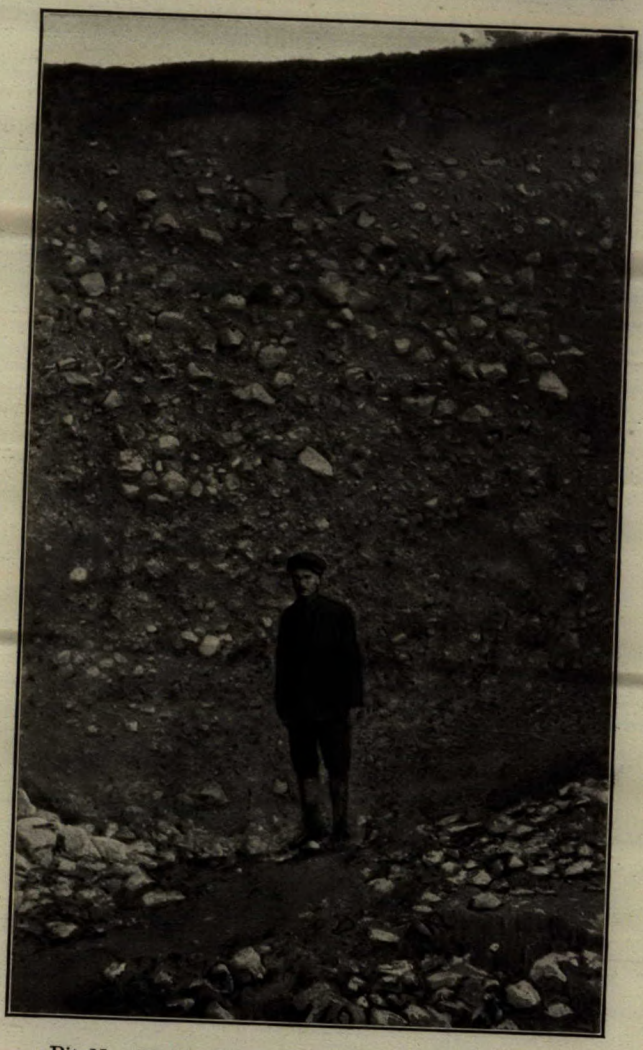
PLATE I.



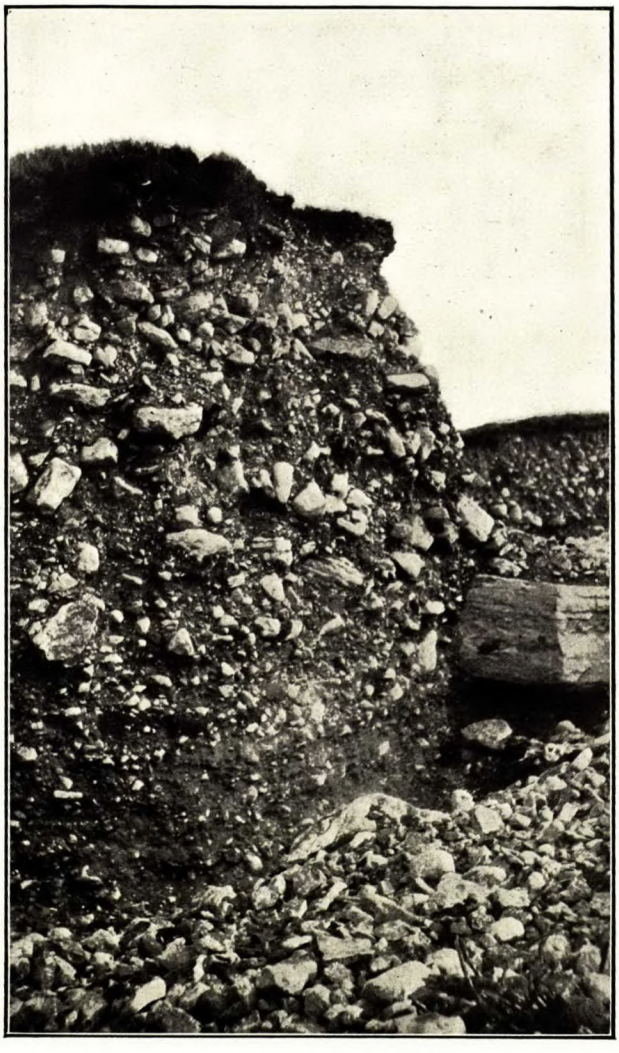
Long Sault rapids and Cornwall canal, St. Lawrence river, west of Cornwall.

PLATE II.

Pit No. 50 (Murphy's). The gravel turns more bouldery and less markedly stratified towards the top of the deposit (left of picture).



Pit No. 56 (Smith's). Showing bouldery gravel in the upper part, and becoming finer towards the bottom.



Pit No. 63 (Hollister's). Showing section of very bouldery gravel directly underneath the top of the ridge.

PLATE V.

Pit No. 92 (Froom's). Illustrating stratification. Boulder sand seen at the extreme left of the picture.

PLATE VI.

Adam's Quarry, in rock outcrop No. 25. The upper part of the wall in centre of picture shows intensely weathered rock.

CANADA

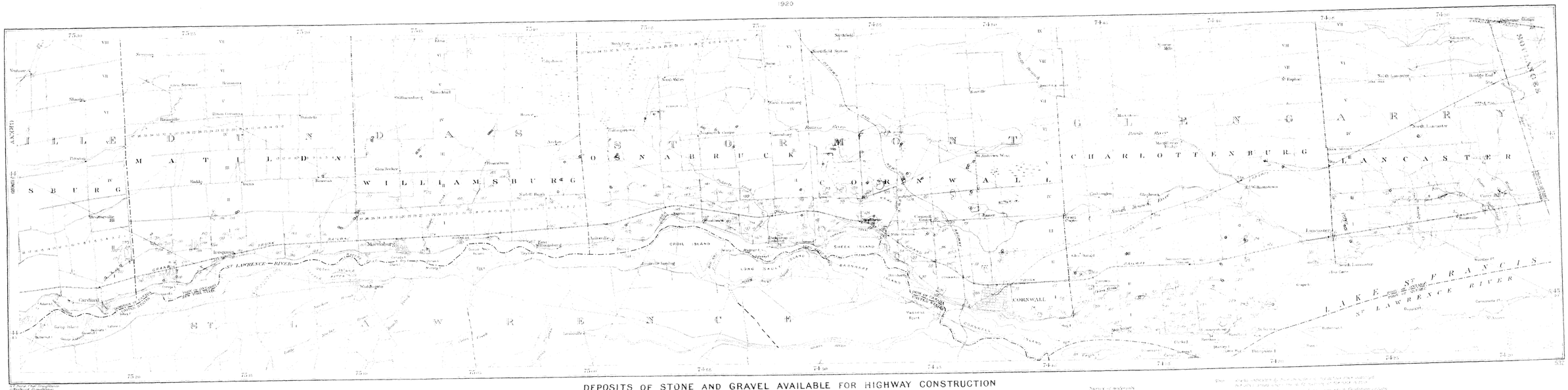
DEPARTMENT OF MINES

MINES BRANCH

CHARLES STEWART, MINISTER; R. G. McCONNELL, DEPUTY MINISTER

E. STOCKTON GRAHAM, DIRECTOR

1920



LEGEND

Bedrock outcrops

Quarry

Fieldstone

Gravel

Gravel pit

DEPOSITS OF STONE AND GRAVEL AVAILABLE FOR HIGHWAY CONSTRUCTION
BETWEEN CARDINAL AND THE QUEBEC BOUNDARY