

Granular Resource Requirements for Proposed Mackenzie Valley Pipelines:

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Northern Oil and Gas Action Program (NOGAP) Project A4:
Granular Resources Inventory and Management**

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SECTION 4.

TECHNICAL PANEL "B"

**REGIONAL BORROW DEPOSITS
INVENTORIES**

REGIONAL BORROW DEPOSITS INVENTORY: MACKENZIE DELTA REGION

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ABSTRACT

The Mackenzie River Delta Region is typified by a scarcity of granular material resources and any identified sources are remote from established communities in the region. The competition for readily available granular material resources between industrial needs and communities is acute. Major granular material sources have been identified on Richards Island, the Caribou Hills, and in the southern portions of the Tuktoyaktuk Peninsula. The potential sources of granular materials in the Mackenzie Delta Region are of glaciofluvial origin and consist of kames, eskers, outwash plains, terraces, beaches and delta deposits. Fine-grained sources of *aeolian* dunes have also been recorded. Numerous studies and investigations have been undertaken by industry, DIAND, and more recently, by the Inuviluit Land Administration to quantify the extent and location of these granular material resources. A comprehensive database to summarize the various investigations completed to date is currently underway.

During the 1970s and the 1980s, significant quantities of granular resources from the Mackenzie Delta were used in the construction of artificial islands for use in Beaufort Sea offshore oil and gas exploration activities. Uniquely, these same artificial islands may be considered as future sources of granular materials through the implementation of prudent reclamation plans.

Introduction

The Mackenzie Delta Region of the Western Canadian Arctic is typified by the scarcity of granular material resources and any identified sources of granular materials are very remote from established communities. The Mackenzie Delta Region, for the purposes of this paper, encompasses the area bounded by the Richardson Mountains in the west (i.e. Yukon/NWT border), Arctic Red River to the south (i.e. Dempster Highway crossing of the Mackenzie Delta), the Canadian Shield to the east and the Beaufort Sea to the north. This expansive region includes Richards Island and the Tuktoyaktuk Peninsula.

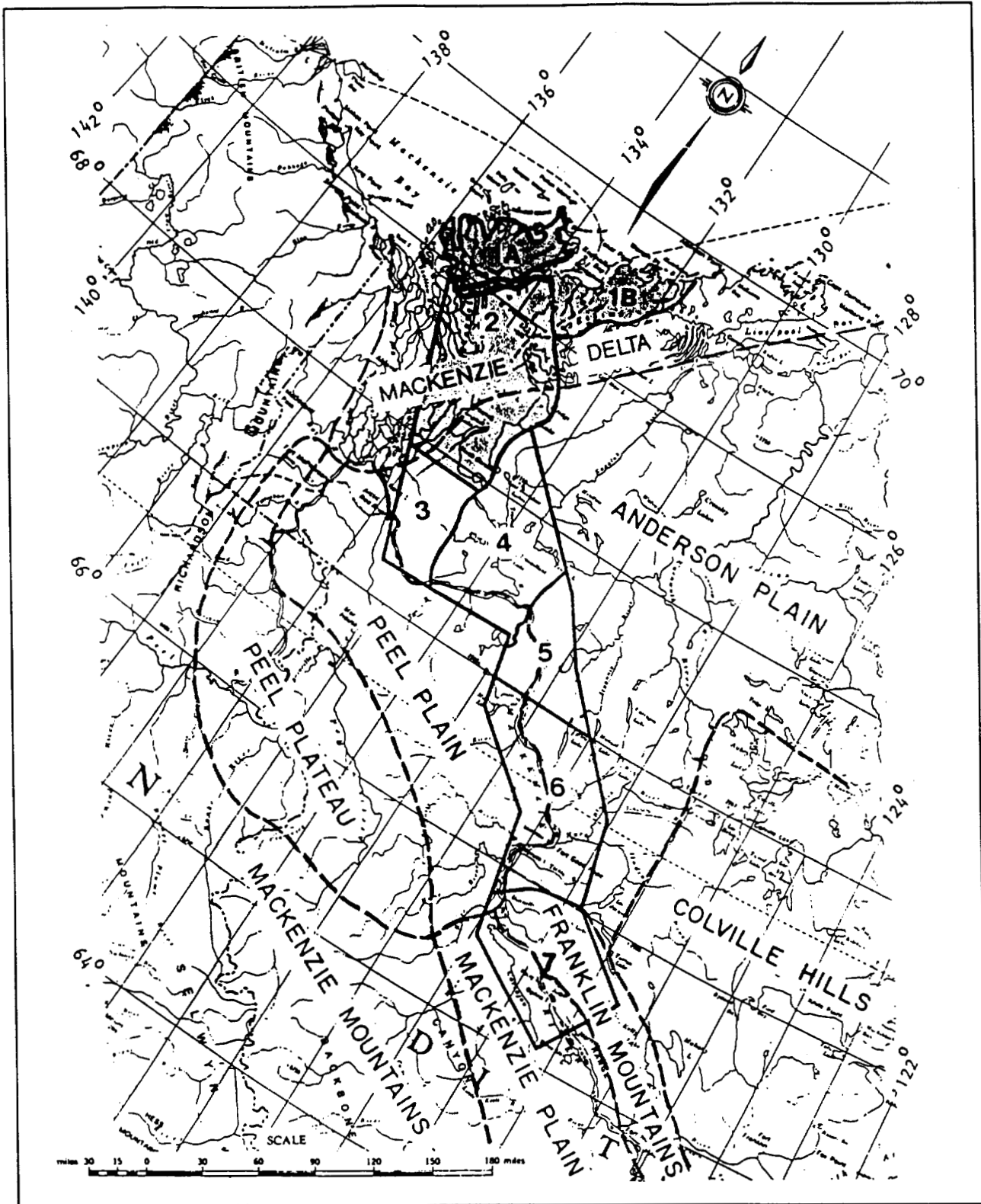
This presentation has been based on the assessment and compilation of data from the various reports on granular material studies and investigations completed in the Mackenzie Delta Region. A complete bibliography of the reports reviewed is provided at the conclusion of this paper. It should be noted that these

reports represent the essential documents considered relevant for a summary of the Regional Borrow Deposit Inventory in the Mackenzie Delta Region.

The Mackenzie Delta Region represents only two of the seven proposed Borrow Management Areas in the Lower Mackenzie Valley Corridor (Figure 1) which were identified in the early 1980s on the basis of physiography, location of existing communities and administrative boundaries (Hardy 1986). The major granular material sources have been identified on Richards Island, the Caribou Hills, and the southern portions of the Tuktoyaktuk Peninsula.

Four northern communities, Fort MacPherson, Aklavik, Inuvik and Tuktoyaktuk are located within the Mackenzie Delta Region. The Inuvialuit Final Agreement (IFA) has granted the Inuvialuit ownership of the granular resources within the major portion (91,000 km²) of the Western Arctic which includes much of the Mackenzie Delta Region. The Inuvialuit Land Administration (ILA) is responsible for the

Figure 1. Mackenzie Delta Borrow Management Areas



management of granular resources on Inuvialuit lands. Indian and Northern Affairs Canada (INAC) will continue to manage the granular resources on the surrounding Crown Lands.

Background

The early work in the investigation and evaluation of granular material resources in the Mackenzie Delta Region was carried out by Roger Brown and Hank Johnston of the National Research Council (NRC) during the planning, development and construction of the new town of Inuvik and its related infrastructure in the 1950s. Due to the scarcity of granular materials within reasonable access of the proposed Inuvik townsite, construction aggregates were produced from quarried and crushed limestone bedrock from the DPW Quarry located on the eastern shoreline of Campbell Lake.

During the next decade, the 1960s, generic sources of granular materials were identified in the Mackenzie Valley and Delta Regions as part of the surficial geology and terrain mapping activities by E.B. Owen, V.N. Rampton and G.V. Minning of the Geological Survey of Canada (GSC). This mapping work by GSC served as an important and valuable foundation for future studies and investigations for granular materials conducted by industry and government agencies.

One of the first detailed airphoto interpretation exercises to identify and delineate potential sources of construction materials in the Mackenzie Valley and the upper (southern) reaches of the Mackenzie Delta was carried out by Jack Mollard of J.D. Mollard and Associates Ltd. This work was carried out in 1969 and 1970 for the Mackenzie Valley Pipe Line Research Limited as a part of the initial feasibility studies for the Mackenzie Valley Oil Pipeline route from Prudhoe Bay, Alaska to the NWT/Alberta border. Subsequently, in 1971-72 J.D. Mollard and Associates completed an airphoto interpretation of the Mackenzie Delta Region (Elliot Creek to Richards Island and Travaillant Lake to the NWT/Yukon border) for Canadian Arctic Gas Study Limited's proposed Mackenzie Valley gas pipeline project.

From these modest beginnings, as the "World Oil Shortage" crisis developed in the 1970s to the early 1980s, numerous and extensive granular material investigations were undertaken by private industry resource development groups and government

agencies, primarily under the direction of the Department of Indian and Northern Affairs (DIAND). The industry groups, who had significant interests in the development of energy resources in the Mackenzie Delta Region with parallel demands for granular materials, included Esso Resources Canada Limited, Shell Canada Resources Limited, Gulf Canada Resources Limited, Canadian Arctic Gas Pipelines Ltd., Mackenzie Oil Pipe Line Research Ltd., Maple Leaf Pipe Line Group (precursor of Foothills Pipe Lines), Beaufort Delta Pipeline Group, Polar Gas Pipeline Limited, Northwest Pipeline Study Group, Dome Petroleum Limited, Interprovincial Pipe Line Limited and others.

During the late 1970s and early 1980s, considerable quantities of granular materials were consumed in the construction of artificial islands for offshore oil and gas programs. The majority of these granular materials were extracted from gravel sources on Richards Island during the early period of offshore activities in near-shore, shallow waters. Subsequently, in the latter days of offshore exploration, in deeper water depths, dynamically anchored drill-ships were used. Today, some of these abandoned artificial islands could be considered as a potential source of granular materials, if prudent reclamation procedures are applied.

During the 1980s and early 1990s, the focus of the various studies and investigations of granular material information was directed to issues dealing with aboriginal land claims. In this regard, the work in the Mackenzie Delta Region was primarily directed to the Inuvialuit Final Agreement (IFA). The extensive information available for the Lower Mackenzie Valley has been compiled in a computerized data base by Lorne Bennett for INAC in 1988.

Granular Source Summary

The initial detailed "Stage I - Community Granular Materials Inventory" investigation carried out by Ripley, Klohn, Leonoff International Ltd. (RKL) in 1972-73 for INAC has served as a comprehensive data base for subsequent granular material investigations by numerous groups. The information developed by RKL has been assembled in seven reports, Zones I to VI, identified as: Tuktoyatuk, Tuktoyaktuk Peninsula, Richards Island, Caribou Hills, Aklavik - Inuvik, Fort MacPherson, and Arctic Red River. Subsequent investigations by EBA Engineering Consultants Ltd., Hardy Associates (1978) Ltd., Terrain Analysis and

Mapping Services Ltd. (V.N. Rampton), Golder Associates Ltd., Northern Engineering Services Ltd., Public Works Canada, and Hardy BBT have provided detailed ground truthing and confirmation of selected granular material sources and potential quarry sites in the Mackenzie Delta Region.

The 1991 report published by Hardy BBT, entitled "Evaluation of Granular Resource Potential - Mackenzie Delta Region", which was prepared for INAC, represents a comprehensive compilation of all historically available data from the numerous investigations conducted in the Mackenzie Delta Region. This report has formed much of the basis for this presentation.

The Hardy BBT report itemized a total of 135 potential granular material sources from the total of 292 prospective sites mapped by various investigators in the past. Furthermore, 28 deposits were classified as having excellent or good prospects by virtue of the quality of granular materials which they contain. On the basis of reasonable ground truthing information such as borehole or test pit data, some 38 million cubic metres of granular materials were considered proven quantities of excellent to good quality sources (Class 1, 2, and 3 material).

The 135 potential "good prospects" may represent an additional 139 million cubic metres of "probable" and "prospective" granular material sources in the Mackenzie Delta region. Further investigation of these sites is recommended by Hardy BBT for exploratory work to confirm availability of granular material resources. When all the mapped borrow sources in the Mackenzie Delta Region, 292 in total, are considered as prospective sources of granular materials, the quantity of Class 1, 2 and 3 construction materials is in the order of 1,809 million cubic metres.

A tabulated summary of the granular material borrow sources in the Mackenzie Delta Region are presented in Table 1A and 1B.

Bedrock Quarry Sources

Golder Associates were retained in 1986 by INAC, to evaluate and identify technically feasible quarry sources in the vicinity of the Mackenzie Delta. The rock from these quarry sources would be used in the development of shore protection for port facilities, concrete structures associated with off-shore facilities, or for the construction of artificial drilling islands in

the Beaufort Sea.

A total of six potential quarry sites (Mt. Sitton, Mt. Davies Gilbert, Mt. Gifford/Roche Moutonee, Gull Creek Quartzite, Gull Creek Dolomite, and Delta Outliner) and three other marginal sites were investigated by Golder. The following five grades of rock were considered:

- a) Armour Stone - large blocks of intact and durable rock (in excess of 5 tonnes) that would be used on production structures in deep water to resist wave erosion.
- b) Rip-Rap - smaller blocks of durable rock (1 to 5 tonnes) that would be used to resist wave erosion of shoreline structures and at between -10m and -20m depth on deep water structures and caisson-type structures.
- c) Blast Rock - blocks of intact rock of up to 1 tonne that would be used in filters and in protected-water construction.
- d) General Fill - the lowest grade of rock that would be used as a substitute for gravel; durability is not essential.
- e) Concrete Aggregate - durable, clean and chemically compatible with Portland Cement; crushing and washing would be normal processing.

A total of 116,525,000 cubic metres of quarried rock of various categories were identified as recoverable from the six potential quarry sites in the Mackenzie Delta Region by Golder Associates.

The preliminary and recoverable volumes of quarried rock from the sites investigated by Golder are summarized in Table 2.

The Campbell Pit, located at the extreme northeast end of the Campbell Hills and currently identified as the "town quarry" for Inuvik, is being mined by North Star Service and Construction (Inuvik) Ltd. It is estimated that approximately 1 million cubic metres of rock has been removed from this quarry which represents less than 10 percent of the recoverable reserves in the quarry. The EBA (1976) study recommends that approval be given for the expansion of this quarry as a continued rock source in the immediate Inuvik area.

Table 1A. Mackenzie Delta Region: "Good Prospects" Granular Resource Volumes

SUMMARY OF GRANULAR RESOURCE VOLUMES

MACKENZIE DELTA REGION
GOOD PROSPECTS (,000 CUBIC METRES)

BORROW MAPPING AREA	GRANULAR MATERIAL CLASS	PROVEN	PROBABLE	PROSPECTIVE	TOTAL
1A ILA	1				
	2	13,200	13,200	13,200	39,600
	3				
1A CROWN	1, 2 & 3				
1B ILA	1	600	600	150,000	151,200
	2		29,800	31,900	61,700
	3	800	4,600	4,700	10,100
1B CROWN	1, 2 & 3				
2 ILA	1	400	1,000	1,000	2,400
	2	1,400	9,500	64,000	74,900
	3	15,200	59,000	172,000	246,200
2 CROWN	1				
	2	6,500	26,000	54,000	86,500
	3				
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SUB-TOTAL	1	1,000	1,600	151,000	153,600
ILA	2	14,600	52,500	109,100	176,200
	3	16,800	68,200	181,400	266,400
SUB-TOTAL	1				
CROWN	2	6,500	26,000	54,000	86,500
	3				
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TOTAL	1	1,000	1,600	151,000	153,600
STUDY AREA	2	21,100	78,500	163,100	262,700
	3	16,800	68,200	181,400	266,400
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TOTAL ALL CLASSES:		38,900	148,300	495,500	682,700

Table 1B. Mackenzie Delta Region: "All Borrow Sources" Granular Resource Volumes

SUMMARY OF GRANULAR RESOURCE VOLUMES

MACKENZIE DELTA REGION
ALL BORROW SOURCES (,000 CUBIC METRES)

BORROW MAPPING AREA	GRANULAR MATERIAL CLASS	PROVEN	PROBABLE	PROSPECTIVE	TOTAL
1A ILA	1				
	2	23,800	23,800	23,800	71,400
	3	200	200	200	600
1A CROWN	1				
	2	200	200	200	600
	3	100	1,400	1,400	2,900
1B ILA	1	600	1,300	150,700	152,600
	2		31,300	34,100	65,400
	3	800	162,600	162,600	326,000
1B CROWN	1				
	2		3,800	3,800	7,600
	3		5,200	5,200	10,400
2 ILA	1	400	1,000	1,000	2,400
	2	9,300	35,300	124,000	168,600
	3	23,300	190,000	717,000	930,300
2 CROWN	1				
	2	6,500	26,000	54,000	86,500
	3	10,200	105,000	531,000	646,200
SUB-TOTAL ILA	1	1,000	2,300	151,700	155,000
	2	33,100	90,400	181,900	305,400
	3	24,300	352,800	879,800	1,256,900
SUB-TOTAL CROWN	1				
	2	6,500	29,800	57,800	94,100
	3	10,200	110,200	536,200	656,600
TOTAL STUDY AREA	1	1,000	2,300	151,700	155,000
	2	39,600	120,200	239,700	399,500
	3	34,500	463,000	1,416,000	1,913,500
TOTAL ALL CLASSES:		75,100	585,500	1,807,400	2,468,000

Table 2. Mackenzie Delta Region: "Bedrock Quarry Sites" Recoverable Volumes

BEDROCK QUARRY SITES
RECOVERABLE VOLUMES – (,000 CUBIC METRES)
MACKENZIE DELTA REGION

SITE NAME	RECOVERABLE VOLUMES					
	TOTAL	ARMOUR ROCK	RIP-RAP	BLAST ROCK	GENERAL FILL	CONCRETE AGGREGATE
MT. FITTON	25,000	5,000	5,000	5,000	5,000	5,000
MT. DAVIES GILBERT	25,000	500	1,000	10,000	7,000	6,500
MT. GIFFORD	18,000	400	800	5,000	6,000	5,000
ROCHE MOUTONEE	125	40	30	25	30	
GULL CREEK QUARTZITE	5,400	500	1,000	1,500	2,000	400
GULL CREEK DOLOMITE	28,000	5,600	5,600	5,600	5,600	5,600
DELTA OUTLIER	15,000	600	500	5,000	5,000	4,350
SUB-TOTAL GOOD PROSPECTS	116,525	12,640	13,930	32,125	30,630	26,850
DPW QUARRY	3,500	450	800	1,500	400	350
CAMPBELL PIT	5,000	500	1,000	2,000	1,000	500
TOTAL ALL SITES:	125,025	13,590	15,730	35,625	32,030	27,700