DEPARTMENT OF MINES AND RESOURCES

MINES, FORESTS AND SCIENTIFIC SERVICES BRANCH

BUREAU OF MINES

OTTAWA, CANADA

ROAD BUILDING ROCKS AND GRAVELS IN PRINCE EDWARD ISLAND

By

R. H. Picher

Memorandum Series
No. 101

November, 1948.

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C O N T E N T S

PREFACE

This report deals with an examination of rocks, gravels, and sands made by the author in Prince Edward Island during 1948, which was part of a general investigation by the Department of Mines and Resources, Ottawa, in cooperation with the Provincial Government, on the mineral resources of the province. The purpose was to study conditions affecting economical development and utilization of these resources. The rocks and gravels were particularly examined as possible sources of material for the construction and improvement of roads. Sand dunes occurring at several places along the shore were also examined as possible sources of silica.

The Provincial Government placed the services of Clinton Milligan at the disposal of the author of the report and his able assistance contributed in no small measure to the completion of the investigation within the allotted time.

C.S. Parsons,
Chief,
Bureau of Mines.

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SUMMARY

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The scarcity in the province of gravel and other deposits suitable for road construction and improvement was noted by the author following his investigations in 1927 and 1928. In the meantime the need for these materials has greatly increased, and in particular at present for use on the Charlottetown-Borden highway. The present investigation was undertaken to determine whether and to what extent, in view of existing needs and circumstances, the available materials in the province are suitable for road use, and partly in the hope of disclosing evidence pointing to a possible enhancement of the province's position in relation to these materials. In the investigation much of the attention was given to a survey of deposits within economic reach of the Charlottetown-Borden highway.

To a limited extent the aforementioned hope was realized. There are indications that a careful search might disclose further sources of conglomerate, and the need for such a search is evident from the fact that, at the present rate of depletion, known sources of this rock, which provides the best road material, will be depleted in about five years. Insufficient supplies of this rock are locally available for paving the whole length of the Charlottetown-Borden highway, and thus limestone, the next best material to hand, may have to be considered as a substitute for the remainder of the road.

*Engineer, Division of Mineral Resources.

Sandstone and shale occur rather commonly in the province, but both are much too soft and friable for use as road material. Easily available beds of limestone are scarce and their operation and their use for roads would be advisable only where better materials are unavailable. A small occurrence of trap rock occupies the eastern end of George Island in Malpeque Bay. If extracted down to water level it would yield about 40,000 cubic yards of first class aggregate. It is difficult of access, however, and considerable initial expenditure would be required in its development. Gravels are scarce on the Island and few of the deposits are suitable as road materials. The dune sand as well as the inland sand is well suited for use locally on heavy clay stretches of road, but otherwise is everywhere too fine to be worth hauling for road improvement. Tests by the Bureau of Mines indicated that the dune sand is unsuitable for glass use of for steel foundry use.

A map showing the location of the road materials deposits, and a list of the deposits as numbered on the map and in the text matter, appear at the end of this report.

DESCRIPTION OF DEPOSITS

Conglomerate

Conglomerate has been the most used material for road improvement on the Island, chiefly because it is easily available at a number of places and because of the satisfactory results that have been obtained wherever it has been used. Among the more important deposits are: those between Iona and Caledonia; the deposit west of Bayfield; the Bedford deposit a short distance north of Charlottetown, which is the nearest source of concrete and road aggregate to Charlottetown; the Springton deposits, now nearly exhausted, but with possibilities of finding new deposits; the deposits west of St. Anne, and also east of Conway; and a large deposit south of Mount Royal. There are several other small deposits scattered throughout the province, including those close to the Charlottetown-Borden highway. These latter are described in the section dealing with the road materials survey of that highway.

All conglomerates used as road material have given decidely good results, both as paving aggregate and in the gravel type of waterbound road surfaces. For best results in the waterbound type of road surfaces, the conglomerates should be crushed. This would provide for a certain amount of much needed angular stones and would improve the size grading by increasing the proportion of the medium size stones, that is, those passing the 0.5 inch screen and retained on the 28-mesh sieve. Because of the great hardness of the pebbles, the crushing would not unduly increase the proportion of fine, of which there is a sufficient amount. The angular stones and the more regular size grading of the whole would make it easier to obtain good compaction on the road and thus get a firm and smooth surface. The increased cost of crushing would be more than offset by the improved quality of the material and the greater durability of the finished road.

No difficulty is usually experienced in working the conglomerate with power shovels. In a few deposits, however, layers or streaks occur in which the conglomerate is so strongly cemented by calcium carbonate that the excavating machine cannot dislodge it. Difficulties are also encountered in drilling this strongly cemented rock preparatory to blasting. Such layers or streaks are usually left in place, which means wasting a perfectly good road material, even better than the looser conglomerate. Fortunately this does not occur often, otherwise the cost of road improvement in the province would be considerably raised.

Discovery of conglomerate deposits requires a careful search as they are not easily found. Unless the conglomerate lies very close to the surface, there would be very little material worked loose by weathering agencies, whereas a gravel deposit may lie under one or even two feet of soil and yet its presence would be indicated by odd pebbles that have gradually worked their way up to the surface. Parts of gravel deposits are often exposed by stream erosion, but conglomerate deposits are flanked by sandstone or other rocks and are thus protected against erosion. Most of the conglomerate deposits lying under a soil cover of say 18 inches or over, have been found by accident and by the owners themselves, who are presumed to know more about their land than anybody else. The majority of the deposits located so far occur either in pairs or in groups of more than two. Thus the most favourable prospecting ground would appear to be within a radius of one and a half miles of the known deposits. In the western part of the Island the surface of some of the conglomerate deposits was exposed to the scraping action of the ice during the glacial period. The scraped off part, mixed with soil material transported by the ice, was dropped as drift east of the conglomerate deposits.

In prospecting for conglomerate, the finding of a drift deposit would naturally indicate the presence of conglomerate somewhere in the vicinity, more likely in a westerly direction from the drift. The few drift deposits worked so far for road purposes, were found after the conglomerate from which they were derived had been discovered and developed, probably because the drift areas were under thicker soil cover than the conglomerates.

Some of the aforementioned drift deposits were reworked and the different constituents were partly sorted by water from the melting ice. These reworked deposits look very much like conglomerate, but are, looser, and can be distinguished by their fine material which is more clayey, and by pebbles derived from the Island red sandstones. Some of the drift deposits worked for road material gave results comparable to those obtained with conglomerate, though roads are slightly more dusty when dry. There is not sufficient red sandstone pebbles in the drift to adversely affect its wearing quality as road aggregate.

The conglomerate deposits of the Island are described in detail in a report* published after the completion of the investigation in 1928. The

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* "Investigations in Ceramics and Road Materials, 1928-1929" - Mines Branch, Department of Mines - Report No. 722, pp. 58-81.

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deposits found since are so well known to those connected with or interested in road or concrete aggregates that a detailed description seems unnecessary. Accordingly, in the present report, attention is confined to the deposits that can be further developed and to the localities where there may be chances of finding new deposits.

5. Two Miles N.E. of West Point - On the farm formerly owned by John A. Stewart, a small deposit of conglomerate occupies the east end of a slight elevation of the ground.

According to the road superintendent, the depth conglomerate is 9 feet, including 15 inches of soil as overburden. A pit dug to the full depth of the deposit has not been worked for some years. It shows about 3 feet of drift, including 15 inches of top soil, and 6 feet of conglomerate under the drift. The drift holds a large amount of pebbles of the same character as those of the conglomerate and for road purposes may be considered as good as the conglomerate.

The deposit extends roughly over an area of 4,000 square yards, as judged by surface indications and about 1500 cubic yards have been excavated. At an average thickness of 7.5 feet, exclusive of overburden, there would be 10,000 cubic yards of conglomerate, drift included.

About three quarters of a mile west of the pit, on the farm of Leonard Stewart, another apparently small deposit of conglomerate forms a slight rise in the ground, but there are no surface indications of conglomerate anywhere between the two deposits.

This undeveloped deposit also appears to have a small areal extent, but it is worth further investigation.

6. One Mile South of Mount Royal; Silliker's Pit - This is a drift deposit that extends over the neighbouring farms, as seen by test pits dug by the owners. The whole deposit, which lies under two or three feet of soil, must be close to 200,000 cubic yards in size, of which about 50,000 cubic yards have been excavated. All pebbles in the drift, with the exception of a small percentage of Island sandstone pebbles, are of the usual conglomerate type, so that at least 50 per cent of the total volume of the deposit must be material derived from some conglomerate. It is possible that the conglomerate lies

somewhere under the higher ground west of the main pit. If so, it must be under fairly deep soil cover, because there are no indications of it on the ground surface nor in the test pits. Thus the area around the drift, particularly the higher land west of it, should be good prospecting ground.

22. One and One-Third Miles Northwest of St. Ann - On the farm of John Redmond, and 150 to 200 yards back of his house a conglomerate deposit occupies the rounded top of a knoll. A pit, now idle, was opened some years ago in the upper north slope of the knoll by a contractor. The deposit should yield a large amount of road material if sandstone layers do not interfere too badly with the excavating. Over 10,000 cubic yards have already been taken out from the north edge, and the top should yield at least 50,000 cubic yards. The pit bank shows conglomerate interstratified with a great deal of sandstone. This must have seriously interfered with the extraction of the conglomerate, which probably explains why the digging was discontinued.

The pit was apparently opened on the edge of the conglomerate deposit, and probably less sandstone would have been encountered had it been started nearer the top of the knoll. Auger sounding reached the conglomerate at several places around the top under 1.5 to 2 feet of soil. Many conglomerate pebbles are seen scattered over the top of the knoll, and also a number of red sandstone fragments so that even under the top, sandstone layers would likely be encountered in digging. However, the layers would be thinner than towards the edge of the deposit, as judged by other similar deposits, such as that described next.

23. One Mile West of St. Ann - A large conglomerate deposit, the eastern end of which lies on the property of Mr. McGuigan, has been almost worked out, except in its western end, where about 50,000 cubic yards are still left. Approximately one-quarter of this is in a field under cultivation and the remainder is in wooded land.

21. One Mile Northwest of Springton - The conglomerate occupies the slope of a bluff facing a creek to the south. It lies on the farm of Hedley Macpherson and along the road leading to Fredericton.

Well over 60,000 cubic yards of material has already been excavated, and from present indications in the pit at least another 10,000 more yards of conglomerate can be obtained before it gets mixed with too much sandstone, or the amount of stripping renders the cost of extraction of the conglomerate too high. The pit was originally started in the lower slope and has been gradually extended along as well as into the face of the bluff. Thin sandstone layers interstratified with the conglomerate are occasionally encountered, including one capping the deposit. This capping apparently becomes thicker as the inner pit face advances into the bluff.

When the deposit was examined in the spring of 1948 the inner pit bank had just about reached the top of the bluff and the sandstone capping, including the top soil, varied from 5 to 8 feet in thickness along the face. The thickness of the conglomerate in the inner face varies from 10 to 15 feet.

Unless the conglomerate bed is thicker and wider than that seen in other Island deposits, it is to be expected that the thickness of conglomerate in the pit face will start to decrease with a further advance of the face and the thickness of stripping will correspondingly increase, since the ground surface on top is level. The proportion of sandstone interbedded with the conglomerate will also increase, so this further complicates the problem.

The same streak of conglomerate is exposed across the road in a smaller pit now idle. This pit has not extended so far into the bluff and shows 4 to 5 feet of conglomerate capped with 2 to 3 feet of sandstone. Why this pit was not further developed is not clear, though the sandstone capping may have been a deterrent. Or possibly the excavation had almost reached the inner edge of the conglomerate, so that the sandstone capping becomes thicker and the conglomerate layer thinner as the excavation proceeds farther into the bluff.

26. One-and a quarter-mile Northeast of Selkirk Road - This deposit lies three-quarters of a mile east of the Iona-Wood Island road. It was traced for a distance of three-quarters of a mile in a north-south direction and runs across several farms. An excavation in the south end was being worked by a road contractor and the material, which is coarse, is crushed and screened for paving aggregate. A rough estimate based on the width and depth of the pit would place the amount of conglomerate available at close to 200,000 cubic yards. With the exception of a small area around the pit, the whole deposit is in woodland. Occasional thick sandstone layers cut almost across the whole width of the deposit.

The Iona-Caledonia area, in which these deposits are situated, has probably yielded more conglomerate than any other part of the province. Most of the conglomerate from this district has come from the large deposit east of Surrey Station. A new deposit was found in 1947 two miles west of Caledonia. The size is not known and there are no surface indications by which to estimate its areal extent. Two pits totalling over 12,000 cubic yards in size have already been opened. The bed of conglomerate is about 7 feet thick and is underlain with clay. The area appears to be good prospecting ground.

10. East of Conway - This group of deposits lie between Conway and the Tyne Valley road; several of them are exhausted. The depth of conglomerate in the different pits runs from 4 to 7 feet. At least 30,000 cubic yards can be obtained from the deposit on T. Boyle's farm, east of the Tyne Valley road, and probably 10,000 or 15,000 cubic yards from A. Smith's deposit, west of the same road.

Conglomerate is also exposed in shallow test pits along the railway embankment between the old railway pit and the Conway "Y", but the area underlain with conglomerate appears to be small.

14. Two-and Three-quarter Miles South of Port Hill - This deposit, lying partly on L. MacLean's farm, and partly on the next two farms to the south, has been completely excavated, except for thick layers strongly cemented with calcium carbonate. These represent roughly one-fifth of the original size of the deposit, which was estimated at close to 100,000 cubic yards in the 1928 investigation. A short distance southeast of the south end of the deposit, are surface indications of another small deposit of conglomerate in level land.

30. One Mile West of Bayfield - The deposit is on Ryan's farm along the shore road. A large excavation over 50,000 cubic yards in size, now partly filled with water, shows medium coarse conglomerate capped with a few inches of sandstone. In the extreme east end of the pit, drift overlies the conglomerate, and carried almost as high a proportion of hard pebbles. It may thus be considered just as suitable for road purposes. About 60 yards south of the pit are three shallow test pits, two of which show conglomerate interstratified with sandstone and the third sandstone only, and this is presumed to be the edge of the deposit. These pits indicate that approximately 40,000 cubic yards of material can be obtained by extending the excavation in a southerly direction. It is not known how far east the conglomerate or the drift runs since the overburden becomes thicker in that direction. To the north and west the pit bank is buried under piles of stripping. The overburden is fairly thick all around and there are no surface indications of conglomerate. It would be difficult, owing to the sandstone capping, to determine the areal extent of the deposit by sounding alone.

29. One Mile N.E. of Peters Road - The deposit is described in the report covering the 1928 investigation. It was not visited in 1948.

Gravel

Gravel deposits are not common in the province. There are a few large deposits in the western part and a number of small deposits scattered throughout the province. Most of the deposits are either too soft or too sandy for road purposes. The few gravels suitable for road aggregate are all found in the western part. Two large deposits of coarse and bouldery gravel, one at Huntley River, and the other north of St. Anthony, yield on crushing, a good road materia although not so durable as the conglomerates. The best gravel of the Island is found west of Nail Pond in the form of a narrow beach along the west coast. It i not a large deposit, but fresh gravel is occasionally brought up the beach by

storm waves. Many layers of hard gravel are found in a large sand track extending for miles along the shore of the Gulf of St. Lawrence, but the thick sand covering most of the gravel renders the extraction of the latter difficult. A medium size deposit of good hard gravel north of Tyne Valley is now partly worked out, and what is left in the deposit is finer and more sandy than what has been already taken out.

1. Three-Quarters of a Mile Northwest of Nail Pond - Along the sea coast is a narrow beach of gravel and sand for a distance of at least one half mile along the shore. As noted, the gravel is undoubtedly the best found on the Island and makes a first class aggregate for roads, pavement, or concrete structures. Wave action has segregated the material into alternating narrow bands or zones of gravel and coarse sand. The gravel zones are 2 to 3 feet wide and protrude slightly above the sand zones. A feature of this gravel not found in other beach gravels is the large proportion of pebbles that look quite similar to the typical conglomerate pebbles of the Island. Since there is no conglomerate exposed anywhere along the beach, those pebbles must have come from some submarine conglomerate layer not far off shore.

The lithological character of the pebbles changes with each successive zone. At water level the pebbles are largely hard and conglomerate pebbles predominate. In the next zone a small portion of the pebbles are of the Island sandstone and limestone type. In each successive zone the proportion of the local rocks in the pebbles gradually increases and the pebble size increases from the water edge up. The upper gravel zone is largely made up of local rocks in the shape of large, flattish pebbles, that is, sandstone and some limestone.

Although the total amount of gravel in the whole beach is large, that available at any one point is rather small, particularly if the upper zone is left out of consideration as holding too many coarse, flattish, and soft sandstone pebbles. It is locally reported, however, that some storms will occasionally pile up great quantities of gravel on the beach, while others draw the gravel back under water. A reserve of gravel could be easily built up either by building stockpiles close to the road, or by hauling with a drag scraper, the gravel farther up the beach, out of reach of storm waves.

3. Little Miminegash Pond - This narrow beach of gravel and sand is very similar to the one described above, as regards size of beach, zoning, and coarseness of pebbles, but is quite different in lithological composition. It is also more sandy. Here the proportion of hard and durable pebbles is not over 20 per cent at the water level and is smaller farther up the beach. The remainder of the pebbles are made up of local rocks, that is, largely red sandstone with smaller amounts of red limestone and greenish grey sandstone. As in the Nail Pond deposit, these pebbles are not friable, but their proportion is too large and

the gravel is too sandy to recommend its use on main roads, as it has not the wearing quality required for moderately heavy traffic. It could be used to advantage, however, on all local roads, and would greatly improve the condition of the clayey stretches of road in wet weather. As concrete aggregate it should be as suitable as the Nail Pond gravel, except perhaps on concrete subjected to pounding and grinding, such as main road concrete pavements.

2. Huntley River - The deposit occurs as a steep knoll along the bank of Huntley River and a short distance west of the Alberton-Tignish highway. It was being worked for road aggregate by a contractor. Close to 100,000 cubic yards have already been excavated and more than that amount is still available in the deposit which is at least 30 feet in depth.

The lithological composition of the pebbles is as follows:-

Hard:	quartz, quartzite	8%
Fairly hard:	limestone and calcareous sandstone	50%
Fairly hard:	fine sandstone	22%
Soft:	sandstone, some calcareous	20%

Apart from a smaller proportion of soft pebbles, the gravel is much the same as regards composition, coarseness and quality, as the St. Anthony deposit described below.

The gravel is run through a grizzly to separate the material larger than 1.5 inches, which is now piled aside, to be crushed for the production of paving aggregate.

7. Half a Mile Northwest of St. Anthony - The gravel lies a short distance west of the western road on the farm of Mr. Hopgood and the deposit forms a steep ridge along the bank of Mill River. About 200,000 cubic yards have been excavated and probably as much remains. The pit cuts across nearly the whole width of the ridge and reaches a depth of 30 feet in places, which is not the full depth of the deposit. The latter extends for some distance through a bush west of the pit.

The gravel carries not more than 30 per cent sand and about 10 to 15 per cent of stones larger than 3 inches. Some of the larger stones are almost 2 feet across. The lithological composition of the pebbles is as follows:-

Hard:	fine igneous and metamorphic rocks	10%
Fairly hard:	fine sandstone	25%
Fairly hard:	limestone with small shaly inclusions	30%
Soft:	red sandstone	35%

The pit was being worked by a contractor for paving aggregate.

It is generally admitted that this gravel has not the wearing quality of the conglomerate, but it is of easy access from the main highway. The great depth of the deposit reduces the cost of stripping to a minimum. The coarseness of the material makes it possible to obtain through crushing a large proportion of angular fragments in the processed aggregate which is a great advantage, particularly in a paving aggregate. The proportion of soft stone is rather high, but the more friable part of the red sandstone crumbles easily in the crushing and screening process, and goes off to waste with the screenings.

8. North of Freeland - A large sand tract extending for miles along the shore of the Gulf of St. Lawrence in the western part of the province holds a considerable amount of gravel, according to old test pit records, but the larger part of the gravel is thickly covered with sand. The deposit north of Freeland and the one next described, one mile southeast of Poplar Grove, appear to be less thickly covered with sand than the average in the tract.

The deposit north of Freeland is on the farm of Joshua Henderson. According to old test pit records, the gravel layer which is 3 to 4 feet thick underlies 3 feet of sand and is underlain by sand. Less than one half of the volume of the gravel layer is made up of pebbles, and more than half of sand. The gravel carries a large proportion of coarse pebbles and fine sand, but only a small amount of medium size material. This could be easily corrected by crushing the gravel. As the proportion of hard pebbles is also fairly high, a good road aggregate could be obtained by crushing.

The main disadvantage, however, is the small depth of gravel and the rather thick overburden, which means that for every cubic yard of gravel extracted, two cubic yards of material would have to be handled. The deposit has a large areal extent, but there are probably gaps here and there where only sand is found.

9. One Mile Southeast of Poplar Grove - On the farm of Douglas Milligan, a test pit dug by the owner near the south end of Conway Cove was examined by the writer in 1928 and showed eleven feet of coarse, moderately sandy gravel under a thin cover of sand. However, according to information obtained by the author in the spring of 1948 the gravel deposit on the whole is very sandy and thick beds of gravel such as were seen in the test pit in 1928 are the exception rather than the rule. This and the fact that the deposit is difficult of access are the main reasons why it has remained undeveloped.

11. One and a Half Miles North of Tyne Valley - The deposit lies on the farm of S. Williams. Next to the Nail Pond beach deposit, this is the best gravel occurring on the Island. Most of the coarser part, however, has been excavated and what remains appears to be more sandy and probably shallower. Although somewhat similar in character to the two preceding gravels, it is outside the large tract of sand mentioned above and occurs in low, clayey land on the edge of a marsh. The deposit is shallow, rises but a few feet above the level of the marsh, and is underlain by red clay. It has been worked extensively for road material and about 50,000 cubic yards have been removed. The area of the excavation is more than half that of the whole deposit. The pit has an average depth of 6.5 feet, of which 2 feet is overburden.

The gravel is quite coarse, has few boulders, and only a moderate amount of sand. Towards one end of the pit the gravel decreases in coarseness and the proportion of sand increases to about 50 per cent. Most of the pebbles are made up of granite, porphyry, trap, and quartzite. The only irregularity in particle size grading is the rather low proportion of small (inch down to one quarter inch) pebbles, but this can be easily remedied by crushing. East of the pit there are surface indications of gravel over an area of approximately 100 by 300 yards, but this part is still flatter than the excavated part and probably shallower and more sandy. The average depth would not be more than 3 feet, so that about 30,000 cubic yards remain in the deposit. Owing to poor drainage and clayey nature of the pit bottom, the deposit could be conveniently worked only in late summer and early fall.

4. West Cape - Stratified sandy gravel is exposed in the upper 10 feet of a steep bank 25 to 35 feet high along the sea coast. The gravel is too soft and sandy for main roads but could be used as a low cost material for improving local roads. As it is conveniently located on the top of the bank, no steep up-grade hauling would be necessary. That part of the bank below the gravel is concealed behind a talus of clayey silt and sand. The gravel deposit is made up of one-third pebbles and two-thirds sand, a large proportion of the pebbles being friable or shaly sandstone. The gravel can be traced for several hundred yards along the coast, and the amount available is apparently large.

28. One Mile West of Murray River - This is one of several similar deposits found in this part of the province. They have much more sand than gravel and would be more properly designated as sand deposits. In the deposit on Horton's farm the upper three feet is made up of at least 80 per cent sand and less than 20 per cent pebbles, nearly all of which are soft sandstone. Farther down the deposit is still more sandy.

The material is much too fine for road purposes, but because of their depth and size, these deposits are a convenient source of supply for clean mortar and concrete sand.

Sand

Sands are fairly common throughout the province. A large sand tract runs for several miles along the Gulf of St. Lawrence in the western part of the Island, and extends a few miles inland. Other large deposits are found west of Murray River in the southeastern end of the province. Along the north shore large sand dunes run almost continuously from opposite Alberton to the entrance of Malpeque harbour, and again from Rustico Bay to St. Peters Bay. Dune sand also occurs on the south shore East of Souris. Coarse beach sand is found along the west coast, where there are many small or medium size deposits between North Point and West Point.

Except as fine aggregate or filler in high grade pavements sand is not much used as road material. More could be used, however, in the improvement of earth roads, particularly clay roads, to which it would impart greater stability under all weather conditions. These roads could be improved at low cost by simply spreading the sand over the clay surface. Sand and clay would gradually get mixed together through traffic action and maintenance operations.

Outside of the west coast beach sands, the Island sands are rather fine for use as fine aggregate in concrete, but cannot be considered unsuitable for the purpose. Streaks of coarse sand suitable for concrete work are found in some of the inland deposits. Fine sand free from any organic impurities could be used as concrete aggregate in structures subjected to compression stresses only in foundation work, for instance. This fine sand is available at many places, but care should be taken to remove the surface sand and treat it as waste before excavating the underlying clean sand. The reason is that the organic matter, the more objectionable impurity, is concentrated at the surface and decreases rapidly in depth.

The beach sands on the west coast are the coarsest occurring in the Island and the best from an engineering standpoint. Nearly all the beaches are narrow, but stretch along the shore from several hundred yards to over half a mile. Storms occasionally pile up large quantities of sand. In places the sand grades into gravelly sand or fine gravel such as occurs at Little Miminegash Pond and described in the section on "Gravel", above. In fact all gradations are found between straight coarse sand and fine sandy gravel.

Test on Dune Sands for Silica Use

These samples of sand were taken, one from Hog Island opposite George Island, another from near Stanhope at the east end of the National Park, and the third from Black Pond, east of Souris. Following is a granulometric analysis made on the three samples by the Bureau of Mines, Ottawa:

	13. Hog Island	24. Stanhope	31. Black Pond
+ 28 mesh	0.0	0.0	0.7
-28 Mesh +48 Mesh	0.6	1.7	87.9
-48 " +65 "	61.4	41.8	11.0
-65 " +100 "	35.8	49.3	0.3
-100 " +150 "	2.1	6.9	0.1
-150 " +200 "	0.1	0.3	0.0

From tests made in the Bureau of Mines the conclusion was reached that, by simple washing and magnetic separation, the sands cannot be brought to a grade suitable for glass manufacture, nor would they likely be suitable for foundry use. With extensive beneficiation it might be possible to bring the sands up to a grade suitable for the manufacture of some glasses, but it is doubtful if such beneficiation would be warranted from an economic viewpoint.

12. Trap Rock

A small outcrop of trap rock forms the extreme east point of George Island, Malpeque Bay, where it overlies sandstone. The trap on this uninhabited island is concealed by soil inshore, but is well exposed along the shore on both sides of the point. It ends on a fault plane on the northwest side of the point, as indicated by slickenslides. The dike strikes north (magnetic) and dips 15° east. It is at least 10 feet thick and is all fractured in angular blocks measuring from 3 to 12 inches across. The trap has a horizontal area of 9,900 square yards, and an average height of 9 feet above water level.

M.S.101.

The whole exposure above water level measures 29,700 cubic yards, and if it were all quarried down to that level would yield 39,600 cubic yards of crusher run material, with 33 per cent voids in the crushed product. The rock would make a high grade aggregate, as indicated by the following laboratory tests made in the Bureau of Mines, and enough could be obtained to surface 40 miles of bituminous pavement 3 inches thick and 20 feet wide.

Percentage of wear:	2.36
Toughness:	24.5
Hardness	18.9
Specific gravity:	3.07
Weight per cubic foot:	191.
Water absorption, lb. per cu. ft.:	0.20

The rock could probably be all quarried and crushed without blasting as there are no blocks too large for the average portable type of crusher. However, relatively high initial expenditures would be required to develop the deposit, and especially in view of the limited yardage of stone available, it would be a matter of deciding whether such expenditures would be warranted in order to obtain a sizeable portion of the material required for use on the Charlottetown-Borden highway. Probably the most practical way of getting the stone to the highway would be to build a landing on the quarry site, load the crushed aggregate on barges and haul it across Malpeque Bay to the wharf at Miscouche, from where trucks would haul the stone where needed along the highway.

Limestone

Occasional beds of brownish to brick red, impure limestone are seen exposed along the shore cliffs, particularly along the west coast and at a few places inland. The more common impurity in the stone consists of shale or clay inclusions arranged in thin layers. Blocks of greenish grey, fairly pure, compact limestone are found scattered on the beach at Little Miminegash and are said by local people to come from a submarine layer not far offshore. A bed of red, impure limestone is also exposed in the shore cliff at the same locality. An abrasion test made in the Bureau of Mines laboratory in 1928, gave a percentage of wear of 4.7 for the red stone and 4.1 for the grey stone. The test indicates that both limestones are suitable as road aggregate, although softer than the average for thick type of stone. However, the small and rare occurrences, together with the thick cover at most of the exposures render the limestone economically unimportant as a source of road metal.

The two limestone exposures near the Charlottetown-Borden highway are described in the section that follows. Their use as road aggregate is advocated not so much because of the quality of the stone as because of the scarcity of better material in that part of the province traversed by the highway.

ROAD MATERIALS SURVEY BETWEEN CHARLOTTETOWN AND BORDEN

General

Owing to the scarcity of suitable road making materials between Charlottetown and Borden, the whole stretch of country extending between these two points was carefully examined, soundings with auger were made at many places, and every occurrence of material reported as looking "different" was investigated. The area covered by this special investigation extends from the shore along the Northumberland Strait to the Wiltshire and New Bedeq roads.

The direct road from Charlottetown to Borden is 39 miles long, of which 2.5 miles near Charlottetown and 1.5 miles near Borden are already pave leaving 35 miles to be improved. The type of pavement to be finally decided upon will probably depend upon the character of the aggregate available and also upon the nature of the subgrade soils.

A 3-inch bituminous pavement on top of a 6-inch base course would require the following quantities of aggregate, for a pavement 20 feet wide:

Wearing course:	980	cubic yards per mile
Base course:	1955	" " " "

or a total of 2,935 cubic yards per mile. A 7-inch cement concrete slab of 1: 2: 3 mix would require the following quantities of aggregate for a pavemen 20 feet wide.

Fine aggregate (sand):	1185	cubic yards per mile
Coarse aggregate:	1760	" " " "

A bituminous or a concrete pavement for the 35 mile stretch of road would require about 103,000 cubic yards of aggregate. In the case of a concrete pavement, however, 41,500 cubic yards would be sand, leaving 61,500 cubic yards for the coarse aggregate. No provision is made in these estimate for a base course under the concrete, since it is assumed that a sand cushion on the compacted subgrade will afford adequate protection for the 7-inch slab

Three deposits of conglomerate at Gamble Corner, a deposit of limestone near Kelly Cross, and another near Maple Plains were the only materials that showed any promising signs as road aggregate. Aside from the Kelly Cross limestone all of them are small. The few small gravel deposits found were much too soft for the purpose. All the conglomerate and limestone occurrences were found grouped within a strip of land slightly over four miles long extending from west of Kelly Cross to near Maple Plains. The survey indicated that the conglomerate deposits at Gamble Corner would provide only 14,000 cubic yards of material, an amount far short of the quantity that would be required to pave the road. Thus the quarrying of the limestone beds estimated to contain 84,500 cubic yards of the rock, appears to be the best way of getting the remainder of the aggregate for the road, as it is the next best material near at hand. The limestone has not been tested as bituminous paving aggregate, but should prove as suitable for that purpose as for concrete aggregate.

Under normal conditions a 3-inch bituminous pavement on 6-inch base course of conglomerate or crushed stone would probably be cheaper to build than a 7-inch concrete slab on a sand cushion. Since, however, a concrete road would require only 61,500 cubic yards of coarse aggregate, all this stone could be obtained from the limestone occurrence west of Kelly Cross, whereas the three conglomerate deposits of Gamble Corner, the limestone bed near Maple Plains, and the one west of Kelly Cross, would all have to be completely excavated to obtain enough material for a bituminous pavement and base course. When this is taken into consideration, the concrete road would probably prove the cheaper of the two.

Conglomerate

17. Harold Francis - At Gamble Corner a narrow band of conglomerate lies on Francis' farm and extends over to Warren Simonds' farm on the east. A small pit on Francis' farm shows 2.5 feet of fine conglomerate overlain with 2 feet of ordinary red, friable sandstone and 18 inches of soil. The sandstone capping is not continuous. Claystone underlies the conglomerate. As determined by auger soundings, the deposit is about 500 yards in length and appears to be fairly uniform in width. Assuming an average width of 10 yards and the same thickness of conglomerate as shown in the pit, would give a conservative estimate of over 4000 cubic yards for the size of the deposit. The sandstone capping could be removed by power shovel as a stripping operation ahead of the conglomerate excavation.

16. John Waddell - Three-quarters of a mile north of Gamble Corner and just west of the county road are four small conglomerate deposits forming slight

rises in the ground on a farm owned by John Waddell. Small pits, now abandoned, were dug in three of the deposits. The larger and more promising of these occurrences as judged by surface indications and soundings is in the middle of a cultivated field. Here, auger soundings reached the conglomerate directly under the top soil over an area of approximately 3,700 square yards. An average thickness of conglomerate of 4 feet, the thickness shown in the old pit, would give about 5000 cubic yards as the size of the deposit.

Just east of this conglomerate area, the auger indicated sandstone under the top soil and there is a chance of getting more conglomerate in that direction if the sandstone reached by the auger is a single layer capping the conglomerate.

The other deposits appear to be smaller than the one described, judged by a few auger soundings, but they may be partly under a sandstone cover, and if so they may be of about the same size. Possibly they are only thin discontinuous patches of conglomerate resting on the underlying sandstone, in which case there would not be sufficient conglomerate to warrant its removal.

18. E. H. MacVittie - Half a mile east of Gamble Corner are several small conglomerate deposits on this farm, all of which occur in the slopes of knolls and apparently occupy only parts of the knolls. What appears to be the most promising of these deposits is in the middle of a cultivated field where a small, shallow pit, now abandoned, was opened several years ago through loose conglomerate resting on sandstone. Auger soundings made in the central part of the field reached conglomerate in places, and sandstone in others, under one to two feet of soil. Toward the edges of the field, farther down the slopes of the knoll, the auger, driven to a depth of about four feet, went through soil only. Assuming a roughly circular area of 90 yards diameter around the small pit to be conglomerate, and an average depth of conglomerate of 2.5 feet, the depth shown in the pit, would give 5,000 cubic yards as the size of the deposit.

The same conditions prevail on another knoll in the next field north, although there is no pit in this field.

About 700 yards north of the pit in the aforementioned cultivated field the auger reached the conglomerate at several places in the flat southern slope of a knoll, around where the pebbles are seen on the surface. Farther away, however, no conglomerate was reached at a depth of 3.5 feet.

The two latter deposits may be about the same size as that in the cultivated field, but may have a thicker soil covering. They may also be only thin patches of conglomerate lying on top of the sandstone, in which case the

would not contain enough material to warrant working. A few test pits would be necessary before reaching a decision on this point.

Along the property line between the cultivated field and the next farm west four test pits have been dug at intervals of about 50 feet in the lower slope of a knoll next to that in the cultivated field. Only one of these shows conglomerate, under 14 inches of soil. The auger, driven to a depth of four feet, did not reach the bottom of conglomerate.

19. Enoch Newson - On the farm of Enoch Newson, near Westmoreland, a pit was opened some years ago in conglomerate interstratified with sandstone and the material was used for road aggregate. The excavation is in the north slope of an east-west sandstone ridge and near its west end.

The inner bank of the pit now has a height of about 20 feet, hardly more than six feet of which is conglomerate and the remainder sandstone topped with two to three feet of soil. None of the several shallow test pits that have been dug around the west end of the ridge, a short distance west of the main excavation, with the idea of extending the workings in that direction, show conglomerate. Southwards into the ridge the pit seems to have reached the edge of the deposit.

When the area was examined in the late spring of 1948, it was thought that the conglomerate might extend under the top of the ridge as far as the southern slope, so the latter was carefully examined for any surface indication of conglomerate, but with negative results. If the conglomerate reaches the southern slope, it must be under thick soil cover. As a last measure two or three test pits should be dug at different heights in the southern slope. If any conglomerate is found a pit could be opened and extended gradually into the ridge in the direction of the present excavation in the northern slope. The thick sandstone cover could be blasted off ahead of the digging operation. The flat top of the ridge is about 30 feet above the conglomerate in the pit and the horizontal distance between the pit and the corresponding elevation on the south slope of the ridge is approximately 250 yards. This would mean blasting close to 4 cubic yards of sandstone, on the average, for each cubic yard of conglomerate extracted, assuming that the thickness of the conglomerate remains the same, that is, 6 feet.

Limestone

The two aforementioned deposits that appear to be suitable for use as road aggregate are described below. Both lie close to the surface.

20. Alph. MacAvinn - Limestone is exposed at two places along a side road leading north from the Kelly Cross-Crapaud road, about one mile west of Kelly

Cross. On leaving the Kelly Cross road the side road goes up to the top of a knoll, then steeply down its north slope. Limestone outcrops in the southern slope and in the steep northern slope of the knoll. The two outcrops are 200 yards apart, horizontally, and are apparently parts of a continuous limestone layer which is overlain with sandstone, the latter occupying the top of the knoll. The limestone layer is 4 feet thick in the southern slope and 7 feet in the northern. The top of the knoll is 9 feet above the limestone, which dips gently north. This would give an average thickness of 6 feet of overburden over the whole distance between the two outcrops. Part of this overburden is friable sandstone, probably loose enough to be stripped off by power shoval, and part is soil.

If the limestone bed is continuous and extends for some distance on both sides of the road, a quarry could be opened in either slope and gradually extended to the other slope. By this method, it is estimated that about 66,700 cubic yards of stripping would be required. To avoid much of this stripping, quarrying operations could be started in the steep north slope where the limestone layer is thickest, and be gradually extended around the top of the knoll instead of through it. The north slope on the farm, west of the road, would be a good place to start the excavation. Since the rock has a gentle dip north, the quarry floor would have a slight slant towards the entrace, this insuring good drainage at all times. The limestone would have to be drilled and blasted.

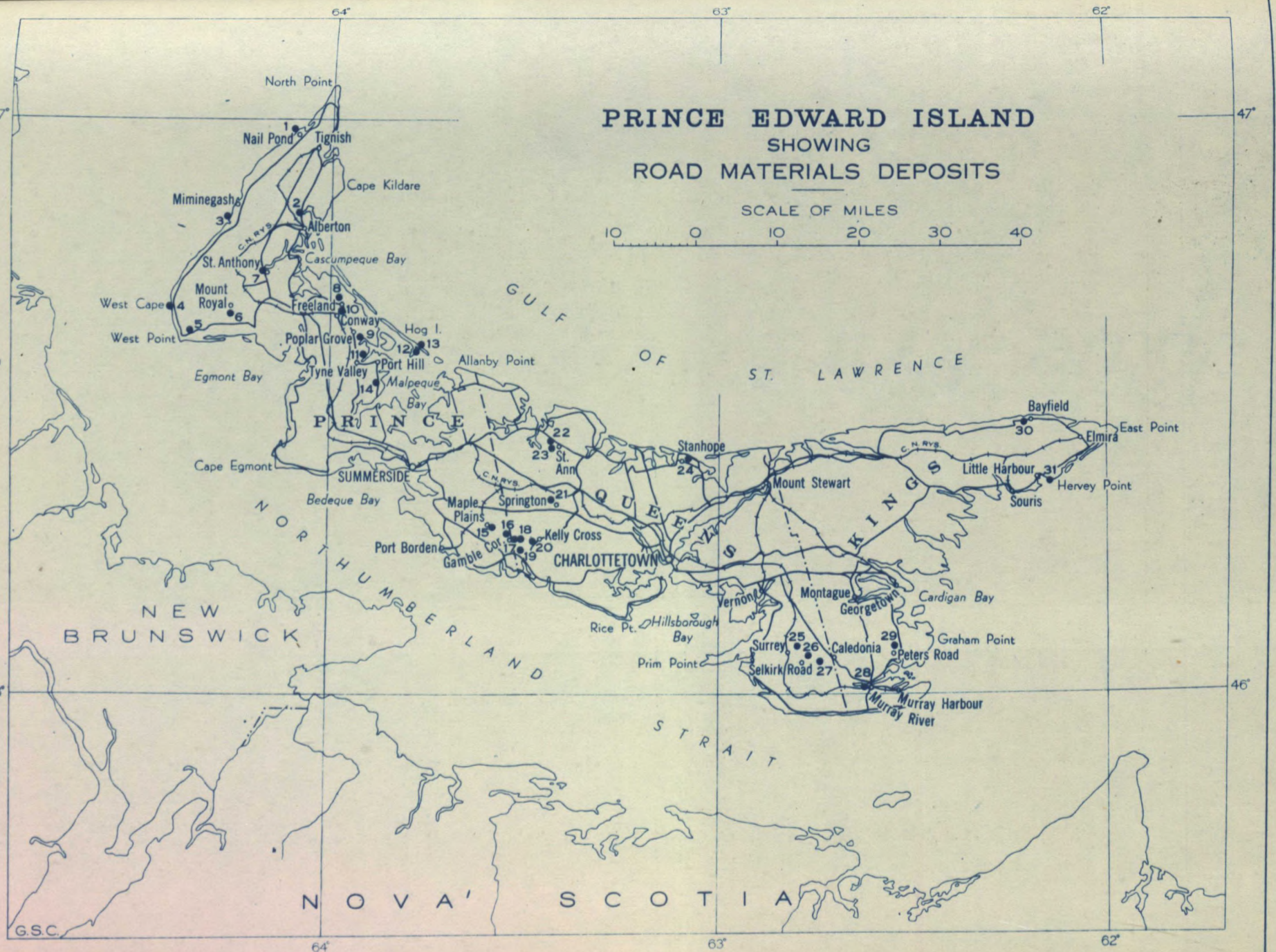
It is not easy to estimate the amount of limestone that can be obtained without knowing how the layer runs. If it extends the same distance east and west as it appears to extend along the road, or approximately 200 yards both ways, and its average thickness is taken as 5 feet, this would give 88,900 cubic yards of crusher run stone or 80,000 cubic yards of usable aggregate.

Before opening a quarry, it would be strongly advisable to make preliminary soundings in the form of shallow trenches reaching the underlying rock to ascertain how the rock runs and its thickness. The best place to do this would be in the steep north slope of the knoll, on MacAvinn's farm. Starting near the road at the level where the limestone is exposed on the road, trenches down to the rock could be dug about every 50 or 75 yards around the knoll. They should be long enough down the slope to expose both top and bottom of the limestone layer and thus determine its thickness.

15. Fred Walsh - About three-quarters of a mile southeast of Maple Plains, on the farm of Fred Walsh, is an abandoned limestone quarry that was worked over 50 years ago by the owner's father for lime burning and the production of agricultural limestone. The stone apparently runs close to the surface for a distance of 200 yards in a southwest-northeast direction. At the quarry, near the southwestern end of the deposit, the thickness of limestone is 6 feet. Assuming the width of the quarry (about 10 yards) to be the width of the deposit would give 5,300 cubic yards of crusher-run stone. Allowing for the screenings, this leaves 4,500 cubic yards as the total amount of paving aggregate that can be obtained.

LIST OF ROAD MATERIAL OCCURRENCES DESCRIBED

1.	Gravel	0.75 mile N.W. of Nail Pond
2.	Gravel	Huntley River
3.	Gravel	Little Miminegash Pond
4.	Gravel	West Cape
5.	Conglomerate	2 miles N.E. of West Point
6.	Drift	1 mile S. of Mount Royal
7.	Gravel	0.5 mile N.W. of St. Anthony
8.	Gravel	N. of Freeland
9.	Gravel	1 mile S.E. of Poplar Grove
10.	Conglomerate	E. of Conway
11.	Gravel	1.5 miles N. of Tyne Valley
12.	Trap Rock	E. end of George Island
13.	Dune sand	Hog Island, opposite, George Island
14.	Conglomerate	2.75 miles S. of Port Hill
15.	Limestone	0.75 mile S.E. of Maple Plains
16.	Conglomerate	0.75 mile N. of Gamble Corner
17.	Conglomerate	Gamble Corner
18.	Conglomerate	0.5 mile E. of Gamble Corner
19.	Conglomerate	Westmoreland
20.	Limestone	1 mile W. of Kelly Cross
21.	Conglomerate	1 mile N.W. of Springton
22.	Conglomerate	1.3 miles N.W. of St. Ann
23.	Conglomerate	1 mile W. of St. Ann
24.	Dune sand	1 mile N.E. of Stanhope
25.	Conglomerate	1.5 miles N.E. of Surrey Station
26.	Conglomerate	1.25 miles N.E. of Selkirk Road
27.	Conglomerate	2 miles W. of Caledonia
28.	Sandy gravel	1 mile W. of Murray River
29.	Conglomerate	1 mile N.E. of Peters Road
30.	Conglomerate	1 mile W. of Bayfield
31.	Dune sand	Black Pond, E. of Souris


PRINCE EDWARD ISLAND
SHOWING
ROAD MATERIALS DEPOSITS
SCALE OF MILES
10 0 10 20 30 40
64°
63°
62°
47°
46°
North Point
Nail Pond
Tignish
Cape Kildare
Miminegash
Alberton
C.N.RYS.
Cascumpeque Bay
St. Anthony
Mount Royal
West Cape
West Point
Freeland
Conway
Hog I.
Poplar Grove
Port Hill
Allanby Point
Egmont Bay
Tyne Valley
Malpeque Bay
GULF OF ST. LAWRENCE
PRINCE
Cape Egmont
SUMMERSIDE
Bedeque Bay
NORTHUMBERLAND STRAIT
NEW BRUNSWICK
Maple Plains
Springton
Kelly Cross
Port Borden
Gamble Cor.
CHARLOTTETOWN
Rice Pt.
Hillsborough Bay
Prim Point
Stanhope
St. Ann
QUEENS
KINGS
Mount Stewart
Bayfield
East Point
Elmira
Little Harbour
Hervey Point
Souris
Vernon
Montague
Georgetown
Cardigan Bay
Graham Point
Surrey
Caledonia
Peters Road
Selkirk
Road
Murray Harbour
Murray River
NOVA SCOTIA
G.S.C.