HOLMAN GRANULAR

INVENTORY

FINAL REPORT: MARCH 1993

Phase B of Field Mapping of Potential Sand and Gravel Reserves, Sachs Harbour and Holman, N.W.T.

Contract Report No. A17134-1-0019/01-ST

French Arctic Consultants Limited

176 River Lane

Ottawa, K1M 1T1

HOLMAN GRANULAR

INVENTORY

FINAL REPORT: MARCH 1993

Phase B of Field Mapping of Potential Sand and Gravel Reserves, Sachs Harbour and Holman, N.W.T.

Contract Report No. A17134-1-0019/01-ST

French Arctic Consultants Limited

176 River Lane

Ottawa, K1M 1T1

EXECUTIVE SUMMARY

Sufficient aggregate exists in the immediate vicinity of Holman to satisfy predicted demand. The granular resources are predominantly of fair (Class 3) to good (Class 2) quality, consisting mostly of moderately graded raised beach gravels. There is a lack of high quality (Class 1) aggregate but an abundance of scree/talus (Class 5). The beach gravels are of variable thickness and widely distributed; they consist of locally derived angular, platey or rounded lithic fragments of either dolomite (limestone) or gabbro.

Existing sources along RCAF Road (HMF-1-3), at Ukpillik Hill (HMF 6,7), and near the airport (HMF-12) contain sufficient aggregate for several years. No news sources need to be developed at present. Easily accessible reserves of approximately 225,000 m^3, mostly Class 2-3, have also been identified. It is recommended that the Ukpillik Hill aggregate source continue to serve for all general use, that sources along RCAF road be reserved for local high quality needs of the community, and that the MOT pit continues to be the source of airstrip maintenance. Significant quantities of poorly graded medium sand adjacent to Ukpillik River (approximately 60,000 m^3) constitute an additional aggregate source, but of poor quality.

It is important that site rehabilitation be undertaken at all aggregate resource locations once they are depleted.

TABLE OF CONTENTS

EXECUTIVE SUMMARY		2
LIST OF FIGURES AND TABLES		3
1.0	INTRODUCTION	6
1.1	Background	6
1.2	Acknowledgements	7
2.0	HOLMAN	8
2.1	Location	9
2.2	Quaternary History	13
2.3	Geomorphology	17
2.4	Permafrost Conditions	19
3.0	MAPPING PROGRAM	20
3.1	Classification of Granular Resources	20
3.2	Previous Work	21
3.3	This Study	26
4.0	SAND AND GRAVEL RESOURCES	27
4.1	General	27
4.2	Location, Quantity and Quality	29
4.2.1	RCAF Road	29
4.2.2	Jacks Bay	32
4.2.3	Ukpillik Hill	33
4.2.4	Ukpillik River	33
4.2.5	MOT pits	40
4.2.6	Unexploitable Reserves	43
5.0	CONCLUSIONS AND RECOMMENDATIONS	44
REFERENCES		46

LIST OF FIGURES AND TABLES

FIGURES

1. Location of Holman and extent of ILA lands.

2. Holman setting. A- General view from Uluksartok Bluff
   B- Community housing, Queens Bay

3. Holman geology. A- Gabbro cliffs near RCAF Lake.
   B- Dolomitic limestone, Ukpillik Hill

4. Paleo-reconstruction of post-glacial marine emergence of the Holman area.

5. Geomorphic processes. A-Mudboils
   B-Thermokarst along ice wedge.

6. Map of granular resources, Holman. Scale: 1:10,000.

7. Aggregate sources along RCAF Road.
   A- Aggregate source HMF-2
   B- Aggregate source HMF-4

8. Typical grain size composition of aggregate along RCAF Road.

9. Ukpalik Hill aggregate source.
   A- Summit of Ukpillik Hill
   B- Typical Class 2-3 aggregate
   C- Undisturbed beach gravel
   D- Stockpiled Class 2 aggregate, August 1992

10. Typical grain size composition of Ukpillik Hill aggregate.

11. Ukpalik River sand deposits
   A- General view
   B- Marine pelecypods in growth position.

12. Typical grain size composition of marine sand and fluvial gravel at Ukpillik Hill River site.

13. Typical grain size composition of aggregate at the MOT pits.

14. MOT aggregate source.
   A- Typical stockpiled aggregate, August 1992
   B- View of undisturbed aggregate source.

TABLES

1. Description of granular resources, Classes 1-5.

2. Potential supply of aggregate, Holman, according to EBA Engineering

3. Proposed utilization plan for aggregate resources, Holman, according to EBA Engineering

4. Summary of sand and gravel resources in vicinity of Holman.

1.0 INTRODUCTION

1.1 Background

The Inuvialuit Final Agreement (IFA) requires that the Inuvialuit and government develop jointly forecasts of public and community needs for sand and gravel in the vicinity of Holman, NWT. These forecasts are to be revised on a periodic basis and formal reserves of granular material and any "restricted development zones" are to be identified.

Funds have been made available under Task 7-Sand and Gravel Inventories of the IFA Implementation Program (IFAIP) to develop an inventory of sand and gravel reserves for each community in the Inuvialuit Settlement Region. The Department of Indian Affairs and Northern Development (DIAND) has been responsible for managing the work plan in co-operation with the Inuvialuit Lands Administration (ILA) and the Government of the Northwest Territories (GNWT). To date, two reports have been completed with respect to Holman: a) by EBA Engineering Consultants Ltd. (1987), in which the known supply and twenty year demand for granular materials was forecast, and b) by Hardy BBT Ltd. (1988), in which a plan for the reservation and development of specific sources of granular materials was developed. In addition, a preliminary gravel investigation was conducted by ILA and DIAND personnel in September 1990 (Unpublished report: S. Kerr). The present report is an extension of these earlier studies and has the following objectives:

1) to map and evaluate potential granular resource materials located in, or near, the community, and
2) to prepare a granular source evaluation statement which would include a discussion of the nature and extent of specific aggregate deposits, and an assessment of current resource utilization.

1.2 Acknowledgements

Included in this report are data collected not only during field investigations in August 1992, but also observations made during earlier studies of terrain conditions and surficial geology in the summer of 1976 and at periodic intervals since then.

Appreciation is extended to the residents of Holman who have assisted me in and around the settlement. In 1992 particular thanks go to Albert Elias who provided truck rental at short notice. Also, Joseph Haluksit, Chairman, Holman Hunters and Trappers Association, and Chairman, Holman Community Corporation provided valuable initial orientation and much background information. Wallace Joss, maintenance foreman at Holman airport also provided perspective, as did Jane Bicknell, ILA, Inuvik. The base map for the aggregate mapping was provided by MACA, GNWT, Yellowknife, courtesy of Terry Hauft, Manager, Mapping and Surveys Division. Grain size analyses upon aggregate samples were undertaken by Chris Lochner at the University of Ottawa.

The present work was authorised by the Department of Supply and Services under DSS Contract No. A 17134-1-0019/01-ST. The Scientific Authority was R.J. Gowan, Geotechnical Advisor, Natural Resources and Economic Development, Indian and Northern Affairs Canada.

2.0 HOLMAN

2.1 Location

Holman is located on the coast of Diamond Jenness Peninsula, western Victoria Island. The community is surrounded by ILA lands 7 (1) (a) and 7 (1) (b) (Figure 1). Sand and gravel rights are attached to both 7 (1) (a) and 7 (1) (b) lands.

The current townsite is located at the head of Queens Bay on a series of gravelly marine beaches extending from current sea level to approximately 15-20 m. a.s.l (Figure 2). The original townsite, located on the east side of Kings Bay, was abandoned in favour of the present site following the use of an extensive area of raised beaches immediately east of Jacks Bay (see Fyles 1963, Plate XIV p. 28) as an airstrip by Geological Survey of Canada personnel in the late 1950's and early 1960's. The current townsite also permits expansion of the community towards Jacks Bay while access to the deep water of Kings Bay, critical for barge access, is maintained.

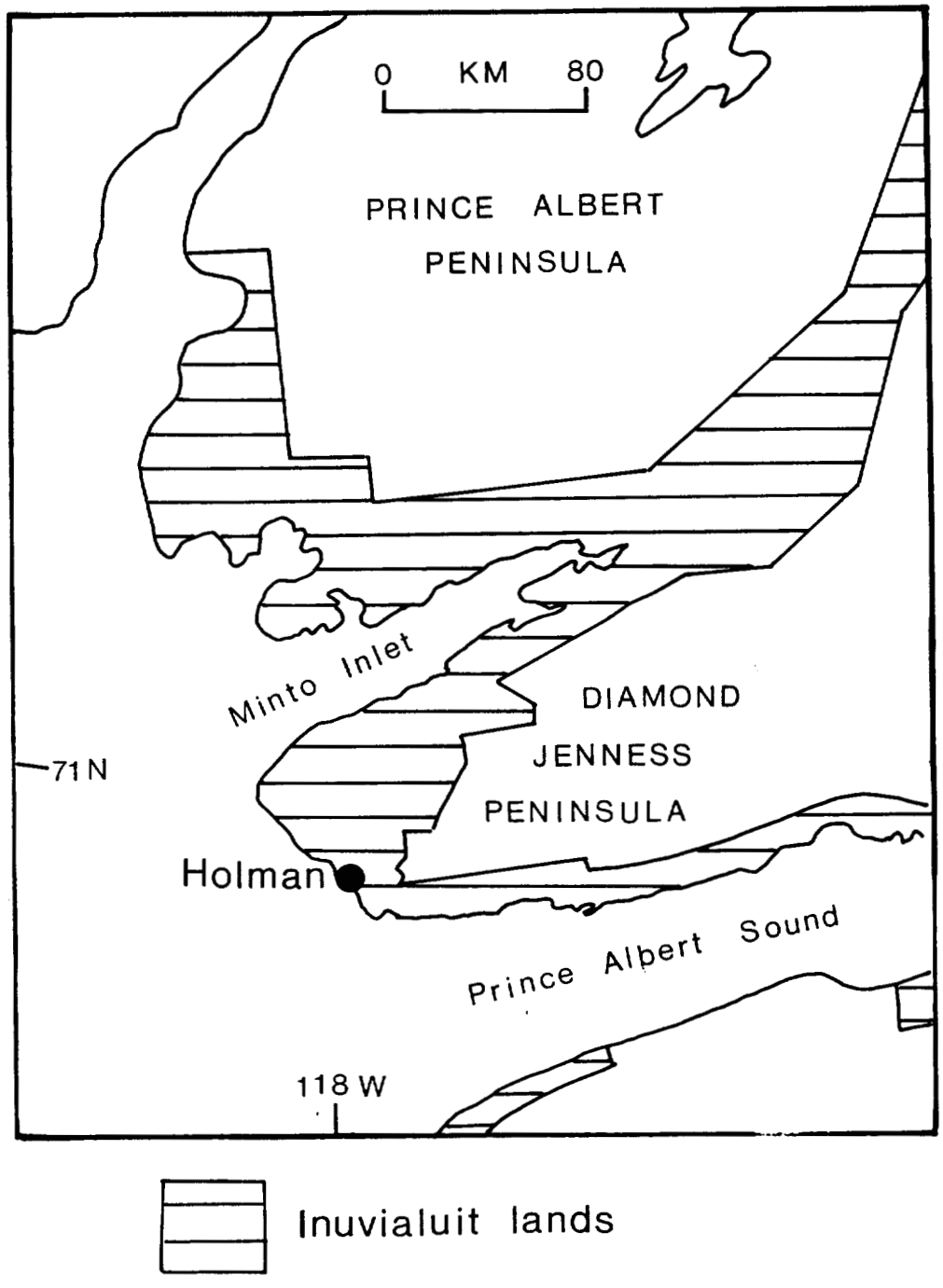
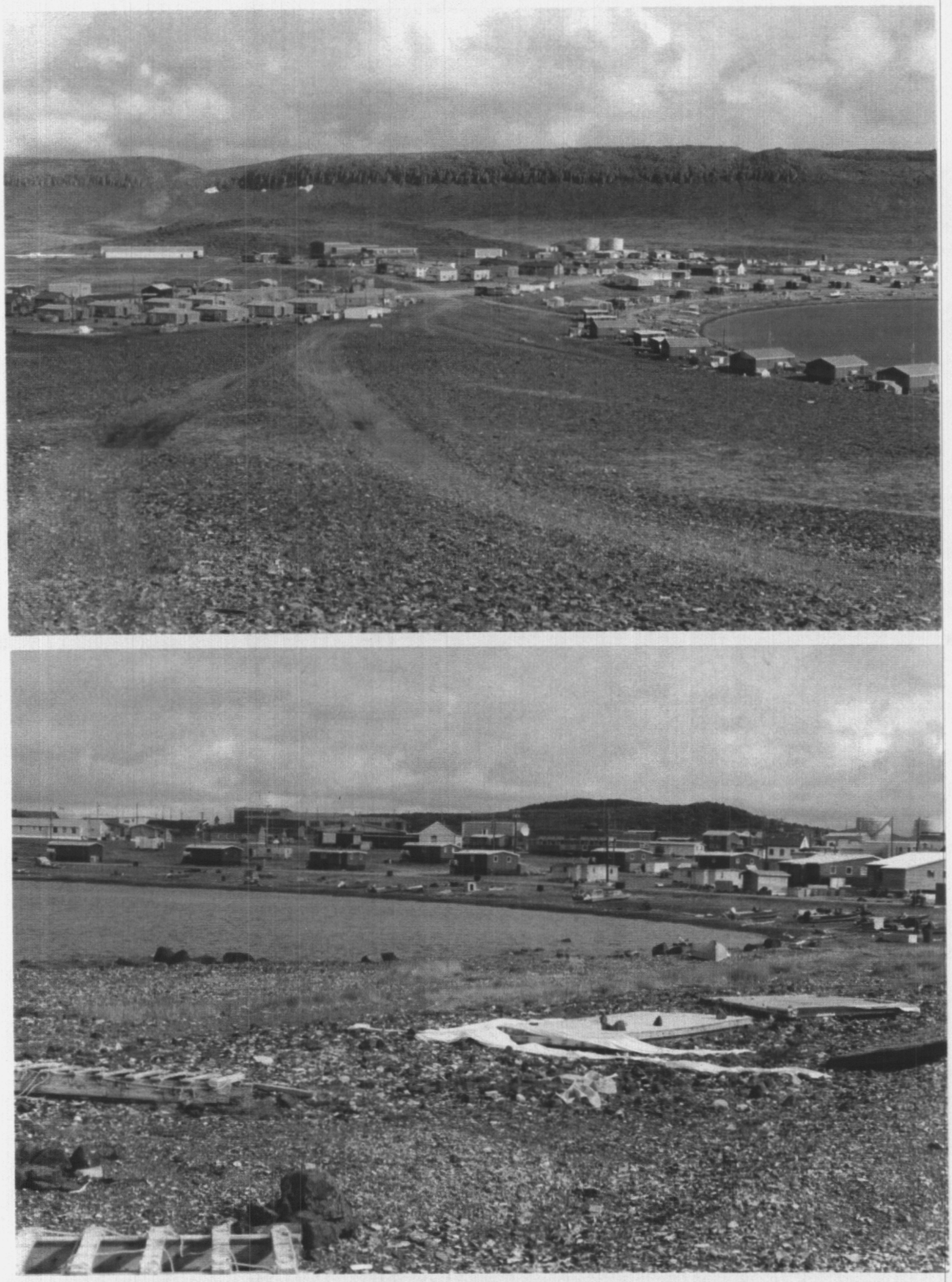


Figure 1. Location of Holman and extent of ILA lands.



A

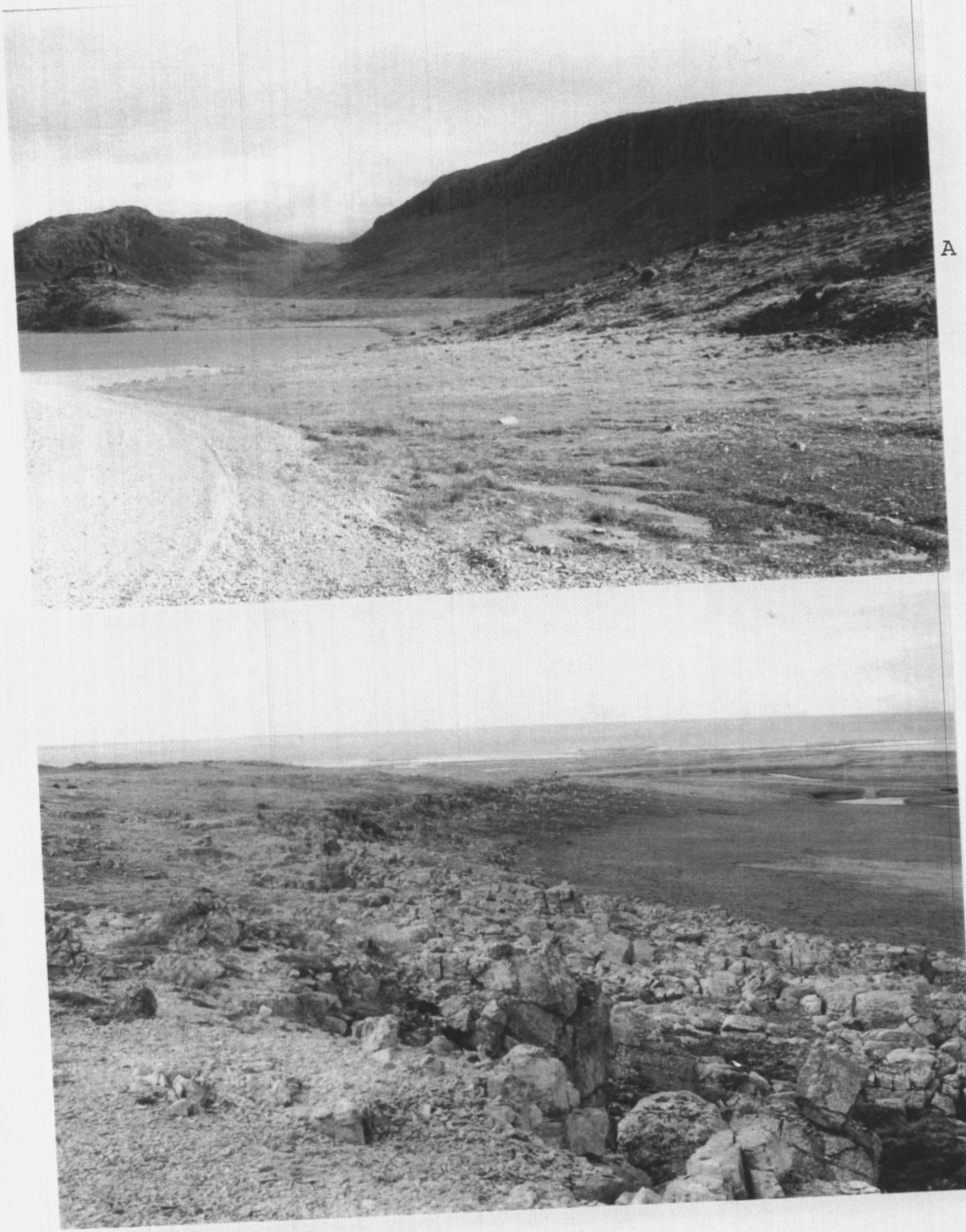
B

Figure 2. Holman setting.
A- General view from Uluksartok Bluff
B- Community housing at head of Queens Bay

The settlement is scenically surrounded by striking cliffs and outcrops consisting primarily of gabbro sills within the Kiliam Formation, of later Precambrian age (Thorsteinsson & Tozer, 1962) (Figure 3 A). According to Thorsteinsson & Tozer (1962, 38) about 90% of exposed rock in the vicinity of Holman Post (the old townsite on the east side of Kings Bay; see Thorsteinsson & Tozer, 1962, Plate 1, p 2) consist of gabbro. As such, it is this rock which outcrops at Uluksartok Bluff and on the headland between Kings Bay and Queens Bay.

Dolomitic limestones (Figure 3 B), light grey to medium light grey in colour, outcrop in the vicinity of Holman at Ukpillik Hill. This rock is probably part of the lower member of the Kiliam Formation, and gives rise to more subdued relief then the gabbro sills. Several lakes occur inland from the settlement, in structurally controlled basins; example are RCAF Lake, from which the community water supply is taken, and Ukpillik Lake.

Following continued expansion of the settlement in the 1970's on the raised beaches immediately adjacent to the initial airstrip, a modern airstrip facility has now been constructed to the north west of Ukpillik Hill, approximately 4 km from the townsite.



A

B

Figure 3. Holman geology.
A- Gabbro cliffs near RCAF Lake
B- Dolomitic limestone exposed on west flank of Ukpillik Hill

2.2 Quaternary History

The west coast of Victoria Island has experienced substantial isostatic rebound and uplift following retreat of the last Wisconsinan (Laurentide) ice sheet. The latter extended onto adjacent Banks Island, where a complex Quaternary history has been established (e.g. Vincent 1983). On Victoria Island in general, and adjacent to Holman in particular, the Quaternary history is still only known in broad outline; an early report by Fyles (1963) establishes the general pattern, and a detailed study by Sharpe (1992; Sharpe & Nixon 1989) has been undertaken for Woolaston Peninsula to the south of Prince Albert Sound. Some observations have also been made by Washburn (1947) at both Holman Post, and at DeSalis Bay, on neighbouring south eastern Banks Island.

One ^{14}C date pertains to marine pelecypod shells collected from a river bank four hundred metres from the shore at an elevation of about 7 m a.s.l. approximately 1.5 km northeast of the old Holman Post (Fyles, 1963, 30). The age of 8,895 $\pm$ 220 years (GC-20) relates to a sea level approximately 10 m above its present level and some 75 m below the maximum marine limit for this area. Fragments of marine shells have been found on the summit of Uluksartok Bluff at an elevation of 75 m a.s.l. indicating that there has been at least this amount of isostatic emergence in post-glacial times.

Striations and glacially polished gabbro rock surfaces occur to the northeast of the townsite, south of RCAF lake. They indicate local ice movement from both E-W. and from NW-SE.

These observations, and the field mapping of raised beaches and marine deposits, enable reconstruction of the post glacial evolution of the Holman physiography (Figure 4 A,B,C). Such a reconstruction greatly assists in understanding the origin of the granular resources of the area, and aids in their classification. For simplicity, three (3) stages of marine emergence following deglaciation can be identified:

Stage 1 (figure 4 A), when sea level was approximately 60 m + a.s.l., would have seen emergence of the higher gabbro cliffs on Uluksartok Bluff and to the east of Kings Bay. Early high level marine beaches (> 60 m a.s.l.), related to these cliffs, would have been gabbro-derived. When the summit of Ukpillik Hill rose to within wave-base, beaches derived from the dolomitic limestone would have formed. Based on the present bedrock topography, the extent of both gabbro & dolomitic areas which would have been within (or near to) wave-base are indicated on figure 4A.

Stage 2 (figure 4 B) approximates conditions when sea level was approximately 15-30 m a.s.l.. At this time significant areas of both the gabbro sills and the dolomitic limestone at Ukpillik Hill would have been exposed above sea level and additional areas

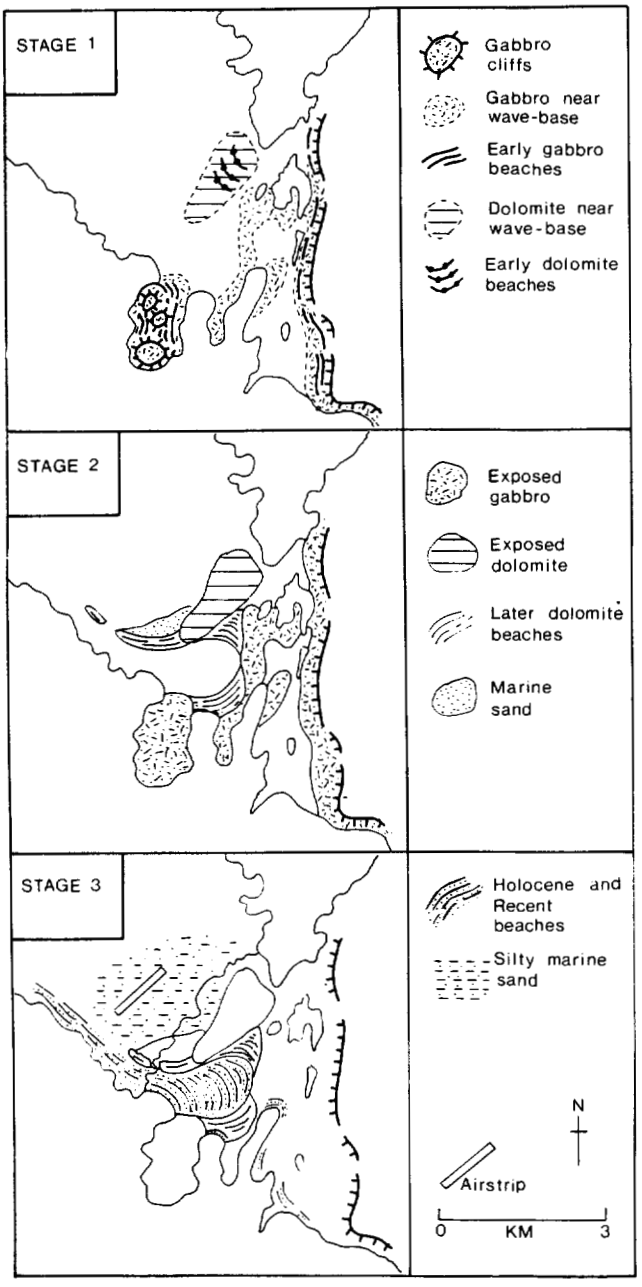


Figure 4: Paleo-reconstruction of post-glacial marine emergence of the Holman area (Stages 1, 2 -late glacial; Stage 3-Holocene) with emphasis upon the origin of aggregate materials.

would have been within wave base. As a consequence, beaches formed at this time period were more varied in lithology than in Stage 1. Gabbro-derived beaches continued to develop in proximity to the gabbro outcrops but at lower elevations and in the broad re-entrant of Jacks Bay, predominantly carbonate-derived beach materials formed, especially adjacent to Ukpillik Hill. A gravelly, carbonate-bedrock derived spit extended to the west of the southern tip of Ukpillik Hill. Behind this, and extending to the west, marine sand and silt accumulated in the vicinity of the present Ukpillik River crossing, and to the south of the present airstrip. Storm beach deposits accumulated at the head of the bay,in the vicinity of the present Holman Golf Course. At the same time, a tombolo composed of relatively well graded elongate and platey beach gravels accumulated on the east side of Jacks Bay linking Uluksartok Bluff to the mainland. It is on these gravels, at an elevation of approx 12-18 m a.s.l., that the present Holman townsite is located.

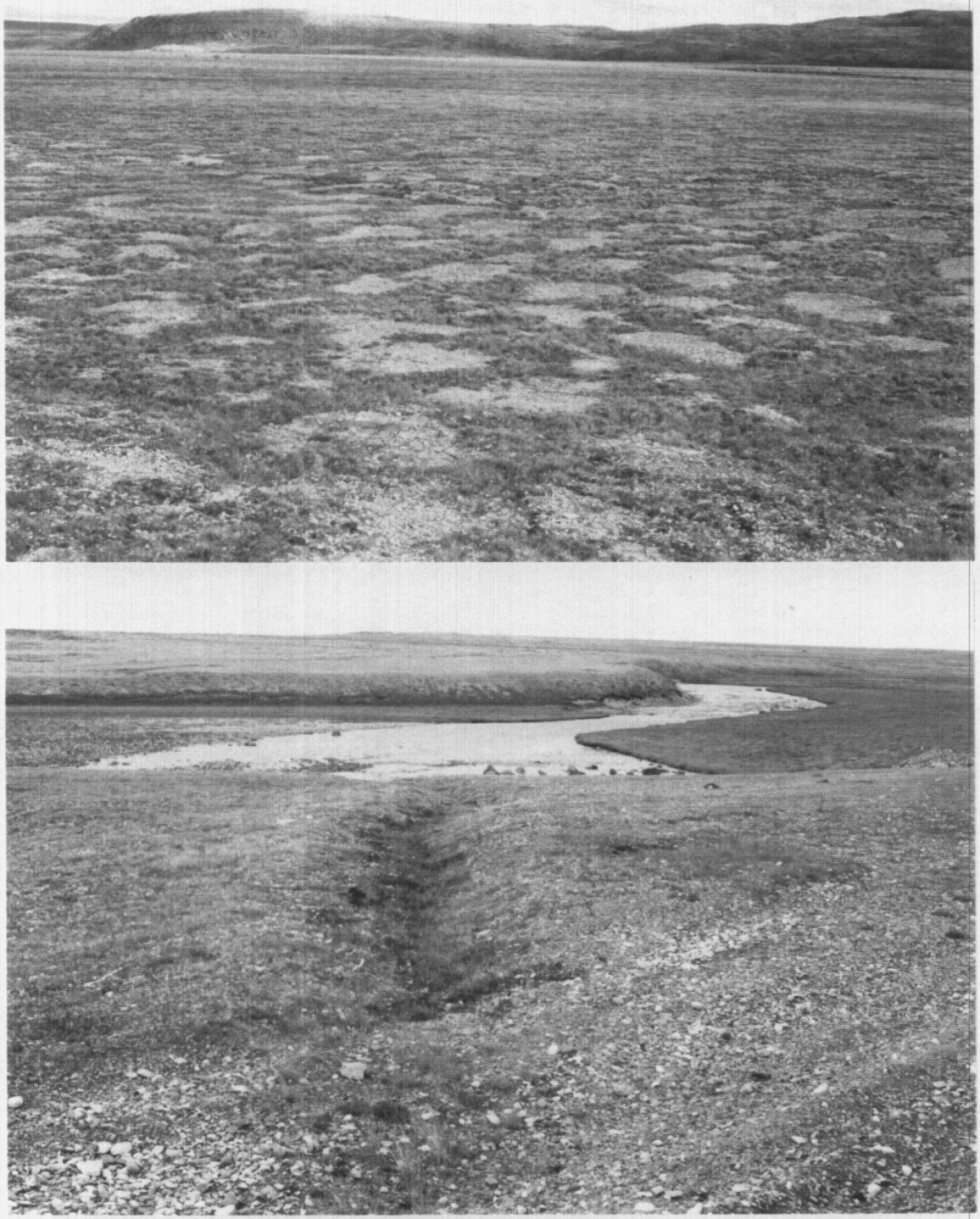
Stage 3 (figure 4C) represents the most recent stage of marine emergence when sea level fell from approximately 15 m to present sea level. Emergence rates would have been much slower than in Stages 1 and 2. If the ^{14}C date collected by Fyles (1963) is representative, this stage typifies the majority of the Holocene, while stages 1 and 2 typify the much shorter period of late glacial (Wisconsinan) rapid uplift. In Stage 3, marine deposits, in the form of gravel, sand and silt infilled the Jacks

Bay embayment and the lowlying areas surrounding the modern airport. As sea level continued to drop, a series of beach ridges formed parallel to the coast line to the west of Holman and to the south of the airport.

2.3 Geomorphology

Periglacial processes active in the vicinity of Holman include those related to 1) snowbanks and stream runoff in the spring, 2) frost weathering of exposed gabbro and dolomite outcrops and mass wasting (solifluction) on lower slopes, and 3) frost action within the unconsolidated marine deposits, especially silty sediment in lowlying areas. In addition, ice-pushing occurs in spring and early summer along the coast and around the larger lakes, and wave action dominates in late summer along both the coast and the larger lakes. The headlands and deep embayments (e.g. Kings Bay) provide suitable shelter for Inuit coastal living.

No quantitative field measurements of geomorphic processes have been carried out in the vicinity of Holman and rates of mass wasting, frost weathering of bedrock, etc are unknown. Patterned ground phenomena are limited to non-sorted circles (mudboils) developed in the silty marine diamictons in the vicinity of the airport (Figure 5 A), and solifluction lobes below sites of long-lasting snowbanks, especially at the foot of the gabbro cliffs and scree slopes (e.g. see Figure 3 A).



A

B

Figure 5. A) Mudboils developed in silty marine diamictons to the N of the airstrip.
B) Thermokarst furrow developed along ice wedge at edge of terrace, Ukpillik River.

2.4 Permafrost and Ground Ice Conditions

Based upon the climate records for Holman and adjacent localities in the Western Arctic (Sachs Harbour, Paulatuk), the mean annual ground temperature (MAGT) is probably -10 to -12^{0}C. The dominance of bedrock in the Holman vicinity, and the coarse, well drained nature of much of the beach gravels, means that ground ice amounts are generally lower and active layer thickness generally greater than in other areas. The lack of vegetation and the lithological conditions typically result in active layers in the beach gravels exceeding 60-85 cms., and probably exceeding several metres on dark gabbro faces of southerly orientations.

Examination of the beach gravels exposed in the walls of the communal ice cellar in the Holman townsite in August, 1992 indicated no excess ice to a depth of at least 4.0 metres. The old ice cellar on the original townsite location to the east of Kings Bay could not be examined because it has now been flooded. Examination of this pit in 1976, however, also indicated a lack of ground ice, in spite of the fact that the location was one of the few areas of wet tundra in the area. In general, one can conclude with confidence that ground ice conditions are relatively low in the Holman vicinity and reflect the dominance of either hard impermeable bedrock or well-drained beach gravels, combined with a lack of tundra vegetation over large areas. Although furrows on several of the raised beaches or at well drained locations (Figure

5 B) indicate thawing of ice wedges formed in thermal contractions cracks, there is little evidence of thermokarst activity, either natural or man-induced (i.e. by terrain disturbance in borrow pits).

3.0 MAPPING PROGRAM

3.1 Classification of granular resources

Granular resources are considered in terms of five classes of material:

Class 1	Excellent quality material
Class 2	Good quality material
Class 3	Fair quality material
Class 4	Poor quality material
Class 5	Bedrock, felsenmeer and talus

Table 1 describes these five classes in detail.

Classes 1-4 are defined in terms of the gradation of the deposit, i.e., the relative sizes of particles in the deposit. A 'clean' well graded granular deposit has approximately equal amounts of sand and gravel sizes but little or no silt or clay sized particles (fines). A poorly graded granular deposit has an excess of some particle sizes and a shortage or lack of others, or has nearly all particles the same size. The desirability of locating and using well graded materials lies in the fact that well graded materials settle well, with finer particles fitting between coarser ones, thereby reducing void spaces to a minimum. The

absence of fines is a further advantage since ice lensing and frost heaving is reduced in well drained, coarse soils. The presence of ground ice is also a hindrance in resource utilization since thermokarst can develop in the borrow pit.

3.2 Previous work

No large scale maps of sand and gravel aggregate exist for the immediate vicinity of Holman. An earlier report by EBA Engineering Consultants Ltd (1987), however, identified possible aggregate bodies and made provisional estimates of supply. These were termed H-1 to H-13. These sources can be grouped into two locations:

a) those occurring more then 5 kms from the townsite and difficult of access, especially sources H-10, H-11, H-12 to the south where imposing gabbro cliffs eliminate overland access, and

b) those occurring in the immediate vicinity of the townsite and where terrain conditions allow relatively easy (i.e. land) access.

In this report the aggregate deposits is (b) above were investigated on a priority basis since all earlier investigations have concluded that abundant aggregate exists in reasonably close proximity to the settlement.

TABLE 1

DESCRIPTION OF GRANULAR RESOURCES, CLASSES 1-5
(Source: Hardy BBT, 1988)

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 asphalt or concrete aggregate, with a minimum of processing.
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 weak materials such as shale are present.
CLASS 3	Fair quality material consisting 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.
CLASS 4	Poor quality material generally consisting of silty, poorly-graded, fine-grained sand with minor gravel. These deposits may also contain weak particles. These materials are considered suitable for general (non-structural) fill.
CLASS 5	Bedrock of fair to good quality, felsenmeer (open areas of broken rock), or talus (broken rock at the bottom of a slope). Potentially excellent sources of construction material, ranging from general fill to concrete aggregate or building stone of quarried and crushed. Also includes erosion control materials such as rip-rap or armour stone.

Table 2 summaries the potential supply reported by EBA Engineering Consultants for all thirteen of the aggregate sources. It was concluded that only one locality (H-8) contained Class 1 granular materials and only one other (H-5) contained Class 2 material, the vast majority being Class 3 material. The report also states that Holman has 'unlimited supplies of Class 5 borrow' since 'bedrock outcrops occur adjacent to the community as both massive and intrusive features. Fragmented rock is also available as felsenmeer in talus slopes located at the base of the outcrops' (p 13).

The potential demand volume for the period 1987-2006 was calculated by EBA Engineering Consultants to be 150 m^3 (Class 1), 25,500 m^3 (Class 2), 86,000 m^3 (Class 3), 14,000 m^3 (Class 4) and 600 m^3 (Class 5). A proposed utilization plan was established, here reproduced as table 3. Tables 2 & 3 indicate a shortfall in easily accessible high quality aggregate (Classes 1 and 2) but an abundance of average quality aggregate and an excess of Class 5 aggregate. This survey was undertaken at a time of relatively high actual or projected activity. Lower activity in recent years suggest that these demand volumes may be overestimates.

A second report, prepared by Hardy BBT Ltd. (1988) recommends a strategy to reserve and develop supplies of sand and gravel on Inuvialuit lands in the vicinity of the townsite. The granular resources at three localities were highlighted as being suitable

SOURCE		DISTANCE (km)	PROVEN m^3	PROBABLE m^3	PROSPECTIVE m^3	CONSIDERATIONS
Class 1						
87-H-8	1	0	3,000	3,000	3,000	Current townsite
Class 2						
87-H-5	2	0		60,000	60,000	Currently developed
87-H-4	2	5.5			150,000	Feasible for development
87-H-13	2	12.5			700,000	
87-H-1	2	14			300,000	Quality indeterminate
Class 3						
87-H-6	3	0		200,000	200,000	Currently developed
87-H-7	3	0		75,000	75,000	Partially developed and inacessible
87-H-8	3	0		300,000	300,000	Current townsite
87-H-10	3	5			75,000	Small and out of the way
87-H-2	3	11			75,000	Coastal, probably oversize material
87-H-11	3	11			200,000	Variable, some boulders
87-H-12	3	15			750,000	Extensive, barge accessible

Table 2. Potential supply of aggregate in vicinity of Holman, according to EBA Engineering Consultants Ltd (1987), table 4.

MATERIAL		1987-1991	1992-1996	1997-2001	2002-2006
CLASS 1	Demand, m^3	150			
	Source(s)	87-H-8			
CLASS 2	Demand, m^3	10,550	5,000	5,000	5,000
	Source(s)	87-H-5/8	87-H-5/8	87-H-5/8	87-H-5/8
CLASS 3	Demand, m^3	26,000	20,000	20,000	20,000
	Source(s)	87-H-8	87-H-8	87-H-8	87-H-8
CLASS 4	Demand, m^3	14,000			
	Source(s)	87-H-8			
CLASS 5	Demand, m^3	600			
	Source(s)	Most Convenient			

NOTES:

1. Source 87-H-8 constitutes the granular material in the sources immediately surrounding the community. For the most part, the material is of Class 3 quality, except for the portion of the source located on the east side of the road near RCAF Lake.

2. Source 87-H-5 (the Transport Canada pit) is the only source of Class 2 material located near the community. It is recommended that the airstrip continue to draw its granular requirements from this pit and that the community use better sections of 87-H-8 as Class 2 material. Any large projects carried out should obtain Class 2 granular material from Sources 87-H-1, 4 and 13, located several kilometres from the community.

3. Holman is surrounded by Class 5 material. The Class 5 material requirement should be obtained from the most convenient location on an as-needed basis.

Table 3. Proposed utilization plan for aggregate resources in vicinity of Holman. (Sources: EBA Engineering Consultants Ltd, 1987, Table 23 including notes).

for public, community and Inuvialuit use because they are located in areas where environmental, wildlife and harvesting impacts are minimised and where developmental costs are considered to be least. These are: 1) Source H-8, which consists of several deposits along the western perimeter of the community, including the Jacks Bay pit which extends towards the coastline, 2) source H-7 (Ukpalik Hill) which lies immediately north of the community in Inuvialuit lands, and 3) source H-5 (the Transport Canada MOT pit) just west and south of the runway. The report also recommended that the quality and quantity of materials in sources H-5, H-7 and H-8 should be more reliably determined by site investigation.

3.3 This study

Within the context of these two earlier reports, the present report describes new work undertaken in 1992 which assessed the extent, nature and quality of aggregate resources in the vicinity of the townsite and to the immediate west as far as the airstrip, and as far north as RCAF Lake and Ukpillik Lake. Black and white air photographs at a scale of 1:20,000 (A 25365 107-116), taken in 1979, were used during field mapping and information subsequently transferred to an air photo mosaic, scale 1:10,000. The latter was compiled by IMC Consulting Group Ltd. for GNWT-MACA and used photographs flown in 1979. The photomap covers the townsite of Holman and the area immediately west to include the airstrip. Wherever possible, detailed stratigraphic logs were compiled and these data are now entered in the aggregate data bank at IAND,

Ottawa, together with UTM grid references for all the sites. Some test results obtained by the GNWT in 1989, and made available to this study, are also entered in the IAND data bank. Aggregate samples were analyzed in the laboratory to confirm the quality assessments made in the field. Unused, depleted and currently exploited sites were all visited. The lack of drilling equipment, however, means that the extent, thickness, volume and quality of the aggregate still remains speculative to a degree. In this report, conservative estimates are reported.

The location, extent and quality of granular reserves are indicated on Figure 6 (back folder).

4.0 SAND AND GRAVEL RESOURCES

4.1 General

There is absolutely no shortage of aggregate in the vicinity of Holman. The aggregate resource problem at Holman, as at Sachs Harbour, is to restrict exploitation to a few localities such that the environmental impact is kept to a minimum. The aggregate at Holman can be of three (3) types:

1) Raised beach gravels, usually rounded, platey or angular carbonate pebbles, up to 10 cm in diameter, with a coarse sand fraction. At higher elevations (>40 m a.s.l.) the raised beach gravels consist primarily of angular platey gabbro fragments (e.g. on Uluksartok Bluff).

2) Medium sand, fosilliferous, well sorted, occurring primarily near the Ukpillik River bridge crossing.

3) Scree and felsenmeer associated with the gabbro cliffs. Blocks may be as much as 2-4 m in dimensions, and crushing is required.

This report deals only with type (1) and type (2) aggregate.

The majority of the beach gravels, and certainly the medium sand at Ukpillik River, are late glacial\early Holocene in age. Most deposits at elevations >7 m a.s.l. are at least 8000 years old. The thickness of beach gravels is difficult to determine without drilling. In some areas, such as to the south of RCAF lake, the gravels are only 10-15 cm thick and constitute a thin veneer lying upon glacially polished and striated bedrock. In other areas, such as beneath the Holman community, the gravels are >4.0 m in thickness, as indicated by the communal ice cellar. Therefore, it is difficult to accurately predict the volumes of gravel present in the Holman vicinity. Moreover, the underlying bedrock topography is extremely variable.

Some of the gravel sources, although of good quality, are unusable because of current land use and other concerns. For example, source HMF-14, located beneath the Holman townsite, cannot be exploited and source HMF-4, at the head of Kings Bay, is the

townsite cemetary. Other localities which are unusable include the raised beach deposits on Uluksartok Bluff, for environmental and aesthetic reasons, and those at the head of the Jacks Bay embayment, where the Holman Golf Course is located. Finally, the Holman Development Plan reserves land adjacent to the shoreline and to the west of the community for summer camps, fishing and general recreation. The prominent raised beaches and marine terraces in that area must be eliminated from any consideration of available, potential aggregate.

4.2 Location, quantity and quality of granular aggregate

Figure 6 (back folder) indicates the location of the various aggregate sources considered in this report. Their characteristics are summarised below (table 4).

4.2.1 RCAF Road (HMF 1-4). (Figures 7, 8)

Three localised sources of Class 1 and 2 aggregate exist adjacent to RCAF road. Sources HMF-1 and HMF-2 are semi-depleted but source HMF-3 has yet to be exploited. A total of approximately 7000 m^3 of usable aggregate still exists at these three localities. All deposits are beach gravel in origin, source HMF-3 clearly being a storm beach.

An additional 10,000 m^3 of Class 2 aggregate exists at the head of Kings Bay (source HMF-4). However, this is unusable because of the location in the vicinity of the settlement cemetery.

Table 4. Summary of sand and gravel resources in vicinity of Holman, NWT.

ource	Name	Location	Proven Volume (m^3)	Quality	ILA lands
I: EXPLOITABLE RESOURCES					
A) **RCAF Road**					
HMF-1	RCAF Road	E side	3600	1	7 (1) (a)
HMF-2	RCAF Road	E side	2500	2	7 (1) (a)
IMF-3	RCAF Road	W side	750	1	7 (1) (a)
B) **JACKS BAY**					
IMF-5	Jacks Bay	W. of townsite (semi-depleted)	10,000	2-3	Townsite
C) **UKPALIK HILL**					
HMF-6	Ukpillik Hill	summit (current operations)	175,000	2-3	7 (1) (a)
HMF-7	Ukpillik Hill	nose (s. end)	15,000	2	7 (1) (a)
HMF-8	Ukpillik Hill	old operations (depleted) (s.end)			Townsite
D) **UKPALIK RIVER**					
IMF-9	Ukpillik River	sand	(1300)	3-4	7 (1) (a)
HMF-10	Ukpillik River	sand	(60,000)	4	7 (1) (a)
IMF-11	Ukpillik River	gravel	30,000	2	7 (1) (a) Townsite
E) **MOT PIT**					
HMF-12	MOT pit (a)	current exploitation	60,000	2-3	7 (1) (a)
	(b)	unexploited	50,000	2-3	7 (1) (a)
HMF-13	MOT pit	unexploited	5,000	2	7 (1) (a)
			TOTAL: 351,850 m^3 (61,300 m^3)*		
II NON-EXPLOITABLE					
IMF-14	Holman	townsite (unusable)	250,000	2	Townsite
IMF-15	Uluksartok Bluffs	(unusable)	?	2-3,5	Townsite/ 7 (1)(a)
HMF-16	Holman Golf Course	(unusable)	30,000	2	7 (1)(a)
HMF-17	Gabbro cliffs	E. of Kings Bay	?	5	7 (1)(a)
HMF-4	Head, Kings Bay	(unusable) (cemetary)	10,000	2	Townsite
			TOTAL: 290,000 m^3		

Total in brackets refers to sand.

A

B

Figure 7. Aggregate sources along RCAF road.
A- Aggregate source HMF-2, semi-depleted; 250 m^3 remains of Class 2
B- Aggregate source HMF-4. Raised beaches at head of Kings Bay. Site used as cemetary.

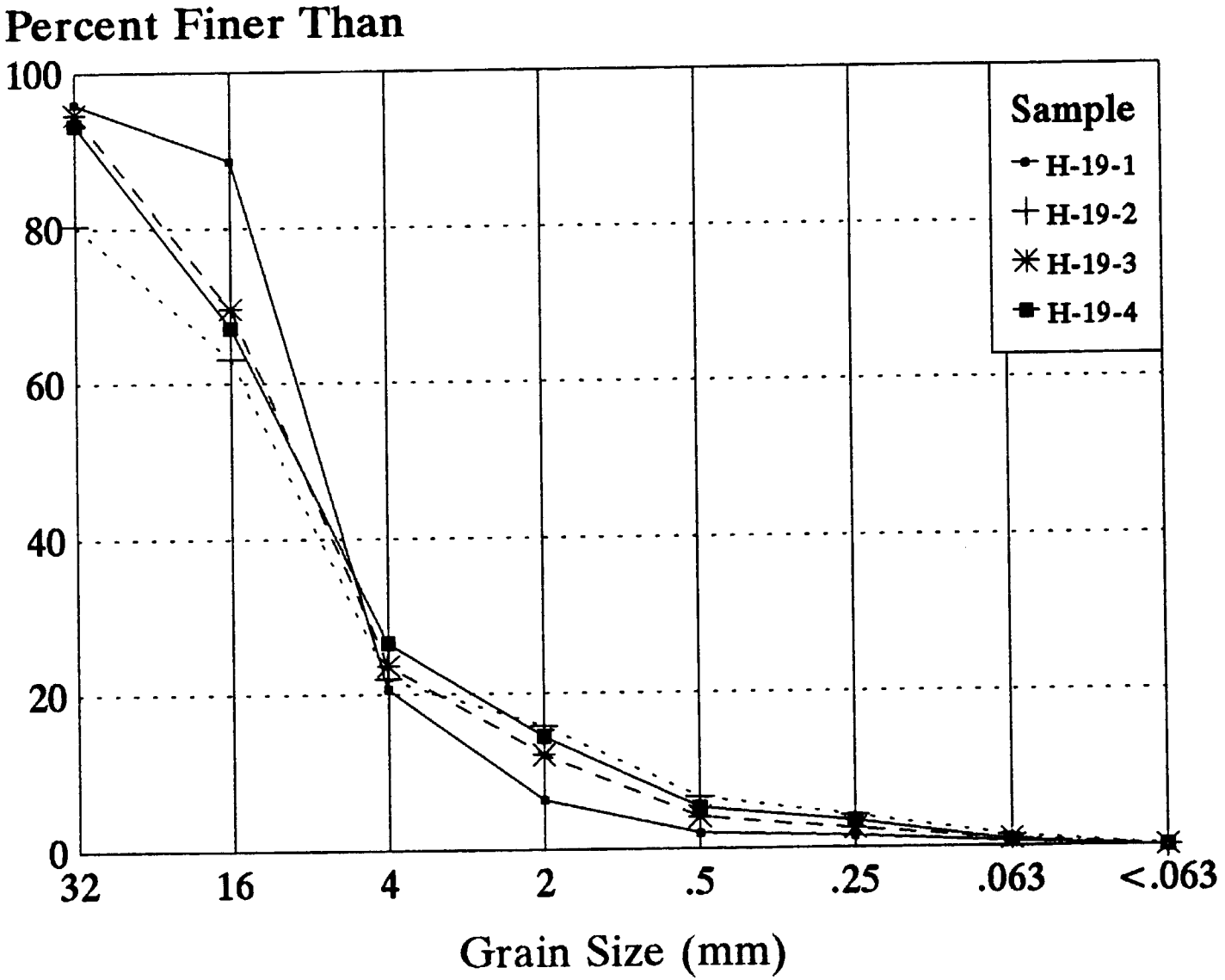


Figure 8. Typical grain size composition of aggregate along RCAF Road (HMF-1-4).

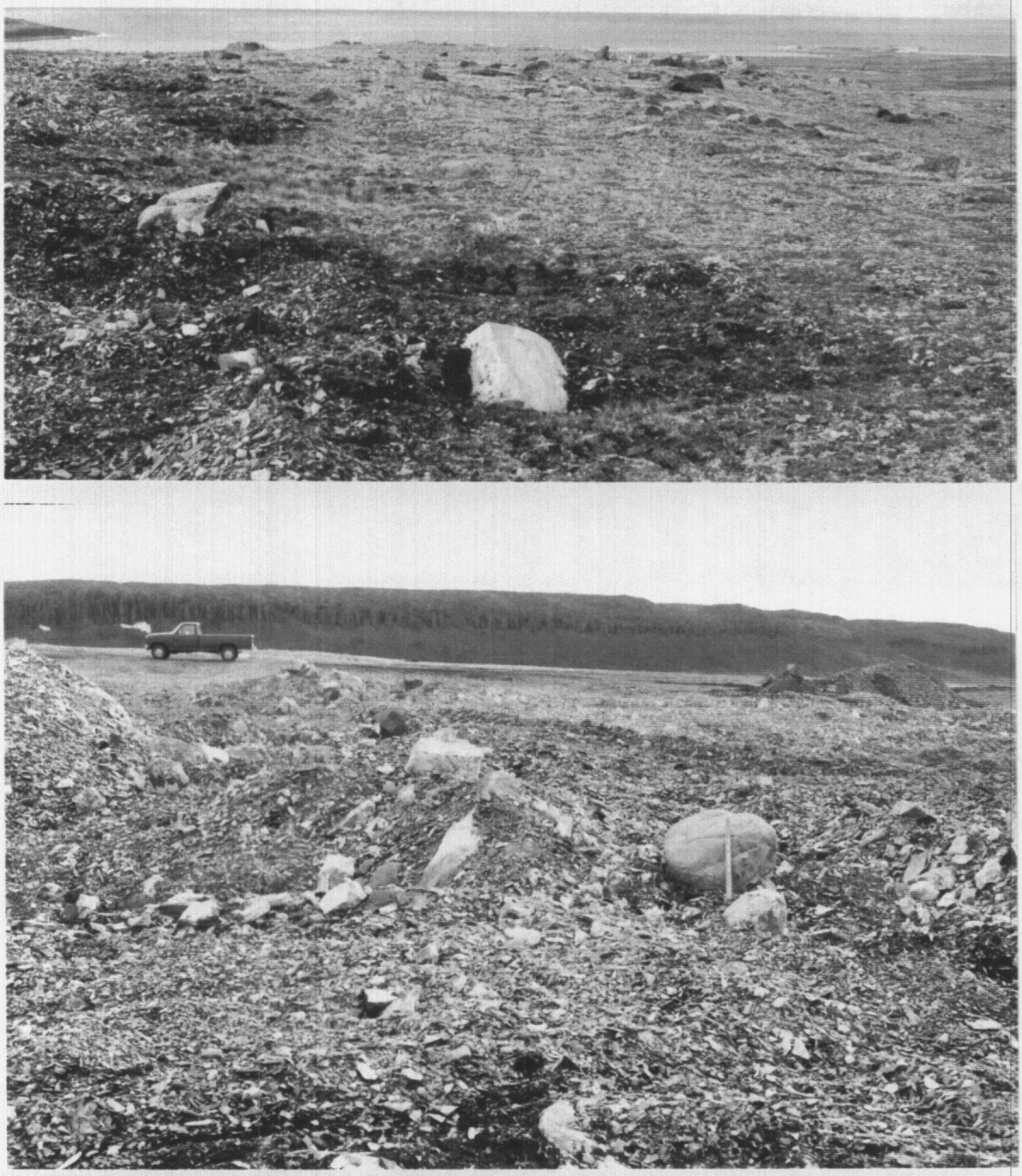
It is recommended that sources HMF-1 to HMF-3 be reserved for local settlement needs since they are readily accessed and of relatively high quality.

4.2.2. Jacks Bay (HMF-5)

A flight of extensive marine raised beach deposits to the immediate west of the hamlet, consisting of rounded to subangular dominantly carbonate pebbles, is aggregate source HMF-5. The quality is Class 2-3. The site is now abandoned since further exploitation would lead to submergence at high tide, especially if the protective beach gravel at the coast were removed. Moreover, the site is reserved for future settlement expansion. Field observations indicate that approximately 10,000 m^3 of class 2-3 is still available at this locality but the land use considerations mentioned above indicate that this source can no longer be considered.

4.2.3 Ukpillik Hill (Sources HMF-6,7,8,11) (Figures 9, 10).

Ukpillik Hill is the location of current aggregate extraction for the community. Beach gravels, either on the flanks or structural summit surface of the limestone hill, are between 1.0-2.0 m in thickness and cover an extensive area. The lowest structural bench is largely depleted of gravel (HMF-8) and is adjacent to the settlement metal dump. Approximately 15000 m^3 of Class 2 aggregate exists adjacent to this site but at the extreme south end of Ukpillik Hill (HMF-7) and extending along the west flank. This aggregate should be reserved for site rehabilitation



A

B

Figure 9. Ukpillik Hill aggregate source:
A- Summit of Ukpillik Hill showing raised beaches
B- Typical Class 2-3 aggregate on summit. Note the large boulders present.

C

D

Figure 9 (cont.). Ukpillik Hill aggregate source:
C- Undisturbed beach gravels on summit of Ukpillik Hill
D- Stockpiled Class 2 aggregate, Ukpillik Hill, August 1992

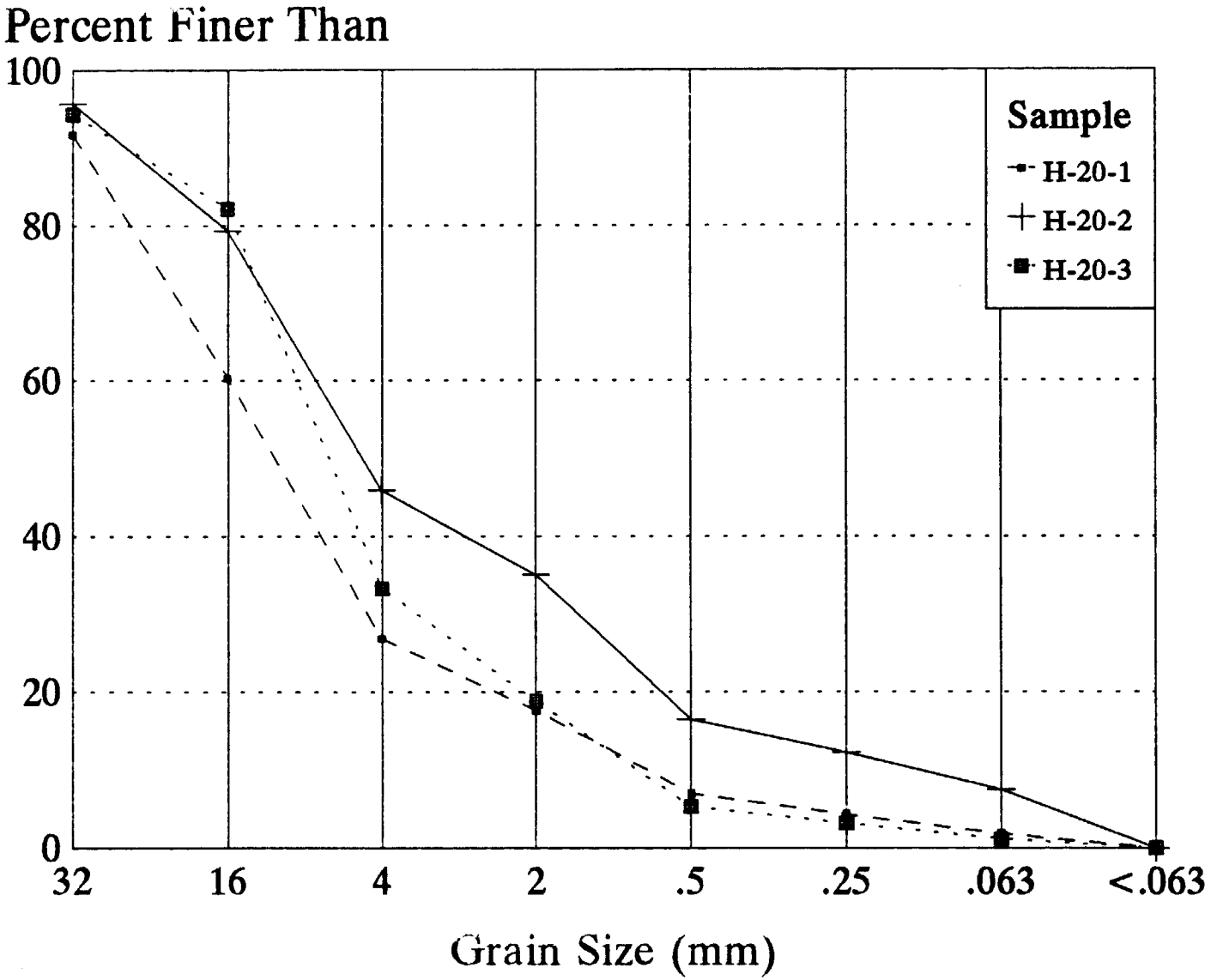


Figure 10. Typical grain size composition of aggregate at Ukpillik Hill (HMF-6, 7, 8); site of current operations, August 1992

of the metal dump when it is full. The largest aggregate volumes, however, exist as beach (storm?) ridges on the summit of Ukpillik Hill. These are the subject of current exploitation (Figure 9, 10). Selective extraction is involved (e.g. see figure 9 B and 9 D) and screeing is avoided. Approximately 175,000 m^3 of Class 2 and some Class 1 aggregate exists on Ukpillik Hill. This is sufficient, easily-accessible aggregate to meet normal community demand for many years.

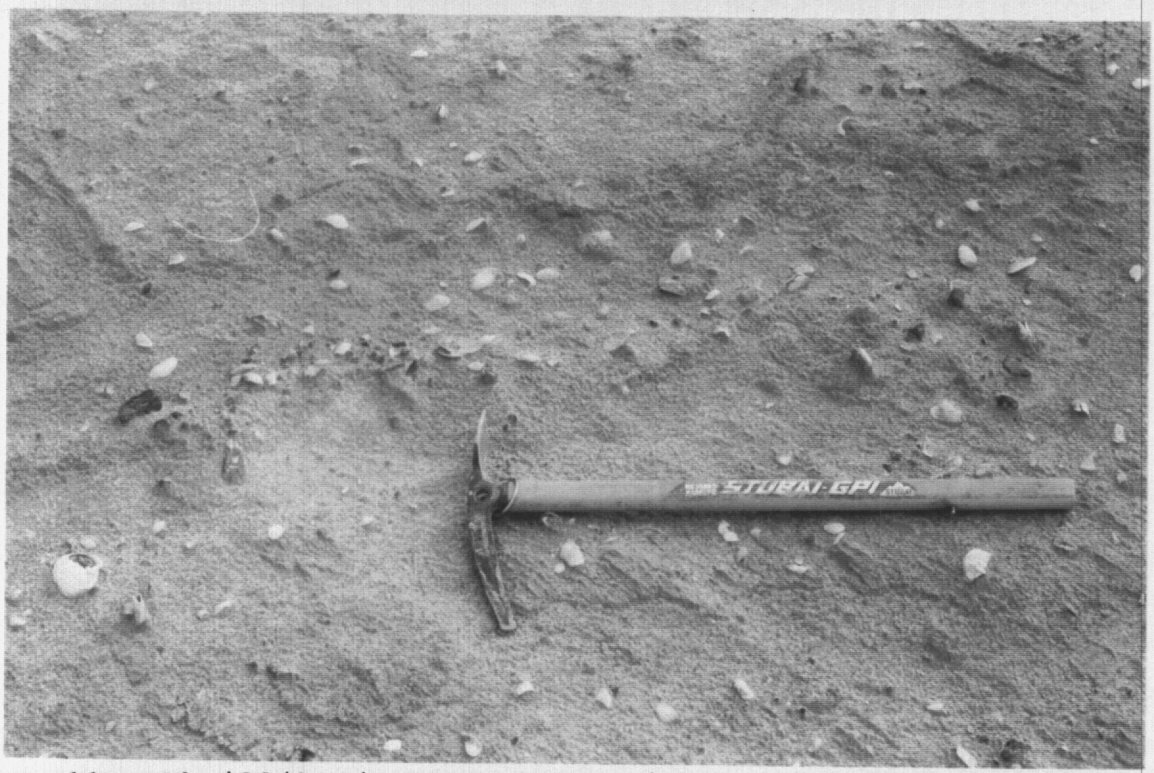
An extension of the Ukpillik Hill aggregate deposits is locality HMF-11. This is a Class 2 gravel deposit of approximately 30000 m^3 which is to be found on the west side of Ukpillik River and to the south of Ukpillik Hill. This deposit probably represents a beach bar, or spit, associated with an early emergence (Stage I, II; Figure 5) longshore current from NE-SW along the eastern flank of Ukpalik Hill. This source is easily accessed, currently unused, and a potential valuable aggregate reserve of relatively high quality for Holman when sources along RCAF Road are finally depleted. It should be developed in a manner which does not affect the river bank morphology (i.e. from the SW).

4.2.4. Ukpillik River (Sources HMF 9,10) (Figures 11, 12)

An extensive area of fine-medium sand with some gravel, exists in the vicinity of the Ukpillik bridge crossing (Figure 11A). Two deposits are identified (Figure 12):

1) HMF-9: a sandy gravel deposit forms a small terrace. It is probably fluvial in origin and Class 3-4 in quality.

A



B

Figure 11. Ukpillik River sand deposits
A. General view of sand deposits
B. Marine pelecypods in growth position/species include Mytilus edulis, Hiatella arctica, and Mya truncata.

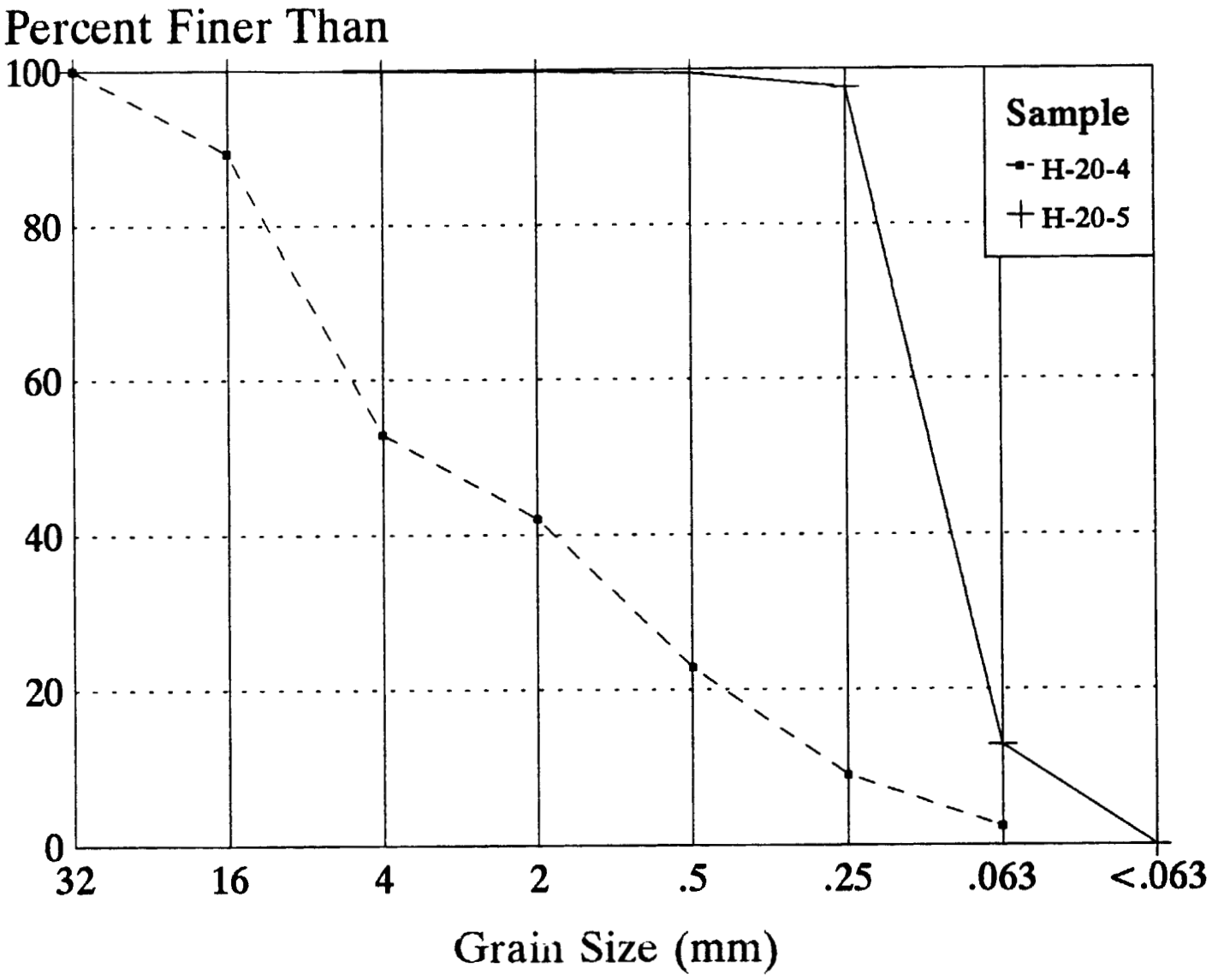


Figure 12. Typical grain size composition of marine sands (H-20-5) and fluvial gravel (H-20-4) occurring at Ukpillik River (HMF-9, 10).

2) HMF-10: a large area of medium sand, relatively well sorted, and contains marine pelecepods, many in growth positions, e.g. Macoma balthica, Hiatella arctica, Mya truncata, Mytilus edulis) (Figure 11 B). The EBA estimate of approximately 200,000 m^3 of Class 3 aggregate at this locality is probably overly optimistic. Investigations suggest the total aggregate deposit was originally approximately 100,000 m^3 and that approximately one third has already been used. Therefore, a conservative estimate is that 60,000 m^3 remains. Because of its poor grading characteristics, it is down-graded to Class 4 deposit.

HMF-10 is easily accessible; HMF-9 requires an access road and should not be a priority for future development.

4.2.5 MOT pits: (S. end of airstrip). (Figures 13, 14).

Substantial quantities of Class 2-3 aggregate exist at the south end of the airstrip. They consist of coarse gravels, relatively well graded (Figure 13), but numerous large boulders (> 1.0 m in diameter) are present. Marine macrofossils, (Hiatella arctica, Mya truncata, Mytilus edulis), frequently crushed, but occasionally in growth position, suggest a storm beach origin.

Substantial quantities of good quality aggregate exist at the site; proven reserves in the area of current workings exceed 60,000 m^3 (e.g. see Figure 14 A) and there is an additional estimated reserve of approximately 55,000 m^3 in adjacent areas (Figure 14 B).

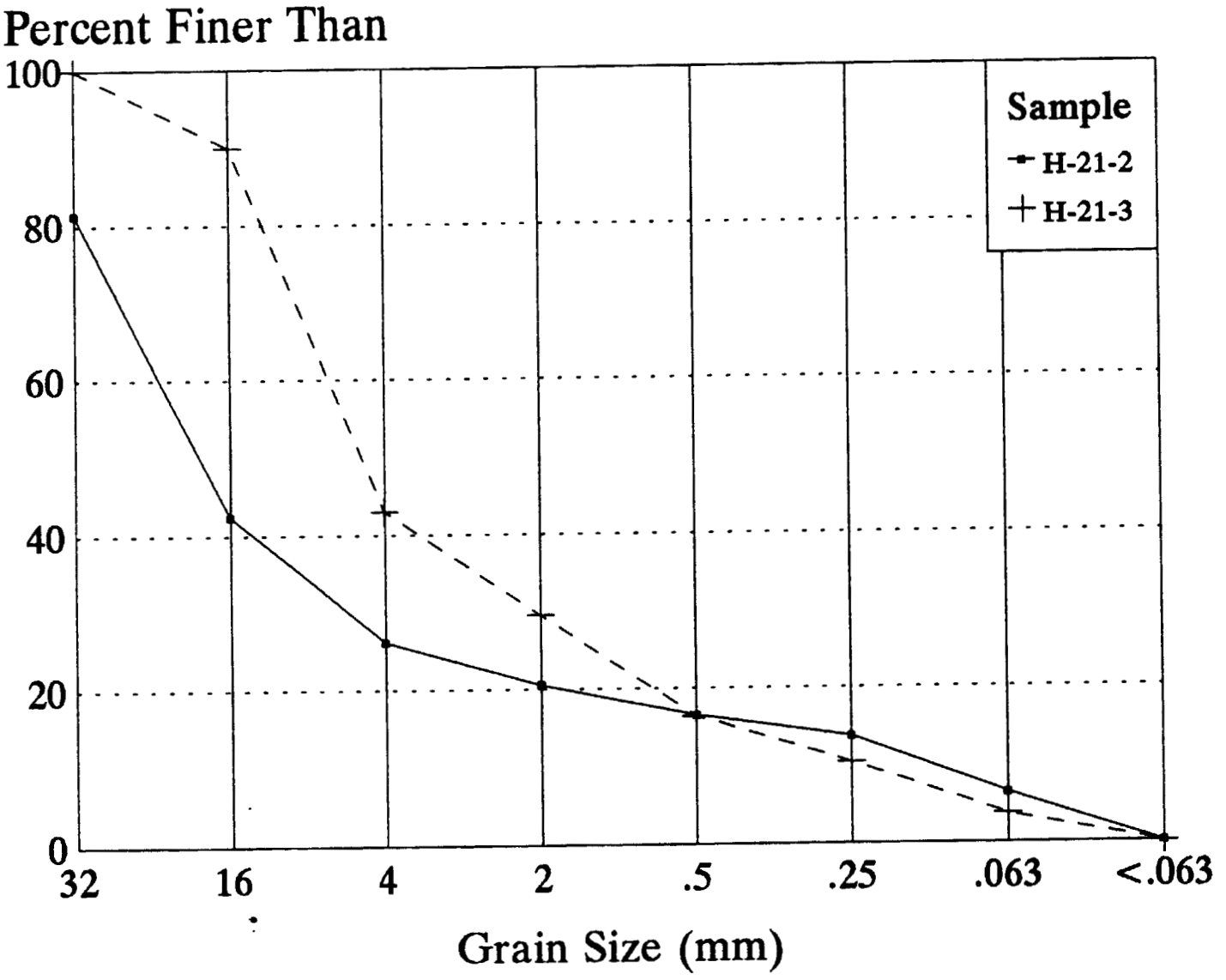


Figure 13. Typical grain size composition of aggregate at the MOT pits (HMF-12, 13).

A

B

Figure 14. MOT aggregate source.

A. Typical Class 2-3 aggregate being stockpiled at (HMF-12), August 1992.

B. Undeveloped area of aggregate souce HMF-12 with large boulders recoved from current workings.

4.2.6. Unexploitable Deposits

Large volumes of Class 2-3 aggregate exist in the vicinity of the Holman settlement but are unusable due to current land use and environmental concerns. These include the raised beach deposits at the head of Kings Bay, already discussed (see section 4.2.1.), high level gabbro-dominated raised beach deposits on Uluksartok Bluff (site HMF-15), the dominantly carbonate-derived pebble gravels beneath the immediate townsite (HMF-14; approximately 250,000 m^3), and the sandy gravels/beach deposits upon which the Holman Golf Course is located (HMF-16; approximately 30,000 m^3).

Extensive scree deposits exist in the vicinity of Holman (HMF -15; HMF-17) but are not considered in this report.

5.0 CONCLUSIONS AND RECOMMENDATIONS

1. Sufficient granular aggregate exists in the immediate vicinity of Holman to serve community uses for at least the next five to ten years, based on predicted use.
2. The majority of these aggregate deposits are of average quality (Class 2,3), and there is a relative lack of Class 1, but an abundance of Class 5, aggregate. The Ukpillik Hill source contains large quantities of aggregate, mostly Class 2 and Class 3, sufficient for most major projects in the foreseeable future for Holman.
3. Existing sources currently being utilized (MOT pit; Ukpillik Hill; RCAF Road) should be fully exploited before new resources are developed. There is no need to consider exploitation of other aggregate resources at present.
4. The most easily accessible reserves of aggregate are located in HMF-11 and adjacent to current operations at Ukpillik Hill (HMF-6) and the MOT pit (HMF-12), a total of approximately 225,000 m^3 of mostly Class 2.
5. Aggregate at HMF-7 should be reserved for the eventual in fill of the adjacent metal dump.
6. Substantial gravel aggregate exists beneath the townsite (HMF-14), at the cemetery (HMF-4) and on Uluksartok Bluff (HMF-15), but these are not considered usable reserves.
7. It is important that site rehabilitation be undertaken at all aggregate locations, once they become depleted. The level of disturbance associated with aggregate extension can be high

yet aesthetics and a pleasing townsite are important for potential tourism in the community.

8. Usage and volumes exploited should be monitored in the coming years and aggregate deposit maps should be updated on an annual basis.

REFERENCES

E.B.A. Engineering Consultants Ltd (1987). Inuvialuit Settlement Sand and Gravel Inventory and Recommendations for Development. Report prepared for Indian and Northern Affairs, Canada, 27 pp and Appendices.

J.G. Fyles (1963). Surficial Geology of Victoria and Stefansson Islands, District of Franklin. Geological Survey of Canada, Bullletin 101., 38 pp.

D.R. Sharpe (1992). Glacial sediments and landform, southern Victoria Island, NWT, Canada. Ph.D. Thesis, Department of Geology and Ottawa-Carleton Geoscience Centre, University of Ottawa, 232 pp.

D.R. Sharpe and F.M. Nixon (1989). Wollaston Peninsula (Victoria Island), District of Franklin, Northwest Territories. Geological Survey of Canada, Map 1650 A, Scale 1:250,000.

R. Thorsteinsson and E.T. Tozer (1962). Banks, Victoria and Stefansson Island, Arctic Archipelago. Geological Survey of Canada, Memoir 330, 83 pp.

J.-S. Vincent (1983). La géologie du Quatenaire et la géomorphologie de l'île Banks, Arctique Canadian. Geological Survey of Canada, Memoir 405, 118 pp.

A.L. Washburn (1947). Reconnaissance geology of portions of Victoria Island and adjacent regions, Arctic Canada. Geological Society of America. Memoir 22, 142 pp.