EBA Engineering Consultants Ltd.
Civil, Geotechnical and Materials Engineers

INUVIALUIT SETTLEMENT SAND AND GRAVEL INVENTORY AND RECOMMENDATIONS FOR DEVELOPMENT

AKLAVIK, N.W.T.

PREPARED FOR

INDIAN AND NORTHERN AFFAIRS CANADA

APRIL 1987

48.

INUVIALUIT SETTLEMENT SAND AND GRAVEL INVENTORY AND RECOMMENDATIONS FOR DEVELOPMENT

AKLAVIK

REPORT SUBMITTED TO

INDIAN AND NORTHERN AFFAIRS CANADA

SUBMITTED BY

EBA ENGINEERING CONSULTANTS LTD.

0101-4575

APRIL, 1987

EXECUTIVE SUMMARY

This report presents the results of a study, conducted under the terms of the Inuvialuit Final Agreement, to determine the supply of granular materials and the 20-year demand for granular materials in the community of Aklavik. Development scenarios and recommendations designed to optimize the utilization of resources for the anticipated demand are presented.

The projected 20-year demand for granular materials in the community is approximately 222,000 cubic metres. Fifty-eight percent of the demand is for maintenance of community facilities, the remainder is for local capital projects (92,000 cubic metres).

Granular materials sufficient to meet the forecast demand are not readily available in the immediate Aklavik area. Rock, rock products and general fill are readily available on an annual basis by trucking over winter roads from the foothills of the Richardson Mountains. Higher quality (Class 1 and 2) aggregate is not located in the vicinity of the community, but must be obtained in the Inuvik region. Substantial undeveloped granular resource deposits are located within thirty kilometres of the community. These deposits comprise both general fill and bedrock. Development of a new source of general fill is recommended since it appears to be superior to that now used and is only slightly further from the community. Implementation of a screening facility would result in a much better quality of general fill. The pit-run gravel currently used for road and pad construction contains a substantial number of cobbles and is difficult to work with. Development of a new rock quarry in the Aklavik region should only be considered for a major project with an unforseen large demand. Adequate volumes of rock can be obtained near Inuvik and hauled to Aklavik on an as-needed basis over winter roads.

TABLE OF CONTENTS

1.0 INTRODUCTION

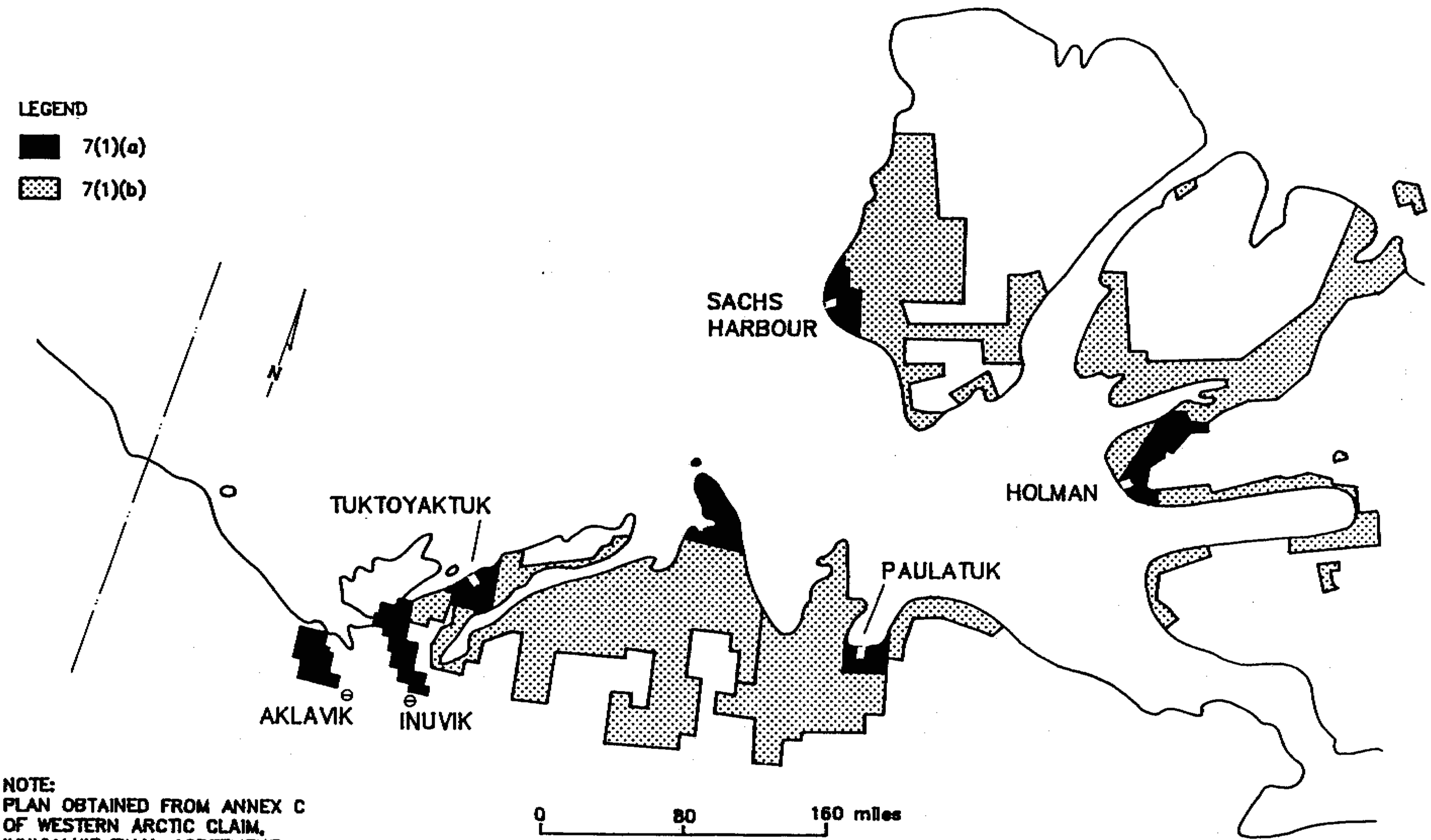
1.1 Background

The Inuvialuit Final Agreement provided that Canada grant to the Inuvialuit, fee simple title to a land quantum of 90,650 square kilometres (35,000 square miles) in the Western Arctic Region. The Agreement further specified that the land be sub-divided into two categories, that with mineral rights and that without. For purposes of classification, the two categories have become known as 7(1)(a) and 7(1)(b) lands, respectively. The former includes 12,950 square kilometres (5,000 square miles) of lands; the latter 77,700 square kilometres (30,000 square miles). The 7(1)(a) lands are generally located adjacent to each of the six communities (Aklavik, Holman, Inuvik, Paulatuk, Sachs Harbour and Tuktoyaktuk, Figure 1) considered in the Final Agreement. The 7(1)(b) lands generally surround the 7(1)(a) lands and extend outward from the communities.

The Agreement recognized that most of the proven granular resources of acceptable quality within reasonable distance of the communities were located on Inuvialuit 7(1)(a) lands. In order to ensure that adequate reserves of granular material were maintained at a regulated cost, the Agreement granted control of the 7(1)(a) granular resources to the Inuvialuit, subject to certain provisions.

For purposes of the project described in this report, the provisions concern the supply of, and the demand for, granular resources. Under the terms of the provisions, the Inuvialuit agreed to maintain granular material reserves of appropriate quality sufficient to meet the projected 20-year demand as determined by the Inuvialuit Land Administration [ILA] and appropriate levels of government . The demand for granular materials was to be formed on the basis of estimates of requirements in each community.

In order to ensure that adequate supplies of sand and gravel of appropriate quality remained available within reasonable distance of the communities, the provisions stipulated that the supply of granular materials should be priorized according to end use as determined by the 20-year demand. The first priority was established as the need of the community, the second priority is the need of the Inuvialuit and the third priority is the need of others.



NOTE:
PLAN OBTAINED FROM ANNEX C OF WESTERN ARCTIC CLAIM, INUVIALUIT FINAL AGREEMENT

EBA Engineering Consultants Ltd.			PROJECT: GRANULAR RESOURCES INVENTORY AND MANAGEMENT PLAN	
CLIENT: INDIAN AND NORTHERN AFFAIRS CANADA			TITLE: INUVIALUIT LANDS LOCATION PLAN WESTERN ARCTIC AGREEMENT	
DATE 87/02/24	DWN EBR	CHKD BAB	JOB NO. 0101-4575	4575-001

Indian and Northern Affairs Canada [INAC], on behalf of the ILA, has undertaken to develop a granular resources inventory and management plan to fulfill these initial obligations. This report presents the resource inventory as it is currently known together with certain development recommendations fo the community of Aklavik.

1.2 Project Authorization

This study was authorized by Supply and Services Canada [SSC] through Contract No. 25ST.A7134-6-0014, awarded to EBA Engineering Consultants Ltd. [EBA]. The Scientific Advisor for the project was Mr. R. J. Gowan, Geotechnical Advisor for the Northern Renewable Resources Directorate of INAC.

1.3 Project Scope

The project scope, as defined by SSC and INAC in the contract, included the following:

a)Development of granular resource supply models for each of the six communities by examination of all existing reports describing granular material deposits.

b)Development of a granular resource demand model for each community through consultation with private and public sector users.

c)Development of a recommended resource development scenario for each community to ensure reserves are established according to the priorities outlined in the Inuvialuit Final Agreement.

d)Preparation of appropriate development recommendations for those sources with the best development prospects.

The following task was subsequently added to the project through a contract amendment:

e)Development of a geotechnical data base consisting of historic borehole information from the study area.

2.0 EVALUATION OF GRANULAR RESOURCES

2.1 Classification

2.1.1 General

A standard for the classification of granular borrow material does not exist within the study area. The first granular resource inventories in the region, carried out in the early 1970's, classified potential borrow material encountered during exploration according to the Unified Classification System [USC]. However, this general classification proved inadequate because there was no direct reference to the end use of the material.

Several years ago, the Government of the Northwest Territories [GNWT] initiated a classification system whereby potential granular borrow was graded according to its most suitable application. The territorial government's system provided the following five material groups:

- Concrete Aggregate [CA],
- Surfacing Material [SM],
- Base [B],
- Subbase [SB],
- Embankment [E] and
- Rip-Rap.

In 1983, INAC adopted a classification system similar to that presented in the draft Territorial Pits and Quarries Regulations that considered both the USC classification of the material as well as the most suitable end use. This system, modified by INAC, is the basis for all borrow material classification carried out under the current contract.

Materials at prospective borrow sources have been graded into one of the five following classes:

Class 1	Excellent Quality Material,
Class 2	Good Quality Material,
Class 3	Fair Quality Material,
Class 4	Poor Quality Material and
Class 5	Bedrock, Felsenmeer and Talus.

These abbreviated descriptions are elaborated upon in the following subsections of this report.

2.1.2 Class 1

Excellent quality material consisting of clean, well-graded, structurally-sound sands and gravels suitable for use as high quality surfacing materials, or as high quality asphalt or concrete aggregate, with a minimum of processing.

2.1.3 Class 2

Good quality material generally consisting of well-graded sands and gravels with limited quantities of silt. This material will provide good quality base and surface course aggregates or structure-supporting fill. Production of concrete aggregate may be possible with extensive processing, except where deleterious materials are present.

2.1.4 Class 3

Fair quality material consisting generally of poorly-graded sands and gravels with or without substantial silt content. This material will provide fair quality general fill for roads, foundation pads or lay-down yards.

2.1.5 Class 4

Poor quality material generally consisting of silty, poorly-graded, fine-grained sand with minor gravel. These deposits may also contain weak particles and deleterious materials. These materials are considered suitable for marginal general (non-structural) fill.

2.1.6 Class 5

Bedrock of fair to good quality, felsenmeer or talus. Potentially excellent sources of construction material, ranging from general fill to concrete aggregate or building stone if quarried and processed. Also includes erosion control materials such as rip-rap or armour stone.

2.1.7 Summary

The five material classes presented above are summarized in Table 1. For reference purposes, the GNWT's classification system has been correlated in the table with the adopted INAC system.

TABLE 1 GRANULAR MATERIAL TYPES

MATERIAL DESCRIPTION	CLASS	POTENTIAL APPLICATIONS
Excellent quality material consisting of clean, well-graded, structurally-sound sands and gravel suitable for use as high-quality (e.g., runway or roof) surfacing materials, or as asphalt or concrete aggregate, with a minimum of processing.	1	Concrete Aggregate (CA), Surfacing Material (SM)
Good quality material generally consisting of well-graded sands and gravels with limited quantities of silt. This material will provide good quality base and surface course aggregates or structure-supporting fill. Production of concrete aggregates may be possible with extensive processing, except where deleterious materials are present.	2	Concrete Aggregate (CA), Surfacing Material (SM)
Fair quality material consisting generally of poorly-graded sands and gravels with or without substantial silt content. This material will provide fair quality general fill for roads, flexible foundation pads, or lay-down yards.	3	Base (B), Subbase (SB), Embankment (E)
Poor quality material generally consisting of silty, poorly-graded, fine-grained sand, with minor gravel. May also contain weak particles and deleterious materials and are considered suitable only for marginal, general (non-structural) fills.	4	Subbase (SB), Embankment (E)
Bedrock of fair to good quality, felsenmeer, or talus. Potentially excellent sources of construction material, ranging from general fill to concrete aggregate or building stone if quarried and processed. Also includes erosion control materials such as rip-rap or armour stone.	5	Rip-rap, or if processed properly, equivalent to Class 1 or any other class of material.

2.2 Inventory

The calculated volumes of the various types of granular materials available at the examined sources have been divided into various certainty levels, as detailed below. These definitions are consistent with those used by INAC.

2.2.1 Proven

A 'proven' volume is one whose occurrence, distribution, thickness and quality is supported by ground truth information such as geotechnical drilling, test pitting and/or exposed stratigraphic sections. Usually the thickness of material encountered in a borehole is extrapolated to a radius not exceeding 50 metres around the hole.

2.2.2 Probable

A 'probable' volume is one whose existence and extent is inferred on the basis of direct and indirect evidence, including topography, landform characteristics, airphoto interpretation, extrapolation of stratigraphy, geophysical data and/or limited sampling.

2.2.3 Prospective

A 'prospective' volume is one whose existence is suspected on the basis of limited direct evidence, such as airphoto interpretation and/or general geological considerations.

In the context of this project, the uncertainty associated with prospective volumes of granular material varies with the terrain conditions specific to the various communities. For instance, substantial amounts of bedrock are located northwest of the community of Aklavik. Since the bedrock has not been explored in detail, the volume of rock is considered to be prospective. Any exploration would likely result in the prospective volume becoming 'probable' or 'proven'. The situation is very different in the vicinity of Tuktoyaktuk, where granular materials are scarce and landforms are poorly defined. Features that contain 'prospective' volumes of material are often found during detailed investigation to contain little or no useable granular material.

3.0 SUPPLY OF GRANULAR RESOURCES

3.1 General

The amount of information available on the borrow sources in the vicinity of each community varies greatly. This is due in part to the historic level of activity in and around each community, but predominately to the relative supply of acceptable quality borrow within reasonable distance of the community.

Communities whose growth has not been significantly affected by northern petroleum exploration (ie. Holman, Paulatuk and Sachs Harbour) have little formal information regarding the location, size and quality of appropriate borrow sources. As the granular materials demand in general is modest and wholly generated by the community, there is little incentive to undertake borrow material studies provided adequate quantities for current needs exist adjacent to the community. The quality of the borrow materials may not meet desirable standards but this is usually offset by the convenient location. If the borrow performs poorly once in place, it is a simple matter to obtain more material and improve the deteriorating areas.

Communities whose recent growth can be partially attributed to northern petroleum exploration (Inuvik and Tuktoyaktuk) have greater requirements for granular resources. These requirements usually impact both the quality and quantity of borrow materials . Industrial developments usually require large volumes of higher quality material.

The extent of identification and investigation of granular material sources has depended upon local demand. Minimal information is available pertaining to borrow reserves in the vicinity of Holman, Paulatuk and Sachs Harbour. Transport Canada has conducted airphoto studies for the area adjacent to each community, but the results have not been confirmed by field evaluations. Information pertaining to borrow resources for Inuvik and Aklavik is available , however, extensive exploration work has not been undertaken because developed sources have been sufficient to meet the demands.

Tuktoyaktuk is a unique situation with respect to supply of granular materials Although Tuktoyaktuk has grown substantially over the past 10 years and petroleum resource activities have put unusual demands on granular material resources, semi-continuous granular resource exploration activities have generally failed to prove large deposits of quality material within a reasonable distance of the community.

The supply of granular resources for the six western Arctic communities was determined summarizing existing data from site investigations, airphoto interpretation and field reconnaissance of prospective sources. These estimates were made by combining the areal extent of the sources (aerial photography and field measurements) with the stratigraphy determined from test pits and boreholes within the source.

The accuracy of the estimates may not accurately reflect the true situation as detail is lacking for certain sources. Some sources have no ground truthing or very few boreholes and test pits and the depth to which the investigations were completed was often insufficient to reasonably represent the extent of the individual materials within a source. Testing of samples for moisture content or grain size analysis was not necessarily carried out consistently and so designation of a certain class of material to a particular source may be based only upon visual soil description.

Source-by-source descriptions and estimated material volumes are located in the Supply appendix. The following sections describe the supply of granular resources situated on or near 7(1)(a) and 7(1)(b) lands adjacent to the community of Aklavik.

3.2 Aklavik

3.2.1 General

The community of Aklavik is situated within the western half of the low-lying Mackenzie Delta. Due to its location in the delta, significant deposits of suitable granular materials are not available within the immediate vicinity of the community. However, substantial sources of granular material are located 18 km east of Aklavik on the flank of the Richardson Mountains.

The Richardson Range is predominantly shale and competent sandstone of Jurassic and Cretaceous age. Bedrock outcrops are prospective sources of Class 5 granular material.that are undeveloped. Complementing the Class 5 potential of the area are several largely unexplored outwash and alluvial deposits that are considered very suitable for general community use.

A complete description of the granular resources located within the community's region is presented in the following sub-sections.

3.2.2 Class 1

Study of the sources in this region revealed no proven, probable or prospective volumes of Class 1 material.

3.2.3 Class 2

Same as Class 1.

3.2.4 Class 3

Of the sources studied only Source 455 and 467 had significant volumes of probable and prospective Class 3 material (Table 2). Source 455 has a probable and prospective volume of 500,000 cubic metres while 467 has a probable and prospective volume of 3,000,000 cubic metres. Both of these sources are located approximately 24 kilometres from the town. A study by Hardy Associates (Hardy,1976) has indicated that a much larger volume; 15,300,000 cubic metres may be projected for Source 467. This was based on an extraction depth of 10 metres Only minimal ground truthing (pits to 2 metres and exposures) has been carried out at 467 and therefore this estimate may be generous. The distribution of probable and prospevtive volumes of Class 3 material is shown on Figure 2.

3.2.5 Class 4

No singular sources of Class 4 material were identified in the study.

3.2.6 Class 5

Sources 463, 464, 468 and 469 are potential rock quarries near Aklavik. All of these sources have large volumes of probable and prospective Class 5 material. Source 463 has the smallest estimated volume at 3,000,000 cubic metres; Source 469 has 5,000,000; Source 468 has 10,000,000 and Source 464 has 20,000,000 (Figure 2 and Table 3). All of these sources will require extensive processing to extract the rock. The sources range as far away as 50 km from Aklavik and access will only be available during the winter months on ice or tundra roads.

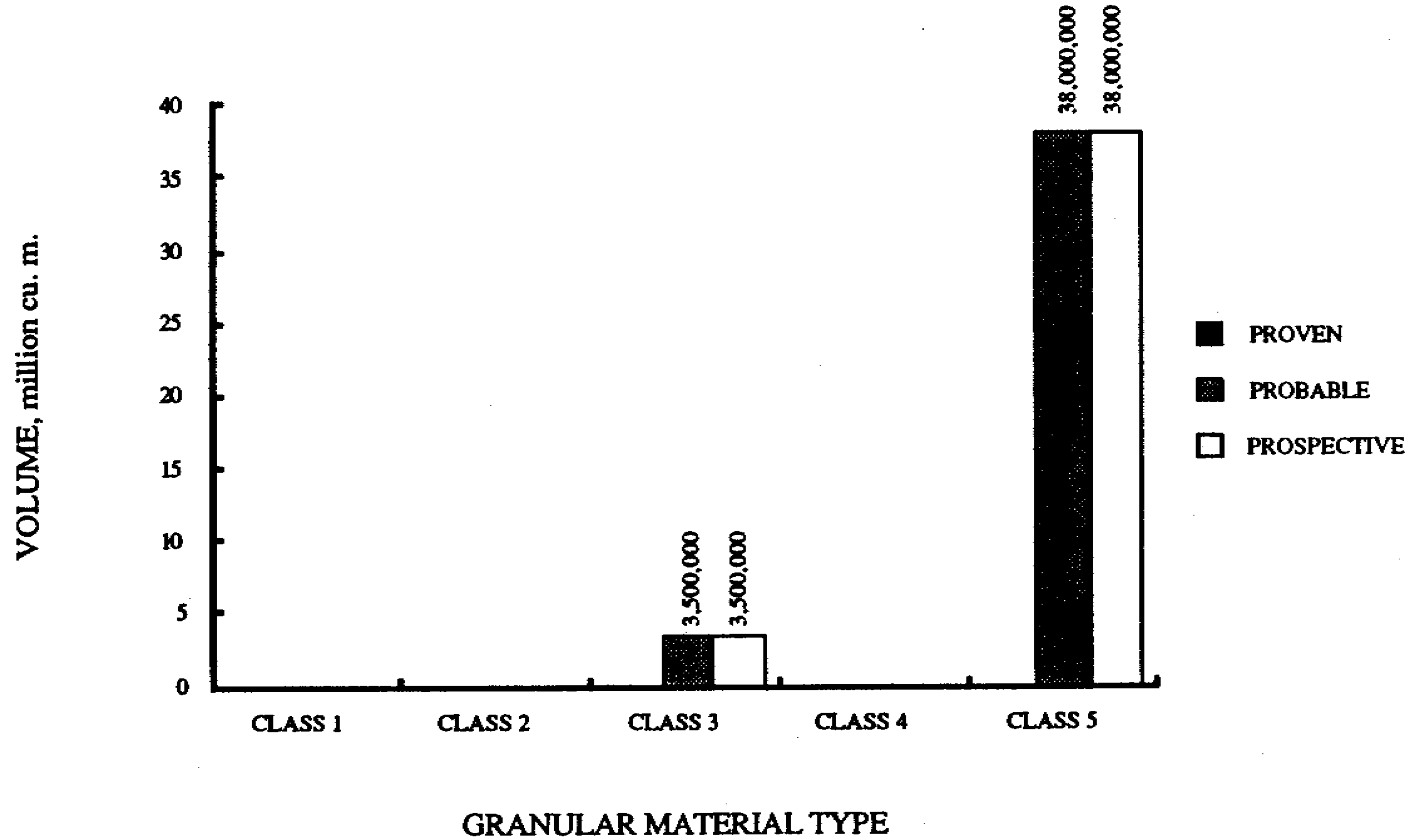


FIGURE 2 SUPPLY OF GRANULAR RESOURCES-AKLAVIK

TABLE 2 DISTANCE TO CLASS 3 GRANULAR RESOURCES-AKLAVIK

SOURCE	DISTANCE (km)	PROVEN (cu. m.)	PROBABLE (cu. m.)	PROSPECTIVE (cu. m.)	CONSIDERATIONS
455	24		500,000	500,000	
467	24		3,000,000	3,000,000	

TABLE 3 DISTANCE TO CLASS 5 GRANULAR RESOURCES-AKLAVIK

SOURCE	DISTANCE (km)	PROVEN (cu. m.)	PROBABLE (cu. m.)	PROSPECTIVE (cu. m.)	CONSIDERATIONS
469	16		5,000,000	5,000,000	Difficult access, poor quality
468	17		10,000,000	10,000,000	Difficult access (Mt. Gifford)
464	51		20,000,000	20,000,000	Difficult access, marginal quality
463	52		3,000,000	3,000,000	Poor quality

4.0 DEMAND FOR GRANULAR RESOURCES

4.1 General

The purpose of the demand model was to determine the requirements for granular materials within the study area for a period encompassing the next 20 years. The needs of the model required that a substantial amount of specific information be obtained. This information consisted of descriptions of proposed types of projects and end users of the granular material, as well as material type and volume requirements.

The first step in compilation of the demand model was the identification of individuals and groups likely to have granular material demands or, alternatively, be concerned with the use of granular materials in general. A list of potential respondents was prepared by identifying the various departments in all levels of government involved with civil-oriented community projects and by forming a list of contractors residing or prominent in each community. A questionnaire was then assembled and distributed.

The questionnaire was designed to determine the need for various quantities of selected types of granular materials and to indicate the end use of the material. The questionnaire recipient was also asked to indicate, if possible, the likely or preferred source of the granular materials for each project or material type. In an attempt to quantify the rate of granular material demand, information was requested to be submitted in four data blocks, each five years in length.

Shortly after submission of the questionnaires, two EBA representatives, Messrs. D. Hayley, P. Eng., and J. Carss, P. Eng., visited each project community, as well as Yellowknife and Cambridge Bay, to meet with recipients of the questionnaires and other representatives of the local community to discuss their specific requirements for granular materials. This not only provided direct contact with most of the users and regulators of granular materials but also permitted the EBA representatives to become familiar with local conditions regarding granular resources.

Recipients of the questionnaire who were not visited were contacted by telephone, where possible, to ensure that all possible input was obtained and to clarify any questions or ambiguities that developed regarding the information sought by the questionnaire. The data collected was then assembled into a computerized data base to facilitate data handling and interpretation.

A large number of the respondents defined material quality in terms other than those in the INAC classification system that was outlined in the questionnaire. Table 1 presents the current interpretation of these various classes of required materials in light of the INAC classification system.

The process of data assimilation indicated that a project requiring granular materials could best be described as belonging to one of three categories: planned capital projects, speculative projects and maintenance. While the demand generated by all three project categories may be somewhat speculative, the 'speculative' projects category specifically refers to large scale projects that may or may not occur within the next 20 years. These projects usually involve a political decision and require a substantial committment of both funding and granular materials and typically involve projects such as airstrips, lengthy highways and construction of infrastructure for the production of oil and gas.

The total demand for granular materials in all of the Western Arctic communities is graphically presented in Figure 8. The total demand for granular materials for the years 1987 to 2007 has been estimated at 17.4 million cubic metres. Ninety-two percent of the demand (16 million cubic metres) is for projects that have been described as speculative, five percent of the demand (0.8 million cubic metres) has been indicated for planned capital projects and three percent of the demand (0.6 million cubic metres) has been designated for maintenance. Most of the demand is created by the various levels of government, with expansion of private industry requiring only three percent of the non-speculative capital project demand.

Despite the attempt of the questionnaire to determine the 20-year demand in 5-year blocks, most data received did not contain any specific 5-year information for non-speculative capital projects beyond 1991. The reasons for this occurrence appear to be two-fold: first, the Territorial Government uses an annually up-dated 5-year plan for budgeting capital expenditures; and second, most of the communities will acquire their basic facilities (ie. schools, nursing stations, government offices, etc.) within the next five years.

Projects designated as speculative appear to require 38 percent of the designated 16 million cubic metres within the next five years and 62 percent thereafter. This break-down is likely as speculative as the projects themselves, since it predominately reflects the desire for the project to occur in the near future. In contrast to the public/private split

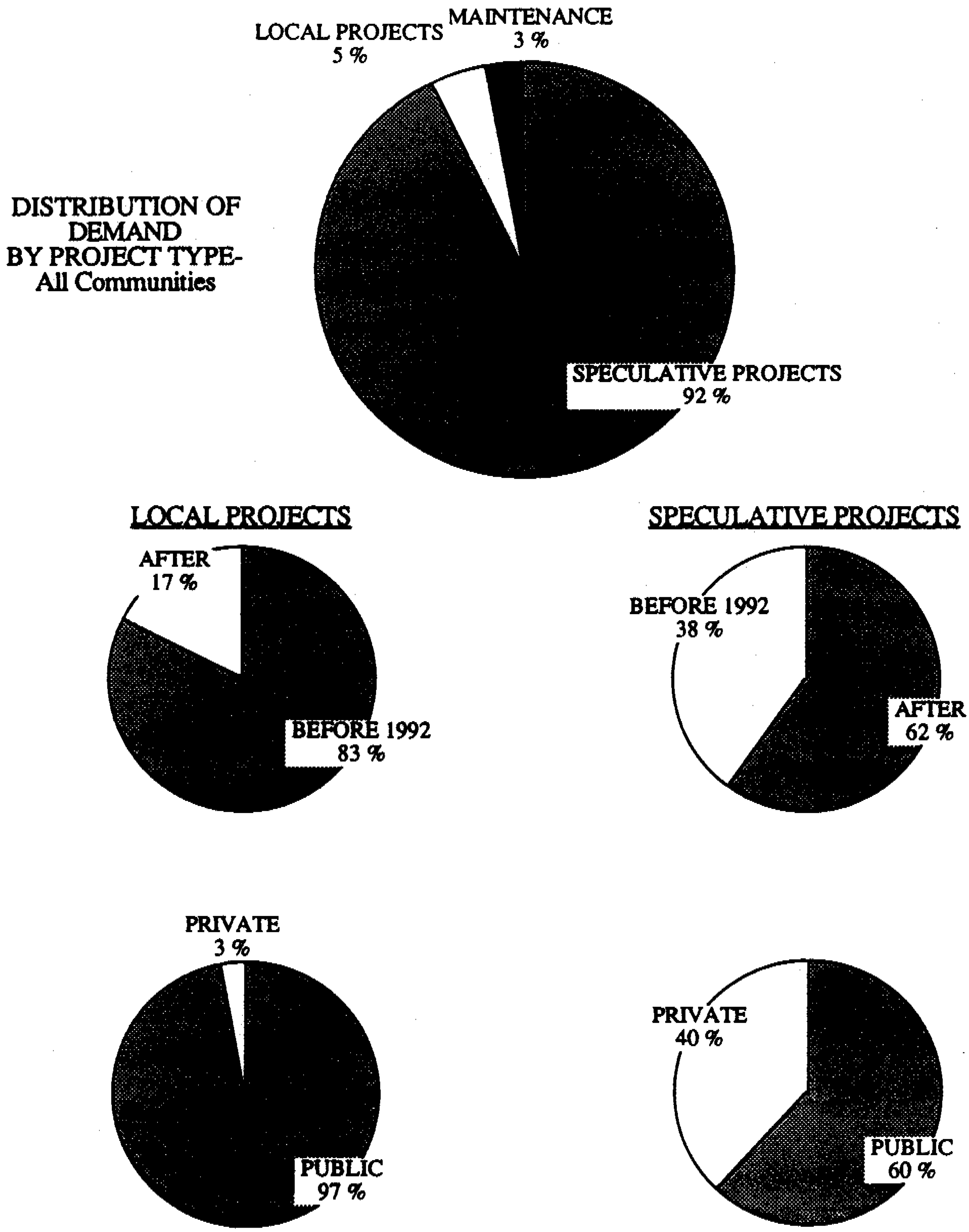


FIGURE 8 GRANULAR RESOURCES DEMAND SUMMARY- ALL COMMUNITIES

on local capital projects, private industry envisages requiring 40 percent (6.9 million cubic metres) of the total speculative demand.

The following subsections present and discuss the demand data collected. Granular material requirements for the projects identified within the area of the community are presented and summarized in the Demand appendix. Figures presenting the required volume of each class of material for Aklavik are contained in the following text.

4.2 Aklavik

4.2.1 General

All of Aklavik's granular material requirements are derived from public projects. The total 20-year demand is estimated to be 221,500 cubic metres of granular materials. Local capital projects will require 129,500 cubic metres; maintenance activities will require 92,000 cubic metres. The entire capital projects volume is required within the next five years. The demand for granular materials in 5-year blocks is summarized in Figure 9; the cumulative demand is presented in Figure 10.

Due to its proximity to the Mackenzie River, Aklavik experiences severe erosion problems on its southern-most edge. This single problem constitutes 45 percent of the granular materials required for the community's identified capital projects. Other local capital projects with significant granular material requirements include a proposed airport rehabilitation project (41 percent) and land development needs (35 percent).

4.2.2 Class 1

Aklavik requires 260 cubic metres of Class 1 granular material. All of the demand is generated between 1987 and 1991, with no apparent requirements for any Class 1 material beyond 1991.

4.2.3 Class 2

The Class 2 granular material requirement is for 4,825 cubic metres. As is the case for Class 1, all material demand is for the years 1987 through 1991, with no requirement for Class 2 material existing beyond 1991.

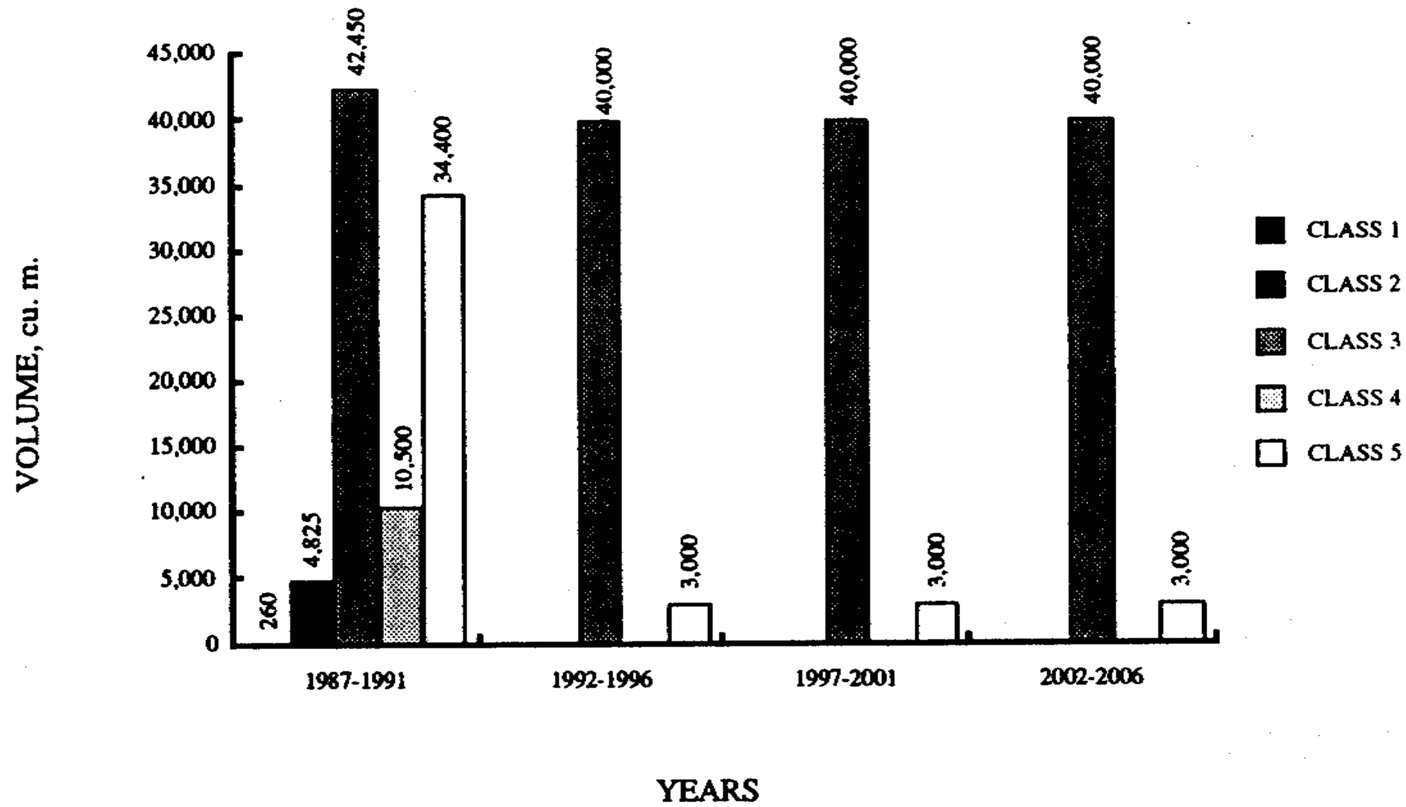


FIGURE 9 DEMAND FOR GRANULAR RESOURCES-AKLAVIK

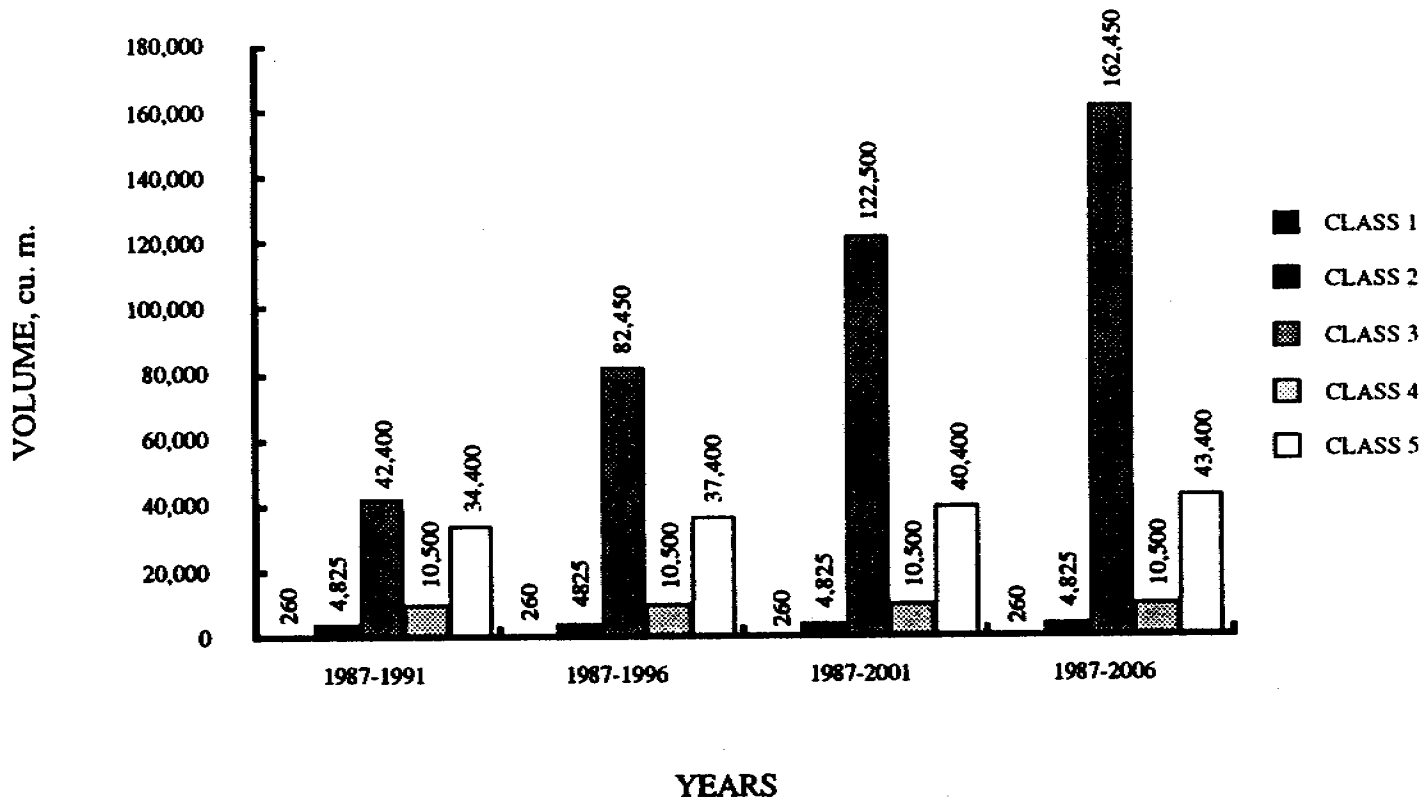


FIGURE 10 CUMULATIVE DEMAND FOR GRANUAR RESOURCES-AKLAVIK

4.2.4 Class 3

Requirements for Class 3 material are 42,450 cubic metres for 1987 to 1991, with each of the subsequent five-year blocks requiring 40,000 cubic metres. The bulk of this demand is for material to be used for road maintenance and other general public projects.

4.2.5 Class 4

Ten thousand, five hundred cubic metres of Class 4 granular material are required during the first five years of the study period, with no apparent requirement for material of this type in the subsequent study years. Most of the demand is generated by land development projects.

4.2.6 Class 5

Aklavik requires 34,400 cubic metres of Class 5 granular material between 1987 and 1991. Requirements during each of the next five-year blocks amount to 3,000 cubic meters. Most of the Class 5 requirements are generated by the airstrip. Over one-half of the 1987 through 1991 demand is for the maintenance and rehabilitation of the strip; the rest of the demand is for material for erosion protection. Demands for material subsequent to 1991 pertain to airstrip maintenance.

The term 'Class 5' is somewhat mis-leading for the demands imposed by airstrip requirements since it essentially refers to Class 1 granular material produced by crushing and screening bedrock.

5.0 DEVELOPMENT SCENARIO

5.1 General

Aklavik currently obtains most of the granular material required for local and capital projects from Willow Creek (an extension of Source 455), located about 18 km W of the community. This source constitutes an active channel that is infilled each year with material transported down-stream by spring run-off. The following winter, the material is excavated and hauled to Aklavik where is it used as fill for the remainder of the year.

Material recovered from this source is generally poorly graded as it is too coarse and has a high fines content. These features make it undesirable for use as road surfacing material; yet better materials are too expensive for routine use. To alleviate the problem, material production through the use of a crusher and suitable Class 5 rock has been suggested. This is an expensive alternative, given the capital and maintenance cost of crushers and the relative remoteness of the Class 5 sources.

The problem with the material from Willow Creek is that of gradation. It is suggested that this could be solved by moving to a different location within the source (to obtain more sand sized material) and implementing a simple screening operation (to remove oversized material). The suggested procedure could economically produce good quality material for general community use.

The recommended granular resource development scenario for the community of Aklavik is summarized in Table 22 and presented in the following subsections.

5.2 Class 1

Aklavik has very nominal requirements for Class 1 granular material, requiring only 260 cubic metres. There are no suitable sources of Class 1 material in the vicinity of Aklavik and it is therefore recommended that this quantity of material be obtained from the superior sections of the YaYa Lake pit, the most substantial source of Class 2 granular material in the area. Alternatively, the required volume could be obtained from Inuvik Source I403, the Campbell Lake Quarry. The alternative approach may be more economical if airstrip maintenance material is being brought into Aklavik from Inuvik, concurrent with the demand for Class 1 material.

TABLE 22 GRANULAR RESOURCE UTILIZATION-AKLAVIK

MATERIAL		1987-1991	1992-1996	1997-2001	2002-2006
CLASS 1	Demand, cu. m.	260			
	Source(s)	YaYa/I403			
CLASS 2	Demand, cu. m.	4,825			
	Source(s)	YaYa/I407/I403			
CLASS 3	Demand, cu. m.	42,450	40,000	40,000	40,000
	Source(s)	467	467	467	467
CLASS 4	Demand, cu. m.	10,500			
	Source(s)	467			
CLASS 5	Demand, cu. m.	34,400	3,000	3,000	3,000
	Source(s)	I402 (3,100)	I402	I402	I402
	Source(s)	468 (31,300)			

NOTES:

1. The Aklavik region has no sources of Class 2, 3 or 4 granular material. Required material will have to be obtained from the Inuvik area.
2. Source 467 has not been explored to date, but appears to be an excellent source of Class 3 material and superior in quality to that now being used (Source 455; Willow Creek).
3. The Aklavik region has considerable Class 5 granular resources; however, at present only rip-rap sized material is available. Unless crushing facilities are in place at Aklavik, Class 5 material processed to Class 1 gradation can only be obtained at Inuvik Sources I402 (Transport Canada pit) or I403 (Campbell Lake Quarry).

5.3 Class 2

As is the case for Class 1 material, there are no suitable sources of Class 2 granular material located in the immediate vicinity of Aklavik. It is therefore recommended that the required volumes of material be obtained either at the YaYa Lake pit or at Source I407, located 61 kilometres down river from Inuvik. As was the case for the Class 1 material, some economy may be realized if material can be obtained from Inuvik Source I403 (Campbell Lake Quarry). The latter scenario results in some high-grading; however, economics should prevail since the required volumes are modest and there are no local sources of the material.

5.4 Class 3

The use of local Source 467 for Class 3 granular material recommended. This source is located up-hill from an existing pit (Source 455),and is a terrace deposit. While no ground truthing information exists, 467 appears to contain a substantial volume of Class 3 granular material, superior in quality to that currently existing at 455 and should meet Aklavik's projected requirements in a satisfactory manner.

5.5 Class 4

Source 467 is also recommended as a source of Class 4 granular material since no acceptable sources of Class 4 material exist in the vicinity of Aklavik. This results in some high-grading, but it will likely be economical to obtain Class 4 borrow from 467 given the volumes of material that will be extracted from the source to meet the Class 3 demand.

5.6 Class 5

The Class 5 granular material demand comprises rip-rap and concrete aggregate sizes. The latter can only be obtained with processing and it is recommended that small volumes of airstrip maintenance aggregate be obtained from Source I403, the Transport Canada pit near Inuvik. Rip-rap sizes for erosion protection projects or large volumes of processed Class 5 material can be produced from nearby Mt. Gifford, Source 468. If the demand for well-graded Class 5 material increases to the point that a crusher is justified, all Class 5 borrow could also be obtained from 468 rather than importing the material from Inuvik.

6.0 BORROW SOURCE DEVELOPMENT RECOMMENDATIONS

6.1 General

The following sections present guidelines and recommendations for developing a management plan.

These recommendations have taken into consideration information presented in the Environmental Guidelines: Pits and Quarries Handbook (Indian and Northern Affairs Canada, 1983), and the draft Territorial Lands and Public Lands Pits and Quarries Regulations. The ILA currently do not have regulations governing pits and quarries, but generally follow the guidelines suggested in the above documents.

6.2 Plan Objectives

Site-specific management plans must consider the requirements and constraints of regional borrow demand and availability. Each plan should ensure that economical recovery of quality granular materials is achieved at each pit while minimizing the adverse environmental impact. The environmental impact on the region can be minimized by restricting granular recovery operations to a select number of pits, realizing that maximum extraction from a pit will likely cause a slight rise in material cost. This cost increase must be weighed against the environmental costs associated with high grading the better drained surface materials. This local practice frequently results in numerous smaller pits being worked simultaneously or sequentially. Pit management plans should be developed primarily to maximize the utilization of limited resources and to minimize environmental disturbance.

6.3 Pit Access

Access to sources of granular material should be by the most economical, least environmentally damaging manner. Areas with granular resources located nearby (Inuvik, Holman, Paulatuk and Sachs Harbour) can access certain resources with all weather roads. Areas with distant resources (Aklavik and Tuktoyaktuk) can usually only obtain borrow in the winter by tundra/ice roads or in the summer by barge, if the sources are located adjacent to a waterway.

Summer operations would require construction of temporary access roads from the sources and docking facilities for barges. The construction of these facilities would probably require large quantities of granular materials, and would significantly reduce the recoverable volumes.

6.4 Pit Development

6.4.1 Site Preparation Work

Site preparation should be conducted in advance of excavation to prevent contamination of granular materials. This preparation also should preferably be carried out in winter to minimize disturbance to the surrounding terrain. Snow should be cleared from both the area to be excavated and yard areas and placed so as to minimize subsequent pit infilling by drifting snow. Topsoil consisting of peat and organic soils, while typically scarce, should be stripped where possible and stockpiled or windrowed at the edges of the pit area. Windrows should be placed parallel to slope direction to prevent ponding of surface water during spring, or contamination of granular materials. Inorganic overburden materials should be stripped and placed in separate stockpiles or windrows, with similar consideration of drainage considerations. The stripped materials are to be reserved for reclamation purposes. Disturbed areas must be kept to a practical minimum.

6.4.2 Extraction Methods

Winter recovery operations will normally consist of the ripping of friable frozen granular material and pushing it into temporary windrows or stockpiles for loading. This type of extraction can be conducted with conventional equipment including bulldozers with rippers, loaders, and trucks. Poorly-bonded or friable granular material will usually be located near the surface of deposits that exhibit positive relief. If an insufficient volume of material cannot be obtained through ripping, blasting will be necessary.

Summer operations will typically consist of stripping and windrowing or stockpiling thawed layers of granular material with bulldozers, commencing when thaw has progressed about 0.5 m into the deposit. The cycle of operation is largely dependent on the rate of thawing, and the drainage considerations. This method allows potentially greater annual recovery by progressively increasing the amount of thawed material, and it may enhance drainage of the material in stockpiles or windrows.

Experience has shown that winter excavation of frozen stockpiles windrowed the previous summer, may be just as difficult as winter excavation directly from the borrow source unless the stock pile process results in a significant reduction in natural moisture content. Moisture reduction from 10 percent in situ to 5 percent in a stockpile has been achieved by use of conveyors during favourable summer conditions (Hayley and MacLeod, 1977). Frozen gravel stockpiles with a moisture content less than 5 percent are usually sufficiently friable for direct loading without ripping.

Drilling and blasting of frozen ground in the winter has proven cost effective for larger operations. The techniques developed and used extensively at Prudhoe Bay, Alaska, is to remove gravel in lifts 5.5 m thick, by drilling shot holes 6 m deep on a 3 m pattern. Load factors are typically 0.9 kg of ANFO explosive per cubic metre of gravel to create manageable size chunks. Typical specifications for Alaska winter construction restrict the size of frozen gravel chunks to 200 mm.

6.4.3 Treatment of Massive Ice

Logistical constraints caused by massive ice during summer development of YaYa Lake pit are described by Hayley and MacLeod (1977). Where practical, the extent of massive ice in a prospective deposit should be defined prior to pit development. The development plans should include methodology for coping with ice bodies as they are encountered.

Where practical, large bodies of massive ice should be avoided. Thin, or less extensive massive ice within the granular material at higher elevations should be excavated and wasted, or exposed to permit thawing during the summer months. Drainage must be considered with either method of disposal.

Relatively thin layers of massive ice at depth may be permitted to thaw provided all overlying recoverable granular materials are removed during one extraction season. Formation of thaw ponds as ice melts during the summer is inevitable in this situation. Appropriate measures must be taken to control drainage and to protect, and ensure access to, adjacent recoverable granular materials.

It may be desirable to identify and preserve thicker ice bodies at depth. If this material thaws it is likely to prevent recovery of adjacent materials, or result in major disturbance of the surrounding areas. A minimum cover of 1.5 m of granular material should be left as insulation over massive ice to prevent excessive thawing. Criteria for establishing the minimum thickness of massive ice beds which should be preserved is influenced by topographic relief, thickness and extent of granular materials, and the effect of thaw ponds on surrounding terrain. Operators involved with large extraction operations may simply wish to excavate and waste the ice.

6.4.4 Drainage Considerations

Adequate drainage of pit areas must be maintained to ensure availability of recoverable granular material and to attain required annual extraction rates. Higher moisture contents inhibit thawing, increase excavation costs and reduce material quality. Small amounts of meltwater runoff from ice bonded and thinly ice-lensed granular materials could be allowed to seep into the surrounding terrain. Larger amounts of runoff, from thawing of large massive ice bodies, should be directed to retention ponds or sumps excavated in the pit floor. Where gravity drainage is possible, natural ponds or drainage ditches may be effective at removing water from the site. However, excavated ditches are generally ineffective in areas of high ice content.

It is essential that pit drainage facilities be maintained and updated frequently to ensure that moisture drains away from the working face, and that ponded runoff does not accumulate on recoverable granular material. Where thaw ponds are allowed to form by exposing buried massive ice, or where collection ponds are created, care should be taken to preserve and maintain access to adjacent recoverable granular materials. A development plan to adequately account for pit drainage is particularly important where summer extraction operations are employed.

6.4.5 Waste Material

All lenses of fine-grained material (silts and clays) found within the granular deposit, should be stripped and wasted. Waste material should be stockpiled near the stockpiled overburden for use in pit reclamation. Fine-grained waste material at depth will undoubtedly have high excess ice contents, hence it may be advisable to construct a dyke of drier overburden around waste piles to prevent flow of thawed waste onto surrounding terrain or into pit areas.

6.5 Restoration

Restoration measures are required whether the pit is being abandoned temporarily or permanently. All worked areas should be cleaned of all debris, and graded to remove all topographic irregularities. Where abandonment is temporary, positive drainage away from existing faces and access routes must be provided by grading or by ditching to ensure the future recovery of remaining materials. Berms should be constructed at the top of pit faces, if necessary, to prevent surface runoff from entering the pit area.

Prior to permanent abandonment, the edges of worked areas or pit walls should be recontoured to blend into the surrounding terrain. All obstructions to natural drainage should be removed and any slopes graded to prevent runoff from channelling and downcutting. If thaw ponds and lakes and massive ground ice are common in the area, flooding of pits is an acceptable, and frequently inevitable, method of restoration. Areas which are not likely to become flooded should be smoothly graded and covered with stockpiled overburden and organics.

Revegetation may be feasible in certain areas by redistributing stockpiled organic topsoil and peat over the graded slopes of areas unlikely to be flooded, and by seeding or allowing reinvasion of natural vegetation, depending on the nature of the site and the quality of the topsoil. Fine-grained overburden soils are generally adequate for surface reclamation, however, the amount of naturally-occurring topsoil is very limited at some sites. The fertility of these soils may require enrichment for revegetation.

6.6 Site Specific Development Recommendations

6.6.1 General

The site specfic development plans presented in the following report subsections pertain to selected sources that are prominent in the development scenario proposed for the community of Aklavik. The level of detail presented for each source reflects the amount of information available for a particular deposit.

6.6.2 Source 467

Access

The source is located on the edge of a stream valley 24 kilometres west of the community of Aklavik and is readily accessible by an ice/tundra road in the winter.

Site Preparation

The site is currently undeveloped. Any site preparation work should be conducted in accordance with the recommendations presented in Section 6.4.1 of this report.

Extraction Methods

Extraction of granular material from the source should be accomplished on an as-needed basis by excavating material that has thawed and drained during the previous summer. If large volumes of granular material are required, ripping of frozen ground and temporary stockpiling will likely be necessary. In addition, it is likely that a substantial amount of oversized material will be present in the granular material excavated. Implementation of a screening operation to remove unwanted sizes should be considered.

Drainage Considerations

The pit floor should be graded where possible, to ensure gravity drainage of surface and melt water. Water should be collected and discharged in an environmently acceptable manner. Good drainage enhances seasonal thaw and limits the ingress of water.

Treatment of Massive Ice

Massive ground ice may be encountered at the source. Depending on the extent and distribution of the ice, it may either be excavated and wasted or covered with an insulating blanket of granular material and left in place. More detailed information on dealing with ground ice is contained in Section 6.4.3 of this report.

Restoration

When the pit becomes partially exhausted, restoration can be undertaken concurrent with further borrow recovery. Restoration should be conducted in accordance with the recommendations presented in Section 6.5 of this report and should primarily consist of roughening the surface and contouring the abandoned areas of the pit to ensure adequate drainage occurs and that large volumes of water are not trapped within the pit area. Revegetation can be considered as pit abandonment proceeds.

6.6.3 Source 468

Access

Source 468 constitutes Mt. Gifford and is located 17 kilometres WSW of the community. It is accessible during winter periods from the ice/tundra road that is constructed to Source 455.

Site Preparation

The quarry is currently undeveloped Any site preparation activities should be conducted in accordance with the recommendations presented in Section 6..4.1 of this report.

Extraction Methods

Extraction of granular construction material from the source can readily be accomplished on an as-needed basis by drilling, blasting and excavating. It is recommended that extraction of granular material be conducted in accordance with the recommendations presented in a previously conducted quarry study for Inuvik (EBA Engineering Consultants Ltd., 1976).

If amour stone is extracted from either quarry, it is suggested that the recommendations presented in EBA (1976) be examined in detail.

Drainage Considerations

The pit floor should be graded where possible, to ensure gravity drainage of surface and melt water. Water should be collected and discharged in an environmently acceptable manner. A pit floor slope of at least 1 percent is recommended.

Restoration

The final shape of a quarry is expected to be a clean, flat-bottomed site, with steep benched sidewalls and a positive drainage system. The overall slope of the sidewalls should not exceed 45 degrees. Revegetation of the quarry floor is not considered practical although revegetation of spoil areas can be considered.

7.0 RECOMMENDATIONS

7.1 General

The recommendations contained in the following subsections pertain to additional work required to confirm the quantity and quality of granular resources contained in sources that are prominent in the development scenario proposed for the community of Aklavik and are presented with regard to all information collected and reviewed during the study.

In summary, the recommendations concern the effort necessary to confirm the product available from bedrock sources and the volume and quality of material available from granular sources.

7.2 Source 467

Source 467 is unexplored at present although it has the potential to supply a substantial portion of Aklavik's Class 3 and Class 4 (and possibly Class 2) material demand. At projected demand rates, the source should last for many years, but it is recommended that a limited geotechnical drilling program be undertaken at the site in an effort to determine and prove the volume and quantity of granular material that can be extracted from the deposit over the next 20 years.

7.3 Source 468

Source 468 constitutes a substantial undeveloped source of sandstone bedrock and can be utilized as a source of granular borrow material. However, if speculative projects such as production of erosion protection materials for offshore petroleum production facilities occur, the source should be evaluated in more detail to determine its potential to supply substantial volumes of large rock blocks.

It is recommended that this be accomplished through a geotechnical/geological drilling program designed to determine the volume and size of rock blocks that could be produced from the deposit.

LIST OF TABLES

LIST OF FIGURES

REFERENCES

AKLAVIK AREA

EBA ENGINEERING CONSULTANTS LTD., 1983a. Evaluation of Potential Sources of Quarry Rock for Marine Structures in the Beaufort Sea Region. Report submitted to the Department of Indian and Northern Affairs, Ottawa, November 1983.

LAWRENCE, D.E., SHNAY, F.G. and VANDINE, D.F., 1972. Granular Resource Inventory- Mackenzie-Aklavik, NTS 107B W1/2. Report prepared by Geological Survey of Canada for the Department of Indian and Northern Affairs, Ottawa, 1972.

LAWRENCE, D.E., SHNAY, F.G., VANDINE, D.F. and THEROUX, L.L., 1972. Granular Resource Inventory- Mackenzie-Aklavik, NTS 107B E1/2. Report prepared by Geological Survey of Canada for the Department of Indian and Northern Affairs, Ottawa, 1972.

RIPLEY, KLOHN & LEONOFF INTERNATIONAL LTD., 1973. Community Granular Materials Inventory- Inuvik, NWT. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, 1973.

R.M. HARDY AND ASSOCIATES LTD. and TERRAIN ANALYSIS AND MAPPING SERVICES LTD., 1976. Granular Materials Inventory: Yukon Coastal Plain and Adjacent Areas. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, 1976.

INUVIK AREA

EBA ENGINEERING CONSULTANTS LTD., 1976a. Geotechnical Evaluation of Granular Material, Mackenzie Delta Area. Report submitted to the Department of Indian and Northern Affairs, Ottawa, March 1976.

INUVIK AREA, cont'd

EBA ENGINEERING CONSULTANTS LTD., 1976b. Evaluation of Potential Rock Quarries: Rocky Hill-Campbell Lake Area, NWT. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, 1976.

EBA ENGINEERING CONSULTANTS LTD., 1983a. Evaluation of Potential Sources of Quarry Rock for Marine Structures in the Beaufort Sea Region. Report submitted to the Department of Indian and Northern Affairs, Ottawa, November 1983.

HARDY AND ASSOCIATES (1978) LTD., 1986. Granular Resource Potential - Lower Mackenzie Valley. Report submitted to the Department of Indian and Northern Affairs, Ottawa, March 1986.

NORTHERN ENGINEERING SERVICES CO. LTD., 1976. Pipeline Related Borrow Investigations (3 volumes). Report submitted to Canadian Arctic Gas Study Limited, November 1976.

RIPLEY, KLOHN & LEONOFF INTERNATIONAL LTD., 1973. Community Granular Materials Inventory - Inuvik, NWT. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, 1973.

RIPLEY, KLOHN & LEONOFF INTERNATIONAL LTD., 1973. Granular Materials Inventory - Zone III, and Zone IV, Zone V, Zone VI (2 volumes). Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, 1973.

TECHMAN LTD., 1976. Preliminary Borrow Source Study, Mackenzie Valley Corridor (4 volumes). Report submitted to Beaufort Delta Oil Project Limited.

TUKTOYAKTUK AREA

BBT GEOTECHNICAL CONSULTANTS LTD., GVM GEOLOGICAL CONSULTANTS LTD., AND TERRAIN ANALYSIS AND MAPPING SERVICES LTD., 1983. Granular Materials Evaluation, Deposits 168 and 211, Tuktoyaktuk, NWT. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, May 1983.

EBA ENGINEERING CONSULTANTS LTD., 1973. Evaluation of Offshore Borrow Resources and Investigation of a Proposed Airstrip Site, Tuktoyaktuk, NWT. Submitted to Imperial Oil Ltd., Frontier Planning Group, Calgary, June 1973.

EBA ENGINEERING CONSULTANTS LTD., 1975. YaYa Granular Resources Study, 1975 (2 volumes). Report submitted to Arctic Petroleum Operators Association (APOA), Calgary, September 1975.

EBA ENGINEERING CONSULTANTS LTD., 1976. Geotechnical Evalaution of Granular Material, Mackenzie Delta Area. Report submitted to the Department of Indian and Northern Affairs, Ottawa, May 1976.

EBA ENGINEERING CONSULTANTS LTD., 1983b. Granular Resource Development and Management Plan for Tuktoyaktuk, NWT. Report submitted to the Department of Indian and Northern Affairs, Ottawa, December 1983.

EBA ENGINEERING CONSULTANTS LTD., 1986 Granular Resource Evalauation, Richards Island, NWT. Report submitted to the Department of Indian and Northern Affairs, Ottawa, December 1986.

EPEC CONSULTING WESTERN LTD., 1982. Dredging and Construction Observations of the Tuktoyaktuk Potable Water Reservoir. Report submitted to the Government of the Northwest Territories, Department of Public Works, Yellowknife, September 1982.

TUKTOYAKTUK AREA, cont'd

R. M. HARDY AND ASSOCIATES LTD., 1977. Granular Materials Inventory, Tuktoyaktuk, NWT. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, August 1977.

R. M. HARDY AND ASSOCIATES LTD., 1978. Geophysical Evalauation of Granular Materials Resources, Tuktoyaktuk, NWT. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, March 1978.

HARDY AND ASSOCIATES (1978) LTD., 1979. Granular Materials Inventory, Phase III, Tuktoyaktuk Harbour, NWT. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, April 1979.

HARDY AND ASSOCIATES (1978) LTD., 1980. Granular Materials Inventory, Tuktoyaktuk, NWT., Sources 160 and 161. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, March 1980.

HARDY AND ASSOCIATES (1978) LTD., 1986. Interim Report- Phase I, Community Granular Management Plan, Tuktoyaktuk, NWT. Prepared for the Government of the Northwest Territories, Department of Public Works Highways Division, Yellowknife, NWT., July 1986.

HARDY BBT LTD., 1986. Interim Report- Phase II, Field Reconnaissance, Community Granular Management Plan, Tuktoyaktuk, NWT. Prepared for the Government of the Northwest Territories, Department of Public Works Highways Division, Yellowknife, NWT., November 1986.

KLOHN LEONOFF CONSULTANTS LTD., 1974. Granular Materials Inventory, Parsons Lake, NWT. Report submitted to Gulf Oil Canada Ltd., October 1974.

MOLLARD, J.D. and ASSOCIATES LTD., 1972. Gravel Inventory Survey, Richards Island and adjacent areas. Report submitted to Arctic Petroleum Operators Association, Calgary, 1972.

PUBLIC WORKS CANADA 1976. Geotechnical Investigation, Mile 970 to Mile 1059, Mackenzie Highway, Volume III. (Combined data 1976-1980), April 1981.

RIPLEY, KLOHN & LEONOFF INTERNATIONAL LTD., 1973. Community Granular Materials Inventory- Tuktoyaktuk, NWT. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, 1973.

RIPLEY, KLOHN & LEONOFF INTERNATIONAL LTD., 1973. Granular Materials Inventory- Zone I, Zone II and Zone III (3 volumes). Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, 1973.

TERRAIN ANALYSIS and MAPPING SERVICES LTD., 1976. Ya-Ya Lake Esker Complex: Site Development and Restoration Plan. Report submitted to the Department of Indian Affairs and Northern Development, Ottawa, October 1976.

THURBER CONSULTANTS LTD., 1981. Tuktoyaktuk Potable Water Reservoir-Geotechnical Report No. 1, Borrow Source and Site Investigations. Report submitted to EPEC Consulting Western Ltd., March 1981.

HOLMAN, PAULATUK AND SACHS HARBOUR AREAS

TRANSPORT CANADA, 1986. Granular Resources- Various northern sites. Letter report prepared for Indian and Northern Affairs Canada, Ottawa, 1986.

SOURCE NUMBER, TEXT REFERENCES AND CROSS REFERENCES

PRIMARY SOURCE NO. OR NAME AND TEXT REFERENCE		CROSS-REFERENCE SOURCE NO. OR NAME AND TEXT REFERENCE	
150	RKL 1973, ZONE 1	157	HARDY 1977
151	RKL 1973, ZONE 1		
152A	RKL 1973, ZONE 1		
153	RKL 1973, ZONE 1	165	HARDY 1977
154	RKL 1973, ZONE 1	166	HARDY 1977
155	RKL 1973, ZONE 1	2.01	HARDY 1986
156	RKL 1973, ZONE 1	T108-112	RKL 1973, TUKTOYAKTUK
157	RKL 1973, ZONE 1	T100-103,150	RKL 1973, TUKTOYAKTUK
158	HARDY 1977	T104,106,107	RKL 1973, TUKTOYAKTUK
159	HARDY 1977	TUK HARBOUR, AIRSTRIP	EBA 1973
160/161	HARDY 1977	TUK HARBOUR, AIRSTRIP	EBA 1973
162	HARDY 1977		
163	HARDY 1977		
164	HARDY 1977		
165	HARDY 1977	153	RKL 1973, ZONE 1
166	HARDY 1977	154	RKL 1973, ZONE 1
167	HARDY 1977	T113	RKL 1973, TUKTOYAKTUK
168	HARDY 1977	168	BBT 1983
169	HARDY 1977	169	HARDY-BBT 1986
170	HARDY 1977		
171	HARDY 1977	25	DPW 1976
172	HARDY 1977	24, 24A, 24B	DPW 1976
173	HARDY 1977	23, 23A, 23B, 23C, 23D	DPW 1976
174	HARDY 1977		
175	HARDY 1977		

PRIMARY SOURCE NO. OR NAME AND TEXT REFERENCE		CROSS-REFERENCE SOURCE NO. OR NAME AND TEXT REFERENCE	
176	HARDY 1977		
177	HARDY 1977		
181	HARDY 1977		
183	HARDY 1977		
184	HARDY-BBT 1986		
211	BBT 1983	211	RKL 1973, ZONE 2
211E	EBA 1986		
214	BBT 1983	2.02	HARDY-BBT 1986
215	EBA 1986	2.03	HARDY-BBT 1986
216	RKL 1973, ZONE 2	216	EBA 1986
216S	EBA 1986		
217	RKL 1973, ZONE 2	217	EBA 1986
217E	EBA 1986		
218	RKL 1973, ZONE 2	218	EBA 1986
218N	EBA 1986		
219	EBA 1986	219	EBA 1986
222	EBA 1986	222	EBA 1976a
300A	RKL 1973, ZONE 3		
301	RKL 1973, ZONE 3		
302	RKL 1973, ZONE 3		
303	RKL 1973, ZONE 3	303; 2.08	EBA 1976a; HARDY-BBT 1986
304	RKL 1973, ZONE 3		
305	RKL 1973, ZONE 3		
306	RKL 1973, ZONE 3		
307	RKL 1973, ZONE 3		

SOURCE NUMBER, TEXT REFERENCES AND CROSS REFERENCES, cont.

PRIMARY SOURCE NO. OR NAME AND TEXT REFERENCE		CROSS-REFERENCE SOURCE NO. OR NAME AND TEXT REFERENCE	
308	RKL 1973, ZONE 3		
309	RKL 1973, ZONE 3		
310A	RKL 1973, ZONE 3		
311	RKL 1973, ZONE 3		
312	RKL 1973, ZONE 3		
313	RKL 1973, ZONE 3		
314	RKL 1973, ZONE 3		
315	RKL 1973, ZONE 3		
316	RKL 1973, ZONE 3		
317	RKL 1973, ZONE 3	2.17	HARDY-BBT 1986
318	RKL 1973, ZONE 3		
319	RKL 1973, ZONE 3		
320	RKL 1973, ZONE 3		
321	RKL 1973, ZONE 3		
322	RKL 1973, ZONE 3	2.16	HARDY-BBT 1986
323A	RKL 1973, ZONE 3	2.15	HARDY-BBT 1986
324A	RKL 1973, ZONE 3	2.14	HARDY-BBT 1986
325	RKL 1973, ZONE 3	2.41	HARDY-BBT 1986
326	RKL 1973, ZONE 3	326A; 2.12	EBA 1976b, HARDY-BBT 1986
327	RKL 1973, ZONE 3	2.33	HARDY-BBT 1986
328A	RKL 1973, ZONE 3	2.39	HARDY-BBT 1986
I400	RKL 1973, ZONE 3		
I401A	RKL 1973, ZONE 3	2.47	
I402	RKL 1973, INUVIK		
I403	RKL 1973, INUVIK		

SOURCE NUMBER, TEXT REFERENCES AND CROSS REFERENCES, cont.

PRIMARY SOURCE NO. OR NAME AND TEXT REFERENCE		CROSS-REFERENCE SOURCE NO. OR NAME AND TEXT REFERENCE	
I404	RKL 1973, INUVIK		
I405A	RKL 1973, INUVIK		
I406	RKL 1973, INUVIK		
I407	RKL 1973, INUVIK	2.13	
455	RKL 1973. ZONE 4		
467	HARDY 1976		
456A	RKL 1973, ZONE 4		
457A	RKL 1973, ZONE 4		
463	HARDY 1976	R24	EBA 1983a
464	HARDY 1976	R25	EBA 1983a
468	HARDY 1976	R27	EBA 1983a
469	HARDY 1976	R26	EBA 1983a
PARSONS LK. 1	KLCL 1974		
PARSONS LK. 2	KLCL 1974		
PARSONS LK. 3	KLCL 1974		
PARSONS LK. 4	KLCL 1974		
PARSONS LK. 5	KLCL 1974		
PARSONS LK. 6	KLCL 1974		
PARSONS LK. 7	KLCL 1974		
PARSONS LK. 8	KLCL 1974		
PARSONS LK. 9	KLCL 1974		
PARSONS LK. 10	KLCL 1974		
PARSONS LK. 11	KLCL 1974		
R28/29	EBA 1976b	R28/29	EBA 1983a
YAYA	EBA 1975		

SUPPLY SUMMARY

AKLAVIK

GRANULAR RESOURCES SUPPLY SUMMARY
Aklavik

SOURCE: 455

LOCATION: 24 km W of Aklavik

REFERENCE(S): RKL 1973,Zone 4

SETTING
River bank

LANDFORM
Flood plain

AREA
1.0 sq km

RELIEF
Level

CONTINUITY
Continuous

DEVELOPMENT CONSTRAINTS
None discernible

WINTER ACCESS
Tundra/ice road

SUMMER ACCESS
None practical

BOREHOLES (#)
None

TEST PITS (#)
4

MOIST. CON. (#)
2

GRAINSIZE (#)
2

	OVERBURDEN	GROUND ICE
TYPE:	Peat, organic silt	None
EXTENT:	All holes	-
THICK.:	Up to 0.6 m	-

POTENTIAL VOLUME, cu. m.: >500,000   RECOVERABLE, cu.m: 500,000

MATERIAL	PROVEN, cu.m. Annual	PROVEN, cu.m. Total	PROBABLE, cu.m. Annual	PROBABLE, cu.m. Total	PROSPECTIVE, cu.m. Annual	PROSPECTIVE, cu.m. Total
CLASS 1						
CLASS 2						
CLASS 3			500,000	500,000	500,000	500,000
CLASS 4						
CLASS 5						

GRANULAR RESOURCES SUPPLY SUMMARY
Aklavik

SOURCE: 456A

LOCATION: 24 km SW of Aklavik

REFERENCE(S): RKL 1973,Zone 4

SETTING
River flood plain

LANDFORM
Series of alluvial fans

AREA
7 sq km

RELIEF
15% grade

CONTINUITY
Continuous

DEVELOPMENT CONSTRAINTS
River envir., wildlife, poor quality

WINTER ACCESS
Tundra/ice road

SUMMER ACCESS
Barge

BOREHOLES (#)
None

MOIST. CON. (#)
None

TEST PITS (#)
1

GRAINSIZE (#)
None

	OVERBURDEN	GROUND ICE
TYPE:	Silt, peat	None
EXTENT:	All holes	-
THICK.:	Up to 0.6 m	-

POTENTIAL VOLUME, cu. m.: 0 RECOVERABLE, cu.m: 0

MATERIAL	PROVEN, cu.m. Annual	PROVEN, cu.m. Total	PROBABLE, cu.m. Annual	PROBABLE, cu.m. Total	PROSPECTIVE, cu.m. Annual	PROSPECTIVE, cu.m. Total
CLASS 1						
CLASS 2						
CLASS 3						
CLASS 4						
CLASS 5						

GRANULAR RESOURCES SUPPLY SUMMARY
Aklavik

SOURCE: 457A

LOCATION: 24 km SW of Aklavik

REFERENCE(S): RKL 1973, Zone 4

SETTING
N/A

LANDFORM
Alluvial fan

AREA
9 sq km

RELIEF
15% grade

CONTINUITY
Continuous

DEVELOPMENT CONSTRAINTS
Wildlife, poor quality

WINTER ACCESS
Tundra/ice road

SUMMER ACCESS
Barge

BOREHOLES (#)
None

TEST PITS (#)
2

MOIST. CON. (#)
None

GRAINSIZE (#)
None

	OVERBURDEN	GROUND ICE
TYPE:	Peat, ice, silt	Lenses, inclusions
EXTENT:	All holes	Intermittent
THICK.:	Up to 1.8 m	Lenses up to 0.3 m

POTENTIAL VOLUME, cu. m.: 0 **RECOVERABLE, cu.m:** 0

MATERIAL	PROVEN, cu.m. Annual	PROVEN, cu.m. Total	PROBABLE, cu.m. Annual	PROBABLE, cu.m. Total	PROSPECTIVE, cu.m. Annual	PROSPECTIVE, cu.m. Total
CLASS 1						
CLASS 2						
CLASS 3						
CLASS 4						
CLASS 5						

GRANULAR RESOURCES SUPPLY SUMMARY
Aklavik

SOURCE: 463

ILA 7(1)(a)

LOCATION: 52 km NW of Aklavik

REFERENCE(S): Hardy 1976; EBA 1983a

SETTING Scree covered ridge top	RELIEF Modest	WINTER ACCESS Tundra/ice road
LANDFORM Ridges	CONTINUITY Continuous	SUMMER ACCESS None
AREA 2.0 sq m	DEVELOPMENT CONSTRAINTS Distance, low quality	

BOREHOLES (#) None	TEST PITS (#) 1+ expos.
MOIST. CON. (#) None	GRAINSIZE (#) 1

	OVERBURDEN	GROUND ICE
TYPE:	None	Unknown
EXTENT:	-	Unknown
THICK.:	-	Unknown

POTENTIAL VOLUME, cu. m.: >>3,000,000 RECOVERABLE, cu.m: 3,000,000

MATERIAL	PROVEN, cu.m. Annual	PROVEN, cu.m. Total	PROBABLE, cu.m. Annual	PROBABLE, cu.m. Total	PROSPECTIVE, cu.m. Annual	PROSPECTIVE, cu.m. Total
CLASS 1						
CLASS 2						
CLASS 3						
CLASS 4						
CLASS 5			3,000,000	3,000,000	3,000,000	3,000,000

GRANULAR RESOURCES SUPPLY SUMMARY
Aklavik

SOURCE: 464

ILA 7(1)(a)

LOCATION: 51 km NW of Aklavik

REFERENCE(S): Hardy 1976; EBA 1983a

SETTING
Rock cliffs

LANDFORM
Roche moutonnees

AREA
2.5 sq km

RELIEF
Up to 150 metres

CONTINUITY
Discontinuous

DEVELOPMENT CONSTRAINTS
Access, fair quality

WINTER ACCESS
Tundra/ice road

SUMMER ACCESS
None

BOREHOLES (#)
None

TEST PITS (#)
Exposures

MOIST. CON. (#)
None

GRAINSIZE (#)
None

	OVERBURDEN	GROUND ICE
TYPE:	None	Unknown
EXTENT:	-	Unknown
THICK.:	-	Unknown

POTENTIAL VOLUME, cu. m.: >20,000,000 **RECOVERABLE, cu.m:** 20,000,000

MATERIAL	PROVEN, cu.m. Annual	PROVEN, cu.m. Total	PROBABLE, cu.m. Annual	PROBABLE, cu.m. Total	PROSPECTIVE, cu.m. Annual	PROSPECTIVE, cu.m. Total
CLASS 1						
CLASS 2						
CLASS 3						
CLASS 4						
CLASS 5			20,000,000	20,000,000	20,000,000	20,000,000

GRANULAR RESOURCES SUPPLY SUMMARY
Aklavik

SOURCE: 467

LOCATION: 24 km W of Aklavik

REFERENCE(S): HARDY 1976

SETTING
Valley edge

LANDFORM
Alluvial fan

AREA
0.7 sq km

RELIEF
Subdued

CONTINUITY
Continuous

DEVELOPMENT CONSTRAINTS
None discernible

WINTER ACCESS
Tundra/ice road

SUMMER ACCESS
None

BOREHOLES (#)
None

MOIST. CON. (#)
None

TEST PITS (#)
Exposure

GRAINSIZE (#)
None

	OVERBURDEN	GROUND ICE
TYPE:	Peat, organic silt	Unknown
EXTENT:	Unknown	Unknown
THICK.:	Up to 0.3 m	Unknown

POTENTIAL VOLUME, cu. m.: >3,000,000

RECOVERABLE, cu.m: 3,000,000

MATERIAL	PROVEN, cu.m. Annual	PROVEN, cu.m. Total	PROBABLE, cu.m. Annual	PROBABLE, cu.m. Total	PROSPECTIVE, cu.m. Annual	PROSPECTIVE, cu.m. Total
CLASS 1						
CLASS 2						
CLASS 3			1,500,000	3,000,000	1,500,000	3,000,000
CLASS 4						
CLASS 5						

GRANULAR RESOURCES SUPPLY SUMMARY
Aklavik

SOURCE: 468

LOCATION: 17 km WSW of Aklavik

REFERENCE(S): Hardy 1976; EBA 1983a

SETTING
North end of escarpment

LANDFORM
Glacially scoured ridges

AREA
70,000 sq m

RELIEF
From 3 m to 30 m

CONTINUITY
Discontinuous

DEVELOPMENT CONSTRAINTS
Access

WINTER ACCESS
Tundra/ice road

SUMMER ACCESS
None

BOREHOLES (#)
None

MOIST. CON. (#)
None

TEST PITS (#)
Exposures

GRAINSIZE (#)
None

	OVERBURDEN	GROUND ICE
TYPE:	None	Unknown
EXTENT:	-	Unknown
THICK.:	-	Unknown

POTENTIAL VOLUME, cu. m.: 10,000,000

RECOVERABLE, cu.m: 10,000,000

MATERIAL	PROVEN, cu.m. Annual	PROVEN, cu.m. Total	PROBABLE, cu.m. Annual	PROBABLE, cu.m. Total	PROSPECTIVE, cu.m. Annual	PROSPECTIVE, cu.m. Total
CLASS 1						
CLASS 2						
CLASS 3						
CLASS 4						
CLASS 5			10,000,000	10,000,000	10,000,000	10,000,000

GRANULAR RESOURCES SUPPLY SUMMARY
Aklavik

SOURCE: 469

LOCATION: 16 km WNW of Aklavik

REFERENCE(S): Hardy 1976; EBA 1983a

SETTING Low ridges	RELIEF Up to 10 m	WINTER ACCESS Tundra/ice road
LANDFORM Small cuesta	CONTINUITY Continuous	SUMMER ACCESS None
AREA 1.8 sq km	DEVELOPMENT CONSTRAINTS Wildlife, access, poor quality	

BOREHOLES (#) None	TEST PITS (#) Rock expos
MOIST. CON. (#) None	GRAINSIZE (#) None

	OVERBURDEN	GROUND ICE
TYPE:	Unknown	Unknown
EXTENT:	Unknown	Unknown
THICK.:	Unknown	Unknown

POTENTIAL VOLUME, cu. m.: 5,000,000 RECOVERABLE, cu.m: 5,000,000

MATERIAL	PROVEN, cu.m. Annual	PROVEN, cu.m. Total	PROBABLE, cu.m. Annual	PROBABLE, cu.m. Total	PROSPECTIVE, cu.m. Annual	PROSPECTIVE, cu.m. Total
CLASS 1						
CLASS 2						
CLASS 3						
CLASS 4						
CLASS 5			5,000,000	5,000,000	5,000,000	5,000,000

DEMAND SUMMARY

AKLAVIK

GRANULAR RESOURCES DEMAND SUMMARY
Aklavik

YEAR GROUP	PROJECT (¥ Denotes Speculative Project)	CATEGORY		VOLUME, cu.m.
1987-1991	AIRFIELD MAINTENANCE	PUBLIC		
			Class 1:	
			Class 2:	
			Class 3:	
			Class 4:	
			Class 5:	3,000
			TOTAL	3,000
1987-1991	AIRFIELD REHABILITIATION	PUBLIC		
			Class 1:	
			Class 2:	
			Class 3:	
			Class 4:	
			Class 5:	15,000
			TOTAL	15,000
1987-1991	ARENA/COMMUNITY HALL	PUBLIC		
			Class 1:	
			Class 2:	325
			Class 3:	1,350
			Class 4:	
			Class 5:	
			TOTAL	1,675
1987-1991	DETACHMENT BUILDING	PUBLIC		
			Class 1:	10
			Class 2:	
			Class 3:	200
			Class 4:	
			Class 5:	
			TOTAL	210
1987-1991	GARAGE	PUBLIC		
			Class 1:	
			Class 2:	100
			Class 3:	100
			Class 4:	
			Class 5:	
			TOTAL	200
1987-1991	MISC. PUBLIC PROJECTS	PUBLIC		
			Class 1:	
			Class 2:	
			Class 3:	20,000
			Class 4:	
			Class 5:	
			TOTAL	20,000

GRANULAR RESOURCES DEMAND SUMMARY
Aklavik

YEAR GROUP	PROJECT (¥ Denotes Speculative Project)	CATEGORY		VOLUME, cu.m.
1987-1991	ROAD/GENERAL MAINTENANCE	PUBLIC	Class 1:	
			Class 2:	
			Class 3:	20,000
			Class 4:	
			Class 5:	
			TOTAL	20,000
1987-1991	R/S/L LAND DEVELOPMENT	PUBLIC	Class 1:	
			Class 2:	3,800
			Class 3:	
			Class 4:	9,500
			Class 5:	100
			TOTAL	13,400
1987-1991	R/S/L SHORELINE PROTECTION	PUBLIC	Class 1:	
			Class 2:	
			Class 3:	
			Class 4:	
			Class 5:	8,300
			TOTAL	8,300
1987-1991	SCHOOL ADDITION	PUBLIC	Class 1:	200
			Class 2:	100
			Class 3:	
			Class 4:	
			Class 5:	
			TOTAL	300
1987-1991	SEWAGE AND SOLID WASTE IMPROVEMENTS	PUBLIC	Class 1:	
			Class 2:	
			Class 3:	
			Class 4:	1,000
			Class 5:	
			TOTAL	1,000
1987-1991	SHORELINE PROTECTION	PUBLIC	Class 1:	
			Class 2:	
			Class 3:	
			Class 4:	
			Class 5:	8,000
			TOTAL	8,000

GRANULAR RESOURCES DEMAND SUMMARY
Aklavik

YEAR GROUP	PROJECT (# Denotes Speculative Project)	CATEGORY	VOLUME, cu.m.	
1987-1991	STAFF HOUSING	PUBLIC	Class 1:	50
			Class 2:	100
			Class 3:	300
			Class 4:	
			Class 5:	
			TOTAL	450
1987-1991	TRADESHOP	PUBLIC	Class 1:	
			Class 2:	400
			Class 3:	500
			Class 4:	
			Class 5:	
			TOTAL	900
1992-1996	AIRFIELD MAINTENANCE	PUBLIC	Class 1:	
			Class 2:	
			Class 3:	
			Class 4:	
			Class 5:	3,000
			TOTAL	3,000
1992-1996	MISC. PUBLIC PROJECTS	PUBLIC	Class 1:	
			Class 2:	
			Class 3:	20,000
			Class 4:	
			Class 5:	
			TOTAL	20,000
1992-1996	ROAD/GENERAL MAINTENANCE	PUBLIC	Class 1:	
			Class 2:	
			Class 3:	20,000
			Class 4:	
			Class 5:	
			TOTAL	20,000
1997-2001	AIRFIELD MAINTENANCE	PUBLIC	Class 1:	
			Class 2:	
			Class 3:	
			Class 4:	
			Class 5:	3,000
			TOTAL	3,000

GRANULAR RESOURCES DEMAND SUMMARY
Aklavik

YEAR GROUP	PROJECT (* Denotes Speculative Project)	CATEGORY		VOLUME, cu.m.
1997-2001	MISC. PUBLIC PROJECTS	PUBLIC		
			Class 1:	
			Class 2:	
			Class 3:	20,000
			Class 4:	
			Class 5:	
			TOTAL	20,000
1997-2001	ROAD/GENERAL MAINTENANCE	PUBLIC		
			Class 1:	
			Class 2:	
			Class 3:	20,000
			Class 4:	
			Class 5:	
			TOTAL	20,000
2002-2006	AIRFIELD MAINTENANCE	PUBLIC		
			Class 1:	
			Class 2:	
			Class 3:	
			Class 4:	
			Class 5:	3,000
			TOTAL	3,000
2002-2006	MISC. PUBLIC PROJECTS	PUBLIC		
			Class 1:	
			Class 2:	
			Class 3:	20,000
			Class 4:	
			Class 5:	
			TOTAL	20,000
2002-2006	ROAD/GENERAL MAINTENANCE	PUBLIC		
			Class 1:	
			Class 2:	
			Class 3:	20,000
			Class 4:	
			Class 5:	
			TOTAL	20,000

1987-2006	SUMMARY OF DEMAND VOLUMES Aklavik	Class 1:	260
		Class 2:	4,825
		Class 3:	162,450
		Class 4:	10,500
		Class 5:	43,400
		TOTAL	