Granular Resources Inventory
- Southern Mackenzie Valley -
Wrigley - 95 O

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES

GRANULAR RESOURCE INVENTORY - SOUTHERN MACKENZIE VALLEY
WRIGLEY (95O)
1:125,000

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SUMMARY

In the Wrigley map-area, sources of granular material are plentiful and widely scattered. Good quality natural granular material is available primarily in glaciofluvial and alluvial deposits. Morainal and glaciolacustrine deposits also contain sand and gravel. Competent, crushable bedrock is exposed in the McConnell and Camsell Ranges, Willow Ridge, and the Wrigley Plateau.

Glaciofluvial outwash plain, terrace, ridge and esker deposits found mostly in the northeastern and southwestern quarters of the map-area contain substantial quantities of sand and gravel. These deposits are generally unfrozen and well drained with little organic cover.

Certain alluvial plain and terrace deposits of the Mackenzie, Blackwater, Wrigley, Ochre, and Johnson Rivers and Hodgson Creek contain gravel and sand in addition to finer material. Alluvial fan deposits adjacent to bedrock ridges consist of colluvium which could supply construction materials when slope angles are low.

Morainal deposits generally contain silt and clay with minor sand and gravel. In drumlinoid and hummocky areas, i.e. north of Fish Lake, sand and gravel content of morainal deposits is often high. These areas could provide good fill and some coarse granular material for construction projects.

Glaciolacustrine deposits are mostly silt and find sand. They often contain ice and are less desirable for fill or granular material.

Bedrock that can be crushed to provide granular material includes limestone, dolomite, sandstone, and conglomerate of twelve geologic formations.

INTRODUCTION

Granular material for construction purposes can be obtained from unconsolidated deposits or competent bedrock. This report will discuss the distribution and physical characteristics of these sources of granular material and will also present an estimate of the quantity of material available in unconsolidated deposits.

Unconsolidated deposits resulting from various geologic processes, i.e. glacier activity, river deposition, wind action, and mass wasting, are a source of natural granular material of gravel (> 2 mm), sand (1/16-2 mm), silt (1/16-1/256 mm), and clay (< 1/256 mm) sizes.

Good natural granular material for construction uses is generally larger than silt size (1/16 mm)[1]. In the southern Mackenzie Valley good granular material comes primarily from deposits of glaciofluvial and glaciolacustrine origin, and secondarily from morainal, eolian, alluvial, and colluvial deposits.

Bedrock that can be crushed by mechanical means can also supply granular material. Competent bedrock suitable for crushing includes limestone, dolomite, sandstone, and certain igneous and metamorphic rock types. Other less resistant rock types, i.e. shale, can be used for fill material but will not be included here as a bedrock source of granular material. In the southern Mackenzie

[1]Silt and clay size material < 1/16 mm can be used for fill. This material is unlimited in the unconsolidated deposits of this map-sheet and will not be included in the numerical estimate of the quantity of granular material available.

Valley limestone and dolomite are the best sources of rippable bedrock.

Published and unpublished Geological Survey of Canada maps and reports, personal communication with officers of the Geological Survey, and field investigation have provided the basic data for this report. Supplementary information on distribution, thicknesses, and textures of unconsolidated deposits was obtained from unpublished oil and pipeline company shot hole and drilling records (see sources of information, Appendix A).

A Geological Survey surficial geology map at a scale of 1:125,000 (Rutter, N. W., and Boydell, A. N., in press) provided data on location and areal extent of unconsolidated deposits containing good granular material. This map will be indexed as GSC Open File and when published it may be viewed in the Geological Survey of Canada offices in Ottawa, Calgary, and Vancouver. Copies will be obtainable at a nominal cost from Riley's Datashare International Ltd., 631 - 8 Avenue South West, Calgary, Alberta.

Quantities of natural granular material in unconsolidated deposits have been computed using data on areal extent and thicknesses obtained from the surficial geology map, drilling results, and field observations. Variables such as ground ice and height of water table were considered when deriving final volumes of material available in each deposit[2]. The tabular summary at the end of this report contains detailed volumetric data.

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[2] The area of each deposit was measured on the surficial geology map with a planimeter. The average thickness of the deposit was multiplied by the area to get the total volume of the deposit. Variables, i.e. water table, type of deposit, were assessed to obtain the final percentage of the total volume that is listed in the table as material available for exploitation.

Information on bedrock that can supply granular material comes mainly from Geological Survey of Canada paper 62-33. Map 45-1962 which accompanies this paper has been used as a base for indicating competent bedrock that is available at or near the surface.

GENERAL GEOLOGY AND PHYSIOGRAPHY

The eastern half of the Wrigley map-area lies within the Great Bear and Great Slave Plain physiographic regions. The McConnell and Camsell Ranges of the Franklin Mountains and the Mackenzie Plain are represented in the western half of the map-sheet (see location map, Figure 1).

Bedrock geology was mapped by the Geological Survey on Operation Mackenzie in 1957 (Douglas, R. J. W., and Norris, D. K., 1963). A reconnaissance surficial geology investigation was taken by B. G. Craig as part of this operation (Douglas and Norris, 1963; Craig, 1965). A detailed surficial geology map based on air photo interpretation and field investigations is being compiled by the Geological Survey in 1972-73 (Rutter, N. W., and Boydell, A. N., in press).

Bedrock formations[3] are basically Mesozoic (Cretaceous shales and sandstones) Paleozoic (Cambrian, Ordovician, Silurian and Devonian limestones, dolomites, sandstones, shales), and Proterozoic shales, sandstones and conglomerates.

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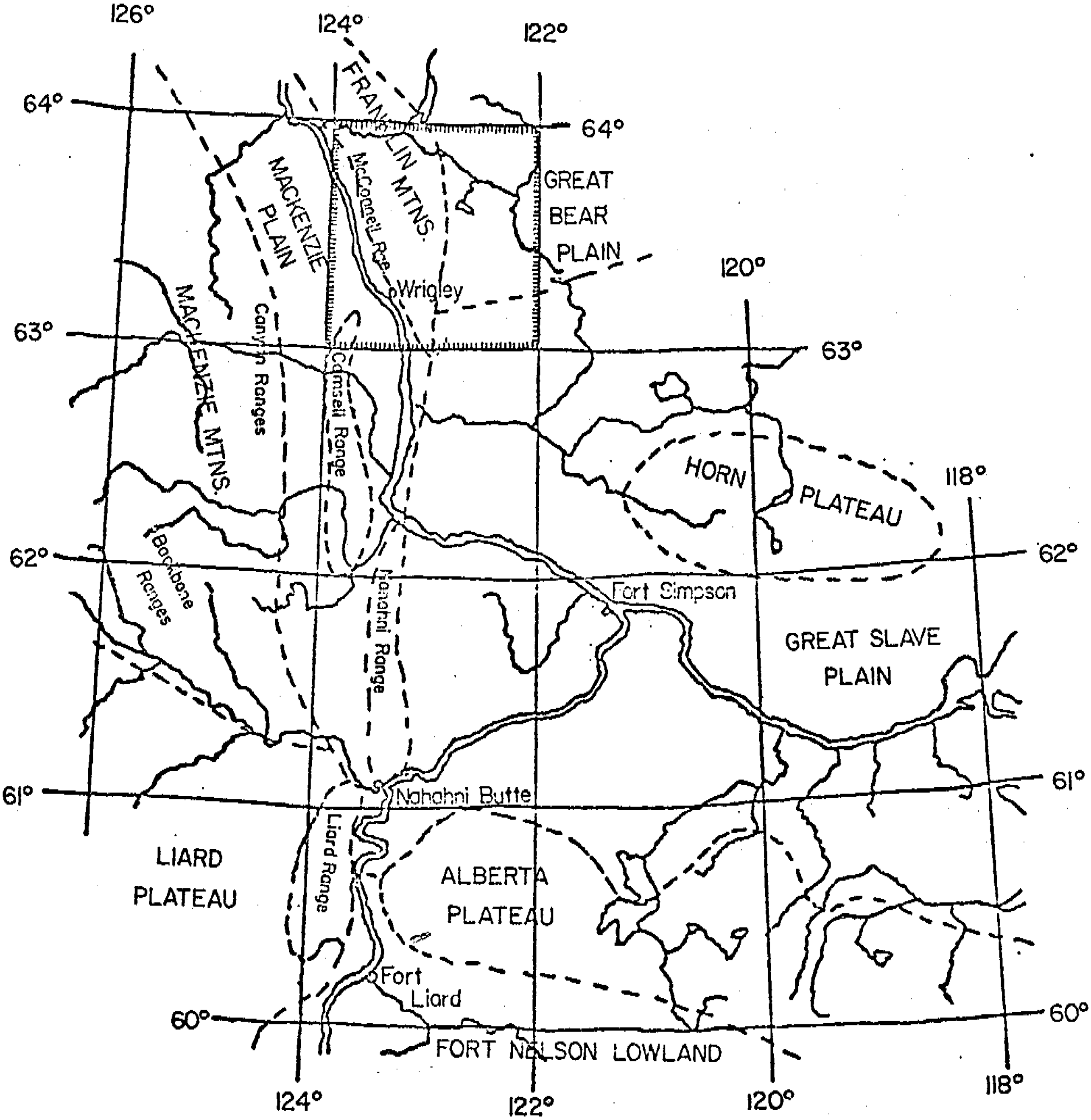
[3] A formation is a bed (of rocks) or assemblage of beds with well-marked upper and lower boundaries that can be traced and mapped over a considerable tract of country (Holmes, 1965).



PHYSIOGRAPHIC REGIONS - WRIGLEY, 95 O

miles 50 Scale

Figure I

after Bostock 1969

The shales which generally occur in lower areas east and west of the McConnell and Camsell Ranges are poor sources of granular material.

Competent limestones, dolomites, sandstones and conglomerates found at or near the surface in the McConnell and Camsell Ranges, Willow Ridge, and in the Wrigley Plateau could be used to supply construction materials.

Morainal deposits mantle the bedrock in lower areas with shot hole records showing them to be at least 50 feet thick in most places[4]. In addition to the ground moraine cover, glacier activity has produced extensive glaciofluvial channel, plain, and esker deposits, and glaciolacustrine plain deposits. Rivers and creeks have reworked unconsolidated material into alluvial plain and terrace deposits and slope wash has created alluvial fans at the base of bedrock ridges.

GEOLOGIC DESCRIPTION OF EXPLOITABLE MAP UNITS

Unconsolidated deposits and bedrock that can supply granular material appear on Figures 2 and 3 respectively.

Figure 2 is adapted from a Geological Survey of Canada surficial geology map. Unconsolidated deposits with good natural granular material are labelled with the appropriate map-unit name and assigned a pattern designation (see Figure 2, 2b). Pattern designations are based on geologic origin and texture of material in the deposit. Where map-unit names are used without pattern designations, i.e., alluvial deposits southeast of Blackwater Lake,

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[4] There might be <50 feet of till over bedrock, but shot holes usually end at 40 to 50 feet even if bedrock is not encountered.

the deposits either consist almost entirely of material $<1/16$ mm or have frozen ground or extensive swampy organic areas.

Figure 3 is a Geological Survey of Canada bedrock geology map. Bedrock at or near the surface is indicated by solid unit boundary, heavy dashed lines, or an x. Bedrock formations preceded by an asterisk (*) could be crushed to obtain granular material (see legend, Figure 3).

Unconsolidated Deposits

Glacial Deposits

Glaciofluvial deposits contain high quality granular material of gravel and sand sizes. Glaciolacustrine plain deposits consist of silt and sand. Morainal plain deposits are generally made up of fine material, but fluted, hummocky, and ridged deposits may contain some sand and gravel.

Glaciofluvial Deposits
(Gp, Gpc, Gt, Gr, Gh, Ghr, $\frac{Apv}{Gt}$, esker)

Glaciofluvial deposits are composed of good quality sand and gravel. These deposits are scattered throughout the map area, but are very abundant east and southeast of Blackwater Lake. Glaciofluvial deposits are indicated by several types of dot and circle patterns or an esker symbol on the natural granular materials map (see Figure 2).

The capital G in the unit mapped indicates the glaciofluvial origin of the deposit and the lower case prefix denotes the principal type(s) of material, e.g. silt (si), sand (s), and gravel and sand (g). It should be noted that if two prefixes are used, the first refers to the most abundant constituent (see legend for surficial geology maps, Figure 2b).

Topographic expression of the unit is indicated by the suffix attached, e.g. ridge (r), plain (p), hummocky (h), terrace (t). Symbols such as esker ( ) also show surface form. Glaciofluvial units vary from flat and gently sloping (Gp, Gt, $\frac{\text{Apv}}{\text{Gt}}$) to hummocky and ridged (Gr, Gh, eskers). Thicknesses of deposits range from 5 to 150 feet. Where no information on thicknesses was available, an average value of 50 feet was used to estimate volumes of glaciofluvial deposits.

Esker ridges ( ) are sinuous ridged deposits formed by rivers beneath glacial ice. These ridges usually consist of clean and fairly well sorted sand and gravel[5]. Eskers in the Wrigley area vary in height from 50 to 200 feet, and in width from 65 to 600 feet.

Glaciofluvial deposits are generally well drained and have little ground ice or organic cover. Deposits affected are by these factors described in the tabular summary.

Glaciolacustrine Deposits
(Lp, Lh, Lpm, $\frac{\text{Lpv}}{\text{tm}}$)

Glaciolacustrine deposits are mostly fine sand and silt. At some localities these deposits contain gravel, i.e. south of Wrigley along the east side of the Mackenzie River. On the granular map the lake deposits have been assigned a striped pattern (see Figure 2).

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[5] Some esker-like ridges in esker complex are composed of till, i.e. O-134.

The capital L in the glaciolacustrine map-unit indicates its origin and the lower case prefixes and suffixes give textural and morphologic information, respectively.

Glaciolacustrine plain deposits are generally flat or gently sloping (Lp, $\frac{\text{Lpv}}{\text{tm}}$). Some hummocky (Lh) and rolling (Lpm) topography is also present. Glaciolacustrine deposits range in thickness from 5 feet[6] ($\frac{\text{Lpv}}{\text{tm}}$ units) to 100 feet (Lp and Lh units along the Mackenzie River).

Ground ice and organic cover may make glaciolacustrine deposits difficult to exploit. Units with significant organic cover and frozen ground are outlined on the natural granular materials map but are not shaded or included in the tabular summary.

Morainal Deposits
(Mp, Mr, Mpr, Mps, Mh,)

Morainal deposits generally do not contain sufficient gravel to be classified as a source of granular material. On the Wrigley map-sheet moraine ridged (Mr, Mpr,), hummocky (Mh), and fluted (Mps) areas sometimes contain gravel in addition to till. Also two moraine plain map-units (Mp) have enough coarse material to be indicated on the granular materials map.

Morainal deposits have been mapped as M with appropriate textural and morphologic modifiers. They have been assigned a broken line pattern

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[6] Glaciolacustrine veneer deposits ($\frac{\text{Lpv}}{\text{tm}}$) are indicated by map-unit names. They have not been assigned a pattern designation nor included in the tabular summary because they are too thin to exploit economically.

or the moraine ridge symbol on the natural granular materials map (see Figure 2).

Field investigations have shown that fluted moraine plain units north of Fish Lake have some gravel, especially on the crests of drumlinoid ridges. These deposits are not indicated as granular resources on the natural granular materials map because they consist mostly of clayey, silty till. However, material in the ridges is well drained making it good for fill purposes.

Morainal deposits vary in thicknesses, but an average figure of 100 feet was used in volume calculations. Percentages of material available in the deposits are low, i.e. 5 to 10%, because of the high content of silt and clay.

Ice content and organic cover in morainal areas is variable and is controlled largely by topography. Well drained ridged and hummocky deposits with less organic cover and ground ice are generally best to exploit for coarse material or fill.

<u>Alluvial Deposits</u>
(Ap, At, Af, Afx)

Alluvial deposits consist of silt, sand, and gravel-sized material. Only those with sand or gravel have been assigned a cross hatched pattern on the accompanying natural granular materials map (see Figure 2). All alluvial deposits are mapped as A with textural and morphologic modifiers.

Alluvial deposits form plains (Ap) with little relief along present river and stream channels, terraces (At) above present channels, and fans (Af, Afx) at the base of mountain slopes. Alluvial deposits vary in thicknesses from 3 to greater than 100 feet.

Alluvial deposits along the Mackenzie River are mostly terrace deposits ranging in thickness from 40 to greater than 100 feet. They contain significant amounts of gravel and sand, are fairly well drained, and have little organic cover.

Alluvial plain and terrace deposits along Mackenzie River tributaries vary in thickness from 8 to 50 feet. They contain sand, gravel, and silt, and are generally well drained with minor ground ice or organic cover. Deposits along the Blackwater River southeast of Blackwater Lake are an exception because they have heavy organic cover and are probably frozen.

Alluvial fan deposits (Af, Afx) are variable in composition and thickness. An average thickness of 25 feet was used in volume estimates when thickness data was unknown after field investigations.

Bedrock

Limestone, dolomite, sandstone, and conglomerate of twelve geologic formations can be used to supply granular material. Outcrop areas of these formations are indicated on Figure 3 with solid lines, heavy dashed lines, or an x symbol. All of the formations occur at or near the surface in the McConnell Range, Camsell Range, Willow Ridge, and Wrigley Plateau.

The area east of the McConnell Range is underlain by soft Cretaceous shales and sandstones which are mantled by glacial drift. A thick drift cover also overlies incompetent Devonian shales in the Mackenzie River Valley. Both rock type and drift cover in these low areas make them poor localities to find competent bedrock for construction materials.

High Quality Bedrock for Construction Materials

Bedrock formations are described in order of their suitability for construction materials.

The Nahanni Formation, unit 21, is a Middle Devonian limestone that is well exposed in both the McConnell and Camsell Ranges. Rocks of this formation are fairly competent and break into blocks with dimensions of three feet square and larger. A few shaly, less competent limestone beds are present. The formation ranges in thickness from 750 feet in the Dahadinni River map-sheet to 300 feet in the McConnell Range and 360 feet in the Camsell Range. In the Camsell Range the presence of calcite veins should make crushing of the rock easier.

The Franklin Mountain Formation (Ordovician and younger), unit 8, outcrops along the eastern side of the McConnell Range. On the northeast face of Mount Kendle it is 1,265 feet thick. The upper part of the formation (765 feet) is mainly tough dolomite and is thinly bedded to platy, making it easy to break by mechanical means. The lower beds are not quite as good a source of construction material as they contain red and green shales along with dolomite and limestone.

The Mount Kindle Formation, unit 9, is well exposed in the McConnell Range. It is Ordovician or younger and consists of a competent dolomite. The formation is approximately 900 feet thick and is a fairly good source of construction material. It should be noted that the massive nature of the formation might make crushing somewhat difficult.

Unit 5, the Mount Clark Formation is a very good source of competent, rippable material, but it is found only in the eastern part of the McConnell Range. Near the peak of Cap Mountain this Cambrian sandstone formation is 450 feet thick.

The Arnica Formation, unit 15, is a competent Middle Devonian dolomite that is exposed in the Camsell Range. In the Wrigley and Dahadinni River map-areas it varies in thickness from 435 to 2,420 feet. The massive nature of the rocks of this formation may mean that crushing could be difficult. However, numerous calcite veins at some localities may make ripping easier.

Unit 25 is a competent Upper Devonian reefy limestone. It is located only on the Wrigley Plateau where it is 65 feet thick. The lower part is thinly bedded and may be easier to break than the thickly bedded upper part.

The Lone Land Formation, unit 4, is Proterozoic in age and outcrops only at Cap Mountain where it is 965 feet thick. The basal beds (200 feet) of the formation are tough sandstone with some lenses of rounded quartz pebbles and the upper beds are shales, siltstones, and mudstones. The basal beds would serve as a good source for bedrock construction materials but the upper beds would be poor.

Rock from unit 1, which is Proterozoic in age, might also be used for construction purposes. Unit 1 outcrops only on the eastern flank of the McConnell Range near Cap Mountain. It is composed of 1,700 feet of strata consisting of interbedded dolomite, sandstone, siltstone, and shale. The sandstone (10 foot thick beds) and dolomite would be the best source of construction material.

The Manetoe Formation, unit 17, is limited in outcrop area as it appears only in the Camsell Range where it is 135 feet thick. It is a competent dolomite both thin and thickly bedded, fractured and veined by calcite.

Unit 12 (Ordovician and younger in age) consists of 540 feet of dolomites and is located only in the Camsell Range. It is silty and sandy in texture and the basal beds are partly brecciated.

Secondary Bedrock Sources for Construction Materials

Two formations, units 16 and 24, can be used as sources of rippable bedrock. However, the outcrop pattern and rock types involved make them less desirable than the previously mentioned units.

The Middle Devonian Bear Rock Formation, unit 16, is a limestone breccia. It is well exposed in the McConnell Range and is approximately 1,100 feet thick. Some rocks in the formation break into blocks and some crumble into smaller fragments. The rocks of this unit are less competent than the Nahanni Formation which often occurs adjacent to it.

The Upper Devonian unit 24 is a sandstone with shale and siltstone interbeds. It occurs both east and west of the Mackenzie River but is generally mantled by glacial deposits. When the sandstone beds appear at the surface, they can be crushed to obtain construction materials.

GEOGRAPHIC DISTRIBUTION OF EXPLOITABLE MATERIALS

All natural granular deposits have been assigned an identification number, i.e. O-1, for use in assembling data. Roman numerals I to IV and geographic names designate groups of natural granular deposits discussed in this report (see Figure 2). The same system of Roman numerals and geographic names has been used to assemble bedrock information for different localities on the map-sheet (see Figure 3).

Further details on volume estimates of natural granular material and types of bedrock available in each Roman numeral area are found in the tabular summary of this report.

I. Mackenzie River Complex

This area west of the McConnell Range has good potential sources of granular material. Unconsolidated deposits are basically glaciofluvial outwash sand and gravel, alluvial sand and gravel, and glaciolacustrine sand and silt.

Glaciofluvial plain, terrace, and ridge deposits are concentrated along the Wrigley and Mackenzie Rivers south of Wrigley settlement.

Volumes have been calculated using 50 foot thicknesses. These well-drained deposits are probably 40% - 50% gravel and coarse sand and estimates of available material in the tabular summary are based on these percentages.

Alluvial sands and gravels are found in plains and terraces along the Mackenzie River and its tributaries. Alluvial plain deposits are generally thin and are estimated to be 8 - 30 feet thick and contain 10% - 40% usable sand and gravel. Alluvial terraces are thicker (40 to 80 feet) and are approximately 40% usable.

Glaciolacustrine plain and hummocky deposits contain mostly silt and fine sand. A thickness of 100 feet was used in estimating volumes. Ground ice, organic cover, and high water table will affect the amount of glaciolacustrine material that can be successfully utilized.

Competent limestone, dolomite, and sandstone of five formations which outcrop in the Camsell Range, Wrigley Plateau, and along the Mackenzie River could supply unconsolidated colluvial material or could be crushed to obtain granular material.

II. Franklin Mountains

Limestone, dolomite, sandstone, and conglomerate which outcrop in the McConnell Range of the Franklin Mountains would supply both colluvium and crushable bedrock for granular materials in this area. Six geologic formations are listed as good units to exploit and one is only fair (see tabular summary).

Unconsolidated deposits consist of alluvial fans along bedrock ridges, alluvial plain and terrace deposits near rivers, and scattered glaciolacustrine, glaciofluvial, and morainal deposits in mountain valleys.

III. Blackwater Lake - Fish Lake Area

Several small glaciofluvial deposits (mostly eskers) contain good sand and gravel. Till of morainal deposits may contain coarse material, i.e. drumlinoid area north of Fish Lake.

Limestone of the Nahanni Formation exposed in Willow Ridge could also be crushed to obtain granular material.

IV. Great Bear Glaciofluvial Area

Extensive deposits of glaciofluvial sand and gravel with plain, ridge, hummocky and esker morphology are present in this area. Most of these deposits are well drained and probably contain only minor permafrost.

Some morainal deposits might also supply coarse material for construction projects. Alluvial deposits contain coarse material but O-54 is the only one of these deposits that is well drained and exploitable. No competent bedrock units are available in area IV.

TABULAR SUMMARY

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes (Million yd.^{3}) Total	Volumes (Million yd.^{3}) Available
	I. Mackenzie River Complex				
O- 1	Glaciofluvial outwash plain deposits, mainly gravel	50	1.21	58.99	23.59
O- 2		50	1.87	98.43	39.37
O- 6		50	1.67	88.06	35.22
O- 86		50	1.32	69.70	27.88
O- 10	Glaciofluvial outwash plain deposits, gravel and sand	50	2.76	145.52	58.20
O- 11		50	7.15	377.06	150.82
O- 8	Glaciofluvial outwash plain, channelled, gravel	50	4.24	223.38	89.35
O- 5	Glaciofluvial terrace deposit, gravel	50	0.62	32.81	22.96
O- 9		50	3.23	270.27	108.10
O- 14		50	0.47	39.15	19.57
O- 48	Glaciofluvial terrace deposit, gravel and sand	50	3.70	309.15	123.66
O- 83	Glaciofluvial terrace, gravel, sand with veneer of alluvial silt	50	5.91	311.44	93.43
O- 85		50	3.23	170.17	51.05

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes (Million yd.^{3}) Total	Available
O- 63	Alluvial terrace deposit, gravel and sand	30	0.58	15.10	6.04
O- 64		30	7.16	221.80	88.72
O- 65		80	2.80	234.36	93.74
O- 66		80	3.46	289.71	115.88
O- 68		80	0.93	78.30	31.32
O- 69		80	1.68	140.13	56.05
O- 72		80	2.65	221.40	88.56
O- 73		80	2.33	195.21	78.08
O- 74		80	0.54	45.63	18.25
O- 75		80	3.81	318.87	127.54
O- 77		80	1.01	84.51	33.80
O- 79		80	1.36	113.94	45.57
O- 89	Alluvial terrace deposits, mainly silt and gravel (*more extensive than indicated on Figure 2)	40	1.59	64.22	12.84
O- 90		40	0.47	18.85	3.77
*O- 91		40	0.62	25.09	5.01
*O- 92		40	0.43	17.29	3.45
O- 49	Alluvial plain deposits, gravel and sand	30	15.37	476.20	190.48
O- 71		8	1.67	15.54	1.55
O- 76		8	0.72	2.16	0.21
O- 88		8	2.49	23.16	2.31
O- 78	Alluvial plain deposits, gravel, sand, and silt	8	0.54	5.07	0.50
O- 80		8	0.47	4.35	0.43
O- 81		8	4.59	42.69	4.26
O- 82		8	12.18	113.19	11.31
O- 84	Alluvial plain deposit, gravel	8	4.47	41.58	4.15

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes (Million yd.^{3}) Total	Available
O- 61	Glaciolacustrine plain deposits, mainly silt, some fine sand	100	0.23	23.76	9.52
O- 96		100	1.32	135.30	40.59
O- 98		100	7.24	739.86	221.95
O-100		100	11.98	1,225.29	367.58
O-102		100	1.67	170.94	51.28
O-103		100	75.97	7,769.85	2,330.95
O-104		100	2.49	254.76	76.42
O-105		100	3.07	303.81	91.14
O-106		100	13.50	1,380.39	414.11
O-116		100	3.38	346.17	103.85
O-117		100	4.78	489.39	146.81
O-118		100	1.32	135.30	40.59
O-119		100	7.94	811.47	243.44
O-120		100	0.27	27.72	8.31
O-123		100	3.38	346.17	103.85
O-124		100	54.30	5,553.90	1,666.17
O- 97	Glaciolacustrine plain deposit, sand and silt	100	3.50	358.05	143.22
O-101	Hummocky glaciolacustrine silt deposit, hummocks usually caused by permafrost	100	2.76	282.48	112.99
O-107		100	1.48	151.14	60.45

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yd.^{3}) Available
O-108	Glaciolacustrine silt deposit, rolling plain topography	100	2.65	270.60	108.24
O-153	Gravelly or sandy till ridges	8		0.70	0.04
O-161		8		2.11	0.11
	Bedrock - limestone of unit 21 (good)				
	- dolomite of unit 15 (good)				
	- limestone of unit 25 (good)				
	- dolomite of unit 17 (good)				
	- sandstone of unit 24 (fair)				
				I. TOTAL	8,208.63
	II. Franklin Mountains				
O- 4	Glaciofluvial outwash plain deposit, gravel	50	3.62	190.57	76.22
O- 12		50	0.16	8.16	3.26
O- 46		50	0.19	10.20	4.08
O- 13	Glaciofluvial terrace deposit, gravel	80	0.19	16.20	8.10
O- 47	Glaciofluvial gravelly ridge and hummocky deposit	50	1.17	61.54	43.07
O- 57	Alluvial plain deposit, gravel and sand	30	2.14	66.30	26.52
O- 58		30	4.55	141.10	56.44

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yd.^{3}) Available
O- 50	Alluvial fan deposits (many other	25	0.39	9.68	4.84
O- 93	alluvial fan deposits occur in McConnell	25	0.39	9.68	4.84
O- 94	Range and are too small to be indicated	25	0.39	9.68	4.84
O- 95	on the map)	25	0.39	9.68	4.84
O-109	Hummocky glaciolacustrine sand and silt deposit, hummocks usually caused by permafrost	100	1.09	111.54	44.61
O-113	Glaciolacustrine plain deposit, silt	100	2.03	206.91	62.07
O-121		100	3.19	326.37	97.91
O-122		100	5.64	576.84	173.05
O-154	Gravelly and sandy till ridges	8		1.05	0.84
O-160		8		2.46	0.12

Bedrock – limestone of unit 21 (good)
- dolomite of unit 8 (good)
- dolomite of unit 9 (good)
- sandstone of unit 5 (good)
- sandstone and conglomerates of unit 4 (good)
- dolomite and sandstone of unit 1 (good)
- limestone breccia of unit 16 (fair)

II. TOTAL 615.65

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yd.^{3}) Available
	III. Blackwater Lake - Fish Lake Area				
O- 3	Glaciofluvial ridge deposit, gravel	50	0.58	30.77	21.53
O-131		50	0.47	24.65	17.25
O-156		50	0.54	28.39	19.87
O- 15	Hummocky glaciofluvial deposit, gravel	50	0.82	43.01	30.10
O-125	Esker ridges of sand and gravel			31.68	25.34
O-126				8.44	6.75
O-127				1.35	1.08
O-128				0.90	0.72
O-129				1.35	1.08
O-130				8.44	6.75
O-132				6.33	5.06
O-155				0.45	0.36
O-156				1.40	1.12
O-158				0.60	0.48
O-157	Till, with some glaciofluvial ridges of sand and gravel	100	10.50	1,074.15	107.42
O- 51	Alluvial plain deposit, gravel and sand	8	2.41	22.31	2.23
O-152	Gravelly or sandy till ridges	8		2.45	0.12
	Bedrock - limestone of unit 21 (good)				
				III. TOTAL	247.26

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yd.^{3}) Available
	IV. Great Bear Glaciofluvial Area				
O- 19	Glaciofluvial outwash plain deposits,	50	10.74	565.59	226.23
O- 26	gravel and sand	50	0.74	38.93	15.57
O- 29		50	3.97	209.10	83.64
O- 31		50	2.41	126.99	50.79
O- 36		50	15.44	813.62	325.44
O- 37		50	0.39	20.57	8.22
O- 38		50	1.36	71.74	28.69
O- 45		50	0.43	22.61	9.04
O- 44	Glaciofluvial plain deposits, some ridges, gravel	50	3.46	182.41	100.32
O- 16	Glaciofluvial ridge deposits of	50	4.59	243.61	170.52
O- 32	sand and gravel	50	1.01	53.21	37.24
O- 42		50	1.55	81.94	57.35
O- 43		50	1.63	86.02	60.21
O- 33	Glaciofluvial hummocky deposit, gravel with some glaciofluvial ridges, sand and gravel	50	5.13	270.47	189.32
O- 27	Glaciofluvial hummocky, ridged deposit,	50	0.19	10.20	7.14
O- 28	gravel and sand	50	0.82	43.01	30.10
O- 23	Glaciofluvial hummocky, ridged deposit,	50	37.57	1,979.82	692.93
O- 24	gravel and sand; 5 - 15% of the area is	50	2.65	139.40	48.79
O- 25	peaty organic material, possible	50	18.12	955.06	334.27
O- 35	permafrost	50	63.21	3,330.47	1,165.66

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yd.^{3}) Available
O- 34	Glaciofluvial hummocky deposit,	50	0.54	28.73	20.11
O- 41	gravel	50	1.59	83.98	58.78
O- 30	Glaciofluvial gravelly outwash; 5 - 15% of the area is peaty organic material, possible permafrost	50	2.37	124.95	43.73
O- 40	Glaciofluvial terrace deposit, gravel and sand	50	4.43	233.58	93.43
O- 39	Glaciofluvial outwash, channelled, gravel	50	3.61	190.57	76.22
O- 16	Esker ridges, gravel and sand			1.80	1.44
O- 23				3.60	2.88
O- 25				4.50	3.60
O- 35				0.90	0.72
O- 36				0.30	0.24
O- 39				0.65	0.52
O- 40				126.72	101.37
O- 42				18.48	14.78
O- 43				8.44	6.75
O-135				1.32	1.05
O-136				17.94	14.35
O-137				8.96	7.16
O-138				1.05	0.84
O-139				5.27	4.21
O-140				2.11	1.68
O-141				4.22	3.37
O-142				7.38	5.90
O-143				14.67	11.73
O-144				0.90	0.72

	Description & Material	Thickness (ft.)	Area (sq. mi.)	Volumes Total	(Million yd.^{3}) Available
O-134	Esker ridge, gravel, sand and till			8.44	6.75
O- 54	Alluvial plain deposit, sand and gravel	30	9.65	299.00	119.60
O- 55	Alluvial terrace deposits, sand	30	0.89	27.70	11.08
O- 56	and gravel	30	0.39	12.10	4.84
O-114	Glaciolacustrine plain deposits,	100	0.39	39.93	15.97
O-115	sand and silt	100	0.70	71.72	28.68
O-145 to O-150	Moraine ridge complex			1.79	0.09
O-151	Morainal straited plain deposit of till with sandy glaciofluvial hummocks	100	2.37	242.55	12.12
O-159	Moraine hummocky deposits, gravel, sand and till	100	4.90	501.27	25.06
	Bedrock - none				
				IV. TOTAL	4,341.24

Total natural granular materials resource estimate: 13,412.78 million cubic yards

Appendix A

Sources of Information

American Geological Institute
1960: Glossary of geology and related sciences; Am. Geol. Institute.

Bostock, H. S.
1948: Physiography of the Canadian Cordillera, with special reference to the area north of the fifty-fifth parallel; Geol. Surv. Can., Mem. 247.

1969: Physiographic regions of Canada; Geol. Surv. Can., Map 1254A.

Craig, B. G.
1965: Glacial Lake McConnell, and surficial geology of parts of Slave River and Redstone River map-areas, District of Mackenzie, Geol. Surv. Can., Bulletin 122.

Douglas, R. J. W., and Norris, D. K.
1963: Dahadinni and Wrigley map-areas, District of Mackenzie, Northwest Territories, Geol. Surv. Can., Paper 62-33.

Holmes, A. H.
1965: Principles of physical geology, Thomas Nelson and Sons Ltd., London.

Prest, V. K., Grant, D. R., and Rampton, V. N.
1967: Glacial Map of Canada; Geol. Surv. Can., Map 1253A.

Ripley, Klohn, and Leonoff Alberta Ltd.
1969: Mackenzie Valley pipline report, volumes I and II.

1970: Presentation of test hole log data.

Rutter, N. W., and Boydell, A. N.
in press: Surficial geology and geomorphology of Wrigley, 95O; Geol. Surv. Can. Open File Series .

Sigma Explorations Ltd.
1971: Seismic Shot Hole Data (unpublished).

Shell Canada
1962: Seismic Shot Hole Data (unpublished).

1963: Seismic Shot Hole Data (unpublished).

1964: Seismic Shot Hole Data (unpublished).