PRELIMINARY REPORT

1977 GRANULAR MATERIALS INVENTORY

TUKTOYAKTUK

NORTHWEST TERRITORIES

R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING AND PROFESSIONAL SERVICES

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1977 GRANULAR MATERIALS INVENTORY

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Prepared For

THE GOVERNMENT OF CANADA

DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

By

R. M. HARDY & ASSOCIATES LTD.

CALGARY ALBERTA

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1.0 INTRODUCTION

The Government of Canada, through the offices of the Department of Indian Affairs and Northern Development, commissioned R. M. Hardy & Associates Ltd. of Calgary to carry out an assessment of granular material sources in the vicinity of Tuktoyaktuk, N.W.T. The principle objective of the study was to locate at least 10 million cubic yards of sand and gravel with an emphasis on finding major deposits or stockpiling sites with year-round access from Tuktoyaktuk. The study area encompassed approximately a 30 mile radius around Tuktoyaktuk, N.W.T., including near-shore and off-shore areas. Most distant sources investigated were located near the proposed Inuvik to Tuktoyaktuk Highway alignment. Data on the location, quantity and quality of granular materials in the following type of deposits was to be investigated and assembled:

(i) Those accessible by dredging, or other means, located under lakes, in the harbour, or offshore;

(ii) Those located on offshore islands including abandoned artificial islands;

(iii) Those accessible following construction of the Inuvik to Tuktoyaktuk Highway; and

(iv) All others, including those listed in the 1973 "Granular Materials Inventory".

The work was formally authorized by the Department of Supply and Services Contract Serial Number OSU77-00133, and the official communique to proceed with the study was received from the Department of Supply and Services by telex on July 13, 1977.

The field work for this study was completed on July 27, 1977, and a total of 22 deposits were investigated during the field program.

This report is a preliminary presentation of our findings regarding the deposits considered to be prime sources of granular materials for the community of Tuktoyaktuk, which could be developed in the near future. This report also presents recommendations for further investigations, including timing and cost estimates, to fully prove quantity and quality of materials, to define the extent and distri-

bution of overburden and ground ice, and to formulate development plans for these deposits.

Of the 22 deposits investigated, the four designated as Deposits 159, 160, 161 and 162 are considered sufficiently promising to warrant further investigation in the near future. Deposit 162 designates the granular materials source at the bottom of Tuktoyaktuk Harbour, and its extent is shown on Figure 1 of Appendix A. Deposits 159, 160 and 161 are situated to the east of Tuktoyaktuk Harbour, as outlined on Figure 2 of Appendix A.

2.0 BACKGROUND DATA

2.1 General

The entire area lies within the continuous permafrost zone, with the active layer thickness varying according to vegetation and overburden thickness. The average active layer thickness is in the order of two feet, and exceeds three feet only where granular materials are essentially bare

of vegetation. Active layer thicknesses in the order of six inches or less are encountered in poorly drained, fine-grained deposits covered by peat. Massive segregated ice bodies, ice lenses, pingo ice and ice wedges are common in the area.

The study area is underlain by thick, interbedded glaciofluvial sands, deltaic sands and marine clays. Often the above strata are capped by till. Extensive thermo-karst has led to the development of lacustrine basins, resulting in the accummulation of lacustrine and colluvial deposits. Marine deposits, both coarse and fine-grained, are located along and near the Beaufort Sea shoreline.

The types of surficial deposits within the area of the primary sources of near-surface granular materials are the glaciofluvial deposits, and underwater sediments in Tuktoyaktuk Harbour, which is probably a large thermokarst basin in glaciofluvial deposits.

2.2 Deposit 162 (Tuktoyaktuk Harbour)

Gravels and sands in the sediments of Tuktoyaktuk Harbour are probably part of the glaciofluvial complex, which was in part underlain by icy sediments and massive ice. Thermokarst development has probably resulted in their present underwater position. Gravel can be expected to be concentrated in upper layers, particularly in shallower water. Such areas would have been former topographic highs, and wave action and currents have likely concentrated sand and gravel at these locations, both during thermokarst and at present.

During 1973, an offshore drilling program was carried out by E. W. Brooker & Associates Ltd., on behalf of Imperial Oil Ltd., to evaluate potential sources of borrow material suitable for construction purposes, in Tuktoyaktuk Harbour. The objective of the study was to locate sandy soils in areas where suction dredging would be feasible. Three potential borrow areas were identified, as shown on Figure 1 of Appendix A.

In Borrow Area I, a wide range of material types was identified, varying from clayey sand to sand with some gravel. Borrow Area II was considered preferrable to Area I, since the sediments are within a narrower gradation band, ranging from silty sand with some clay to clean sand with a trace of gravel. Both sand and gravel were identified in Borrow Area III. Gravel containing sand, silt and clay ranging from 0 to 14 feet thickness was found above fine to medium grained, uniform sand in this area. Permafrost was not encountered during the 1973 offshore drilling program in most holes.

Based on the above data and the results of our 1977 office studies and field work, the most promising areas for granular material deposits within Tuktoyaktuk Harbour appear to be concentrated within the northern portion of the harbour, as outlined on Figure 1.

A volume of 6.9 million cubic yards of granular material is estimated, within the outlined area, of which 1.4 million cubic yards may be gravel. This estimate is based on the assumption that approximately 15 percent of the outlined area contains granular material to a depth of 15 feet, of which 20 percent is gravel.

2.3 Deposit 159 (Northeast of Tuktoyaktuk Harbour)

Deposit 159 is a glaciofluvial outwash plain modified by thermokarst. It is located between the eastern entrance to Tuktoyaktuk Harbour and Aveltkok Inlet.

Relief over the area is generally less than 50 feet, with one to six feet overburden at higher elevations and thicker peat cover in depressions and swales. Approximately 50 percent of the area probably has overburden of less than six feet. The active layer thickness in the areas of higher elevation varies from one to three feet. Ice content in the sands and gravels is estimated at an average of 10 percent. The uplands are well drained to moderately well drained.

Deposit 159 contains fair to good quality sands and gravels. However, gravel beds are generally thin and discontinuous within the upper 10 feet of sandy units. The total volume of extractable granular materials is estimated to be 4.6 million cubic yards, of which 900,000 cubic yards is gravel.

2.4 Deposit 160 (South of Pikiolik Lake)

This deposit is bordered by Pikiolik Lake to the north, Mayogiak Inlet to the south and Tuktoyaktuk Harbour to the west. In terms of geology and geomorphology, this deposit is essentially identical to Deposit 159. The overburden thickness, in the proposed pit development areas, varies from two to eight feet. On isolated knolls, overburden thickness is less.

Deposit 160 contains mainly sand, with irregular occurrences of gravel. The total volume of extractable granular materials is estimated to be 4.4 million cubic yards, of which 700,000 cubic yards is gravel.

2.5 Deposit 161 (East of Mayogiak Inlet)

This deposit is located to the south of Deposit 160, and east of Mayogiak Inlet. In terms of geology and geomorphology, this deposit is similar to Deposits 159 and 160. Overburden, in the potential pit development areas, ranges from one to six feet in thickness.

During 1973, E. W. Brooker & Associates Ltd. carried out a drilling program on behalf of Imperial Oil Ltd. for a proposed airstrip in the area shown on Figure 2 of Appendix A.

The current study, and test hole data from the previous investigation indicate that Deposit 161 contains granular material ranging from clean well graded sandy gravel to silty sand with some clay, and that gravel beds are generally thin and discontinuous.

It is estimated that Deposit 161 contains 1.9 million cubic yards of extractable granular materials, of which 300,000 cubic yards may be gravel.

3.0 PROPOSED FURTHER INVESTIGATIONS

3.1 General

Further investigations to prove out the extent, quality and quantity of granular materials within the

primary sources identified, should include a detailed field investigation and sampling program, a laboratory testing program and an office study.

Background information to optimize data aquisition during the field program has been obtained in conjunction with the current study. Based on these data, an efficient field sampling program, augmented with a geophysical survey for the underwater deposit, is recommended. Sampling of granular materials should be by means of a field drilling program. A geophysical survey with acoustic marine sources would be utilized to interpolate subsurface stratigraphy between sampling locations for the underwater deposit.

As an alternative sampling method of the harbour bottom sediments, a clam shell dredge could be utilized. However, better definition of soil stratigraphy and sample depth will be obtained by drilling, therefore, details given for the harbour bottom sampling program assume a drilling operation.

3.2 Proposed Field Program

3.2.1 Deposit 162

It is recommended that the geophysical survey of the underwater deposit be undertaken prior to sampling, in order that actual sampling locations are chosen based on the geophysical survey data. However, interpolation of subsurface data from the geophysical survey, based on samples obtained prior to the geophysical survey would also be possible, if time and weather constraints do not prevent the undertaking of the geophysical survey in the preferred sequence.

The depth of penetration and the vertical resolution of marine, acoustical sources depends on the frequency of the source. The system we would specify to the geophysical sub-contractor would operate at 3.5, 7.5 and 200 khz (e.g., RTV 1000), and a Trisponder Navigational System for accurate positioning. The results from the survey with this system consist of reflections from subsurface layers versus distance along lines, and the reflecting layers can be correlated to data obtained by sampling of sediments.

Survey lines would be spaced at 500 foot intervals, resulting in a total survey of approximately 20 miles. A staff geophysicist from R. M. Hardy & Associates Ltd. would be on site to provide field supervision of the geophysical sub-contractor, and for field interpretation of survey data.

Twenty-six proposed locations for harbour bottom sampling have been tentatively selected, as shown on Figure 1 of Appendix A. These locations identify areas where granular sediments are likely to occur. However, these locations should remain flexible, pending the results of the geophysical survey. The harbour bottom sediments should be drilled and sampled to a depth of 20 feet.

Two methods of obtaining harbour bottom sediments are possible. One method would employ reverse-air circulation with cuttings blown up the centre of a double walled casing. The second method would be wet drilling through a single walled casing, and sampling with Shelby tubes equipped with a sample catcher. The method chosen for the harbour bottom sampling program will be contingent on the availability of drilling equipment when the program is authorized.

3.2.2 Deposits 159, 160 and 161

The field program for detailed investigations of these deposits should include drilling of test holes, and obtaining representaive samples at locations within the deposits where overburden is likely to be thinnest and volumes of extractable granular materials the thickest. Such areas are likely to be on upland ridges, and the location and orientation of these ridges are shown on Figure 2 of Appendix A. Test holes should be drilled at 500 to 1000 foot intervals along these ridges.

For this frequency of drilling, Deposits 159 and 160 will require in the order of 100 test holes, and approximately 60 test holes will be required in Deposit 161. The majority of these test holes should be drilled to depths in the order of 20 feet, with a limited number of holes to 60 feet. The purpose of the deep test holes will be to determine if massive ice is present beneath the granular materials.

The drilling method proposed for the on-shore deposits is tri-cone drilling without casing, utilizing air for circulation.

3.3 Laboratory Testing Program

The proposed laboratory testing program would be limited to grain size analyses of representative samples. For estimating purposes, we have assumed 10 grain size analyses for harbour bottom samples, 30 grain size analyses each for Deposits 159 and 160 samples, and 20 grain size analyses for samples from Deposit 161.

3.4 Office Study

Based on the results of the field and laboratory programs, an office study will be carried out to define the quantity and quality of granular materials in the deposits, to delineate the extent and distribution of overburden and ground ice, and to recommend site development and restoration plans.

3.5 Project Team

To insure continuity for the study, the proposed project team will be made up of the same key personnel who are currently engaged in the Phase I of the study. These

personnel are Mr. T. J. Fujino, P.Eng., Project Manager, Mr. N. Hernadi, P.Eng., Project Engineer and Mr. G. Daw, P.Eng., Field Engineer. Dr. V. N. Rampton, of Terrain Analysis and Mapping Services Ltd. will be retained as sub-consultant, acting as Project Geologist.

4.0 RECOMMENDED TIMING FOR FURTHER INVESTIGATIONS

4.1 Geophysical Survey

The geophysical survey of the harbour bottom deposit will be carried out with acoustic marine sources operated from a boat. Consequently, ice-free conditions will be required in the harbour to undertake this survey. This survey should be carried out prior to the harbour bottom sampling program, therefore, to complete this phase of the study during 1977, the geophysical survey team should be on site prior to the end of September, 1977. Otherwise geophysical surveying would not be feasible until Summer 1978.

If authorized for 1977, a 10 day mobilization period should be assumed for the geophysical survey team.

4.2 Field Drilling and Sampling Program

Drilling and sampling of the harbour bottom deposit is recommended to be carried out from the ice surface. A winter drilling program will also be suitable for the on-shore field investigation. Consequently, we recommend that this phase of the study be undertaken in February and/or March 1978.

5.0 COST ESTIMATE

5.1 Field Program

5.1.1 Geophysical Survey

Geophysical sub-contractor	
Mobilization and demobilization	$ 10,000.00
4 survey days @ $2,000.00	8,000.00
On-site supervision by R. M. Hardy & Associates Ltd., data interpretation and planning of drill program (including 4 days office time by Dr. V. N. Rampton)	4,600.00
Subtotal for Geophysical Survey	$ 22,600.00

5.1.2 Field Drilling Program

5.1.2.1 Project Planning and Field Preparation

Office time for Project Manager, Project Engineer, Field Engineer and survey crew, including 2 days office time for Dr. V. N. Rampton	$ 5,000.00

5.1.2.2 Mobilization and Demobilization

For a 3 man survey crew and a 2-man drilling crew, including air fares, charters, air freight, travelling time and miscel laneous expenses	$ 8,425.00
Mobilization and demobilization of the drill rig from Inuvik along the winter road	3,000.00
Subtotal for Mobilization and Demobilization	$ 11,425.00

5.1.2.3 Drilling Program for Deposit 162 (Tuktoyaktuk Harbour)

Survey personnel	$ 1,500.00
Drilling personnel	2,500.00
Drill rig (including drilling contractor personnel)	6,750.00
Accommodations	1,950.00
Vehicle support	350.00
Project Engineer (office time)	150.00
Miscellaneous (expendables, telephones, etc)	400.00
Subtotal for Drilling Deposit 162	$ 13,600.00

5.1.2.4 Drill Program for Deposit 159

Survey personnel	$ 3,750.00
Drilling personnel	5,000.00
Drill rig	13,500.00
Accommodations	4,125.00
Vehicle Support	750.00
Project Engineer (office time)	300.00
Miscellaneous (expendables, telephones, etc)	600.00
Subtotal for Drilling Deposit 159	$ 28,025.00

5.1.2.5 Drill Program for Deposit 160

Survey personnel	$ 3,750.00
Drilling personnel	5,000.00
Drill rig	13,500.00
Accommodations	4,125.00
Vehicle Support	750.00
Project Engineer (office time)	300.00
Miscellaneous (expendables, telephones, etc)	600.00
Subtotal for Drilling Deposit 160	$ 28,025.00

5.1.2.6 Drill Program for Deposit 161

Survey personnel	$ 3,000.00
Drilling personnel	3,000.00
Drill rig	8,100.00
Accommodations	2,700.00
Vehicle Support	500.00
Project Engineer (office time)	200.00
Miscellaneous (expendables, telephones, etc)	500.00
Subtotal for Drilling Deposit 161	$ 18,000.00

5.2 Laboratory Testing Program

Pit-run gravel sieve analyses

Deposit 162	10 @ $42.00	$ 420.00
Deposit 159	30 @ $42.00	1,260.00
Deposit 160	30 @ $42.00	1,260.00
Deposit 161	20 @ $42.00	840.00
Subtotal for Laboratory Testing Program		$ 3,780.00

5.3 Office Study and Report Preparation

Dr. V. N. Rampton	
- 7 days office time @ $230.00	$ 1,610.00
- travel and miscellaneous expenses	1,000.00
Engineering time, drafting, typing, reproduction and printing for preparation of the final report	$ 27,000.00
Subtotal for Office Study and Report Preparation	$ 29,610.00
Total Estimated Cost for the Geophysical Survey, the Field Drilling Program, Laboratory Testing, Office Study and Report Preparation	$160,065.00

Assuming the scope of the study is reduced to include investigation of only one of the on-shore sources (i.e., only Deposit 159), as well as investigation of the underwater source (Deposit 162) as outlined in this report, the total estimated cost would be reduced to $104,000.00. This figure includes a reduction of $7,940.00 for the office study, to reflect the reduced workload for this phase of the project.

The above estimate is based on the costing schedule in effect for the phase of the study currently underway, and our best estimates of costs for services provided by the sub-consultant and by sub-contractors. It should be noted, however, that work carried out during 1978 will be subject to adjustment in hourly and unit rates.

Respectfully submitted,

R. M. HARDY & ASSOCIATES LTD.,

Per:

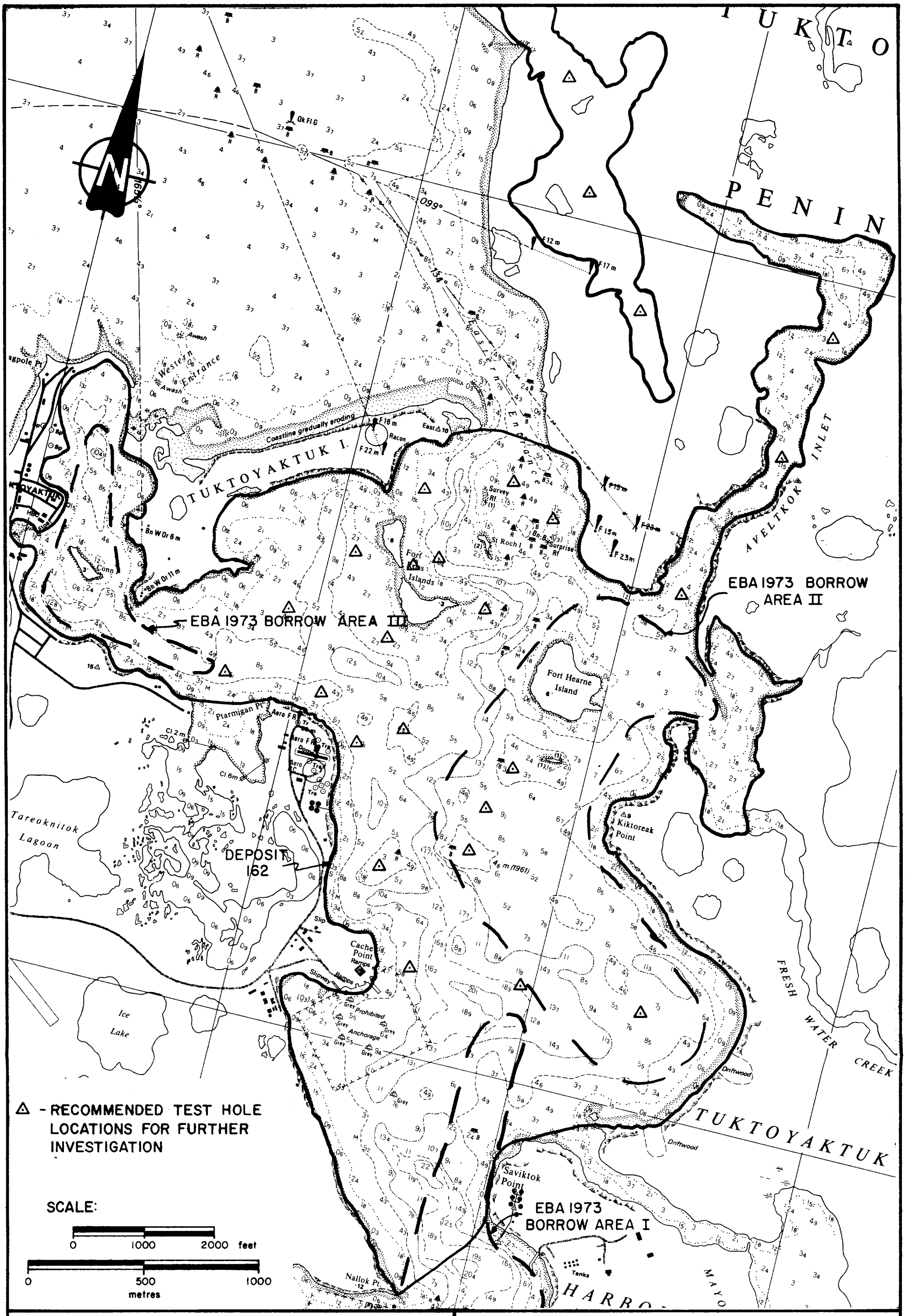
N. Hernadi, P.Eng.

Reviewed by:

T. J. Fujino

GRANULAR MATERIALS REPORT 1982
(SEDIMENTS IN TUKTOYAKTUK HARBOUR)
showing recommended test hole locations

FIG. 1



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GRANULAR MATERIALS DEPOSIT 162 (SEDIMENTS IN TUKTOYATUK HARBOUR) SHOWING RECOMMENDED TEST HOLE LOCATIONS

FIG. 1

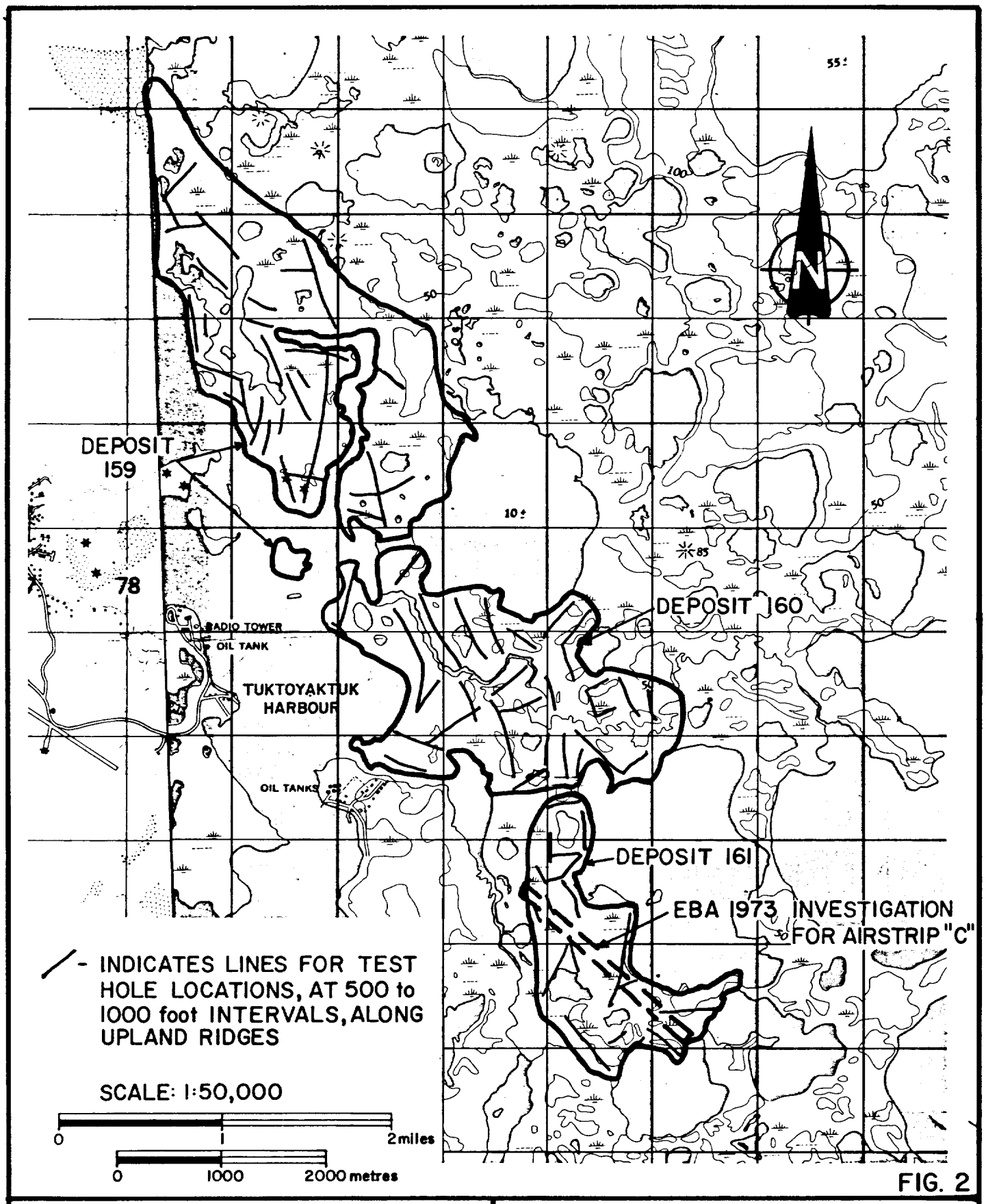

FIG. 2

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GRANULAR MATERIALS DEPOSITS 159,160 & 161 (EAST OF TUKTOYAKTUK HARBOUR) SHOWING RECOMMENDED AREAS OF FURTHER INVESTIGATION