

GRANULAR RESOURCE EVALUATION

RICHARDS ISLANDS N.W.T.

PREPARED FOR



Indian and Northern
Affairs Canada



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GRANULAR RESOURCE EVALUATION
RICHARDS ISLAND, N.W.T.

submitted to:

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1.0 INTRODUCTION

The discovery of petroleum reserves north of the Mackenzie Delta has led the Government of Canada to anticipate an increased future demand for granular resources in the Mackenzie Delta region. Recent settlement of COPE land claims has reallocated from Crown lands many of the previously identified reserves of quality granular material. Therefore, a need was identified to further delineate existing sources and to locate new sources of granular material.

Indian and Northern Affairs Canada (INAC) engaged EBA Engineering Consultants Ltd. (EBA) to undertake a study that would re-evaluate and update information on the granular resources that remain on Crown lands. This study comprises three phases:

1. An office study to review available ground truthing data and air-photos in order to identify prospects for further investigation.
2. A drilling program to explore prospects selected in Phase 1.
3. An evaluation of the prospects explored in Phase 2 and preparation of recommendations for site development.

The overall objective of the study is to locate supplies of granular material and to prepare pit development plans for sources judged to contain sufficient volumes of recoverable granular material.

This report presents a general background of the geological and geomorphic setting of Richards Island, and a description of procedures used to identify and evaluate the granular resources in both office and field portions of the project. It also describes results of the drilling program, a summary of the volume and quality of the granular resources investigated, and recommendations for pit development and further work.



1.1 Authorization

The project was authorized by Contract No. OST85-00413, awarded to EBA on February 21, 1986. The designated Scientific Authority is Mr. R.J. Gowan, Geotechnical Advisor for Northern Renewable Resources Directorate of Indian and Northern Affairs Canada.



2.0 IDENTIFICATION OF POTENTIAL GRANULAR RESOURCES

2.1 Geologic Setting of Richards Island

Richards Island is predominantly composed of Quaternary fluvial, deltaic and estuarine sediments that comprise clays, silts and sand. Coarser glacial sediments overlie the fluvial deposits on the south half of the island. The retreat of the most recent Wisconsin glaciation provided final deposition on the island, leaving behind rolling ground moraine, lacustrine deposits, as well as ice-contact landforms including eskers and kames. A substantial number of higher elevation landforms exhibit evidence of wave modification, in the form of beach and terrace features.

The region lies well within the region of continuous permafrost with a mean annual air temperature of approximately -10°C . Ground ice is common, varying from interstitial ice, ice wedges and pingos, to massive bodies of nearly clear tabular ice. Mackay (1974) suggests that the growth of tabular ice can elevate the ground surface by 5 to 10 metres; evidence from boreholes drilled on Richards Island indicates that bodies of massive ice within glacially derived features can exceed 20 metres in thickness. In some cases, the relief of a portion of a landform may be attributed to the presence of tabular ground ice.

Massive ice was not found to be continuous in any given landform. Mineral soil was often encountered in boreholes drilled between locations where massive ice was logged. Much of present day Richards Island topography is complex terrain resulting from the growth and degradation of massive ice bodies (French, 1976).

2.2 Review of Existing Studies

Several granular resource inventory studies have been undertaken in the Richards Island area since 1972. These studies were prompted by a relatively high material demand for construction materials in the Tuktoyaktuk and



southern Beaufort Sea area, due to oil and gas exploration activities. The first inventory, completed by Mollard and Associates (1972) for the Arctic Petroleum Operators Association, comprised airphoto delineation of 131 potential granular sources in the Mackenzie Delta region, followed by a walk-over survey of 65 of these sites. On Richards Island, 23 potential sources were delineated, and 12 were visited during the walk-over survey.

The second study was completed by Ripley, Klohn and Leonoff International Ltd. (RKL) in 1972. The study comprised both airphoto interpretation and field investigation of potential granular resources in four zones located in the Inuvik - Tuktoyaktuk - Mackenzie Delta area. Richards Island lies within Zone II of their study area. Twenty-eight separate sources on Richards Island were explored using both test pitting and borehole sampling techniques. Based on this exploration, it was concluded that over two million cubic metres of materials were suitable for exploration. The borrow source numbering system used in the present report is based on that initiated by RKL.

Borrow prospects delineated by RKL with the highest potential for development were located in the vicinity of Ya-Ya Lake. Engineering and management studies of the this deposit were undertaken in 1975 and 1976 (EBA, 1975; Terrain Analyses and Mapping Services Ltd., 1976). This area, now on Inuvialuit land, is outside the scope of this study, thus these reports were used for background reference only.

A study commissioned by INAC and completed by BBT Geotechnical Consultants Ltd. et al., in 1983, included an investigation of the northern portion of Source 211, located near Willow Lake. This report provided lithologic details of the source at nine borehole locations. An extrapolation of the boring data by the authors concluded that 500,000 m³ of "General Fill" was available for development, of which 365,000 m³ existed in the active layer. This fill comprised predominantly sand with a minor gravel component.



A review of the previously identified sites conducted for this program, concentrated mainly on the RKL (1972) report because it was judged to be the most extensive documentation of granular resources in the area.

A preliminary rating system for exploration was based on the following criteria:

- o **Quantity** of fill estimated by aerial photograph interpretation/delineation and topographic information from maps,
- o **Quality** of fill estimated either from previous borings or from geomorphological interpretation of features observed on the aerial photographs,
- o **Location** of the fill body with reference to potential future development,
- o **Access** to the source by winter roads that would follow lakes and streams, and
- o **Existing Data.** The extent and level of confidence about the size and quality of the deposit depends on the level of information available from existing data.

2.3 Airphoto Interpretation

The area shown in Figure 1 was examined on airphotos at a scale of 1:60,000 to locate potential borrow sources. A detailed airphoto interpretation of prospective sources was used to refine the boundaries of the sources identified in the RKL (1972) study and also to locate additional prospects, especially in the northern half of Richards Island.

Table 1 lists the 14 prospects identified for future investigation, the location of each, an estimate of the area of the feature, and an evaluation of its priority for investigation. Eight of these sites had been previously identified and investigated by RKL (1972). The six unexplored areas have been identified using the number of a nearby RKL (1972) source, with a suffix (North, South, West, or East) to indicate its bearing from the RKL (1972) source.



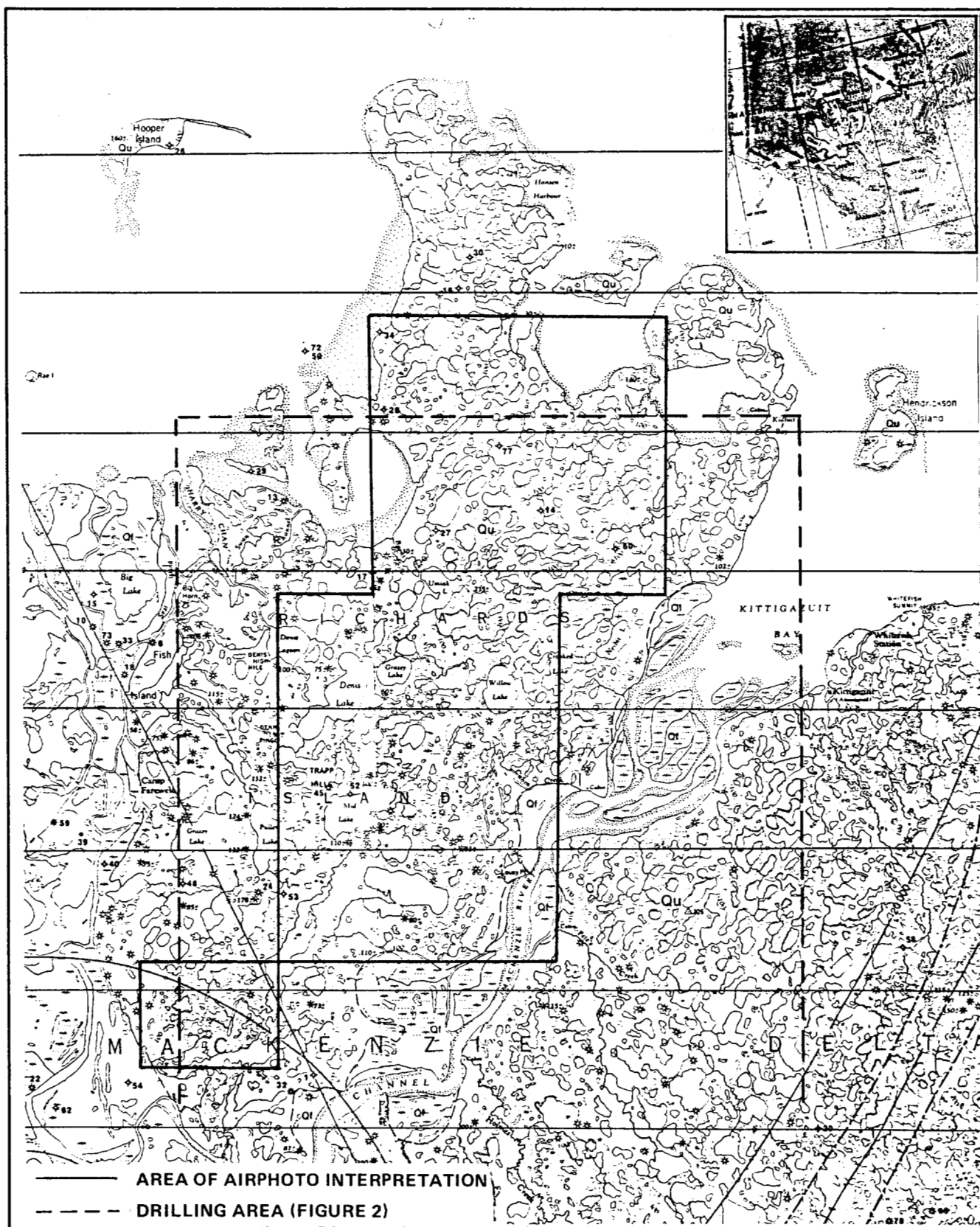


FIGURE 1 STUDY AREA

TABLE 1 SUMMARY OF GRANULAR RESOURCE PROSPECTS

| SOURCE NO. | ESTIMATED AREA | UTM COORDINATES ZONE 8 | | RELATIVE PRIORITY RATING | COMMENTS |
|-------------|-------------------|---------------------------|---------|--------------------------------|------------------------------------------------------------------------------------------|
| | | (mN) | (mE) | | |
| 206 (North) | 2,250,000 | 7,699,000 | 523,000 | High | Northerly Extension to Source 206. May be of variable quality. |
| 209 (South) | 1,360,00 | 7,712,000 | 529,000 | Medium | New area to the southeast of Source 209. Logistics may not allow investigation. |
| 211 | 1,672,800 | 7,690,000 | 528,000 | Medium | Supplement previous data in Southwest end of deposit. Define quantity and quality. |
| 211 (East) | 320,000 | 7,690,000 | 534,000 | Low | |
| 212 | 777,000 | 7,682,000 | 527,000 | Low | As an alternate to 218, should 218 prove unsatisfactory. |
| 216 | 1,062,000 | 7,677,000 | 527,000 | High | |
| 216 (South) | 430,000 | 7,675,000 | 526,400 | Medium | |
| 217 | 567,000 | 7,675,500 | 522,500 | Low | |
| 217 (East) | 427,000 | 7,676,000 | 524,000 | Medium | |
| 218 | 690,000 | 7,683,500 | 521,500 | Medium | Area well delineated. One hole on west Lake is warranted. |
| 218 (North) | 1,158,000 | 7,688,000 | 523,500 | Medium | Area previously untested. Several small prospects lying north of Source 218. |
| 219 | 3,283,000 | 6,677,000 | 517,000 | Low-Medium | Suspect thin layer of granular material. |
| 220 | 1,504,000 | 7,670,000 | 516,500 | Medium-High | Source on COPE land. Focus was shifted to Source 219. |
| 227 | 4,000,000 | 7,668,000 | 509,000 | High | Thorough data available in RKL report. |

Forty investigation boreholes were proposed to explore the prospects listed in Table 1, with coverage weighted to conform with the priorities listed. Drilling locations were identified on the basis of airphoto interpretation and then transferred to 1:50,000 topographical maps. Approximate UTM coordinates could be determined for use in field location of each borehole. Locations given in Table 1 approximate the centre of each source.

Initial exploration priorities required reevaluation as the field program progressed. Program modifications were required because all of the field exploration could not be completed within the time constraints imposed by the program budget. Unusually heavy snow accumulations in the area considerably slowed the progress of the drilling equipment between prospects. On-site review of the aerial photograph coverage ensured that exploration was concentrated at prospects that had the highest probability of providing the largest quantity of "General Fill".



3.0 FIELD PROGRAM

3.1 Equipment and Crew

The drilling subcontractor was Midnight Sun Drilling Ltd., of Whitehorse, Y.T. Drilling was carried out using a CME 750 drill rig mounted on an all-terrain vehicle. All holes were advanced using a 150 mm auger core barrel and solid stem augers. Continuous core was recovered and visually logged. Representative samples were bagged and placed in five gallon pails for shipment to EBA's Edmonton laboratory. Drilling was conducted 24 hours per day in two 12 hour shifts. A two-man drill crew plus an engineer or technologist was employed on each shift.

The location and elevation of each borehole was determined by survey. In addition, topographic sections were obtained for the more-promising sources to improve fill volume computations.

A sled camp was used as the base of operations. The camp was mobilized from Inuvik and moved three times during the program to maintain close proximity to the sites being investigated. In addition to the two shifts of drill crew and engineers, the camp complement included the INAC Scientific Authority, two representatives from GSC, one surveyor, a cook, a camp maintenance man, a bulldozer operator, a Nodwell operator, and two bear monitors.

3.2 Exploration

Nine potential sources and additional GSC study sites were investigated during the 20-day field program conducted between March 15 and April 4, 1986. The location of each source is shown on the area map, Figure 2. The



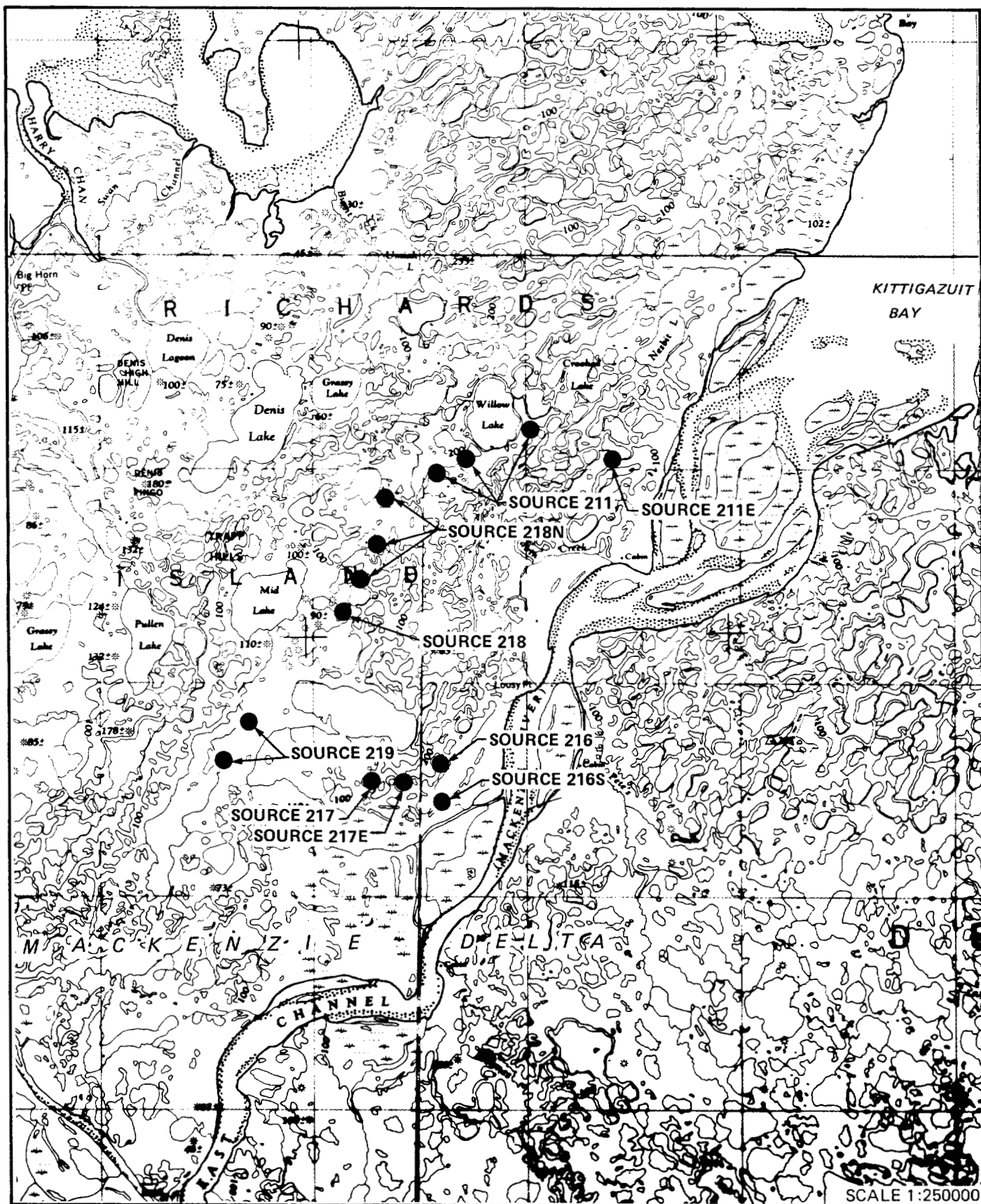


FIGURE 2 AREA MAP SHOWING SOURCES INVESTIGATED DURING FIELD PROGRAM

program was revised in response to the field conditions encountered. This resulted in only 9 of the 14 prospects targeted for exploration being drilled. The rationale for the choice of sites was as follows:

- o emphasis was placed on Source 219 as a possible extension of the Ya-Ya lake deposits which are located on Inuvialuit land and on Source 211 since there was a need to complete the delineation initiated by BBT in 1983.
- o Source 220 was deleted from the program as it is partially located on Inuvialuit land.
- o Source 227 was deleted from the program because of site access difficulties.

A drilling program for the Terrain Sciences Division of the Geological Survey of Canada (GSC) was added to the scope of the INAC program shortly before commencement of the fieldwork. The expanded drilling program was structured to make maximum use of the rig while moving between sources and the areas of interest to the GSC that is, Source 219 and between Lousy Point and Mid Lake.

At Source 219, four boreholes were drilled for the GSC. In addition, one INAC borehole was advanced to a depth greater than that normally drilled, to gain information for GSC's requirements. At Source 216, one borehole was extended to a greater depth for the GSC. Between March 24 and March 28, 1986, 18 borings were completed for the GSC on a line that was established between Lousy Point and Mid Lake. This is documented in more detail in the operational calendar given in Appendix A.

Table 2 summarizes the drilling conducted at the INAC sources. The reader is referred to the GSC for information regarding boreholes drilled for the GSC program.



TABLE 2 SUMMARY OF ACTIVITY

| SITE | DAYS DRILLING | NUMBER OF BORINGS |
|----------|---------------------|-------------------|
| 211 | March 30 - April 2 | 11 |
| 211East | April 2 - April 3 | 2 |
| 216 | March 22 - March 24 | 4 |
| 216South | March 22 | 1 |
| 217 | March 21 - March 22 | 2 |
| 218 | March 29 | 2 |
| 218North | March 29 - March 30 | 4 |
| 219 | March 17 - March 21 | 11 |
| TOTAL | | 39 |

3.3 Laboratory Program

Samples obtained during the exploration program were sealed in plastic bags and shipped to EBA's Edmonton laboratory for testing. Moisture content determinations were conducted on 320 samples. Sieve analyses were conducted on 77 samples to determine particle size distributions. Petrographic analyses were conducted on samples from Source 219 and Source 211.

Appendices B through J contain descriptions of each Source, a site plan, borehole logs, and laboratory testing results.



4.0 EVALUATION OF GRANULAR MATERIAL SOURCES EXPLORED IN THIS STUDY

4.1 Criteria for Evaluation of Granular Material Sources

The quality of granular materials at each of the explored sources have been evaluated using the following criteria: grain size distribution, mineralogy, ice content (moisture content), and volume of potential fill materials. Using the the first three criteria the material can be classified as one of the five borrow types described below. An inventory of granular materials for the sources investigated is presented as Table 3 at the end of this section.

The following material classification is adapted from both the Granular Resource Development and Management Plan for Tuktoyaktuk N.W.T. (EBA,1983) and the proposed Territorial Pits and Quarry Regulations.

4.1.1 Type I Borrow Material

Type I borrow has been classified as granular material suitable for use as high quality surfacing material or asphalt and concrete aggregate. This material must consist of a structurally sound aggregate that falls within a relatively narrow gradational range. Processing (crushing, washing and blending) usually will be necessary to produce the required gradation.

4.1.2 Type II Borrow Material

Type II borrow is a quality gravel that will be required for a stable surface course on roads and for fills supporting structural loads. This material should possess the gradational characteristics shown in Figure 3, and have a moisture content below 10 percent. Type II borrow material will be relatively frost stable, will place and compact with reasonable effort, and will have good load bearing characteristics.



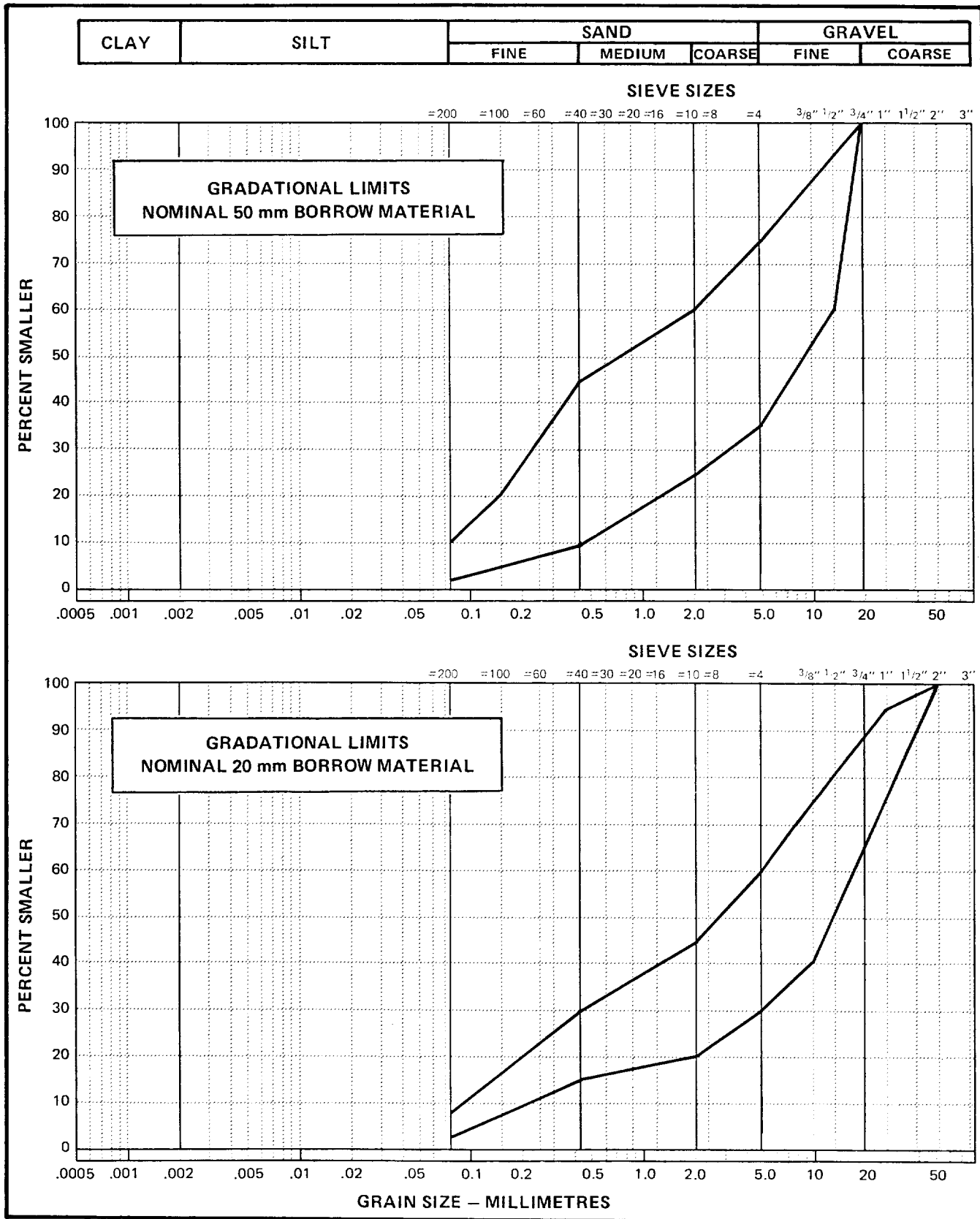


FIGURE 3 TYPICAL GRADATIONAL LIMITS FOR TYPE II BORROW MATERIAL NOMINAL 20 mm AND 50 mm MAXIMUM SIZE

4.1.3 Type III Borrow Material

Type III granular borrow has been classified as material suitable for use as general fill for roads, airstrips, and general site preparation. Gradational limits of this material are similar to those for Type II (Figure 3) except that a fines content of up to 15 percent by weight is considered acceptable.

Moisture contents for this classification should be limited to less than 10 percent since most of the moisture will be located in the fines. If the moisture content is too high, it will be unstable upon thaw, resulting in poor trafficability, potential sloughing, and settlement. The fill is "frost susceptible" which will likely result in poor trafficability each spring.

4.1.4 Type IV Borrow Material (Sand)

Fine and medium-grained uniform sand comprises a substantial portion of the area's granular resources inventory. The uniform grain size distribution of the material results in relatively poor compaction properties. However, the material may be suitable for use as pipeline backfill or for other non-structural applications where the strength and trafficability of the borrow are not a concern. In some circumstances it may form acceptable fill for pad construction when higher quality gravel is available for structurally sound surface layer. Maximum silt content should be limited to 10 percent to allow adequate drainage.

4.1.5 Type V Borrow Material

Type V granular borrow material has been classified as material suitable for use in erosion control measures. This type of material commonly consists of cobbles, boulders, or rock fragments.



4.2 Inventory Levels

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

Proven Resources

A "proven" resource 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 the borehole is extrapolated to a radius not exceeding 50 m around the hole.

Probable Resources

A "probable" resource is one whose existence and extent has been inferred on the basis of several different types of direct or indirect evidence, including topography, landform characteristics, airphoto interpretation, extrapolation of stratigraphy, geophysical data and/or limited sampling.

Prospective Resources

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

Because all of the sites discussed in this report have now had at least limited drilling, no resource falls into the prospective category; they have been either upgraded to probable status or deleted from the inventory. Table 3 presents the current inventory level for each source.



TABLE 3 SUMMARY OF GRANULAR RESOURCES
RICHARDS ISLAND, N.W.T.

MATERIAL WITH MOISTURE CONTENT LESS THAN 10%

| SOURCE | TYPE II | | TYPE III | | TYPE IV | |
|----------|-----------------------------|--------------------------------------------|-----------------------------|-------------------------------|-----------------------------|-------------------------------|
| | PROVEN (m ³) | PROBABLE ¹ (m ³) | PROVEN (m ³) | PROBABLE (m ³) | PROVEN (m ³) | PROBABLE (m ³) |
| 211 | 8,500 | 49,500 | | | 50,000 | 130,000 |
| 211East | | | | | | |
| 216 | | | | | | |
| 216South | | | | | | |
| 217 | | | | | | |
| 217East | | | | | | |
| 218 | | | | | | |
| 218North | | | | | | |
| 219 | 30,000 | | | | | |
| TOTAL | 38,500 | 49,500 | | | 50,000 | 130,000 |

MATERIAL WITH MOISTURE CONTENT OVER 10%

| | | | | | |
|----------|-------|--------|---------|-----------|------------------------|
| 211 | 6,000 | 17,000 | | 81,000 | 298,000 |
| 211East | | | | 15,000 | rec.reqd. ² |
| 216 | | | | | rec.reqd. |
| 216South | | | | 13,000 | rec.reqd. |
| 217 | | | | 7,500 | rec.reqd. |
| 217East | | | | 0 | 0 |
| 218 | | | | 0 | rec.reqd. |
| 218North | | | | 0 | 0 |
| 219 | | | 200,000 | rec.reqd. | |
| TOTAL | 6,000 | 17,000 | 200,000 | 116,000 | 298,000 |

1. Total volume at each site is the sum of the "proven" and "probable" volumes.

2. Rec. reqd. - further reconnaissance (usually a summer walkover) is required to delineate the area of the source in greater detail than possible from air photographs.



4.3 Evaluation Summary

This section is intended to provide a brief summary of the findings of the geotechnical investigation program. A more detailed description of each of the sites and the materials encountered while drilling is provided in Appendices B through J.

Table 3 provides a summary of the estimated recoverable volumes of each type of material at each site. The inventory separates material with moisture contents less than 10 percent from material with moisture content greater than 10 percent. The material with moisture content less than 10 percent is immediately extractable. The material included with moisture content greater than 10 percent will drain if overburden is stripped, and thaw occurs. One or more summers may be required for sufficient thaw and drainage to occur before extraction operations can proceed.

In each appendix, the volume of each material type available is listed in terms of "proven" and "probable" volumes. The "probable" volume is in addition to that considered "proven". Estimates of volumes of granular material, especially those considered "probable", should be treated with caution recognizing that few boreholes have been drilled in most areas, and that complicated subsurface conditions have been found where data is available.

Results from the drilling program often reduce the volumes projected by earlier studies, such as RKL (1972). This may be partially attributed to difficulties associated with locating source boundaries during winter. The volume of recoverable material may be more accurately determined by mapping surface exposures during a summer reconnaissance program. In these cases the notation "rec. reqd." is given instead of an estimated volume in Table 3.



4.3.1 Source 211

Source 211 is a long sinuous, esker-like ridge that runs along the southern and eastern shores of Willow Lake (Figure 2). The ridge has been partially dissected and nine areas that comprise the source have been identified. Six areas were investigated during this program. The remaining three areas were investigated by BBT in 1983. One area was investigated in part, by each each exploration program.

Of the six areas investigated, one was found to contain only silt and ice. The remaining sources were found to contain deposits of Type IV (sand) with some also containing supplies of Type II material. Development of these areas is recommended, thus a pit development plan is included in Appendix B.

4.3.2 Source 211East

Source 211E consists of two ridges, one east and one west of an unnamed lake at 536000 mE and 7689500 mN. One borehole drilled in the western ridge encountered fine sand with 10 percent silt and moisture contents of approximately 20 percent. Silt and ice was encountered in the borehole on the eastern ridge. Development of either source is not recommended due to the high ice content and marginally acceptable silt contents.

4.3.3 Source 216

Source 216 consists of a steep-sided ridge located 2 km south of Lousy Point and 3 km west of the East Channel. The ridge is partially dissected by kettle-like lakes. Four boreholes were drilled on this ridge. Two boreholes located on a small terrace on the east side of the central portion of the main ridge penetrated a deposit of poorly-graded sand with a variable silt content (3 - 20 percent), a trace of fine gravel and some thin silty beds. On the basis of this investigation, a limited quantity of low quality Type IV fill can be identified, but source development is not recommended.



However, because the RKL study encountered some well-graded gravel on another portion of this site, summer reconnaissance and further investigation may be warranted.

4.3.4 Source 216South

Source 216South is a hillock located 6.5 km south of Lousy Point, 3 km west of the East Channel. One borehole was drilled to a depth of 8.0 m and exposed fine sand with silt and organic lenses. Although some relatively low silt contents (8-12 percent) were encountered, the overall concentration of silt and organic material, combined with high moisture contents (15-20 percent) make the source of little value, thus development is not recommended.

4.3.5 Source 217

Source 217 is an esker-like ridge located 9 km southwest of Lousy Point, 6 km west of the East Channel. Two boreholes were drilled at the source. One borehole encountered silt and massive ice while the other encountered fine sand with high moisture contents (averaging 25 percent). During their investigation RKL (1972) encountered a well-graded sand. These findings indicate that the source is variable and that more investigation would be necessary if development were contemplated. Current data would not favour further investigation or development at this site.

4.3.6 Source 217East

Source 217East is a hummocky ridge with several terrace-like features located immediately east of Source 217, 4 km west of the East Channel. One borehole was drilled on this feature to a depth of 9.2 m, encountering a sequence of silty sand and sandy silt. The average fines content was estimated at approximately 50 percent and the moisture content was over 30 percent. Development of this site is not recommended.



4.3.7 Source 218

Source 218 consists of two flat-topped sharp-sided hillocks near the north-west shore of Mid Lake. One borehole drilled on each site encountered deposits of silt, massive ice and fine sand. The sand cannot be practically recovered because of its high moisture content (20 - 30 percent) and the silt and ice overburden. However, test pits excavated by RKL (1972) encountered clean, well-graded sand with some fine gravel. Further investigation by summer reconnaissance would be required before finally judging the merits of this source however, it does not appear to be a valued prospect.

4.3.8 Source 218North

Source 218North consists of a series of small ridges and hillocks extending north of Source 218 towards Willow Lake. One borehole was drilled on each of four of the six features that were included in the proposed program. Three of the boreholes penetrated mainly massive ice, although some thin layers of granular material comprising both sands and gravels were found below 1 to 2 m of overburden. The fourth borehole encountered interbedded silt and some interbedded sand with a bed of gravel at a depth of 5.0 m. Based upon these boreholes, it is considered unlikely that significant volumes of recoverable granular material are present at this site.

4.3.9 Source 219

Source 219 is a prominent flat-topped ridge near the north end of Ya-Ya Lake. It is approximately 1 to 2 km wide, 5 km long and 15 m high. This deposit appears to contain a large amount of types II, III and IV granular material. The deposit is variable with some boreholes encountering massive ice or silt at shallow depths. A small area suitable for initial development has been identified. Recommendations for pit development are presented in Appendix J.



For the remainder of the source, summer reconnaissance and further delineation is required. Delineation should comprise drilling on a grid of approximately 50 m or a combined program of drilling on a wider spacing with a suitable geophysical method.

Preliminary recommendations for development of the entire source are included in Appendix J. Actual development must await favourable results from further exploration. The development plan should be refined at that time.



5.0 BORROW SOURCE MANAGEMENT PLANS

5.1 General

A site-specific management plan is presented in Appendix B for Source 211. Preliminary site-specific recommendations are presented in Appendix J for Source 219. These plans 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 following sections present the objectives of the management plans, their limitations, general considerations regarding pit development and restoration which pertain to all borrow sources, and recommendations for refining the site-specific plans. Complete descriptions of the results of the drilling program are included in Appendices B to J.

5.2 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. The pit management plans have been developed primarily to maximize the utilization of limited resources and to minimize environmental disturbance.



5.3 Pit Access

Access to the various gravel sources on Richards Island will only be feasible by winter road. Current practice is to use streams and lakes as winter access to either the Mackenzie River or the Coast. Site 211 is approximately 10 km from the main ice road on the MacKenzie River and Site 219 is close to Ya-Ya Lake. Economical development of granular resources on Richards Island for use in the Tuktoyaktuk area will be possible only if the Inuvik-Tuk ice road is maintained.

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

5.4 Pit Development

5.4.1 Site Preparation Work

Site preparation should be conducted sufficiently 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.

5.4.2 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. Frozen gravel stockpiles with a moisture content less than 5% are usually sufficiently friable for direct loading without ripping. Moisture reduction from 10% in situ to 5% in a stockpile has only been achieved by use of conveyors during favourable summer conditions (Hayley and MacLeod, 1977).



The excavation plan must take into account the type of material, its extent and the volumes to be recovered. Normal practice in the region is to strip load and transport frozen granular material during the winter. The frozen gravel is ripped and worked to breakdown frozen lumps before loading in the pit. This practice has been developed for a region where deposits are relatively small and discontinuous and project demands are modest.

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 m² 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.

5.4.3 Treatment of Massive Ice

Logistical constraints caused by massive ice during summer development of Ya-Ya 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.



Thicker ice bodies at depth, frequently at the base of the deposit, should be preserved. 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.

5.4.4 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.



5.4.5 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.

5.5 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. Since thaw ponds and lakes and massive ground ice are common in the Tuktoyaktuk 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.

The surface of areas to be revegetated should be broken up with a caterpillar ripper tooth in the fall after frost has penetrated to a depth of about 150 mm. The resulting roughened surface serves to reduce potential wind erosion, and provide sheltered sites for re-establishment of vegetation.



6.0 SUMMARY AND RECOMMENDATIONS

Nine potential sources of granular materials on Richards Island have been investigated. Of these, two sources are candidates for development.

Source 211 is generally well defined as a result of this and previous studies. A total of 8500 m³ of type II and 50,000 m³ of type IV material is recoverable from the southern section of the source. An additional total volume of 6000 m³ of type II and 81000 m³ of type IV granular resources with moisture content over 10% is available. With proper pit development, this material will thaw and drain to be recoverable in subsequent years.

The volume and quality of the resource of source 219 is less well defined. Further delineation is recommended. Currently, a small area containing a proven volume of 30,000 m³ of type II material has been located at this source. In the portion of the source where the most exploration drilling has been conducted, a volume of 200,000 m³ is estimated to exist. However, further exploration is required before this larger area can be developed.

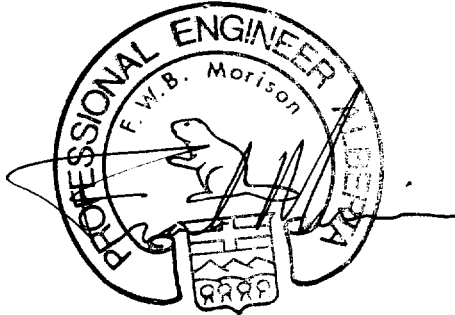
Exploration drilling was hampered by the difficulty of undertaking a proper reconnaissance of the site before drilling. Indications are that deposits of good quality granular material are often reflected by surface exposures. A summer reconnaissance program should be undertaken to properly map surface exposures of gravel. This reconnaissance should precede any further drilling in the area.

The following sites should be included in a summer reconnaissance program: 206North, 209South, 211East, 216, 216South, 217, 218, 219. A walkover at source 219 should be undertaken before delineation drilling is undertaken. Sources 206North and 209South were not drilled during this program, although they were identified at the outset as priority prospects. Consideration should be given to inclusion of these sources in future studies in the region.

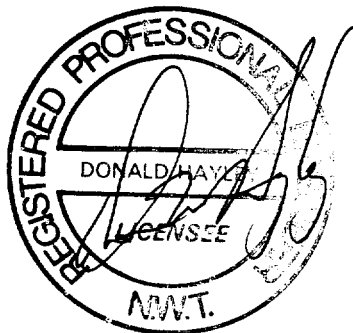


Respectfully submitted,

EBA Engineering Consultants Ltd.

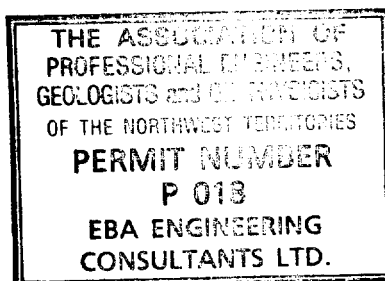


F.W.B. Morison
Project Engineer



D.W. Hayley, P. Eng.
Senior Project Director

FWB:chb



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TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION

March 15, 1986

EBA personnel, INAC representative and Challenger surveyor travel from Edmonton and meet camp on Mackenzie River ice road approximately 4 km north of Swimming Point. D-6 cat cleared access road along creek bed to unnamed lake at coordinates Lat. 69° 10' N Long. 134° 30', where camp was initially located.

March 16, 1986

1200 - 1400 Drill rig departs ice road and travels to camp location.
1400 - 2015 Preparations on-going prior to departing for Source 219.
2015 - 2400 Drill rig and crew travelling from camp location to Source 219. D-6 cat called from camp to assist with move.

March 17, 1986

0000 - 0230 Drill rig and crew travelling from camp to Source 219 continues.
0230 - 0800 On location borehole 86-219-S01. Location set by airphoto and topo map interpretation. Drill and sample to a completed depth of 9.1 m.
0800 - 0930 Prepare to move to location 86-219-S02; Borehole location not yet been established by surveyor.
0930 - 1140 Move rig and set up at borehole location 86-219-S02
1140 - 1545 Drill and sample borehole 86-219-S02 to a completed depth of 7.6 m. Refusal due to coarse gravel.
1545 - 1800 Rig down, move to borehole location 86-219-S03. Set up and prepare to drill.
1800 - 2020 Drill and sample borehole 86-219-S03 to a depth of 8.5 m at which time GSC took over the borehole.
2020 - 2400 Continue drilling and sampling borehole 86-219-S03 taken over by GSC.

March 18, 1986

0000 - 0700 Continue drilling and sampling as requested by GSC: Borehole 86-219-S03 drilled to a completed depth of 19.2 m.
0700 - 0900 Rig down, move to location 86-219-S04 and prepare to drill.
0900 - 1230 Drill and sample borehole 86-219-S04 to a completed depth of 11.5 m.
1230 - 1500 Rig down, move to location 86-219-S05 and prepare to drill.



TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION (continued)

March 18, 1986 (continued)

| | |
|-------------|---------------------------------------------------------------------------------------------------|
| 1500 - 1700 | Drill and sample borehole 86-219-S05 to a completed depth of 6.7 m. Refusal due to coarse gravel. |
| 1700 - 2050 | Rig down, move to location 86-219-S07 and prepare to drill. |
| 2050 - 2400 | Drilling and sampling borehole 86-219-S07. |

March 19, 1986

| | |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0000 - 0045 | Continue drilling and sampling borehole 86-219-S07 to a completed depth of 6.1 m. |
| 0045 - 0400 | Rig down, move to location 86-219-S08. High winds and blowing snow makes both site location and set up difficult. |
| 0400 - 0600 | Drill and sample borehole 86-219-S08 to a completed depth of 6.2 m. |
| 0600 - 1400 | Rig down, begin move to GSC borehole location. Repair winch cable on D-6 cat. Flat tire on rig, set up and prepare to drill borehole for INAC. |
| 1400 - 1715 | Drill and sample borehole 86-219-S06 to a completed depth of 7.8 m. Borehole terminated due to sloughing gravel. |
| 1715 - 2030 | Rig down, move to GSC borehole location 86-GSC219-S01. Set up and prepare to drill. |
| 2030 - 2050 | Drill and sample borehole 86-GSC219-S01 to a completed depth of 2.1 m. Borehole terminated due to drilling on an ice wedge. GSC representative instructs drill crew to move approximately 5 m and begin new borehole. |
| 2050 - 2400 | Drill and sample borehole 86-GSC219-S02. |

March 20, 1986

| | |
|-------------|--------------------------------------------------------------------------------------------|
| 0000 - 0110 | Continue borehole 86-GSC219-S02 to a completed depth of 10.2 m. |
| 0110 - 0345 | Relocate drill rig, drill and sample borehole 86-GSC219-S03 to a completed depth of 4.7 m. |
| 0345 - 0830 | Rig down, move to location 86-GSC219-S04 and prepare to drill. |
| 0830 - 1100 | Drill and sample borehole 86-GSC219-S04 to a completed depth of 5.5 m. |
| 1100 - 1330 | Rig down, move to location 86-219-S09, prepare to drill borehole for INAC. |
| 1330 - 1530 | Drill and sample borehole 86-219-S09 to a completed depth of 5.8 m. |
| 1530 - 1800 | Rig down, move to location 86-219-S10 and prepare to drill. |



TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION (continued)

March 20, 1986 (continued)

| | |
|-------------|---------------------------------------------------------------------|
| 1800 - 2045 | Drill and sample borehole 86-219-S10 to a completed depth of 4.7 m. |
| 2045 - 2145 | Rig down, move to location 86-219-S11 and prepare to drill. |
| 2145 - 2400 | Drill and sample borehole 86-219-S11. |

March 21, 1986

| | |
|-------------|--------------------------------------------------------------------------------------------------------------------------|
| 0000 - 0200 | Continue to drill and sample borehole 86-219-S11 to a completed depth of 10.0 m. |
| 0200 - 0300 | Rig down, prepare to move drill rig and mud shack to camp location. |
| 0300 - 0700 | Rig and mud shack travel from Source 219 to camp. Rig has flat tire on route which requires repair. |
| 0700 - 1900 | Drill rig and mud shack at camp. Mud shack mounted on ski bunks. Routine service and maintenance performed on drill rig. |
| 1900 - 2000 | Drill rig escorted by D-6 cat travel from camp to Source 217. |
| 2000 - 2040 | Prepare to drill borehole 86-217-S01. |
| 2040 - 2150 | Drill and sample borehole 86-217-S01 to a completed depth of 4.9 m. |
| 2150 - 2315 | Rig down, move to location 86-217-S02. Prepare to drill borehole. |
| 2315 - 2400 | Drill and sample borehole 86-217-S02. |

March 22, 1986

| | |
|-------------|------------------------------------------------------------------------------------------------------------------------------------|
| 0000 - 0435 | Continue to drill and sample borehole 86-217-S02 to a completed depth of 12.6 m. |
| 0435 - 0645 | Rig down, move to location 86-217E-S01. Prepare to drill borehole. |
| 0645 - 0935 | Drill and sample borehole 86-217E-S01 to a completed depth of 9.2 m. |
| 0935 - 1350 | Rig down, travel from Source 217 to Source 216 South. Prepare to drill borehole 86-216S-S01. |
| 1350 - 1545 | Drill and sample borehole 86-216S-S01 to a completed depth of 8.0 m. |
| 1545 - 2305 | Rig down, move from Source 216 South to Source 216. Crew change made at the Mackenzie River ice road. Set up and prepare to drill. |
| 2305 - 2400 | Drill and sample borehole 86-216-S01. |



TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION (continued)

March 23, 1986

| | |
|-------------|----------------------------------------------------------------------------------------------|
| 0000 - 0050 | Continue to drill and sample borehole 86-216-S01 to a completed depth of 6.2 m. |
| 0050 - 0345 | Rig down, prepare to move to next borehole location. Repair flat tire, weld new lugs on rim. |
| 0345 - 0700 | Travel to borehole location 86-216-S02. |
| 0700 - 0915 | Crew change made at Mackenzie River ice road. |
| 0915 - 1045 | Relocate borehole with reference to RKL test pit. Set up and prepare to drill. |
| 1045 - 1200 | Drill and sample borehole 86-216-S02 to a completed depth of 5.6 m. |
| 1200 - 1430 | Rig down, move to location 86-216-S03. Prepare to drill borehole. |
| 1430 - 1740 | Drill and sample borehole 86-216-S03 to a completed depth of 12.3 m. |
| 1740 - 2045 | Rig down, move to location 86-216-S04. Prepare to drill deep borehole. |
| 2045 - 2400 | Drill and sample borehole 86-216-S04. GSC personnel extend borehole beyond 6.1 m at 22:30. |

March 24, 1986

| | |
|-------------|----------------------------------------------------------------------------------------------------|
| 0000 - 1640 | Continue to drill and sample borehole 86-216-S04 to a completed depth of 30.9 m, on behalf of GSC. |
| 1640 - 1930 | Rig down, move to location 86-GSC-S05. Set up and prepare to drill borehole. |
| 1930 - 2200 | Drill and sample borehole 86-GSC-S05 to a completed depth of 10.1 m. |
| 2200 - 2345 | Rig down, move to location 86-GSC-S06. |
| 2345 - 2400 | Drill and sample borehole 86-GSC-S06. |

March 25, 1986

| | |
|-------------|----------------------------------------------------------------------------------|
| 0000 - 0230 | Continue to drill and sample borehole 86-GSC-S06 to a completed depth of 10.1 m. |
| 0230 - 0445 | Rig down, move to location 86-GSC-S07. Prepare to drill borehole. |
| 0445 - 0755 | Drill and sample borehole 86-GSC-S07 to a completed depth of 15.8 m. |
| 0755 - 1015 | Rig down, move to location 86-GSC-S08. Set up and prepare to drill borehole. |
| 1015 - 1300 | Drill and sample borehole 86-GSC-S08 to a completed depth of 9.9 m. |



TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION (continued)

March 25, 1986 (continued)

| | |
|-------------|---------------------------------------------------------------------------------|
| 1300 - 1530 | Rig down, move to location 86-GSC-S09. Set up and prepare to drill borehole. |
| 1530 - 1630 | Drill and sample borehole 86-GSC-S09 to a completed depth of 5.15 m. |
| 1630 - 1840 | Rig down and move to location 86-GSC-S10. Set up and prepare to drill borehole. |
| 1840 - 2155 | Drill and sample borehole 86-GSC-S10 to a completed depth of 7.3 m. |
| 2155 - 2345 | Rig down, move to location 86-GSC-S11 and prepare to drill borehole. |
| 2345 - 2400 | Drill and sample borehole 86-GSC-S11. |

March 26, 1986

| | |
|-------------|--------------------------------------------------------------------------------------------------------------------------------|
| 0000 - 0155 | Drill and sample borehole 86-GSC-S11 to a completed depth of 4.6 m. Unable to advance augers due to coarse gravel and cobbles. |
| 0155 - 0345 | Rig down, move to location 86-GSC-S12 and prepare to drill borehole. |
| 0345 - 0620 | Drill and sample borehole 86-GSC-S12 to a completed depth of 9.1 m. |
| 0620 - 0800 | Rig down, move to location 86-GSC-S13 and prepare to drill borehole. |
| 0800 - 0940 | Drill and sample borehole 86-GSC-S13 to a completed depth of 7.0 m. |
| 0940 - 1200 | Rig down, move to location 86-GSC-S14 and prepare to drill borehole. |
| 1200 - 1715 | Drill and sample borehole 86-GSC-S14 to a completed depth of 13.6 m. |
| 1715 - 1840 | Rig down, move to location 86-GSC-S15 and prepare to drill borehole. |
| 1840 - 2310 | Drill and sample borehole 86-GSC-S15 to a completed depth of 13.1 m. |
| 2310 - 2400 | Rig down, move to location 86-GSC-S16 |

March 27, 1986

| | |
|-------------|----------------------------------------------------------------------|
| 0000 - 0010 | Complete set up. |
| 0010 - 0200 | Drill and sample borehole 86-GSC-S16 to a completed depth of 6.1 m. |
| 0200 - 0420 | Rig down, move to location 86-GSC-S17 and prepare to drill borehole. |



TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION (continued)

March 27, 1986 (continued)

| | |
|-------------|--------------------------------------------------------------------------------|
| 0420 - 0705 | Drill and sample borehole 86-GSC-S17 to a completed depth of 10.1 m. |
| 0705 - 1115 | Rig down, move to location 86-GSC-S18 and prepare to drill. Repair winch line. |
| 1115 - 1315 | Drill and sample borehole 86-GSC-S18 to a completed depth of 10.1 m. |
| 1315 - 1530 | Rig down, move to location 86-GSC-S19 and prepare to drill borehole. |
| 1530 - 2340 | Drill and sample borehole 86-GSC-S19 to a completed depth of 17.8 m. |
| 2340 - 2400 | Rig down, prepare to move. |

March 28, 1986

| | |
|-------------|----------------------------------------------------------------------|
| 0000 - 0115 | Move to location 86-GSC-S20 and prepare to drill borehole. |
| 0115 - 0455 | Drill and sample borehole 86-GSC-S20 to a completed depth of 10.7 m. |
| 0455 - 0600 | Rig down, move to location 86-GSC-S21 and prepare to drill borehole. |
| 0600 - 0930 | Drill and sample borehole 86-GSC-S21 to a completed depth of 7.6 m. |
| 0930 - 1300 | Rig down, move to location 86-GSC-S22 and prepare to drill borehole. |
| 1300 - 1900 | Drill and sample borehole 86-GSC-S22 to a completed depth of 16.2 m. |

END OF GSC PROGRAM

| | |
|-------------|---------------------------------------------------------------------|
| 1900 - 2400 | Rig on standby, waiting for D-6 cat to return after camp relocated. |
|-------------|---------------------------------------------------------------------|

March 29, 1986

| | |
|-------------|---------------------------------------------------------------------|
| 0000 - 0500 | Continue rig standby. |
| 0500 - 0700 | Move rig to location 86-218-S02 and prepare to drill borehole. |
| 0700 - 0830 | Drill and sample borehole 86-218-S02 to a completed depth of 5.2 m. |
| 0830 - 1115 | Rig down, move to location 86-218-S01 and prepare to drill. |



TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION (continued)

March 29, 1986 (continued)

| | |
|-------------|----------------------------------------------------------------------|
| 1115 - 1315 | Drill and sample borehole 86-218-S01 to a completed depth of 7.05 m. |
| 1315 - 1920 | Rig down, move to location 86-218N-S01 and prepare to drill. |
| 1920 - 2100 | Drill and sample borehole 86-218N-S01 to a completed depth of 8.2 m. |
| 2100 - 2230 | Rig down, move to location 86-218N-S02 and prepare to drill. |
| 2230 - 2400 | Drill and sample borehole 86-218N-S02. |

March 30, 1986

| | |
|-------------|------------------------------------------------------------------------|
| 0000 - 0025 | Continue borehole to a completed depth of 6.2 m. |
| 0025 - 0440 | Rig down, move to location 86-218N-S03 and prepare to drill borehole. |
| 0440 - 0620 | Drill and sample borehole 86-218N-S03 to a completed depth of 8.4 m. |
| 0620 - 1300 | Rig down, move to location 86-218N-S04 and prepare to drill borehole. |
| 1300 - 1600 | Drill and sample borehole 86-218N-S04 to a completed depth of 8.0 m. |
| 1600 - 1940 | Rig down, move to Source 211 and prepare to drill borehole 86-211-S01. |
| 1940 - 2310 | Drill and sample borehole 86-211-S01 to a completed depth of 15.2 m. |
| 2310 - 2400 | Rig down, prepare to move. |

March 31, 1986

| | |
|-------------|---------------------------------------------------------------------------------------------------|
| 0000 - 0110 | Move to location 86-211-S02 and prepare to drill. |
| 0110 - 0250 | Drill and sample borehole 86-211-S02 to a completed depth of 4.7 m. |
| 0250 - 0455 | Rig down, move to location 86-211-S03 and prepare to drill. |
| 0455 - 0620 | Drill and sample borehole 86-211-S03 to a completed depth of 7.0 m. |
| 0620 - 1345 | Rig down and move to location 86-211-S04. Front ski bunk on mud shack required 4 hours of repair. |
| 1345 - 2210 | Drill and sample borehole 86-211-S04 to a completed depth of 18.3 m. |
| 2210 - 2400 | Rig down and move to location 86-211-S05. |



TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION (continued)

April 1, 1986

| | |
|-------------|----------------------------------------------------------------------|
| 0000 - 0045 | Set up and prepare to drill. |
| 0045 - 0810 | Drill and sample borehole 86-211-S05 to a completed depth of 19.5 m. |
| 0810 - 1030 | Rig down and move to location 86-211-S06. Prepare to drill borehole. |
| 1030 - 1400 | Drill and sample borehole 86-211-S06 to a completed depth of 9.8 m. |
| 1400 - 1530 | Rig down and move to location 86-211-S07. Prepare to drill borehole. |
| 1530 - 1730 | Drill and sample borehole 86-211-S07 to a completed depth of 7.3 m. |
| 1720 - 1920 | Rig down and move to location 86-211-S08. |
| 1920 - 2305 | Drill and sample borehole 86-21-S08 to a completed depth of 10.7 m. |
| 2305 - 2345 | Rig down and move to location 86-211-S09. |
| 2345 - 2400 | Drill and sample borehole 86-211-S09. |

April 2, 1986

| | |
|-------------|----------------------------------------------------------------------------------|
| 0000 - 0350 | Continue to drill and sample borehole 86-211-S09 to a completed depth of 12.2 m. |
| 0350 - 0450 | Rig down and move to location 86-211-S10. |
| 0450 - 0615 | Drill and sample borehole 86-211-S10 to a completed depth of 3.7 m. |
| 0615 - 0700 | Rig down and move to location 86-211-S11. |
| 0700 - 0930 | Drill and sample borehole 86-211-S11 to a completed depth of 3.45 m. |
| 0930 - 1315 | Rig down, move to location 86-211E-S01. Prepare to drill borehole. |
| 1315 - 1900 | Drill and sample borehole 86-211E-S01 to a completed depth of 10.2 m. |
| 1900 - 2125 | Rig down and move to location 86-211E-S02. Prepare to drill borehole. |
| 2125 - 2400 | Drill and sample borehole 86-211E-S02. |

April 3, 1986

| | |
|-------------|------------------------------------------------------------------------------------------------|
| 0000 - 0010 | Continue to drill and sample borehole 86-211E-S02 to a completed depth of 8.5 m. |
| 0010 - 0100 | rig down and prepare to move to camp location positioned adjacent to Mackenzie River ice road. |
| 0100 - 0500 | Rig moves to camp. |



TABLE A.1 OPERATIONAL CALENDAR - RICHARDS ISLAND, N.W.T.
GRANULAR RESOURCE INVESTIGATION (continued)

April 3, 1986 (continued)

0500 - 0900 Demobilize equipment.

EBA personnel, INAC representative and Challenger surveyor travel to Inuvik. INAC and Challenger travel on to Edmonton. EBA personnel arrange to have equipment and samples shipped to Edmonton.

April 4, 1986

EBA personnel travel from Inuvik to Edmonton.



APPENDIX B
SOURCE 211

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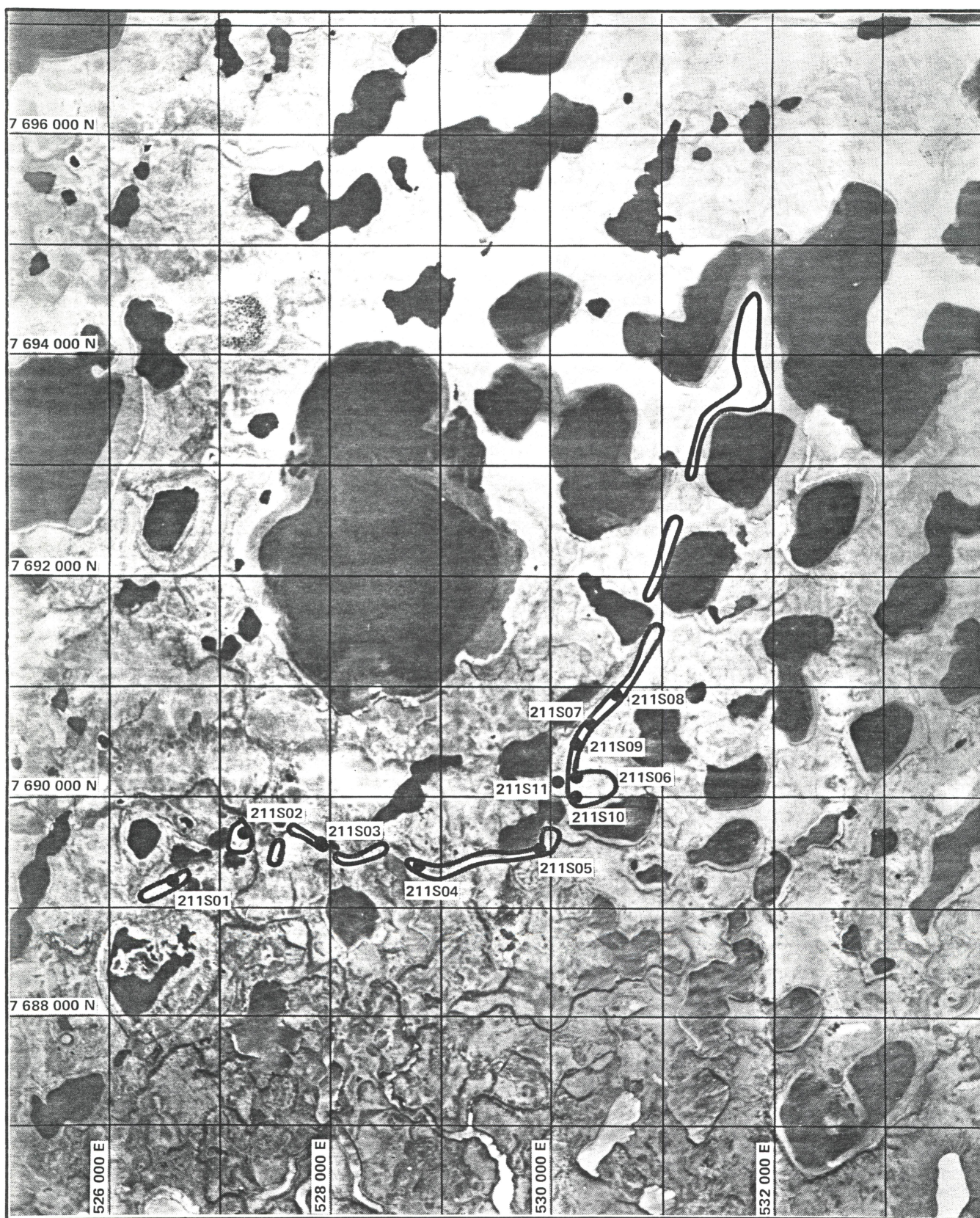


FIGURE B.1 SITE PLAN FOR SOURCE 211

APPENDIX B

SOURCE 211

B.1 SUMMARY

Area 'A'

| | | |
|-----------------------------------|---------------------------------------------------------------------------|-------------------------------|
| Material Type: | fine uniform sand well-graded sand with some gravel | |
| Fines Content: | 3-8% | |
| Area of Feature: | 121,000 m ² | |
| Developable Area: | 121,000 m ² | |
| Estimated Volume: | Proven (m ³) | Probable (m ³) |
| type II borrow | 5,500 | 24,500 |
| type IV borrow | 40,000 | 50,000 |
| type IV borrow w/m.c. over 10% | 30,000 | 30,000 |
| Excavation Depth: | 3.5 m maximum | |
| Moisture Content: | 5-10% above 1.5 m 20% below 1.5 m | |
| Borehole Reference: | 211S06, 211S07, 211S08, 211S09, 211S10, 211S11 RKL211-B,C; RKL211-3 | |

Area 'E'

| | |
|-------------------|--------------------------------------------------------------------|
| Material Type: | fine uniform sand well-graded sand with some gravel to 50 mm |
| Fines Content: | less than 10% |
| Area of Feature: | 100,000 m ² |
| Developable Area: | 30,000 m ² |



| | | |
|------------------------------------|--------------------|-------------------|
| Estimated Volume: | Proven | Probable |
| | (m ³) | (m ³) |
| type II borrow w/ m.c. over 10% | 6000 | 17,000 |
| type IV borrow w/ m.c. over 10% | 6000 | 17,000 |
| Excavation Depth: | 3.5 m maximum | |
| Moisture Content: | 10-20% | |
| Borehole Reference: | 211S05 RKL217-A | |

Area 'F'

| | | |
|-----------------------------------|--------------------------------------------------------------------|-------------------|
| Material Type: | fine uniform sand well-graded sand with some gravel to 50 mm | |
| Fines Content: | 5-10% | |
| Area of Feature: | 150,000 m ² | |
| Developable Area: | 51,000 m ² | |
| Estimated Volume: | Proven | Probable |
| | (m ³) | (m ³) |
| type II | 3,000 | 25,000 |
| type IV borrow w/m.c. over 10% | 8,000 | 48,000 |
| Excavation Depth: | 3.5 m maximum | |
| Moisture Content: | 5% above 2 m 20% below 2 m | |
| Borehole Reference: | 211S04 | |

Area 'G'

| | |
|-------------------|------------------------|
| Material Type: | uniform sand |
| Fines Content: | 5-10% |
| Area of Feature: | 130,000 m ² |
| Developable Area: | 74,000 m ² |



| | | |
|--------------------------------------|-------------------|-------------------|
| Estimated Volume: | Proven | Probable |
| | (m ³) | (m ³) |
| type IV borrow | 10,000 | 80,000 |
| type IV borrow w/ w/m.c. over 10% | 10,000 | 80,000 |

Excavation Depth: 4 m

Moisture Content: 5% above 2 m
over 20% below 2 m

Borehole Reference: 211S03
RKL211-4; RKL211-D

Area 'H'

SUMMARY

Material Type: silt, ice

Fines Content: n.a.

Area of Feature: 100,000 m²

Developable Area: 0

| | | |
|-------------------|--------|----------|
| Estimated Volume: | Proven | Probable |
| | 0 | 0 |

Excavation Depth: not recommended

Moisture Content: over 30%

Borehole Reference: 211S02

Area 'I'

Material Type: fine uniform sand

Fines Content: 5%

Area of Feature: 103,000 m²

Developable Area: 52,000 m²

| | | |
|-------------------|-------------------|-------------------|
| Estimated Volume: | Proven | Probable |
| | (m ³) | (m ³) |
| type IV borrow | 27,500 | 122,500 |
| w/m.c. over 10% | | |

Excavation Depth: 3.5 m

Moisture Content: 20%

Borehole Reference: 211S01



B.2 SITE DESCRIPTION

B.2.1 Location and Geological Origin

Source 211 is a ridge approximately 8 km long and up to 18 m in height that runs along the southern and eastern shores of Willow Lake. It is approximately 10 km west of the East Channel. Figure B1 shows the general location of the deposit, while Figures B.2 (a and b) show the location of the boreholes on the site.

Geologically, the ridge appears to an esker related to the the most recent glacial retreat. It is perched on an older glacial outwash ridge (BBT 1983). The maximum depth of the esker material has been reported as four metres (BBT,1983). Below the contact, the outwash deposits often contain finer material: ice, coal and other organic impurities.

B.2.2 Summary of Previous Studies

This source has been test pitted by Ripley, Klohn and Leonoff (RKL) and drilled by both RKL (1972) and BBT (1983) to approximately 10 m below surface. Each study found medium-grained sand at surface with a trace of gravel, which graded to a fine-grained, siltier sand at a depth of approximately 3 to 5 m. Ice or icy silt was found in some borings at a depth of 4 to 7 m. Both studies reported a great deal of variability. The BBT report identified four zones within the source which were suitable for development. Consistent with that study, these areas are designated 'A' to 'D'.

Further delineation drilling was carried out in Area A and the conclusions derived from all exploration in the area are given in the following section. In this section, a short summary of the BBT(1983) findings for Areas B, C and D is presented. For more detail the reader is referred to that report.



Area B

BBT(1983) found that this area appeared to contain the highest amount of gravel of any portion of source 211 that they explored. Between 1.8 and 5.5 m of sand with fine gravel was encountered by boreholes at this site. No massive ice was encountered during drilling. BBT(1983) estimates the volume to be 70,000 m³.

Area C

Two holes were drilled by BBT and two were drilled by RKL(1972) in Area C. On the basis of this information, the base of the good quality material lies at an elevation of 37.0 m. The material is predominantly fine-grained, uniform sand. Total volume is estimated to be 80,000 m³.

Area D

One borehole was drilled on this area by both RKL and BBT. Fine-grained sand was encountered with a small amount of gravel near the surface. The upper 1.5 m was dry but below that depth, the deposit had an appreciable ice content. A maximum depth of 4.6 m may contain good material. The total volume of material is estimated by BBT to be 150,000 m³.

B.2.3 Results of Current Study

Eleven boreholes were drilled over the southern portion of this deposit. Six holes were drilled in the area previously identified as area 'A' to more fully delineate this portion of the deposit. The rest of the holes were drilled in five sections of the esker to the south and west of Area A. These portions have been designated as Areas E through I.

Most of the source was barren of vegetation. In some areas where snow cover had been blown off, surficial lag gravel was evident.



The material available is predominantly a fine to medium grained sand borrow (Type IV). Some small deposits of gravelly sand have been located in Areas A, E, and F. This gravelly sand is usually of Type II specification, although a few samples are slightly gap graded. A gradation envelope for both types of material encountered is given on Figure B.3.

Table B.1 shows the estimated volume of material within each section of the deposit. The base of the useable material was assumed to be flatlying, at the elevation encountered by the single borehole. The cross-sectional area of the deposit was calculated from the profile surveyed in the field during the investigation, then the volume was calculated by measuring the length of the deposit from the airphotos. For Area A the topographic information contained in the BBT (1983) report was used in combination with a base profile inferred from the borings.

A petrographic analysis was made on a sample of Type II material combined from Areas 'A' and 'F'. The result is given in Table B.2. The presence of a significant component of chert suggests that the material is not desirable as a concrete aggregate.

Area A

This deposit consists mainly of fine or medium grained sand, containing little silt or gravel. Up to 20% fine gravel was encountered within the top 0.3 m of the deposit. Most of the deposit contains 6% or less silt.

The top 1.5 m of the deposit had a low moisture content (3-8%) so that the source could be developed using conventional equipment to this depth. Below this depth, the deposit was well bonded with some visible ice present as moisture contents rise to approximately 20 percent. At an average of 3 m below surface the sand changed character. The different material can be identified by the presence of coal and petrified wood. At one borehole (211S07) a layer of massive ice 2 m thick was encountered at the contact,



TABLE B.1 ESTIMATED VOLUMES OF RECOVERABLE
GRANULAR MATERIAL SOURCE 211

MATERIAL CONTAINING LESS THAN 10% MOISTURE

| AREA | TYPE II BORROW | | TYPE IV BORROW | |
|-------|-----------------------------|--------------------------------------------|-----------------------------|-------------------------------|
| | PROVEN (m ³) | PROBABLE ¹ (m ³) | PROVEN (m ³) | PROBABLE (m ³) |
| A | 5,500 | 24,500 | 40,000 | 50,000 |
| E | | | | |
| F | 3,000 | 25,000 | | |
| G | | | 10,000 | 80,000 |
| I | | | | |
| TOTAL | 8,500 | 49,500 | 50,000 | 130,000 |

MATERIAL CONTAINING MORE THAN 10% MOISTURE

| | | | | |
|-------|-------|--------|--------|---------|
| A | | | 30,000 | 30,000 |
| E | 6,000 | 17,000 | 6,000 | 17,000 |
| F | | | 8,000 | 48,000 |
| G | | | 10,000 | 80,000 |
| I | | | 27,000 | 123,000 |
| TOTAL | 6,000 | 17,000 | 81,000 | 298,000 |

NOTE: 1. Total volume at each area is the sum of "proven" and "probable" volumes.



TABLE B.2 PETROGRAPHIC ANALYSIS - SOURCE 211

| | | |
|----------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Quartzitic Sandstone | 41.3% | - medium to coarse sandstone, silicified and could be grouped with orthoquartzites; pitted, light brown to white, hard, durable. |
| Orthoquartzite | 35.5% | - medium to fine quartz sandstones that have been silicified, also some siltstones, rounded, hard, smaller fractions are more broken and angular. |
| Chert | 18.8% | - Amorphous silica to crystalline chert; gradation between amorphous silica and silicified siltstones (orthoquartzitic) is very indistinct. |
| Basalt | 3.4% | - Black to dark grey, "asphaltic" clasts, very hard, rounded to fresh looking broken faces. |
| Quartz | 0.6% | - Crystalline fragments from larger clasts, hard, white angular. |
| Limestone | 0.3% | - One particle of grey, fossiliferous limestone, angular. |
| Soft Sandstone | 0.1% | - One particle of non-silicified sandstone rounded and friable |
| <hr/> 100 % | | |

NOTE: Based on combined sample of 211S04 (1.2-1.3 m) and 211S08 (0-0.3 m)



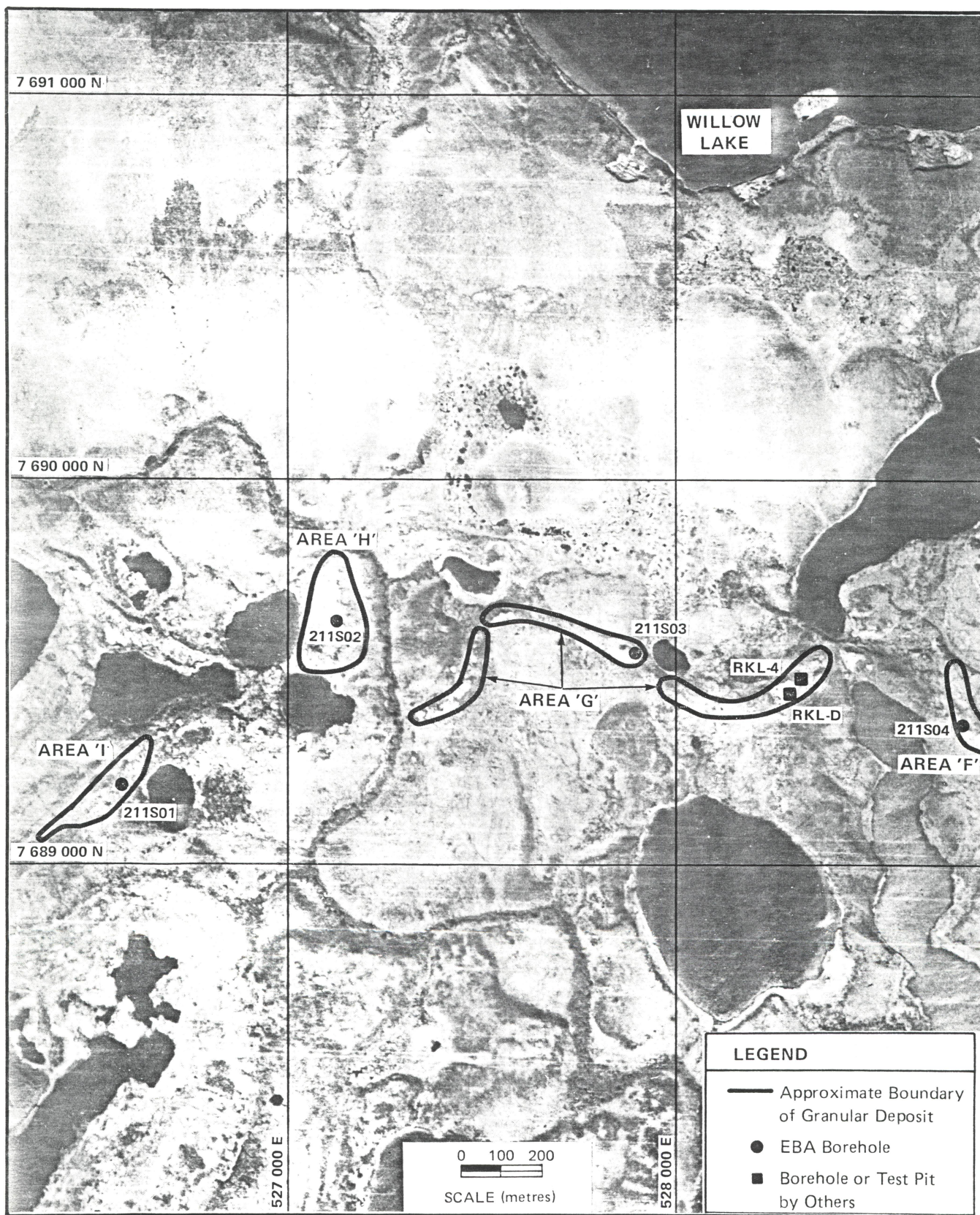


FIGURE B.2a PIT DEVELOPMENT SITE PLAN
SOURCE 211 (WEST SIDE)

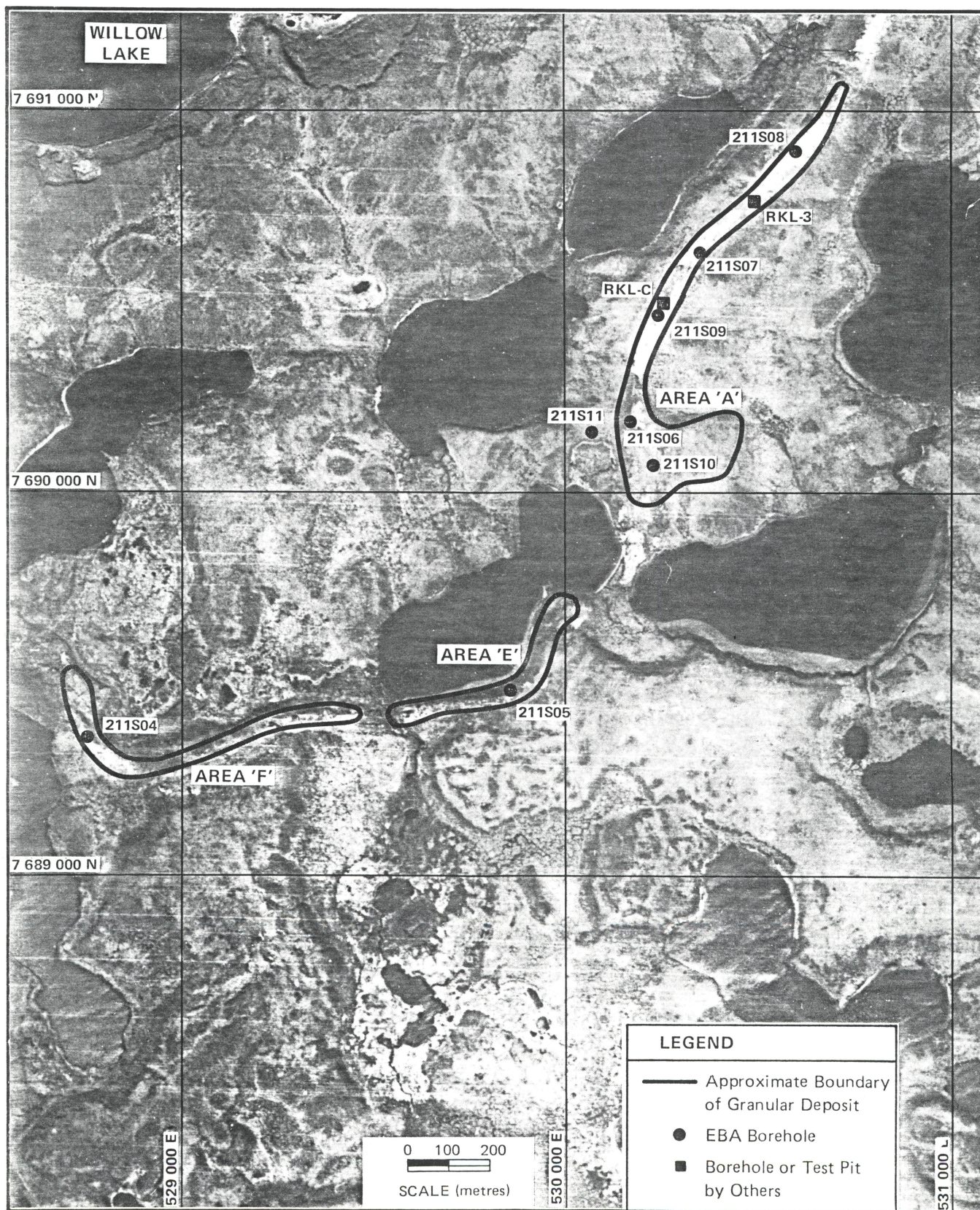
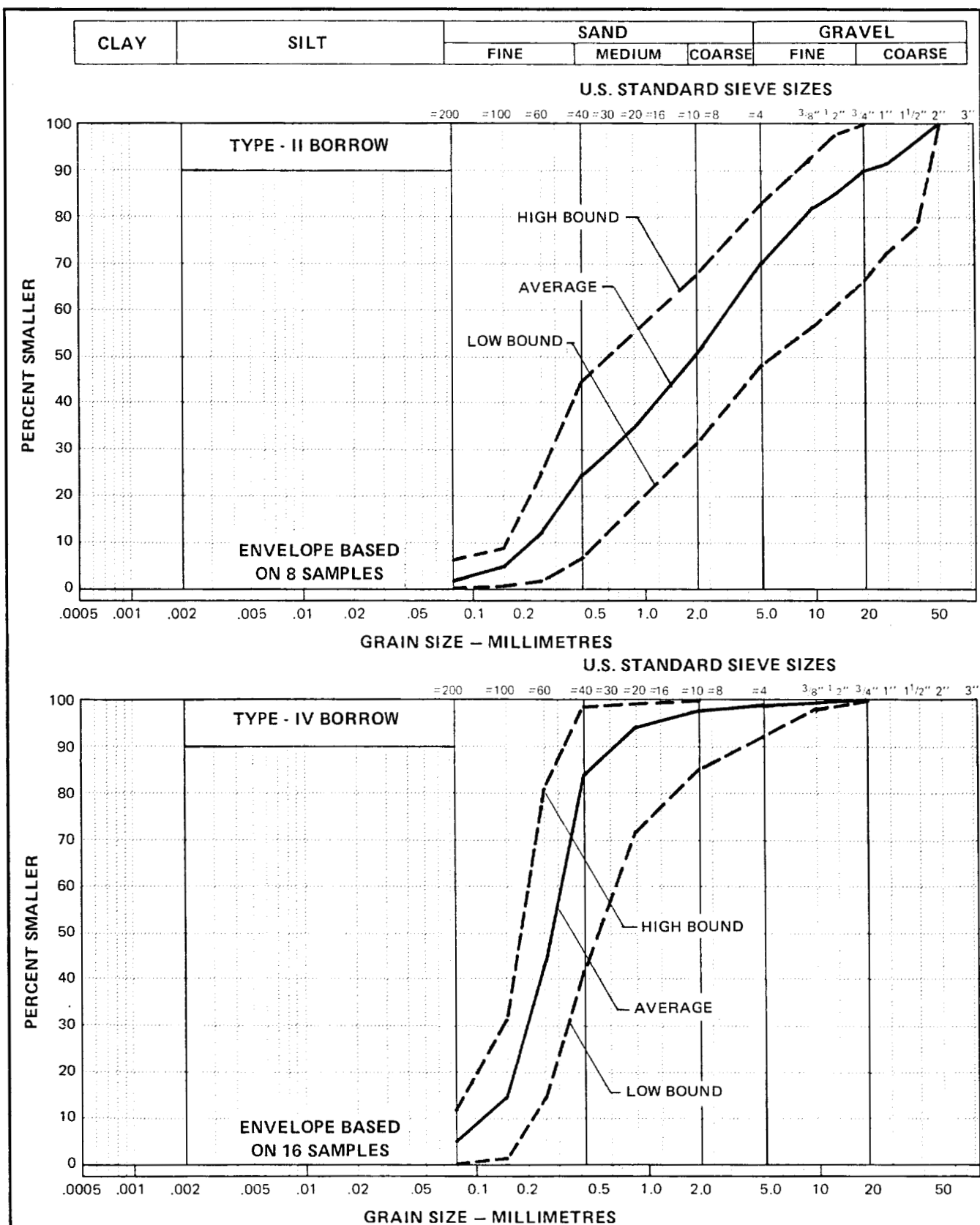


FIGURE B.2b PIT DEVELOPMENT SITE PLAN
SOURCE 211 (EAST SIDE)



**FIGURE B.3 GRAIN SIZE ENVELOPES
FOR SOURCE 211 MATERIAL**

while in others sand was encountered to depths of 6 to 10 m. The narrow extent of the deposit was evidenced by the findings of boreholes 211S10 and 211S11 which were made about 100 m from the highest point of the ridge. At these points the cleaner sand that comprises the most useful deposit was not encountered.

The upper 3 m of site 211(A) contains 105,000 m³ of sand. At most, 30,000 m³ of sand and gravel could be scraped from the surface for quality granular (type II) fill.

Area E

One to 1.5 m thick layers of uniform sand and gravelly well-graded sand were encountered below 1 m of organic silt overburden, the uniform sand being the upper member. The well-graded sand could be classed as type II except that the moisture content is between 10 and 20 percent. The moisture content of the uniform sand is between 20 and 30 percent. These observations are based on a single borehole (211S05).

Area F

Two metres of gravelly sand was encountered at surface in borehole 211S04. Stratigraphy is presented in Figure B.5a. This material appeared to be very clean with only 2% silt. Its moisture content averages less than 5 percent. At the 2 m depth the material becomes sand and contains coal impurities. This is characteristic of the older outwash deposit. At a 4.5 m depth, lenses of silt and ice were encountered. Sand continued to a depth of 17 m although it often contained coal and organic impurities. It is probable that 28,000 m³ of the esker deposit in the form of gravelly sand (type II) is present, and can be stripped, with care, from the surface. Additionally, 56,000 m³ of sand from the outwash deposit may be developed before ice is encountered. However this material contains coal and the moisture content is high (30 percent).



Area G

Sand was encountered in Area G to a depth of 5.5 m below surface where a massive body of ground ice was found (Figure B.5b). The sand encountered in the borehole (211S03) was fine-grained and uniformly graded. Silt content averaged approximately 5 percent and the moisture content averaged less than 5 percent in the upper 2 m, but then rose to greater than 20 percent.

A test pit and a borehole were completed by RKL during their 1972 study. The test pit encountered 4 m of sand reported to be well graded and clean but the borehole encountered only 2 m of sand reported to be silty.

Up to 180,000 m³ of uniform sand may be available from this area.

Area H

Based upon a single borehole (211S02) drilled to nearly a 5 m depth this feature appeared to be composed mainly of massive ice. No usable granular material was encountered.

Area I

Fine-grained, uniform sand was found in a single borehole (211S01) to a depth of approximately 14 m. A few ice lenses and a considerable amount of coal impurities were found at depth. The upper 3.5 m of the deposit contained clean material, with a 3% silt content. No coal fragments were observed. Unfortunately, the moisture content was high (20%) throughout the profile. At 3.5 m, a silt and ice lens marked the transition to more marginal material. Figure B.5 shows the profile across the deposit with the stratigraphy inferred from the borehole. It is estimated that approximately 150,000 m³ of sand is available from this area.



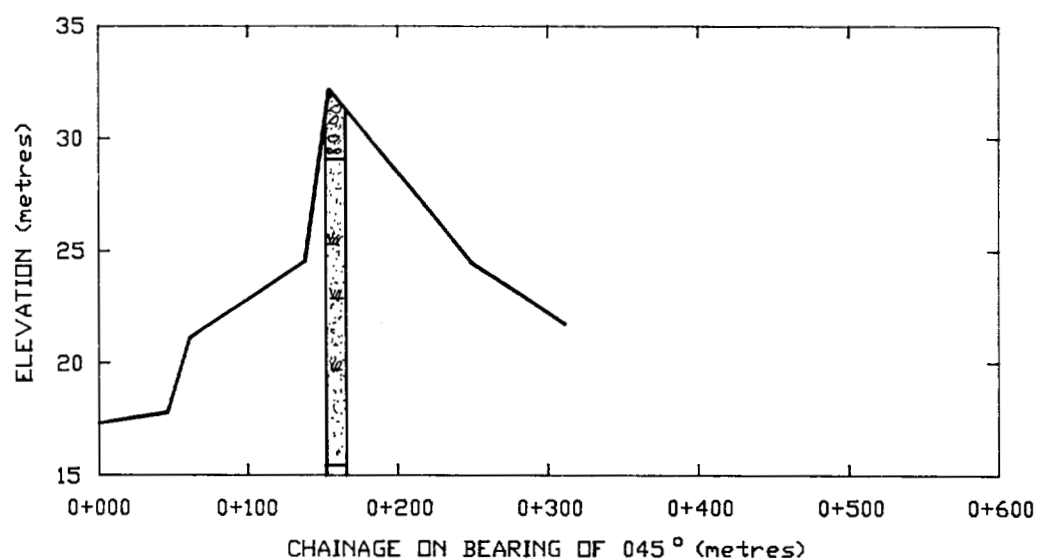


FIGURE B.4a PROFILE AT BOREHOLE 211-S04

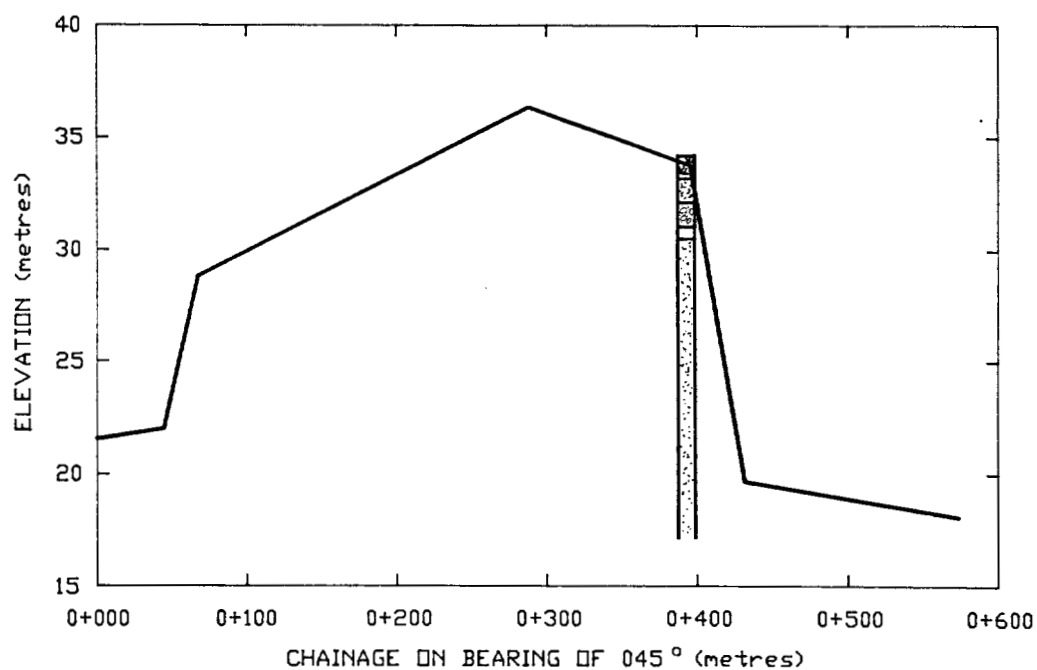
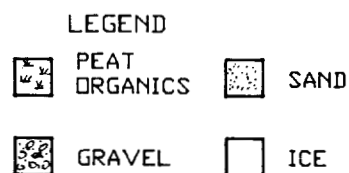


FIGURE B.4b PROFILE AT BOREHOLE 211-S05



4480-007

FIGURE B.4 TOPOGRAPHIC PROFILES AT SOURCE 211
(BOREHOLES S04 AND S05)

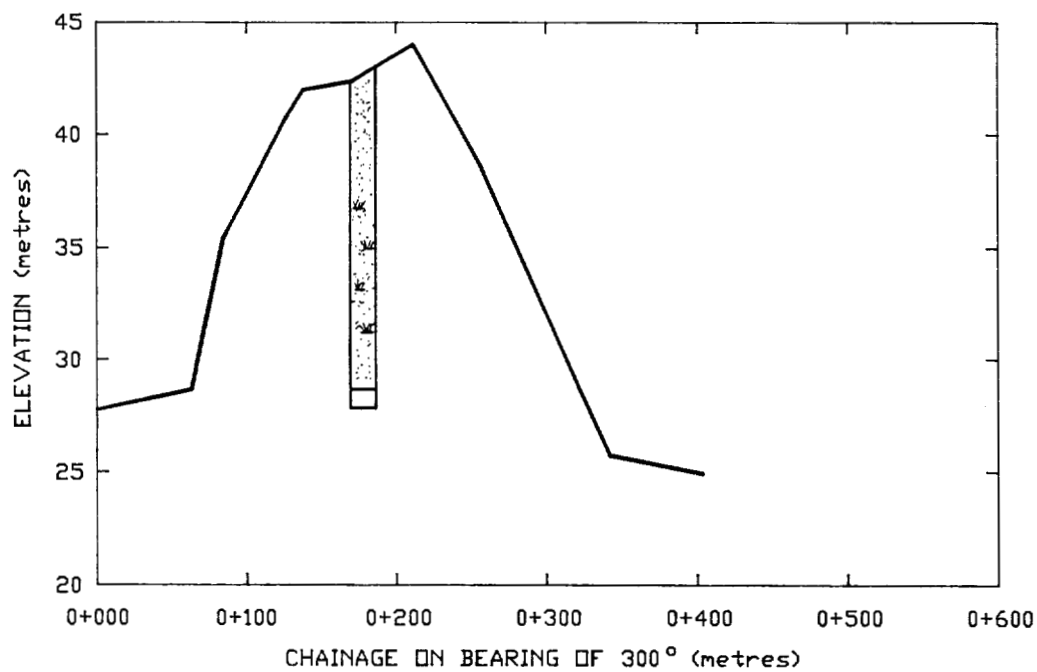


FIGURE B.5a PROFILE AT BOREHOLE 211-S01

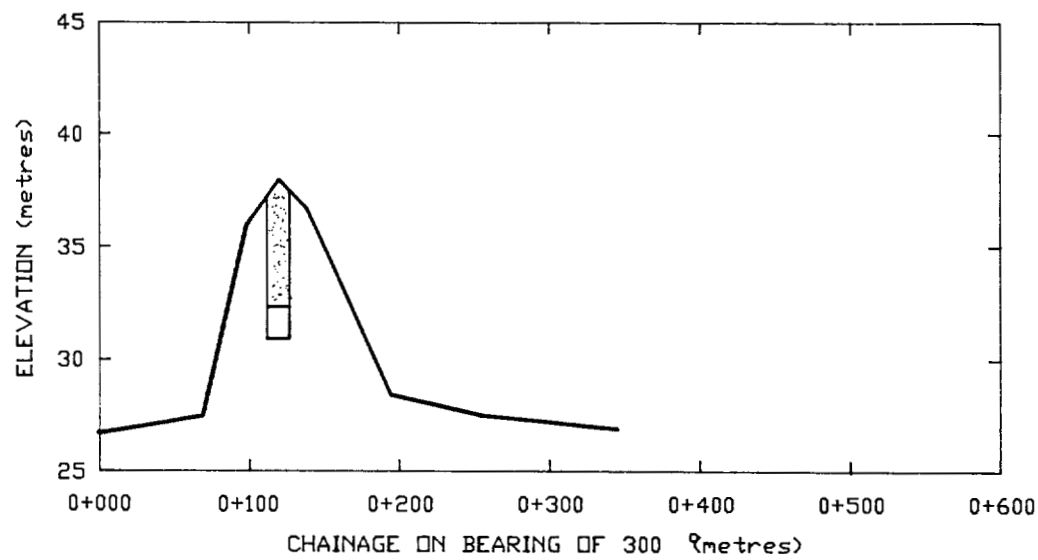
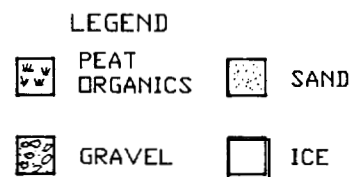


FIGURE B.5b PROFILE AT BOREHOLE 211-S03



4480-006

FIGURE B.5 TOPOGRAPHIC PROFILES AT SOURCE 211
(BOREHOLES S01 AND S03)

B.3 PIT DEVELOPMENT

B.3.1 Access

Access to this source will be possible only during the winter period. The selected access route depends upon the intended destination for the materials. From the MacKenzie River ice road the most direct route is from the south using Cabin Creek. Alternatively, the northern end of the site may be accessed from a series of lakes lying north of the source.

B.3.2 Site Preparation

Site preparation should be carried out within the guidelines given in Section 5 of this report. To keep disturbance of the area to a minimum, only one of the areas should be worked at a time. Pit preparation work may be desirable one summer ahead of extraction from areas G and I. This would involve stripping surface organic soils and topsoil followed by progressive thawing, stripping windrowing and stockpiling the material to reduce its water content.

B.3.3 Extraction Methods

Extraction of the top 1.5 m of the resource will be feasible during the winter by ripping and pushing frozen granular material into temporary stockpiles for loading onto trucks. In the subsequent year the remainder of the material may drain sufficiently to be extracted.

B.3.4 Treatment of Massive Ice

Massive ground ice has been encountered in most of the boreholes drilled at this source. However, the occurrence of the ice is considered to be too irregular to define its distribution. The most shallow occurrence of ice was a depth of 3.2 m. The most probable depth range for encountering massive ice is 3.5 to 5 m.



The sand found below massive ice deposits generally contains a larger concentration of coal and organics thus extraction is not recommended below massive ice without further exploration drilling.

B.3.5 Drainage Considerations

The pit floor should be graded where possible, to ensure gravity drainage of surface water and meltwater. Water should be collected and discharged in an environmentally acceptable manner. Good drainage enhances seasonal thaw and limits the ingress of moisture. Prior to spring break-up and removal of the equipment, the pit floor should be graded to reduce the potential of ponds forming during the summer.

The deposit lies to the east and south of Willow Lake, which is important to the hunters and trappers of the area. Therefore drainage should be directed away from this lake, south or east of the deposit.

Prior to spring break-up and removal of the equipment, the pit floor should be graded to reduce the potential of ponds forming during the summer.

B.3.7 Restoration

After the pit is exhausted, the pit bottom should be graded to a slight slope to direct drainage away from Willow Lake. The previously stockpiled topsoil and organics should then be spread over the area. The feasibility of a revegetation program should be considered in a separate study.

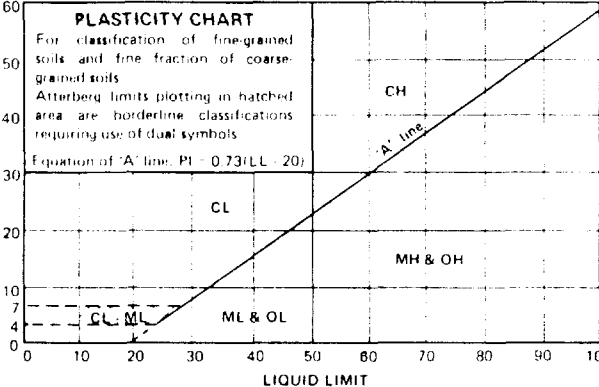


B.4

BOREHOLE LOGS



UNIFIED SOIL CLASSIFICATION†

| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | | |
|-----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------|---------------------------------------------|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve* | GRAVELS 50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS | | GW | Well-graded gravels and gravelly sands with less than 5% fines | $C_u = \frac{D_{60}}{D_{10}} > 60$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for GW | | |
| | | | | GP | Poorly-graded gravels and gravelly sands with less than 5% fines | | | |
| | | GRAVELS WITH FINES | GM | Silty gravels, gravel-sand silt mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols | | | |
| | | | GC | Clayey gravels, gravel-sand clay mixtures | | | | |
| | | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | | SW | | Well-graded sands and gravelly sands, little or no fines | $C_u = \frac{D_{60}}{D_{10}} > 60$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for SW |
| | | | | | SP | | Poorly-graded sands and gravelly sands, little or no fines | |
| | SANDS WITH FINES | | SM | Silty sands, sand-silt mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols | | | |
| | | | SC | Clayey sands, sand-clay mixtures | | | | |
| | FINE-GRAINED SOILS 50% or more passes No. 200 sieve* | | SILTS AND CLAYS Liquid limit 50% or less | | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | <div>PLASTICITY CHART For classification of fine-grained soils and fine fraction of coarse-grained soils Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols Equation of "A" line: $PI = 0.73(LL - 20)$</div>  | |
| | | | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | |
| | | OL | | | Organic silts and organic silty clays of low plasticity | | | |
| | | SILTS AND CLAYS Liquid limit greater than 50% | | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | |
| CH | | | | Inorganic clay of high plasticity, fat clays | | | | |
| OH | | | | Organic clays of medium to high plasticity | | | | |
| PT | | | | Peat, muck and other highly organic soils | | | | |
| PT | | | | Peat, muck and other highly organic soils | | | | |
| *Based on the material passing the 3 in. (75 mm) sieve *ASTM Designation D 2487, for identification procedure see D 2488 | | | | | | | | |

*Based on the material passing the 3 in. (75 mm) sieve.
 †ASTM Designation D 2487, for identification procedure see D 2488

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|----------------------------|--|
| N | Nf | Poorly-bonded or friable | |
| | Nbn | No excess ice, well-bonded | |
| | Nbe | Excess ice, well-bonded | |

NOTE:

- Dual symbols are used to indicate borderline or mixed ice classifications
- Visual estimates of ice contents indicated on borehole logs $\pm 5\%$
- This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes

LEGEND

Soil Ice

VISIBLE ICE LESS THAN 50% BY VOLUME

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|--------------------------------------------------|--|
| V | Vx | Individual ice crystals or inclusions | |
| | Vc | Ice coatings on particles | |
| | Vr | Random or irregularly oriented ice formations | |
| | Vs | Stratified or distinctly oriented ice formations | |

VISIBLE ICE GREATER THAN 50% BY VOLUME

| ICE | ICE + Soil Type | | |
|-----|----------------------------------------------------------------|--|--|
| | ICE | | |
| | Ice with soil inclusions | | |
| | Ice without soil inclusions (greater than 25 mm (1 in.) thick) | | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | SPECIAL TESTS | UNIT |
|------------------------------|-----|--------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---|---------------|------|
| N7 889 204 E 526 563 Z8 | | | | RELATIVE ELEVATION 42.4 (m) | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | | |
| TYP | NO. | | | | | | | | Q | | |
| 0 | | | | | | | | | | | 0 |
| | 1 | SAND (SP) - trace silt, fine-grained, uniform, massive, medium brown | Non-Nf | | | | | | | | |
| | 2 | -light greyish brown | Non | | | | | | | | |
| | 3 | -dark grey | | | | | | | | | 2 |
| | 4 | | | | | | | | | | |
| | 5 | -fine-grained, uniform, olive grey | | | | | | | | | |
| 4 | 6 | -occasional very thinly bedded SILT (ML) lens 5 mm thick, even, parallel, continuous | | | | | | | | | 4 |
| | 7 | -DRILLER'S NOTE: hard coring | Vx 5% | | | | | | | | |
| | 8 | -vertical ice lenses 2 mm thick, clear | | | | | | | | | |
| | 9 | | Non, trace Vr | | | | | | | | |
| 6 | 10 | -medium to fine-grained, thinly bedded, wavy, nonparallel | | | | | | | | | 6 |
| | 11 | -trace coal | | | | | | | | | |
| | 12 | | | | | | | | | | |
| | 13 | -very thinly bedded lens of coal and wood fragments, curved | | | | | | | | | 8 |
| 8 | 14 | | | | | | | | | | |
| | 15 | | | | | | | | | | |
| | 16 | -trace to some silt | | | | | | | | | |
| 10 | | | | | | | | | | | 10 |

101C-4480
 Completed 23:10 86/03/30
 DRILLING RIG: CME 750
 Compiled by JGC MAV

SAMPLE TYPE
 COREL
 AUGER

EBA Engineering Consultants Ltd.
 (Edmonton)
 DRAWING NUMBER

BOREHOLE NUMBER
 211S01

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | SPECIAL TESTS | UNIT |
|------------------------------|-------------------------------------|---------------------------------------------------------|------------------------|-----------------------------|------------------|--------------|----|----|--|---------------|------|
| N7 889 204 E 526 563 Z8 | | | | RELATIVE ELEVATION 42.4 (m) | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | WATER CONTENT DO | | | | | | |
| TYP | NO. & Q | | | | PLASTIC LIMIT | LIQUID LIMIT | | | | | |
| 10 | 16 | -trace silt | Nbn | | 20 | 40 | 60 | 80 | | | |
| | 17 | -thinly bedded lenses of coal 10 mm to 20 mm thick, | | | | | | | | | |
| | 18 | -petrified woody organics and coal lenses still | | | | | | | | | |
| 12 | 19 | -coal and organic lenses thinly bedded to 40 mm | | | | | | | | | |
| | 20 | -fine-grained, uniform | | | | | | | | | |
| | 21 | -organics and coal disseminated throughout | | | | | | | | | |
| | 22 | | | | | | | | | | |
| 14 | 23 | ICE-clear, trace sand particles disseminated throughout | | | | | | | | | |
| | 24 | | | | | | | | | | |
| | END OF BOREHOLE 15.2 m (27.2 m El.) | | | | | | | | | | |
| 16 | | | | | | | | | | | |
| 18 | | | | | | | | | | | |
| 20 | | | | | | | | | | | |

101C-4480
Completed 23:10 86/03/30
DRILLING RIG: CME 750
Compiled by JGC MAV

SAMPLE TYPE

CRREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
211501

PAGE 2 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | | | |
|------------------------------|-----|---|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------|---------------|-------------------|--------------|--|---------------|------|--|--|--|--|
| N7 689 635 E 527 122 Z8 | | | | RELATIVE ELEVATION 29.6 (m) | | | | | | | | | | | |
| SAMPLE | | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | | | | |
| TYP | NO. | Q | | | | | | | | | | | | | |
| 0 | | | ROOT MAT SILT (ML) -sandy | | | | | | | | | | | | |
| | 1 | | SAND (SM) -some silt, trace gravel to 50 mm, smooth, subrounded, orangish brown -silt content decreases to trace silt with depth | Nf | | | | | | | | | | | |
| | 2 | | CLAY TILL (CL) -silty, trace gravel, stratified ice lenses 1 mm to 5 mm thick | | | | | | | | | | | | |
| 2 | 3 | | ICE-trace sand particles disseminated throughout -clear | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | | | |
| | 6 | | -small air bubbles throughout | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | | | |
| 4 | 9 | | | | | | | | | | | | | | |
| | 10 | | END OF BOREHOLE 4.7 m (24.9 m E1.) | | | | | | | | | | | | |

101C-4480
Completed 02:50 86/03/31
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

CRREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
211502

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-----|---------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 689 552 E 527 906 Z8 | | | | RELATIVE ELEVATION 37.9 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. | | | | | | | | | | | | |
| 0 | | SAND (SP-SM) - trace to some silt, trace gravel on surface, uniform, homogeneous, light greyish brown | Nf | | | | | | | | 0 | | |
| 1 | | -trace silt | | | | | | | | | | | |
| 2 | | -trace gravel, trace silt, medium to fine-grained sand, uniform, gravel to 40 mm, smooth, massive, dark olive grey | | | | | | | | | 2 | | |
| 3 | | -trace gravel to 20 mm, thickly laminated, even, parallel, continuous, regularly spaced, olive brown and dark olive | | | | | | | | | | | |
| 4 | | -without gravel | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| 6 | | -coarse to fine-grained sand, massive | | | | | | | | | 4 | | |
| 7 | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| 9 | | ICE | | | | | | | | | 6 | | |
| 10 | | -clear, air bubbles throughout | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | |
| 12 | | END OF BOREHOLE 7.0 m (30.9 m El.) | | | | | | | | | 8 | | |
| | | | | | | | | | | | 10 | | |

101C-4480
Completed 06:15 86/03/31
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

CORREL

AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
211503

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | SPECIAL TESTS | UNIT |
|------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|
| N7 689 361 E 528 747 Z8 | | | | RELATIVE ELEVATION 32.1 (m) | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | | |
| TYP | NO. Q | | | | | | | | | | |
| 0 | 1 | SAND (SP) -gravelly, trace silt, coarse to fine-grained sand, poorly graded, subangular clasts to 50 mm, medium brown | Nr | | | | | | | | 0 |
| | 2 | -becoming: by 0.8 m SAND and GRAVEL (SP) -trace silt, gravel to 50 mm, subangular | | | | | | | | | |
| | 3 | -some gravel, clasts to 10 mm, rounded, massive, medium to fine-grained sand | | | | | | | | | |
| 2 | 4 | -becoming: by 2.0 m SAND (SP) -trace silt, fine-grained, uniform, medium grey | Nbn-Nbe | | | | | | | | 2 |
| | 5 | -massive, mottled medium grey and light iron oxide staining | | | | | | | | | |
| | 6 | -coal fragments to 20 mm | | | | | | | | | |
| | 7 | -very thinly bedded lenses of coal fragments | | | | | | | | | |
| 4 | 8 | -10 mm lens of SILT TILL (ML) -clayey, dark grey | 50:50 | | | | | | | | 4 |
| | 9 | -6 mm lens of ICE | | | | | | | | | |
| | 10 | -becoming trace to some coal with depth, angular clasts to 10 mm | | | | | | | | | |
| 6 | 11 | SAND (SW) -trace silt, trace coal, well graded, massive, medium to dark grey, with random light iron oxide staining | Nbn-Nbe | | | | | | | | 6 |
| | 12 | SAND (SP) -medium to fine-grained | | | | | | | | | |
| 8 | | -occasional coal fragments to 3 mm disseminated throughout | | | | | | | | | 8 |
| 10 | | | | | | | | | | | 10 |

101C-4480
Completed 22:10 86/03/31
DRILLING RIG: CME 750
Compiled by JGC MAV

SAMPLE TYPE

CARREL
AUGER

EBA Engineering Consultants Ltd.
(Edmonton)

DRAWING NUMBER

BOREHOLE NUMBER
211S04

PAGE 1 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | | | | | |
|------------------------------|-----|---|--------------------------------------------------------------------------------------------------------|-----------------------------|--------|---------------|-------------------|--------------|--|--|---------------|------|--|--|--|--|--|
| N7 689 361 E 528 747 Z8 | | | | RELATIVE ELEVATION 32.1 (m) | | | | | | | | | | | | | |
| SAMPLE | | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | | | | |
| TYP | NO. | Q | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |
| | 13 | | -very thinly cross bedded coal lenses at a 10 degree angle | Non | | | | | | | | | | | | | |
| | 14 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | |
| | 15 | | -angular coal clasts 10 mm to 15 mm | | | | | | | | | | | | | | |
| | 16 | | -trace gravel, occasional thinly bedded lens of SILT (ML) | | | | | | | | | | | | | | |
| | 17 | | -occasional very thinly bedded lens of SILT (ML) 1 mm thick, brown | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | |
| | 18 | | -dark olive grey | | | | | | | | | | | | | | |
| | 19 | | -occasional very thinly bedded lens organics and coal at a 30 degree angle, even, parallel, continuous | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | |
| | 20 | | | | | | | | | | | | | | | | |
| | 21 | | -trace gravel, coarse to fine-grained sand | | | | | | | | | | | | | | |
| | 22 | | ICE+SAND (SP) -thickly laminated -becoming ICE-clear, trace very thin sand laminae | 70: 30 | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | |
| | 23 | | ICE+SILT (ML) -sandy, 100 mm lens ICE-clear END OF BOREHOLE 18.3 m (13.8 m El.) | 50: 50 0 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | |

101C-4480
Completed 22: 10 86/03/31
DRILLING RIG: CME 750
Compiled by JGC MAV

SAMPLE TYPE

CARREL
AUGER

EBA Engineering Consultants Ltd.
(Edmonton)

DRAWING NUMBER

BOREHOLE NUMBER
211504

PAGE 2 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | | | |
|------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|--|--|--|--|
| N7 689 486 E 529 857 Z8 | | | | RELATIVE ELEVATION 33.6 (m) | | | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | | | |
| TYP | NO. & Q | | | | | | | | | | | | | | |
| 0 | 1 | ROOT MAT ORGANIC SILT (OL)-some fine-grained sand, very thinly bedded, wavy, occasional thinly bedded lens of dark brown to black organics, light greyish brown | Nr | | | | | | | | 0 | | | | |
| | 2 | SAND (SP-SM)-trace silt, trace woody organics to 20 mm in diameter, occasional thinly bedded lens of fibrous organics, curved, greyish olive | Nbn | | | | | | | | | | | | |
| 2 | 3 | SAND (SW)-gravelly, trace silt, trace coal and organics, gravel to 20 mm, well graded, angular, smooth, massive | Vc-Vx 15% | | | | | | | | 2 | | | | |
| | 4 | -20 mm ICE lens | | | | | | | | | | | | | |
| | 5 | -occasional thinly bedded lens of GRAVEL (GW)-silty -DRILLER'S NOTE: coarse gravel, unable to advance CREL barrel, drill with solid auger | | | | | | | | | | | | | |
| | 6 | ICE+SAND (SP)-fine-grained, very thinly bedded, wavy, nonparallel | 80: 40 | | | | | | | | 4 | | | | |
| 4 | 7 | -becoming by 4.1 m SAND (SP)-trace silt, trace organics and coal disseminated throughout, medium to fine-grained, uniform, massive, dark olive grey | Nbn | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | | | |
| | 9 | -coal fragments to 10 mm and woody organics disseminated throughout | Vr-Vx 5% | | | | | | | | | | | | |
| 6 | 10 | | | | | | | | | | 6 | | | | |
| | 11 | -some organics, wood fragments and petrified organic matter -10 mm thinly bedded PEAT (PT) lens, dark brown to black, wavy | Vc-Vx 5% | | | | | | | | | | | | |
| | 12 | SAND (SP)-trace silt GRAVEL (GW)-sandy, trace silt, gravel to 75 mm, smooth, subrounded to subangular, well graded | | | | | | | | | | | | | |
| | 13 | SAND (SP)-trace silt, medium to fine-grained, uniform, massive, dark olive grey -trace gravel to 10 mm | Nbn | | | | | | | | | | | | |
| 8 | 14 | -trace gravel to 25 mm, trace coal fragments | | | | | | | | | 8 | | | | |
| | 15 | SAND (SP/SW)-trace silt, coarse to fine-grained | | | | | | | | | | | | | |
| | 16 | SAND (SW)-trace gravel, trace silt, well graded | | | | | | | | | | | | | |
| 10 | 17 | | | | | | | | | | 10 | | | | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-------|------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---------------|------|--|----|--|
| N7 689 486 E 529 857 Z8 | | | | RELATIVE ELEVATION 33.6 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 10 | | SAND (SP) - trace silt, medium to fine-grained, occasional thickly laminated SILT (ML) lens | | | | | | | | | | | |
| | 17 | | | | | | | | | | | | |
| | 18 | -trace fibrous organics | Vx-Vr < 5% | | | | | | | | | | |
| | 19 | | Non | | | | | | | | | | |
| 12 | 20 | -some silt, occasional cross bedded organic laminae 1 mm thick at a 30 degree angle, even, parallel, continuous | | | | | | | | | | 12 | |
| | 21 | -trace to some silt, fine-grained | | | | | | | | | | | |
| | 22 | | | | | | | | | | | | |
| | 23 | -trace silt, medium to fine-grained, uniform, dark olive grey, with thickly laminated vertical SILT (ML) lenses, brown | | | | | | | | | | | |
| 14 | 24 | | | | | | | | | | | 14 | |
| | 25 | -coal and petrified wood fragments disseminated throughout | | | | | | | | | | | |
| | 26 | -cross bedded coal and organic laminae at a 40 degree angle, even, parallel, continuous | | | | | | | | | | | |
| 16 | 27 | | | | | | | | | | | 16 | |
| | 28 | | Vx < 5% | | | | | | | | | | |
| | 29 | -very thinly bedded lens of medium-grained sand | Non-Vx < 5% | | | | | | | | | | |
| 18 | 30 | | | | | | | | | | | 18 | |
| | 31 | -100 mm lens of coal, wood fragments and petrified wood matter | | | | | | | | | | | |
| | 32 | -homogeneous | | | | | | | | | | | |
| | | -medium to fine-grained sand | | | | | | | | | | | |
| | | END OF BOREHOLE | 19.5 (14.1 m El.) | | | | | | | | | | |
| 20 | | | | | | | | | | | | 20 | |

101C-4480
Completed 08:10 86/04/01
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

CORREL
AUGER











EBA Engineering Consultants Ltd.
(Edmonton)

DRAWING NUMBER

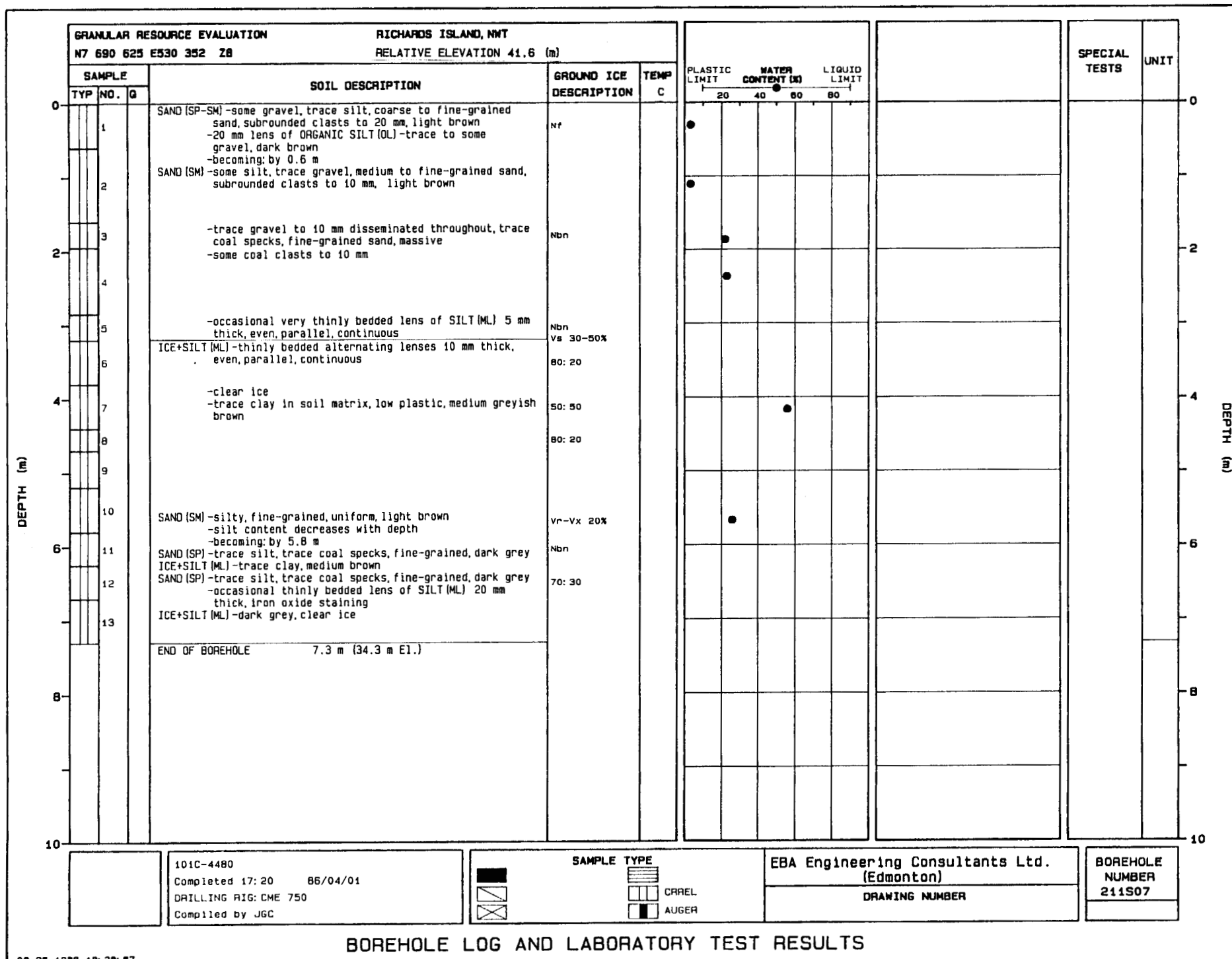
BOREHOLE NUMBER
211505
PAGE 2 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | SPECIAL TESTS | UNIT |
|------------------------------|--------|------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|
| N7 690 185 E 530 169 Z8 | | | | RELATIVE ELEVATION 43.2 (m) | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | | |
| TYP | NO. 10 | | | | | | | | | | |
| 0 | | GRAVEL (GP) -sandy, trace silt, coarse to fine-grained sand, fine-grained gravel, subrounded, clasts to 20 mm, massive | | | | | | | | | 0 |
| | 1 | -becoming: by 0.4 m | Nr | | | | | | | | |
| | 2 | SAND (SP) -trace gravel to 15 mm, trace silt, coarse to fine-grained sand, medium brown | | | | | | | | | |
| | 3 | -medium to fine-grained | | | | | | | | | |
| 2 | 4 | -trace coal specks, fine-grained, massive, medium to dark grey | Nbn | | | | | | | | 2 |
| | 5 | -with iron oxide staining | | | | | | | | | |
| | 6 | | | | | | | | | | |
| | 7 | -occasional 5 mm coal clast | | | | | | | | | |
| 4 | 8 | | | | | | | | | | 4 |
| | 9 | | | | | | | | | | |
| | 10 | -trace petrified wood to 10 mm | | | | | | | | | |
| | 11 | -150 mm lens of coal | | | | | | | | | |
| 6 | 12 | | Vr-Vs 15-20% | | | | | | | | 6 |
| | 13 | | | | | | | | | | |
| | 14 | ICE+SAND (SP) -occasional very thinly bedded lens of SILT (ML) -sandy, 3 mm thick, randomly spaced | | | | | | | | | 8 |
| | 15 | | | | | | | | | | |
| | 16 | | | | | | | | | | |
| 10 | | SAND (SP) -trace silt, trace coal, fine-grained, medium grey | | | | | | | | | 10 |
| | | END OF BOREHOLE 9.8 m (32.4 m El.) | | | | | | | | | |

| | | | | |
|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------|
| 101C-4480 Completed 14:00 86/04/01 DRILLING RIG: CME 750 Compiled by JGC | SAMPLE TYPE      | SAMPLE TYPE      | EBA Engineering Consultants Ltd. DRAWING NUMBER | BOREHOLE NUMBER 211S06 |
|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------|

BOREHOLE LOG AND LABORATORY TEST RESULTS



BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | SPECIAL TESTS | UNIT |
|------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|
| N7 690 897 E 530 594 Z8 | | | | RELATIVE ELEVATION 42.6 (m) | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | | |
| TYP NO. | Q | | | | | | | | | | |
| 0 | 1 | GRAVEL (GW)-sandy, trace silt, trace rootlets, coarse to fine-grained sand, gravel clasts to 50 mm, rounded to subrounded, medium brown -becoming: by 0.3 m | Nil | | | | | | | | 0 |
| | 2 | SAND (SP)-some gravel, trace silt, coarse to fine-grained sand, fine-grained gravel to 15 mm, medium brown -trace gravel to 10 mm, subrounded | | | | | | | | | |
| 2 | 3 | | | | | | | | | | 2 |
| | 4 | -trace silt, medium to fine-grained, massive, dark olive grey -trace gravel to 10 mm, coarse to fine-grained sand | Non | | | | | | | | |
| | 5 | | | | | | | | | | |
| | 6 | -trace gravel to 20 mm | | | | | | | | | |
| 4 | 7 | -trace coal fragments to 5 mm, medium to fine-grained sand | | | | | | | | | 4 |
| | 8 | | | | | | | | | | |
| | 9 | -50 mm lens of coal and petrified wood fragments, with stratified ice lens 5 mm thick -fine-grained sand, thickly laminated, even, parallel, continuous, regularly spaced -medium to fine-grained sand, massive, brownish grey | Non | | | | | | | | |
| | 10 | | | | | | | | | | |
| 6 | 11 | -becoming: by 6.2 m | | | | | | | | | 6 |
| | 12 | SAND (SP/SW)-trace gravel, trace silt, coarse to fine-grained sand, gravel to 25 mm, smooth, subangular to rounded | | | | | | | | | |
| | 13 | | | | | | | | | | |
| | 14 | -trace gravel to 75 mm, subrounded, smooth, medium to fine-grained sand -becoming: by 7.8 m | | | | | | | | | |
| 8 | 15 | SAND (SP/SW)-trace to some silt, fine-grained sand -fine-grained, uniform, homogeneous | Non | | | | | | | | 8 |
| | 16 | | | | | | | | | | |
| | 17 | -becoming: by 8.8 m | | | | | | | | | |
| | 18 | SAND (SM)-silty, trace coal and petrified wood fragments, fine-grained, uniform | | | | | | | | | |
| 10 | 19 | ICE+SAND (SP)-occasional thickly laminated lens of SILT (ML). | | | | | | | | | 10 |

101C-4480
Completed 23: 05 88/04/01
DRILLING RIG: CME 750
Compiled by J6C MAV

SAMPLE TYPE

CAREL
AUGER

EBA Engineering Consultants Ltd.
(Edmonton)
DRAWING NUMBER

BOREHOLE NUMBER
211908
PAGE 1 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | SPECIAL TESTS | UNIT |
|------------------------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|
| N7 690 465 E 530 240 Z8 | | | | RELATIVE ELEVATION 41.9 (m) | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | | |
| TYP | NO. & Q | | | | | | | | | | |
| 0 | 1 | SAND (SW) - gravelly trace silt, well graded, gravel to 20 mm, dry, loose (poorly bonded), greyish brown | Nr | | | | | | | | 0 |
| | 2 | | | | | | | | | | |
| | 3 | -hole sloughing from surface to 1.7 m -50 mm lens of PEAT (PT) - dark brown to black -becoming: by 1.9 m | | | | | | | | | 2 |
| 2 | 4 | SAND (SW) - trace gravel to 20 mm, trace silt, coarse to fine-grained sand, well graded, massive, dark grey -becoming: by 2.4 m | Nbn | | | | | | | | |
| | 5 | SAND (SP) - trace silt, fine grained, trace coal fragments, olive grey | | | | | | | | | |
| | 6 | -occasional very thinly bedded lens of coal and petrified wood fragments, lenses 10 mm thick, even, parallel, continuous -medium to fine-grained, grey | | | | | | | | | |
| 4 | 7 | | Nbn | | | | | | | | 4 |
| | 8 | | | | | | | | | | |
| | 9 | -becoming: by 5.0 m SAND (SP/SW) - trace silt, coarse to fine-grained | | | | | | | | | |
| 6 | 10 | -trace coal fragments and petrified wood disseminated throughout | | | | | | | | | 6 |
| | 11 | ICE+SILT (ML) - sandy | | | | | | | | | |
| | 12 | SAND (SP) - trace silt, trace coal, trace wood to 15 mm in diameter, medium to fine-grained | | | | | | | | | |
| | 13 | ICE+SILT (ML) - sandy SAND (SP) - trace silt, medium to fine-grained | | | | | | | | | |
| 8 | 14 | -becoming: by 7.9 m SAND (SP/SW) - trace to some silt, fine-grained, uniform, massive, homogeneous, olive grey | Nbn-trace Vx | | | | | | | | 8 |
| | 15 | | | | | | | | | | |
| | 16 | | | | | | | | | | |
| 10 | 17 | ICE+SILT (ML) - sandy | 50: 50 60: 40 | | | | | | | | 10 |

101C-4480
Completed 03: 50 86/04/02
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

CAREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
211S09

PAGE 1 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

[illegible]

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | | | |
|------------------------------|---------|-------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|--|--|
| N7 690 072 E 530 226 Z8 | | | | RELATIVE ELEVATION 42.8 (m) | | | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | | | |
| TYP | NO. & Q | | | | | | | | | | | | | | |
| 0 | | ROOT MAT ORGANIC SILT (OL) - trace fine-grained sand, trace rootlets | Nf becoming Nbn | | | | | | | | 0 | | | | |
| 1 | | | | | | | | | | | | | | | |
| 2 | | SAND (SP) - trace silt, fine-grained, uniform, homogeneous, olive brown | | | | | | | | | | | | | |
| 3 | | SILT (ML) - trace to some fine-grained sand, thickly laminated, wavy, nonparallel, nonplastic, dark greyish brown | Vs 25% | | | | | | | | | | | | |
| 4 | | - trace to some clay | Vs 5-10% | | | | | | | | | | | | |
| 5 | | ICE+SILT (ML) | 60: 40 50: 50 | | | | | | | | | | | | |
| 6 | | -200 mm lens of SILT (ML) - trace clay, dark olive grey | | | | | | | | | | | | | |
| 7 | | ICE - trace silt | | | | | | | | | | | | | |
| 7A | | SILT (ML) - clayey, low plastic, brown | | | | | | | | | | | | | |
| 4 | | END OF BOREHOLE 3.7 m (39.1 m El.) | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |

101C-4480

Completed 06:15 86/04/02

DRILLING RIG: CME 750

Compiled by MAV

SAMPLE TYPE

CRREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
211S10

BOREHOLE LOG AND LABORATORY TEST RESULTS

B.5

LABORATORY TESTING



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.80 | 1 | core | | | | | | | | | | F |
| 0.50- | 0.60 | 1A | | 16 | | | | | | | | | F |
| 0.80- | 1.60 | 2 | core | | | | | | | | | | F |
| 1.10- | 1.20 | 2A | SP | 25 | | | | | 3.0 | 97.0 | 0.0 | | F |
| 1.60- | 2.20 | 3 | core | | | | | | | | | | F |
| 1.80- | 1.90 | 3A | SP | 23 | | | | | 3.0 | 97.0 | 0.0 | | F |
| 2.20- | 3.10 | 4 | core | | | | | | | | | | F |
| 2.50- | 2.60 | 4A | SP | 24 | | | | | 3.0 | 97.0 | 0.0 | | F |
| 3.10- | 3.70 | 5 | core | | | | | | | | | | F |
| 3.40- | 3.50 | 5A | | 22 | | | | | | | | | F |
| 3.70- | 4.10 | 6 | core | | | | | | | | | | F |
| 3.90- | 4.10 | 6A | SP | 20 | | | | | 3.0 | 97.0 | 0.0 | | F |
| 4.10- | 4.70 | 7 | core | | | | | | | | | | F |
| 4.30- | 4.60 | 7A | | 26 | | | | | | | | | F |
| 4.70- | 5.30 | 8 | core | | | | | | | | | | F |
| 5.10- | 5.30 | 8A | | 32 | | | | | | | | | F |
| 5.30- | 5.90 | 9 | core | | | | | | | | | | F |
| 5.70- | 5.90 | 9A | | 29 | | | | | | | | | F |
| 5.90- | 6.20 | 10 | core | | | | | | | | | | F |
| 6.20- | 6.70 | 11 | core | | | | | | | | | | F |
| 6.60- | 6.70 | 11A | SP | 25 | | | | | 3.0 | 97.0 | 0.0 | | F |
| 6.70- | 7.50 | 12 | core | | | | | | | | | | F |
| 7.50- | 7.80 | 13 | core | | | | | | | | | | F |
| 7.60- | 7.80 | 13A | | 31 | | | | | | | | | F |
| 7.80- | 8.50 | 14 | core | | | | | | | | | | F |
| 8.50- | 9.30 | 15 | core | | | | | | | | | | F |
| 9.10- | 9.30 | 15A | | 25 | | | | | | | | | F |
| 9.30- | 10.10 | 16 | core | | | | | | | | | | F |
| 9.90- | 10.10 | 16A | | 25 | | | | | | | | | F |
| 10.10- | 10.70 | 17 | core | | | | | | | | | | F |
| 10.50- | 10.70 | 17A | | 23 | | | | | | | | | F |
| 10.70- | 11.40 | 18 | core | | | | | | | | | | F |
| 11.40- | 12.00 | 19 | core | | | | | | | | | | F |
| 11.90- | 12.00 | 19A | | 32 | | | | | | | | | F |
| 12.00- | 12.60 | 20 | core | | | | | | | | | | F |
| 12.60- | 13.30 | 21 | core | | | | | | | | | | F |
| 13.30- | 13.90 | 22 | core | | | | | | | | | | F |
| 13.60- | 13.80 | 22A | | | | | | | | | | | F |
| 13.90- | 14.50 | 23 | core | | | | | | | | | | F |
| 14.50- | 15.20 | 24 | core | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 211S01

Page 1

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | |
| 0.90- | 1.70 | 2 | core | 4.7 | | | | | | | | | |
| 1.30- | 1.40 | 2A | | | | | | | | | | | |
| 1.70- | 2.10 | 3 | core | | | | | | | | | | |
| 2.10- | 2.60 | 4 | core | | | | | | | | | | |
| 2.60- | 2.90 | 5 | core | | | | | | | | | | |
| 2.90- | 3.20 | 6 | core | | | | | | | | | | |
| 3.20- | 3.50 | 7 | core | | | | | | | | | | |
| 3.50- | 4.00 | 8 | core | | | | | | | | | | |
| 4.00- | 4.40 | 9 | core | | | | | | | | | | |
| 4.40- | 4.70 | 10 | core | | | | | | | | | | |

BA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 211502

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- 0.90 | 1 | core | | | | | | | | | | | | F |
| 0.70- 0.90 | 1A | | SP-SM | 3 | | | | | 9.0 | 91.0 | 0.0 | | | F |
| 0.90- 1.70 | 2 | core | | | | | | | | | | | | F |
| 1.50- 1.70 | 2A | | SP-SM | 4 | | | | | 5.0 | 95.0 | 0.0 | | | F |
| 1.70- 2.40 | 3 | core | | | | | | | | | | | | F |
| 2.10- 2.30 | 3A | | | 24 | | | | | | | | | | F |
| 2.40- 3.00 | 4 | core | | | | | | | | | | | | F |
| 2.80- 3.00 | 4A | | SP-SM | 20 | | | | | 7.0 | 93.0 | 0.0 | | | F |
| 3.00- 3.50 | 5 | core | | | | | | | | | | | | F |
| 3.50- 4.10 | 6 | core | | | | | | | | | | | | F |
| 4.10- 4.70 | 7 | core | | | | | | | | | | | | F |
| 4.50- 4.70 | 7A | | | 26 | | | | | | | | | | F |
| 4.70- 5.30 | 8 | core | | | | | | | | | | | | F |
| 5.30- 6.00 | 9 | core | | | | | | | | | | | | F |
| 5.50- 5.60 | 9A | | SP | | | | | | 2.0 | 98.0 | 0.0 | | | F |
| 6.00- 6.30 | 10 | core | | | | | | | | | | | | F |
| 6.30- 6.70 | 11 | core | | | | | | | | | | | | F |
| 6.70- 7.00 | 12 | core | | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 211S03

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-----|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- 0.60 | 1 | core | | | | | | | | | | | F |
| 0.50- 0.60 | 1A | | SP | 6 | | | | | 2.0 | 67.0 | 31.0 | | F |
| 0.80- 1.50 | 2 | core | | | | | | | | | | | F |
| 1.20- 1.30 | 2A | | SP | 2 | | | | | 2.0 | 58.0 | 40.0 | | F |
| 1.50- 2.10 | 3 | core | | | | | | | | | | | F |
| 1.50- 1.60 | 3A | | | 3 | | | | | | | | | F |
| 2.10- 2.70 | 4 | core | | | | | | | | | | | F |
| 2.40- 2.50 | 4A | | SP | 28 | | | | | 1.0 | 99.0 | 0.0 | | F |
| 2.70- 3.50 | 5 | core | | | | | | | | | | | F |
| 3.20- 3.30 | 5A | | | 28 | | | | | | | | | F |
| 3.50- 4.30 | 6 | core | | | | | | | | | | | F |
| 4.00- 4.10 | 6A | | SP | 28 | | | | | 4.0 | 96.0 | 0.0 | | F |
| 4.30- 5.10 | 7 | core | | | | | | | | | | | F |
| 4.60- 4.70 | 7A | | | 27 | | | | | | | | | F |
| 5.10- 6.10 | 8 | core | | | | | | | | | | | F |
| 5.60- 5.70 | 8A | | | 20 | | | | | | | | | F |
| 6.10- 7.00 | 9 | core | | | | | | | | | | | F |
| 6.60- 6.70 | 9A | | | | | | | | | | | | F |
| 7.00- 7.90 | 10 | core | | | | | | | | | | | F |
| 7.50- 7.60 | 10A | | | 16 | | | | | | | | | F |
| 7.90- 8.35 | 11 | core | | | | | | | | | | | F |
| 8.10- 8.20 | 11A | | | | | | | | 1.0 | 99.0 | 0.0 | | F |
| 8.35- 9.30 | 12 | core | | | | | | | | | | | F |
| 8.70- 8.80 | 12A | | | 17 | | | | | | | | | F |
| 10.20- 11.30 | 13 | core | | | | | | | | | | | F |
| 10.60- 10.70 | 13A | | | | | | | | | | | | F |
| 11.30- 12.20 | 14 | core | | | | | | | | | | | F |
| 11.70- 11.80 | 14A | | | 20 | | | | | | | | | F |
| 12.20- 12.80 | 15 | core | | | | | | | | | | | F |
| 12.50- 12.60 | 15A | | | | | | | | | | | | F |
| 12.80- 14.00 | 16 | core | | | | | | | | | | | F |
| 13.20- 13.30 | 16A | | | | | | | | | | | | F |
| 14.00- 14.90 | 17 | core | | | | | | | | | | | F |
| 14.50- 14.60 | 17A | | | 33 | | | | | | | | | F |
| 14.90- 15.70 | 18 | core | | | | | | | | | | | F |
| 15.70- 16.20 | 19 | core | | | | | | | | | | | F |
| 16.20- 16.80 | 20 | core | | | | | | | | | | | F |
| 16.50- 16.70 | 20A | | | | | | | | | | | | F |
| 16.80- 17.20 | 21 | core | | | | | | | | | | | F |
| 16.90- 17.00 | 21A | | | | | | | | | | | | F |
| 17.20- 17.70 | 22 | core | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 211S04

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-----|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 17.70- 18.30 | 23 | core | | | | | | | | | | | | F |
| 18.10- 18.20 | 23A | | | | | | | | | | | | | F |
| 18.20- 18.30 | 23B | | | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 211S04

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | F |
| 0.60- | 0.80 | 1A | | 11 | | | | | | | | | F |
| 0.90- | 1.80 | 2 | core | | | | | | | | | | F |
| 1.50- | 1.70 | 2A | SP-SM | 32 | | | | | 9.0 | 91.0 | 0.0 | | F |
| 1.80- | 2.40 | 3 | core | | | | | | | | | | F |
| 2.20- | 2.40 | 3A | SP | 20 | | | | | 3.0 | 78.0 | 19.0 | | F |
| 2.40- | 2.90 | 4 | core | | | | | | | | | | F |
| 2.70- | 2.80 | 4A | SW | 11 | | | | | 4.0 | 75.0 | 21.0 | | F |
| 2.90- | 3.00 | 5 | core | | | | | | | | | | F |
| 3.80- | 4.00 | 6 | core | | | | | | | | | | F |
| 4.00- | 4.70 | 7 | core | | | | | | | | | | F |
| 4.30- | 4.50 | 7A | | 25 | | | | | | | | | F |
| 4.70- | 5.00 | 8 | core | | | | | | | | | | F |
| 5.00- | 5.50 | 9 | core | | | | | | | | | | F |
| 5.50- | 6.20 | 10 | core | | | | | | | | | | F |
| 6.10- | 6.20 | 10A | SP | 33 | | | | | 3.0 | 94.0 | 3.0 | | F |
| 6.20- | 6.70 | 11 | core | | | | | | | | | | F |
| 6.50- | 6.70 | 11A | | | | | | | | | | | F |
| 6.70- | 7.30 | 12 | core | | | | | | | | | | F |
| 7.30- | 7.80 | 13 | core | | | | | | | | | | F |
| 7.70- | 7.80 | 13A | | | | | | | | | | | F |
| 7.80- | 8.40 | 14 | core | | | | | | | | | | F |
| 8.40- | 9.10 | 15 | core | | | | | | | | | | F |
| 8.80- | 9.00 | 15A | | | | | | | | | | | F |
| 9.10- | 9.90 | 16 | core | | | | | | | | | | F |
| 9.90- | 10.70 | 17 | core | | | | | | | | | | F |
| 10.30- | 10.50 | 17A | | 28 | | | | | | | | | F |
| 10.70- | 11.00 | 18 | core | | | | | | | | | | F |
| 11.00- | 11.60 | 19 | core | | | | | | | | | | F |
| 11.60- | 12.00 | 20 | core | | | | | | | | | | F |
| 11.90- | 12.00 | 20A | | | | | | | | | | | F |
| 12.00- | 12.60 | 21 | core | | | | | | | | | | F |
| 12.60- | 13.10 | 22 | core | | | | | | | | | | F |
| 13.10- | 13.40 | 23 | core | | | | | | | | | | F |
| 13.30- | 13.40 | 23A | | 30 | | | | | | | | | F |
| 13.40- | 14.50 | 24 | core | | | | | | | | | | F |
| 14.50- | 15.20 | 25 | core | | | | | | | | | | F |
| 14.70- | 14.80 | 25A | | | | | | | | | | | F |
| 15.20- | 15.70 | 26 | core | | | | | | | | | | F |
| 15.70- | 16.30 | 27 | core | | | | | | | | | | F |
| 16.30- | 16.90 | 28 | core | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 211S05

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-----|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 16.40- 16.60 | 28A | | | | | | | | | | | | | F |
| 16.90- 17.50 | 29 | core | | | | | | | | | | | | F |
| 17.50- 18.40 | 30 | core | | | | | | | | | | | | F |
| 18.20- 18.40 | 30A | | | | | | | | | | | | | F |
| 18.40- 18.90 | 31 | core | | | | | | | | | | | | F |
| 18.90- 19.50 | 32 | core | | | | | | | | | | | | F |
| 19.40- 19.50 | 32A | | | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 211505

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | | F |
| 0.20- | 0.30 | 1A | | 3 | | | | | | | | | | F |
| 0.90- | 1.70 | 2 | core | | | | | | | | | | | F |
| 1.20- | 1.30 | | SP-SM | 3 | | | | | 5.0 | 95.0 | 0.0 | | | F |
| 1.70- | 2.00 | 3 | core | | | | | | | | | | | F |
| 2.00- | 2.45 | 4 | core | | | | | | | | | | | F |
| 2.20- | 2.30 | 4A | | 25 | | | | | | | | | | F |
| 2.45- | 2.90 | 5 | core | | | | | | | | | | | F |
| 2.70- | 2.80 | 5A | SP | 24 | | | | | 1.0 | 99.0 | 0.0 | | | F |
| 2.90- | 3.40 | 6 | core | | | | | | | | | | | F |
| 3.40- | 4.10 | 7 | core | | | | | | | | | | | F |
| 3.80- | 3.90 | 7A | | 25 | | | | | | | | | | F |
| 4.10- | 4.40 | 8 | core | | | | | | | | | | | F |
| 4.40- | 4.90 | 9 | core | | | | | | | | | | | F |
| 4.60- | 4.70 | 9A | SP | | | | | | 1.0 | 99.0 | 0.0 | | | F |
| 4.90- | 5.35 | 10 | core | | | | | | | | | | | F |
| 5.20- | 5.30 | 10A | | 32 | | | | | | | | | | F |
| 5.35- | 6.10 | 11 | core | | | | | | | | | | | F |
| 5.70- | 5.80 | 11A | SP-SM | 28 | | | | | 9.0 | 91.0 | 0.0 | | | F |
| 6.10- | 7.00 | 12 | core | | | | | | | | | | | F |
| 6.50- | 6.60 | 12A | | 27 | | | | | | | | | | F |
| 7.00- | 7.80 | 13 | core | | | | | | | | | | | F |
| 7.50- | 7.60 | 13A | | | | | | | | | | | | F |
| 7.80- | 8.40 | 14 | core | | | | | | | | | | | F |
| 8.20- | 8.30 | 14A | | 28 | | | | | | | | | | F |
| 8.40- | 9.30 | 15 | core | | | | | | | | | | | F |
| 8.90- | 9.00 | 15A | | | | | | | | | | | | F |
| 9.30- | 9.80 | 16 | core | | | | | | | | | | | F |
| 9.70- | 9.80 | 16A | | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 211S06

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.60 | 1 | core | SP-SM | 3.4 | | | | 6.0 | 76.0 | 18.0 | | | F |
| 0.60- | 1.60 | 2 | core | SM | 3.3 | | | | 13.0 | 86.0 | 1.0 | | | F |
| 1.60- | 1.95 | 3 | core | | | | | | | | | | | F |
| 1.80- | 1.90 | 3A | | 22.0 | | | | | | | | | | F |
| 1.95- | 2.95 | 4 | core | | | | | | | | | | | F |
| 2.30- | 2.40 | 4A | SP-SM | 23.0 | | | | | 6.0 | 94.0 | 0.0 | | | F |
| 2.85- | 3.20 | 5 | core | | | | | | | | | | | F |
| 3.10- | 3.20 | 5A | | | | | | | | | | | | F |
| 3.20- | 3.80 | 6 | core | | | | | | | | | | | F |
| 3.80- | 4.40 | 7 | core | | | | | | | | | | | F |
| 4.10- | 4.20 | 7A | | 56.0 | | | | | | | | | | F |
| 4.40- | 4.70 | 8 | core | | | | | | | | | | | F |
| 4.70- | 5.20 | 9 | core | | | | | | | | | | | F |
| 5.20- | 5.80 | 10 | core | | | | | | | | | | | F |
| 5.60- | 5.70 | 10A | | 26.0 | | | | | | | | | | F |
| 5.80- | 6.25 | 11 | core | | | | | | | | | | | F |
| 6.25- | 6.70 | 12 | core | | | | | | | | | | | F |
| 6.25- | 6.35 | 12A | | | | | | | | | | | | F |
| 6.70- | 7.30 | 13 | core | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 211S07

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.30 | 1 | core | GW | 4 | | | | 1.0 | 48.0 | 51.0 | | F |
| 0.30- | 1.50 | 2 | core | SP | 3 | | | | 1.0 | 83.0 | 16.0 | | F |
| 1.50- | 2.10 | 3 | core | | 2 | | | | | | | | F |
| 2.10- | 2.40 | 4 | core | | | | | | | | | | F |
| 2.30- | 2.40 | 4A | | SP-SM | 19 | | | | 7.0 | 90.0 | 3.0 | | F |
| 2.40- | 3.20 | 5 | core | | | | | | | | | | F |
| 3.00- | 3.20 | 5A | | SP-SM | 12 | | | | 6.0 | 88.0 | 6.0 | | F |
| 3.20- | 4.00 | 6 | core | | | | | | | | | | F |
| 4.00- | 4.50 | 7 | core | | | | | | | | | | F |
| 4.40- | 4.50 | 7A | | SP | 24 | | | | 2.0 | 98.0 | 0.0 | | F |
| 4.50- | 4.70 | 8 | core | | | | | | | | | | F |
| 4.70- | 5.20 | 9 | core | | | | | | | | | | F |
| 5.20- | 5.90 | 10 | core | | | | | | | | | | F |
| 5.80- | 5.90 | 10A | | | 25 | | | | | | | | F |
| 5.90- | 6.20 | 11 | core | | | | | | | | | | F |
| 6.20- | 7.00 | 12 | core | | | | | | | | | | F |
| 6.90- | 7.00 | 12A | | SP | | | | | 2.0 | 97.0 | 1.0 | | F |
| 7.00- | 7.50 | 13 | core | | | | | | | | | | F |
| 7.50- | 7.80 | 14 | core | | | | | | | | | | F |
| 7.80- | 8.20 | 15 | core | | | | | | | | | | F |
| 8.00- | 8.20 | 15A | | | 24 | | | | | | | | F |
| 8.20- | 8.80 | 16 | core | | | | | | | | | | F |
| 8.80- | 9.30 | 17 | core | | | | | | | | | | F |
| 9.20- | 9.30 | 17A | | | | | | | | | | | F |
| 9.30- | 9.80 | 18 | core | | | | | | | | | | F |
| 9.80- | 10.20 | 19 | core | | | | | | | | | | F |
| 10.20- | 10.70 | 20 | core | | | | | | | | | | F |
| 10.60- | 10.70 | 20A | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | F |
| 0.70- | 0.90 | 1A | | 17 | | | | | | | | | F |
| 0.90- | 1.70 | 2 | core | | | | | | | | | | F |
| 1.40- | 1.70 | 2A | SW | 4 | | | | | 5.0 | 64.0 | 31.0 | | F |
| 1.70- | 1.80 | 3 | core | | | | | | | | | | F |
| 1.80- | 2.40 | 4 | core | | | | | | | | | | F |
| 2.10- | 2.30 | 4A | | 24 | | | | | | | | | F |
| 2.40- | 3.20 | 5 | core | | | | | | | | | | F |
| 2.70- | 2.90 | 5A | SP | 33 | | | | | 2.0 | 98.0 | 0.0 | | F |
| 3.20- | 3.70 | 6 | core | | | | | | | | | | F |
| 3.70- | 4.60 | 7 | core | | | | | | | | | | F |
| 4.40- | 4.60 | 7A | SP | 27 | | | | | 1.0 | 99.0 | 0.0 | | F |
| 4.60- | 5.00 | 8 | core | | | | | | | | | | F |
| 5.00- | 5.60 | 9 | core | | | | | | | | | | F |
| 5.40- | 5.60 | 9A | | 22 | | | | | | | | | F |
| 5.60- | 6.10 | 10 | core | | | | | | | | | | F |
| 6.10- | 6.90 | 11 | core | | | | | | | | | | F |
| 6.70- | 6.90 | 11A | | | | | | | | | | | F |
| 6.90- | 7.20 | 12 | core | | | | | | | | | | F |
| 7.20- | 7.80 | 13 | core | | | | | | | | | | F |
| 7.80- | 8.20 | 14 | core | | | | | | | | | | F |
| 7.90- | 8.00 | 14A | | 24 | | | | | | | | | F |
| 8.20- | 9.10 | 15 | core | | | | | | | | | | F |
| 9.10- | 10.00 | 16 | core | | | | | | | | | | F |
| 9.80- | 9.90 | 16A | | | | | | | | | | | F |
| 9.60- | 9.80 | 16B | | | | | | | | | | | F |
| 10.00- | 10.70 | 17 | core | | | | | | | | | | F |
| 10.70- | 11.60 | 18 | core | | | | | | | | | | F |
| 11.40- | 11.60 | 18A | | | | | | | | | | | F |
| 11.60- | 12.20 | 19 | core | | | | | | | | | | F |
| 12.00- | 12.20 | 19A | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USE | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-----|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- 0.90 | 1 | core | | 38.0 | | | | | | | | | | F |
| 0.50- 0.60 | 1A | | | | | | | | | | | | | F |
| 0.90- 1.70 | 2 | core | | | | | | | | | | | | F |
| 1.10- 1.20 | 2A | | | 20.0 | | | | | | | | | | F |
| 1.40- 1.50 | 2B | | | 37.0 | | | | | | | | | | F |
| 1.70- 2.00 | 3 | core | | | | | | | | | | | | F |
| 1.90- 2.00 | 3A | | | 39.0 | | | | | | | | | | F |
| 2.00- 2.40 | 4 | core | | | | | | | | | | | | F |
| 2.30- 2.40 | 4A | | | | | | | | | | | | | F |
| 2.40- 2.70 | 5 | core | | | | | | | | | | | | F |
| 2.70- 3.20 | 6 | core | | | | | | | | | | | | F |
| 3.20- 3.70 | 7 | core | | | | | | | | | | | | F |
| 3.60- 3.70 | 7A | | | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 211S10

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | | F |
| 0.20- | 0.30 | 1A | | | | | | | | | | | | F |
| 0.60- | 0.70 | 1B | | | | | | | | | | | | F |
| 0.90- | 1.10 | 2 | core | | | | | | | | | | | F |
| 1.10- | 1.40 | 3 | core | | | | | | | | | | | F |
| 1.40- | 1.70 | 4 | core | | | | | | | | | | | F |
| 1.70- | 2.00 | 5 | core | | | | | | | | | | | F |
| 2.00- | 2.40 | 6 | core | | | | | | | | | | | F |
| 2.10- | 2.20 | 6A | | 67.0 | | | | | | | | | | F |
| 2.40- | 2.75 | 7 | core | | | | | | | | | | | F |
| 2.75- | 3.05 | 8 | core | | | | | | | | | | | F |
| 3.05- | 3.45 | 9 | core | | | | | | | | | | | F |
| 3.25- | 3.35 | 9A | | 201.0 | | | | | | | | | | F |

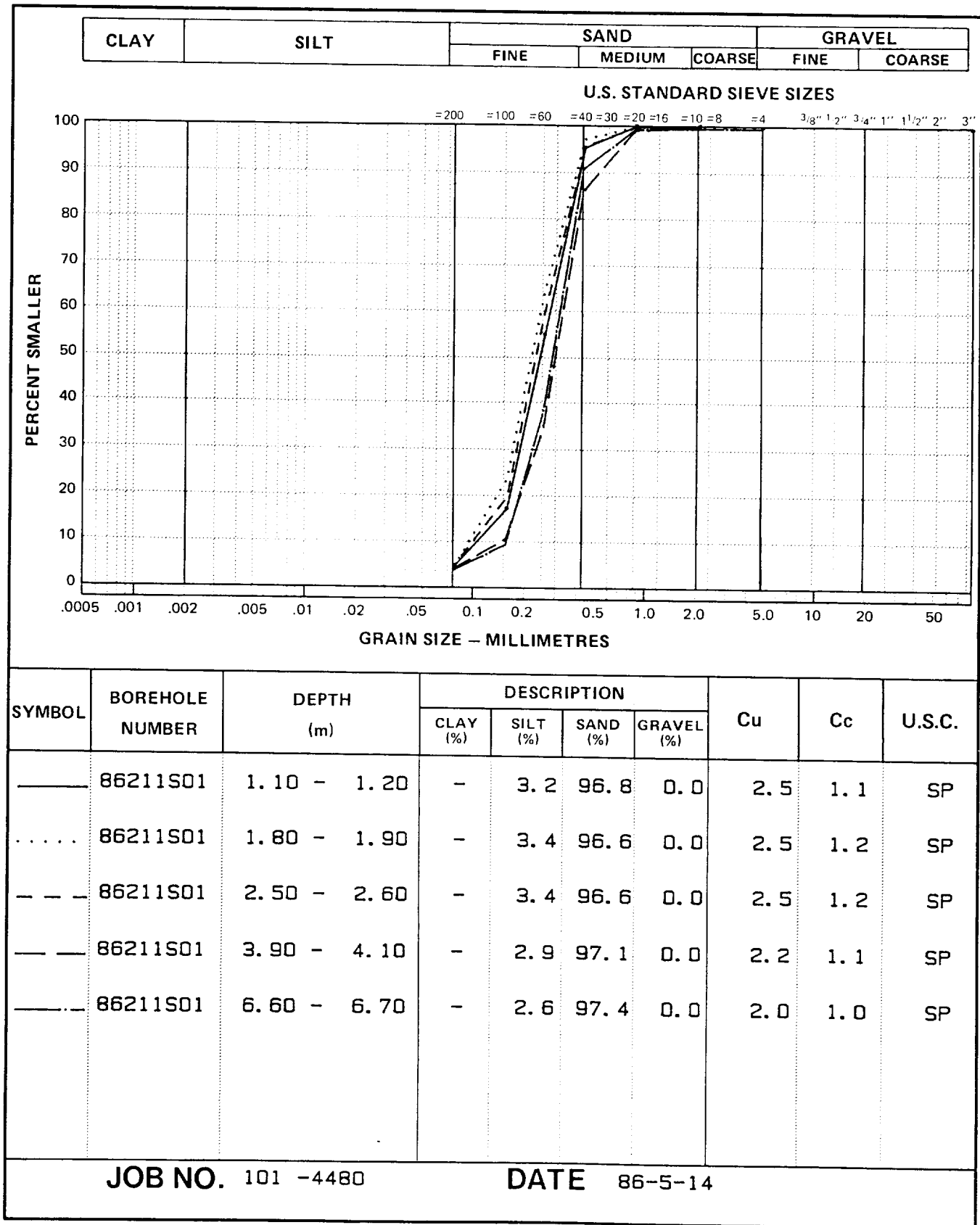
BA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

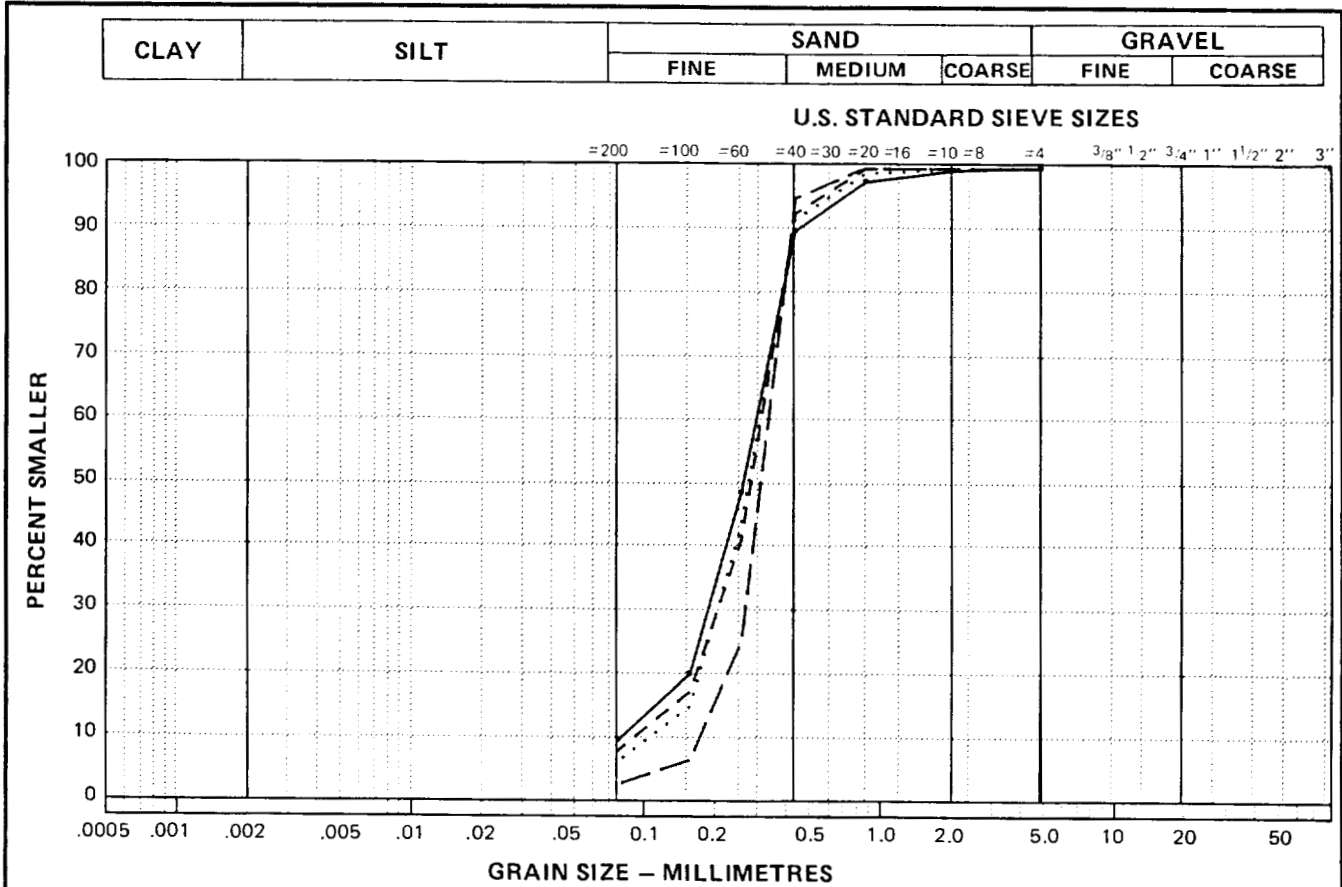
Project Number: 101C-4480
BOREHOLE NO. 211S11

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PARTICLE - SIZE ANALYSIS OF SOILS



PARTICLE - SIZE ANALYSIS OF SOILS

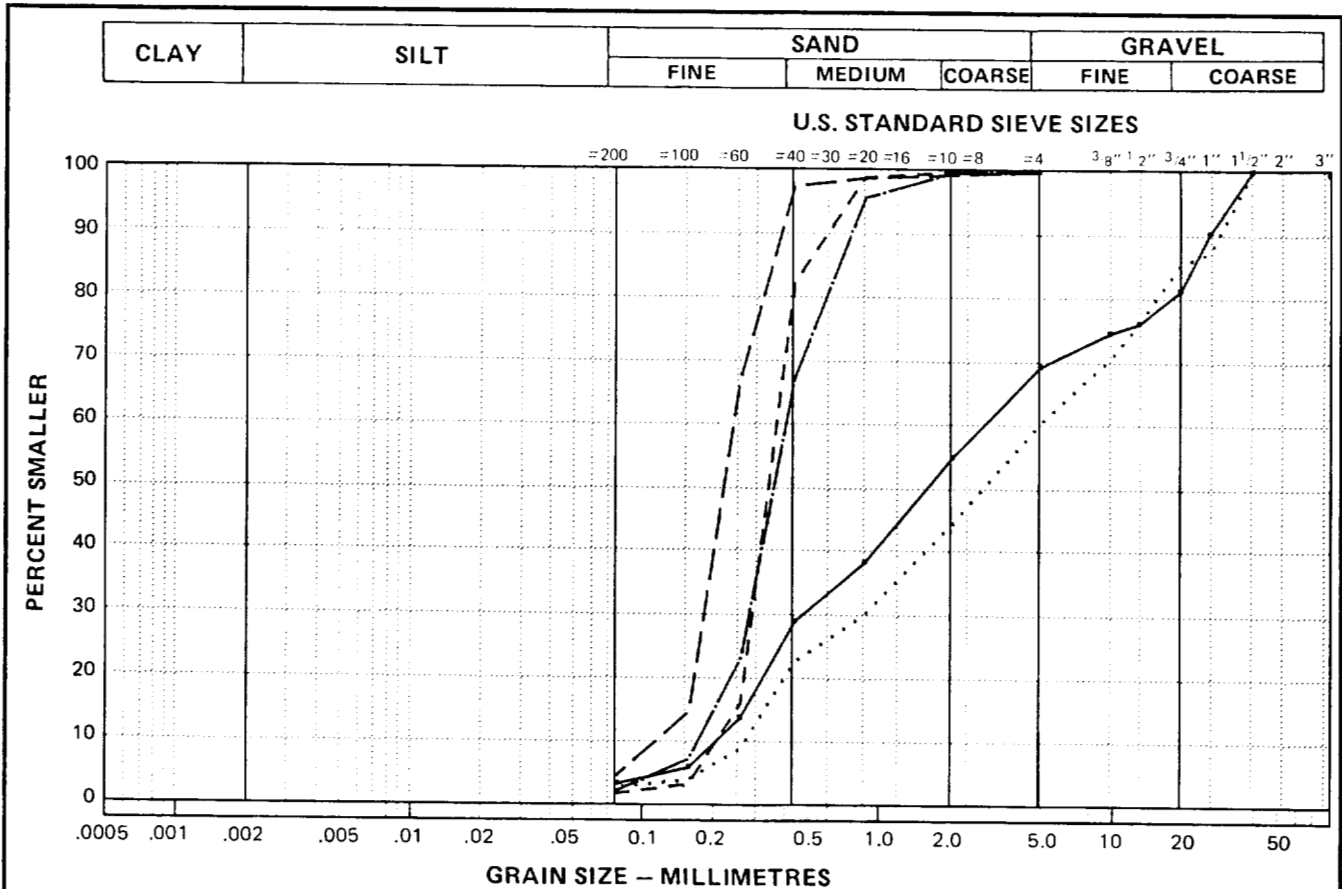


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| _____ | 86211S03 | .70 - .90 | - | 8.7 | 91.3 | 0.0 | 3.6 | 1.4 | SP-SM |
| ..... | 86211S03 | 1.50 - 1.70 | - | 5.4 | 94.6 | 0.0 | 2.8 | 1.2 | SP-SM |
| ----- | 86211S03 | 2.80 - 3.00 | - | 7.1 | 92.9 | 0.0 | 3.3 | 1.4 | SP-SM |
| _____ | 86211S03 | 5.50 - 5.60 | - | 1.7 | 98.3 | 0.0 | 1.9 | 1.2 | SP |

JOB NO. 101 -4480

DATE 86-5-27

PARTICLE - SIZE ANALYSIS OF SOILS

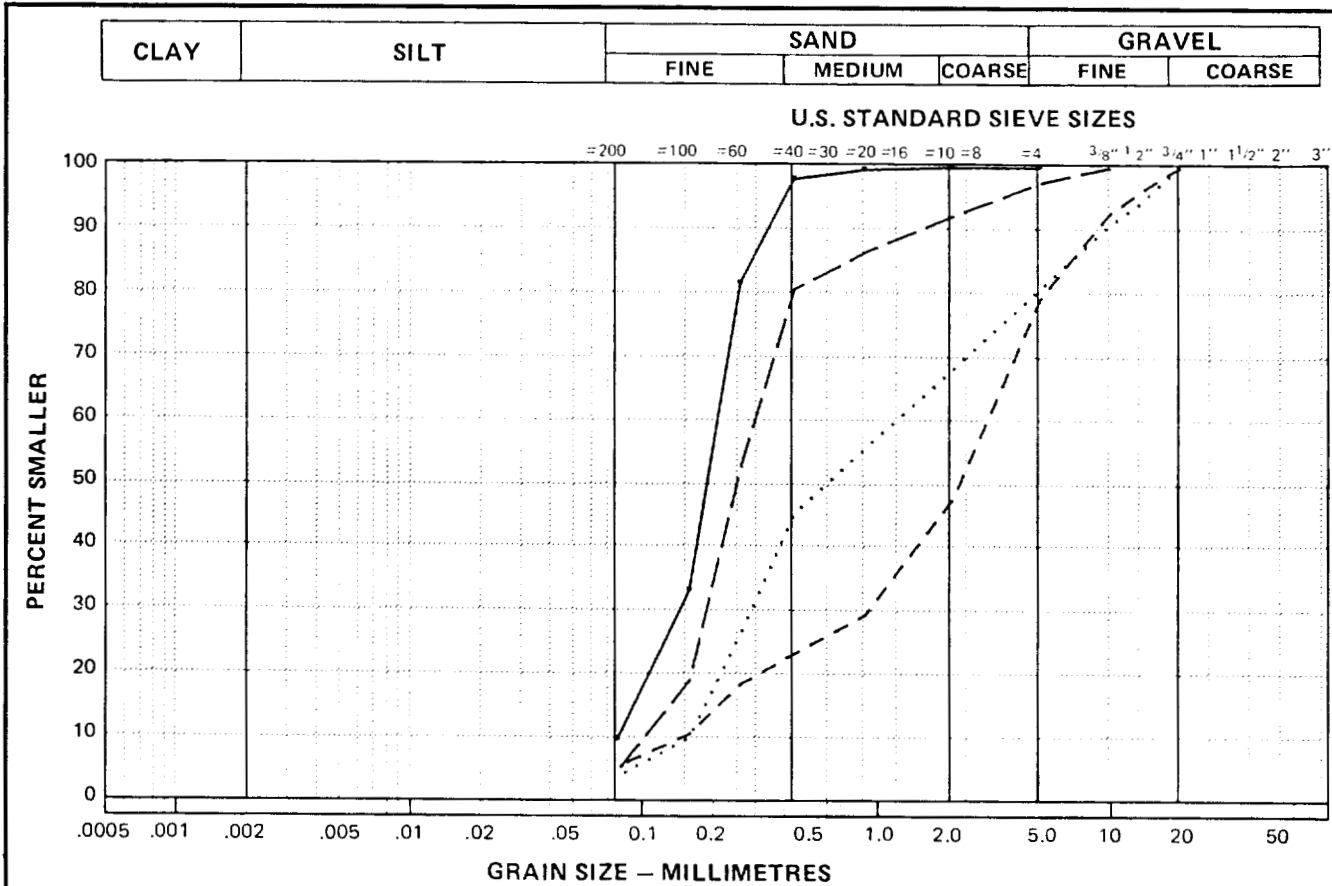


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|---------|-----------------|-------------|-------------|----------|----------|------------|------|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — — — — | 86211S04 | .50 - .60 | - | 2.1 | 66.7 | 31.2 | 13.4 | .4 | SP |
| ..... | 86211S04 | 1.20 - 1.30 | - | 1.6 | 58.3 | 40.1 | 17.8 | .6 | SP |
| - - - - | 86211S04 | 2.40 - 2.50 | - | .6 | 99.4 | 0.0 | 1.7 | 1.1 | SP |
| — — — | 86211S04 | 4.00 - 4.10 | - | 3.5 | 96.5 | 0.0 | 2.0 | 1.1 | SP |
| — — — — | 86211S04 | 7.50 - 7.60 | - | 1.0 | 99.0 | 0.0 | 2.3 | 1.1 | SP |

JOB NO. 101 -4480

DATE 86-5-15

PARTICLE - SIZE ANALYSIS OF SOILS

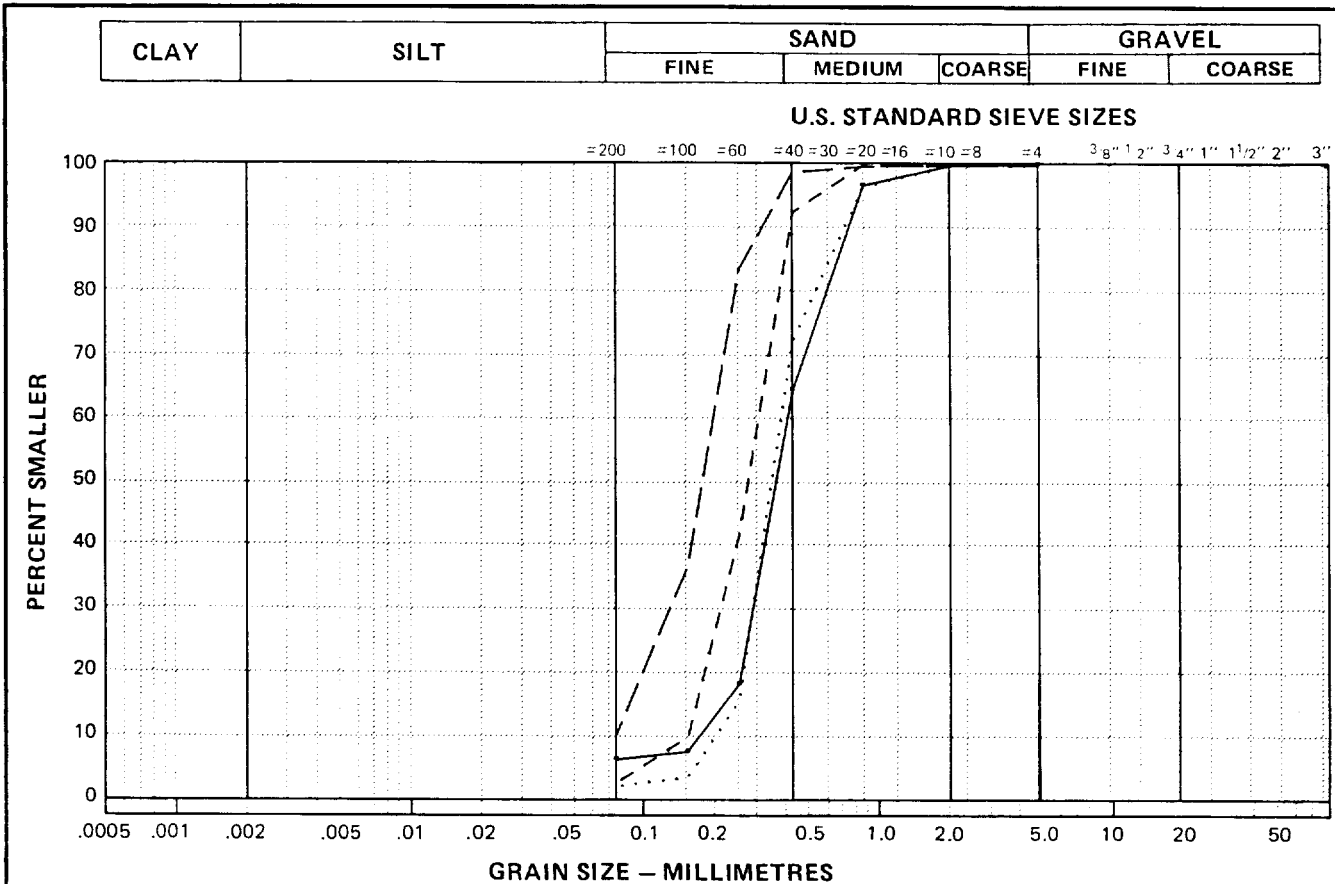


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|------|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — | 86211S05 | 1.50 - 1.70 | - | 8.8 | 91.2 | 0.0 | 2.6 | 1.3 | SP-SM |
| ..... | 86211S05 | 2.20 - 2.40 | - | 2.7 | 77.9 | 19.4 | 7.6 | .4 | SP |
| — — — | 86211S05 | 2.70 - 2.80 | - | 4.3 | 74.7 | 21.0 | 18.4 | 1.9 | SW |
| — — — | 86211S05 | 6.10 - 6.20 | - | 3.6 | 93.8 | 2.6 | 2.9 | 1.1 | SP |

JOB NO. 101 -4480

DATE 86-5-14

PARTICLE - SIZE ANALYSIS OF SOILS

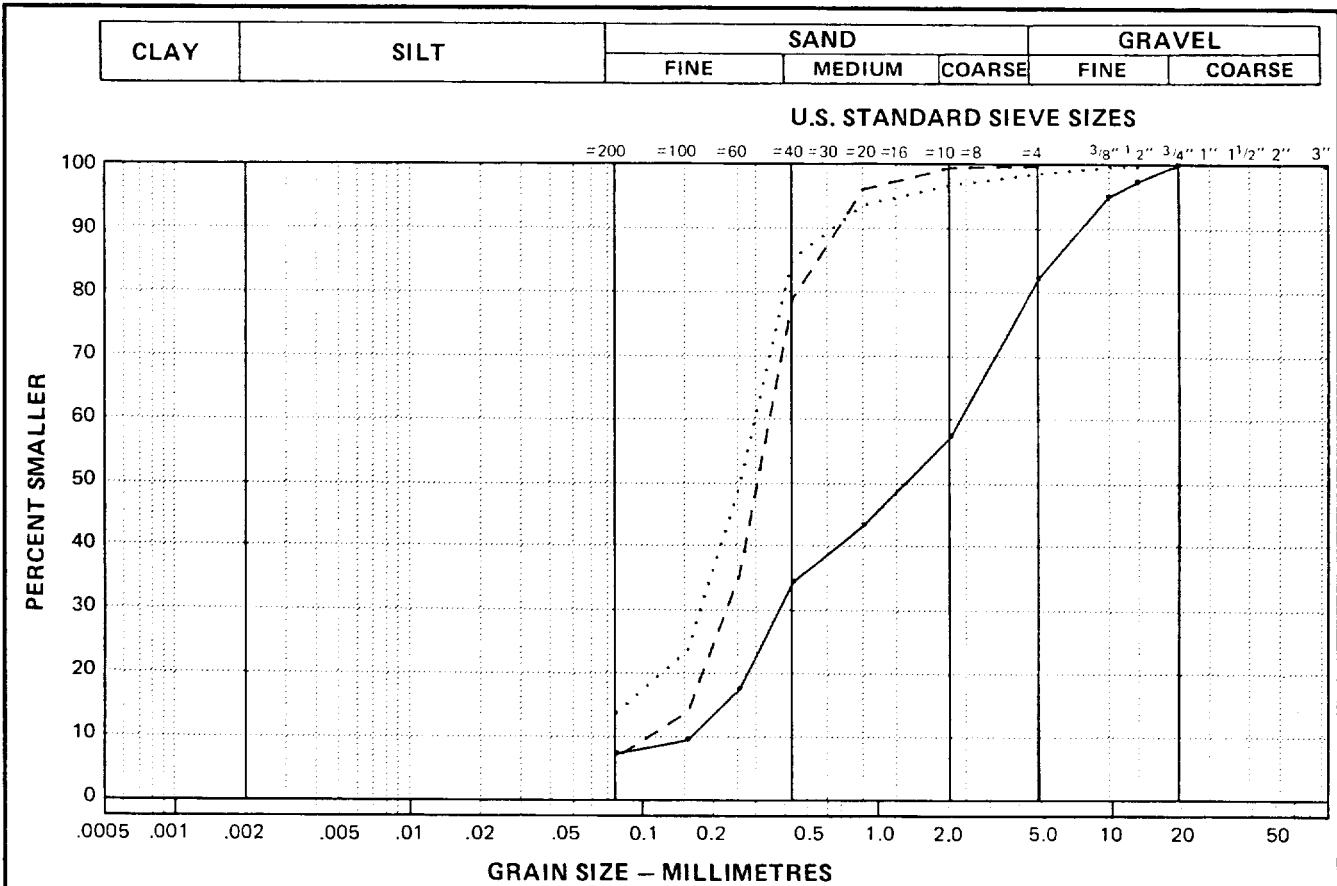


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| _____ | 86211S06 | 1.20 - 1.30 | - | 5.0 | 95.0 | 0.0 | 2.3 | 1.2 | SP-SM |
| ..... | 86211S06 | 2.70 - 2.80 | - | .8 | 99.2 | 0.0 | 1.8 | 1.1 | SP |
| — — — | 86211S06 | 4.60 - 4.70 | - | 1.3 | 98.7 | 0.0 | 2.0 | 1.0 | SP |
| — — | 86211S06 | 5.70 - 5.80 | - | 9.0 | 91.0 | 0.0 | 2.6 | 1.1 | SP-SM |

JOB NO. 101 -4480

DATE 86-5-14

PARTICLE - SIZE ANALYSIS OF SOILS

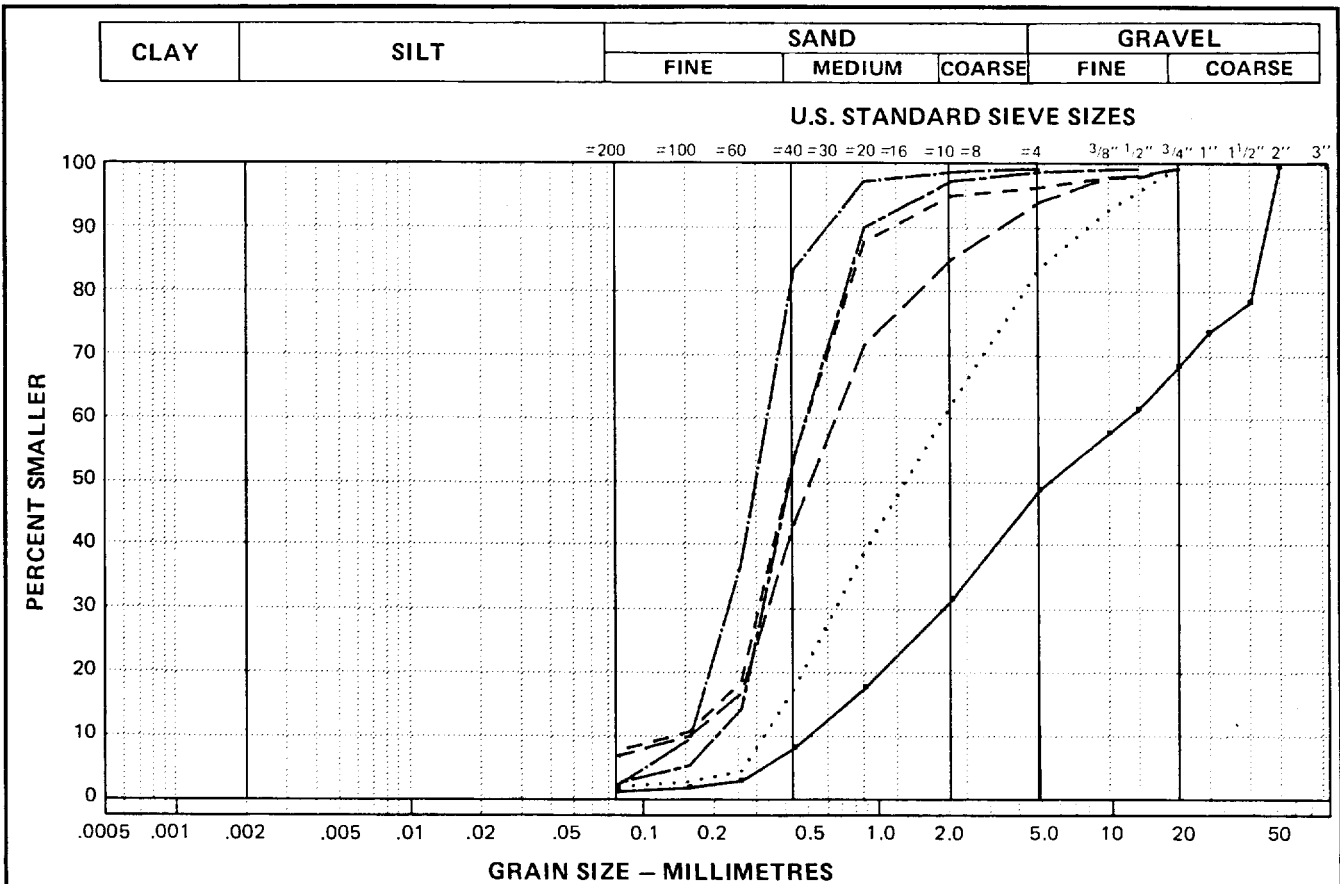


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|------|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — | 86211S07 | 0.00 - .60 | — | 6.0 | 75.9 | 18.1 | 13.4 | .4 | SP-SM |
| ..... | 86211S07 | .60 - 1.60 | — | 12.6 | 86.1 | 1.3 | — | — | — |
| — — — | 86211S07 | 2.30 - 2.40 | — | 5.5 | 94.5 | 0.0 | 3.0 | 1.3 | SP-SM |

JOB NO. 101 -4480

DATE 86-5-14

PARTICLE - SIZE ANALYSIS OF SOILS

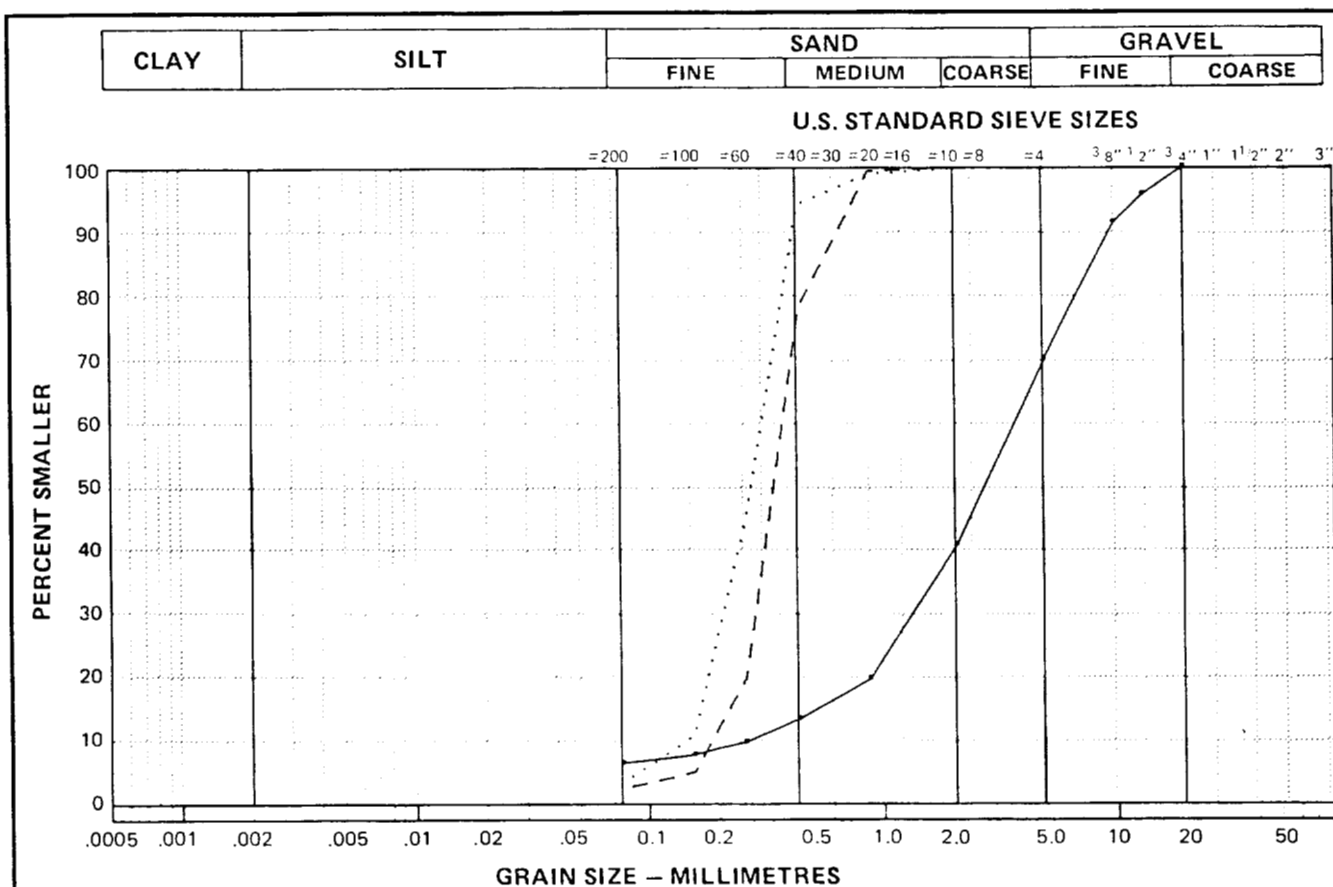


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|------|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| _____ | 86211S08 | 0.00 - .03 | - | .5 | 48.0 | 51.5 | 22.4 | .6 | GP |
| ..... | 86211S08 | .30 - 1.20 | - | 1.3 | 82.7 | 16.0 | 5.7 | .7 | SP |
| __ _ _ | 86211S08 | 2.30 - 2.40 | - | 7.0 | 89.9 | 3.1 | 3.3 | 1.3 | SP-SM |
| ___ _ | 86211S08 | 3.00 - 3.20 | - | 6.2 | 88.3 | 5.5 | 4.1 | 1.1 | SP-SM |
| _____ | 86211S08 | 4.40 - 4.50 | - | 1.6 | 98.4 | 0.0 | 2.1 | 1.0 | SP |
| _____ | 86211S08 | 6.90 - 7.00 | - | 1.9 | 97.5 | .6 | 2.4 | 1.0 | SP |

JOB NO. 101 -4480

DATE 86-5-27

PARTICLE - SIZE ANALYSIS OF SOILS



| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|------|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| _____ | 86211S09 | 1.40 - 1.70 | - | 4.8 | 64.6 | 30.6 | 11.2 | 1.6 | SW |
| ..... | 86211S09 | 2.70 - 2.90 | - | 1.8 | 98.2 | 0.0 | 2.0 | .9 | SP |
| --- | 86211S09 | 4.40 - 4.60 | - | .7 | 99.3 | 0.0 | 1.9 | 1.1 | SP |

JOB NO. 101 -4480

DATE 86-5-14

APPENDIX C
SOURCE 211East

TABLE OF CONTENTS

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| C.1 | SUMMARY |
| C.2 | SITE DESCRIPTION |
| | C.2.1 Location and Geological Origin |
| | C.2.2 Summary of Previous Studies |
| | C.2.3 Results of Current Study |
| C.3 | BOREHOLE LOGS |
| C.4 | LABORATORY TESTING |

LIST OF FIGURES

Figure C.1 Site Plan for Source 211East



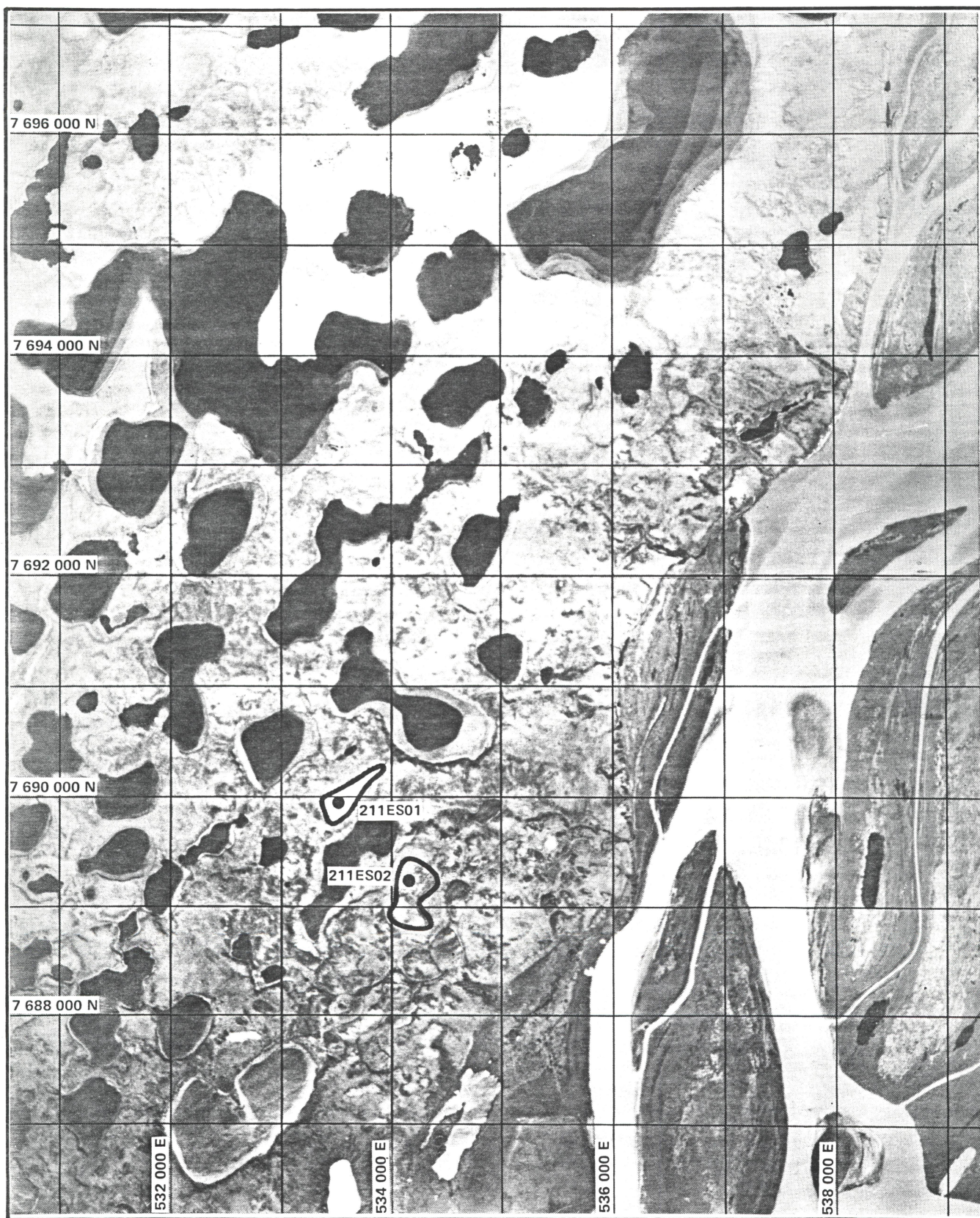


FIGURE C.1 SITE PLAN FOR SOURCE 211E

APPENDIX C
SOURCE 211East

C.1 **SUMMARY**

| | | |
|-----------------------------------|-----------------------------|-------------------------------|
| Material Type: | fine sand or silt | |
| Fines Content: | 10% | |
| Area of Feature: | 320,000 m ² | |
| Developable Area: | 0 | |
| Estimated Volume: | Proven (m ³) | Probable (m ³) |
| type IV borrow w/m.c. over 10% | 15,000 | rec. reqd. |
| Excavation Depth: | not recommended | |
| Moisture Content: | 20 to 25% | |
| Borehole Reference: | 211ES01, 211ES02 | |

C.2 **SITE DESCRIPTION**

C.2.1 Location and Geological Origin

Source 211East is a glacio-fluvial terrace about 5 km east of Willow Lake and approximately 2 km west of the East Channel. It consists of two ridges, one to the east and one to the west of the lake at 553600 mE and 7689500 mN. Its location is indicated on Figure 2 and Figure C.1. The total area of the landform is estimated to be 320,000 m.

C.2.2 Summary of Previous Studies

No previous studies have been carried out for this site. However, the ridge to the west of the lake appears to have been previously used for borrow material. Several conical piles of boulders are scattered at the site.



C.2.3 Results of Current Study

One borehole was drilled on each of two hillocks which comprise this area. Borehole 860211E-S01, advanced on the larger, western feature, encountered fine sand containing about 10% silt for the entire depth of the borehole. High moisture contents (20%) were measured from the surface, which suggest that extraction of the resource would be difficult. The second borehole encountered silt and massive ice deposits.

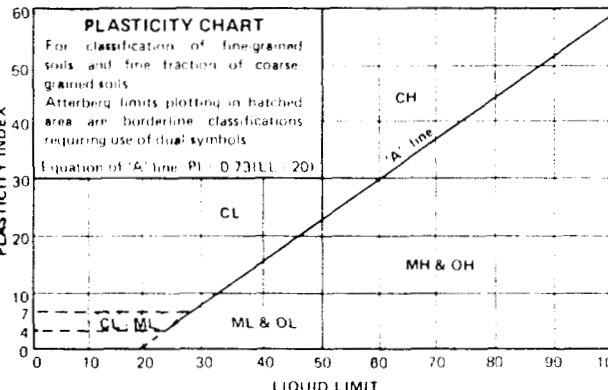
This area is not recommended for development because of its high moisture content. Quantities of similar and better quality material are available nearby at source 211.



C.3 BOREHOLE LOGS



UNIFIED SOIL CLASSIFICATION†

| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | | |
|------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| COARSE GRAINED SOILS More than 50% retained on No. 200 sieve* | GRAVELS 50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS | GW | Well-graded gravels and gravel-sand mixtures with few fines | $C_u = \frac{D_{60} - D_{10}}{D_{10}}$ Greater than 4 $C_c = \frac{D_{30}^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | |
| | | | GP | Poorly-graded gravels and gravel-sand mixtures with few fines | Not meeting both criteria for GW | | | |
| | | GRAVELS WITH FINES | GM | Silty gravels, gravel-sand-silt mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 | | | |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures | Atterberg limits plot above "A" line and plasticity index greater than 7 | | | |
| | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | $C_u = \frac{D_{60} - D_{10}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | |
| | | | SP | Poorly-graded sands and gravelly sands, little or no fines | Not meeting both criteria for SW | | | |
| | | SANDS WITH FINES | SM | Silty sands, sand-silt mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 | | | |
| | | | SC | Clayey sands, sand-clay mixtures | Atterberg limits plot above "A" line and plasticity index greater than 7 | | | |
| | | | FINE GRAINED SOILS 50% or more passes No. 200 sieve* | SILTS AND CLAYS Liquid limit 50% or less | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | <div>Classification on basis of percentage of fines: GW, GP, GM, GC, SM, SC Less than 5% pass No. 200 sieve More than 5% to 12% pass No. 200 sieve 12% to 17% pass No. 200 sieve Borderline classifications requiring use of dual symbols</div> <div>PLASTICITY CHART For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of "A" line: $PI = 0.73(LL - 20)$</div>  | |
| | | | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | |
| OL | Organic silts and organic silty clays of low plasticity | | | | | | | |
| SILTS AND CLAYS Liquid limit greater than 50% | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | | | | |
| | CH | Inorganic clay of high plasticity, fat clays | | | | | | |
| | OH | Organic clays of medium to high plasticity | | | | | | |
| | HIGHLY ORGANIC SOILS | | | PT | Peat, muck and other highly organic soils | *Based on the material passing the 3-in. (75 mm) sieve. †ASTM Designation: D 2487, for identification procedure see D 2488. | | |

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|----------------------------|--|
| N | Ni | Poorly-bonded or friable | |
| | Nbn | No excess ice, well-bonded | |
| | Nbe | Excess ice, well-bonded | |

NOTE:

- Dual symbols are used to indicate borderline or mixed ice classifications.
- Visual estimates of ice contents indicated on borehole logs $\pm 5\%$.
- This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

LEGEND

Soil Ice

VISIBLE ICE LESS THAN 50% BY VOLUME

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|--------------------------------------------------|--|
| V | Vx | Individual ice crystals or inclusions | |
| | Vc | Ice coatings on particles | |
| | Vr | Random or irregularly oriented ice formations | |
| | Vs | Stratified or distinctly oriented ice formations | |

VISIBLE ICE GREATER THAN 50% BY VOLUME

| ICE | ICE + Soil Type | Ice with soil inclusions | |
|-----|-----------------|----------------------------------------------------------------|--|
| | ICE | Ice without soil inclusions (greater than 20 mm (1 in.) thick) | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | |
|------------------------------|-----|----|------------------|---------------------------------------------------------|---------------|--------------------------------------------------------|----|----|--|---------------|------|
| N7 689 914 E 533 432 Z8 | | | | RELATIVE ELEVATION N.A. | | | | | | | |
| SAMPLE | | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT WATER CONTENT (%) LIQUID LIMIT | | | | SPECIAL TESTS | UNIT |
| TYP | NO. | Q | | | | 20 | 40 | 60 |  |  |  | 80 |
| DEPTH (m) | 0 | 1 | | SAND (SM) - silty, trace rootlets, massive, light brown | Non | | | | | | 0 |
| | | 2 | | -fine-grained, uniform, homogeneous, medium brown | | | | | | | |
| | | 3 | | | | | | | | | |
| | | 4 | | | | | | | | | |
| | 2 | | | -trace coal specks disseminated throughout | | | | | | | 2 |
| | | 5 | | | Non, trace Vr | | | | | | |
| | | 6 | | -stratification faintly evident | | | | | | | |
| | | 7 | | | | | | | | | |
| | 4 | | | | | | | | | | 4 |
| | | 8 | | | | | | | | | |
| | | 9 | | | | | | | | | |
| | | 10 | | | | | | | | | 6 |
| | | 11 | | | | | | | | | |
| | | 12 | | | | | | | | | |
| | 8 | | | | | | | | | | 8 |
| | 13 | | | | | | | | | | |
| | 14 | | | | | | | | | | |
| 10 | | 15 | | END OF BOREHOLE 10.2 m | | | | | | | 10 |

101C-4480

Completed 19:00 86/04/02

DRILLING RIG: CME 750

Compiled by JGC

SAMPLE TYPE

CARREL
AUGER

EBA Engineering Consultants Ltd.
(Edmonton)

DRAWING NUMBER

BOREHOLE NUMBER
211ES01

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | |
|------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 689 250 E534 150 Z8 | | | | RELATIVE ELEVATION N.A. | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP NO. | Q | | | | | | | | | | | | |
| 0 | 1 | ROOT MAT | Nr | | | | | | | | 0 | | |
| | 2 | ORGANIC SILT (OL) - trace fine-grained sand, nonplastic, light brownish grey -becoming: by 0.3 m | Nbn | | | | | | | | | | |
| | 3 | SILT (ML) - trace to some silt, silt content increases to silty with depth, fine-grained, uniform, homogeneous, thinly bedded, wavy, nonparallel, dark olive brown -becoming: by 1.2 m | | | | | | | | | | | |
| 2 | 4 | SILT (ML) AND SAND | Nbn, trace Vr | | | | | | | | 2 | | |
| | 5 | ICE-clear, air bubbles throughout | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | |
| | 7 | SILT (ML) - sandy, fine-grained, uniform, homogeneous, nonplastic, olive brown | Nbn, trace Vr | | | | | | | | | | |
| | 8 | | | | | | | | | | | | |
| 4 | 9 | -20 mm lens of ICE-clear | | | | | | | | | 4 | | |
| | 10 | | Vr 5% | | | | | | | | | | |
| | 11 | | | | | | | | | | | | |
| | 12 | -massive | Nbn | | | | | | | | | | |
| | 13 | | | | | | | | | | | | |
| 6 | 14 | | | | | | | | | | 6 | | |
| | 15 | | | | | | | | | | | | |
| | 16 | | | | | | | | | | | | |
| | 17 | | | | | | | | | | | | |
| 8 | 18 | | Nbn, trace Vr | | | | | | | | 8 | | |
| | 19 | | | | | | | | | | | | |
| | | END OF BOREHOLE 8.5 m | | | | | | | | | | | |

101C-4480
Completed 00:10 86/04/03
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

CRREL
AUGER

EBA Engineering Consultants Ltd.
(Edmonton)

DRAWING NUMBER

BOREHOLE NUMBER
211ES02

BOREHOLE LOG AND LABORATORY TEST RESULTS

C.4

LABORATORY TESTING



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | DSO | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.45 | 1 | core | | | | | | | | | | | F |
| 0.15- | 0.30 | 1A | | 18.0 | | | | | | | | | | F |
| 0.45- | 0.90 | 2 | core | | | | | | | | | | | F |
| 0.90- | 1.50 | 3 | core | | | | | | | | | | | F |
| 1.30- | 1.40 | 3A | SP-SM | 26.0 | | | | | 6.0 | 94.0 | 0.0 | | | F |
| 1.50- | 1.95 | 4 | core | | | | | | | | | | | F |
| 1.70- | 1.80 | 4A | SP-SM | 23.0 | | | | | 7.0 | 93.0 | 0.0 | | | F |
| 1.95- | 2.90 | 5 | core | | | | | | | | | | | F |
| 2.30- | 2.40 | 5A | | 26.0 | | | | | | | | | | F |
| 2.90- | 3.35 | 6 | core | | | | | | | | | | | F |
| 3.10- | 3.20 | 6A | SP-SM | 24.0 | | | | | 11.0 | 91.0 | 0.0 | | | F |
| 3.35- | 4.00 | 7 | core | | | | | | | | | | | F |
| 3.80- | 3.90 | 7A | | 23.0 | | | | | | | | | | F |
| 4.00- | 5.20 | 8 | core | | | | | | | | | | | F |
| 5.00- | 5.10 | 8A | SP-SM | 22.0 | | | | | 10.0 | 90.0 | 0.0 | | | F |
| 5.20- | 6.10 | 9 | core | | | | | | | | | | | F |
| 5.90- | 6.00 | 9A | | 26.0 | | | | | | | | | | F |
| 6.10- | 6.70 | 10 | core | | | | | | | | | | | F |
| 6.50- | 6.60 | 10A | | | | | | | | | | | | F |
| 6.70- | 7.15 | 11 | core | | | | | | | | | | | F |
| 7.15- | 7.45 | 12 | core | | | | | | | | | | | F |
| 7.45- | 8.85 | 13 | core | | | | | | | | | | | F |
| 8.10- | 8.20 | 13A | | | | | | | | | | | | F |
| 8.85- | 9.75 | 14 | core | | | | | | | | | | | F |
| 9.00- | 9.10 | 14A | | | | | | | | | | | | F |
| 9.75- | 9.90 | 15 | core | | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 211ES01

Page 1 of 1

BASIC SOIL CHARACTERISTICS DATA

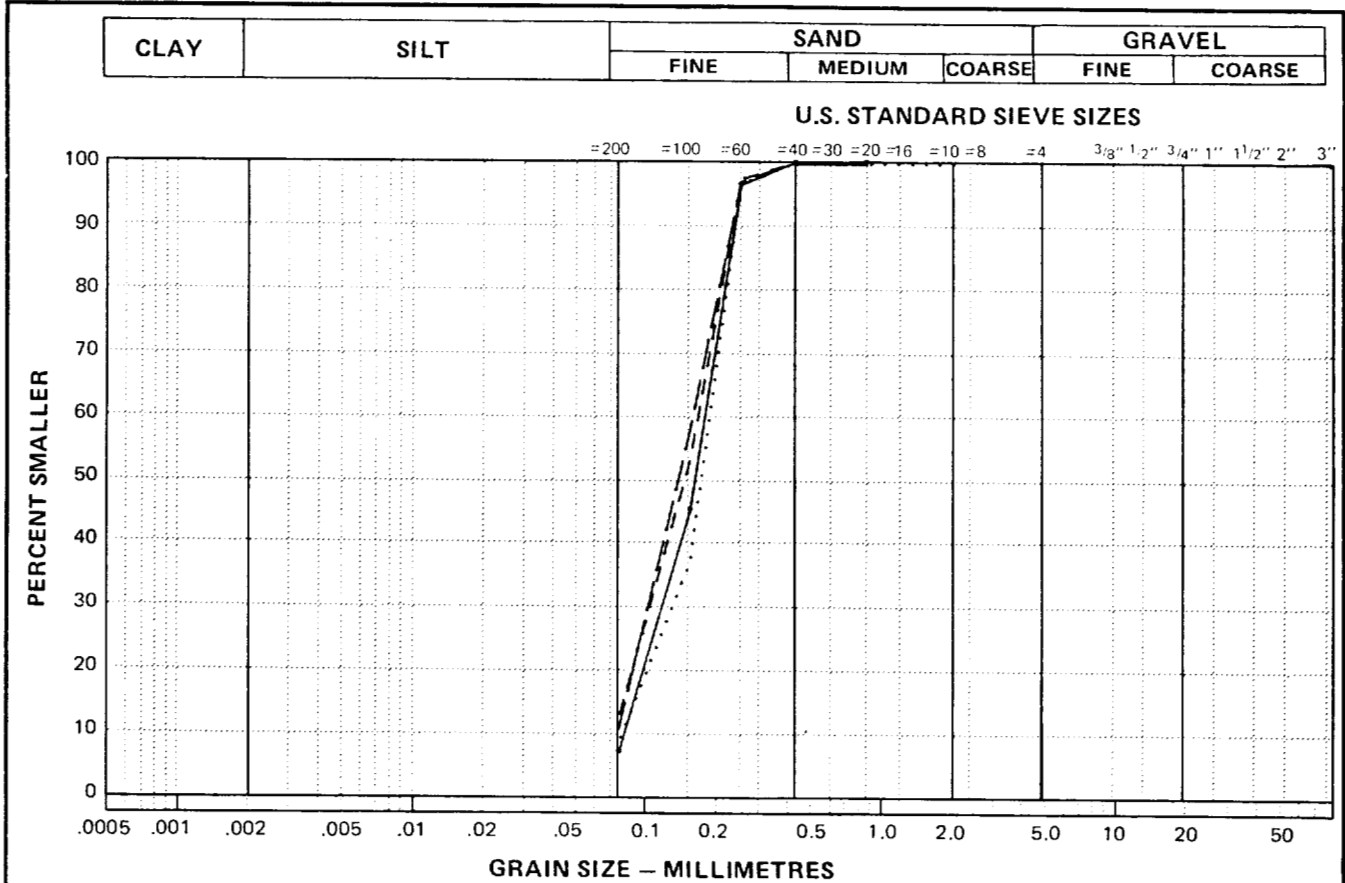
| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.30 | 1 | core | | | | | | | | | | | |
| 0.20- | 0.30 | 1A | | 7.9 | | | | | | | | | | |
| 0.30- | 1.20 | 2 | core | | | | | | | | | | | |
| 1.00- | 1.10 | 2A | | 27.0 | | | | | | | | | | |
| 1.20- | 1.80 | 3 | core | | | | | | | | | | | |
| 1.50- | 1.60 | 3A | | 33.0 | | | | | | | | | | |
| 1.80- | 2.30 | 4 | core | | | | | | | | | | | |
| 2.00- | 2.10 | 4A | | 34.0 | | | | | | | | | | |
| 2.30- | 2.60 | 5 | core | | | | | | | | | | | |
| 2.60- | 3.20 | 6 | core | | | | | | | | | | | |
| 3.20- | 3.50 | 7 | core | | | | | | | | | | | |
| 3.40- | 3.50 | 7A | | 26.0 | | | | | | | | | | |
| 3.50- | 3.80 | 8 | core | | | | | | | | | | | |
| 3.80- | 4.40 | 9 | core | | | | | | | | | | | |
| 4.30- | 4.40 | 9A | | | | | | | | | | | | |
| 4.40- | 4.70 | 10 | core | | | | | | | | | | | |
| 4.70- | 5.00 | 11 | core | | | | | | | | | | | |
| 5.00- | 5.50 | 12 | core | | | | | | | | | | | |
| 5.50- | 5.90 | 13 | core | | | | | | | | | | | |
| 5.80- | 5.90 | 13A | | 27.0 | | | | | | | | | | |
| 5.90- | 6.20 | 14 | core | | | | | | | | | | | |
| 6.20- | 6.50 | 15 | core | | | | | | | | | | | |
| 6.50- | 7.30 | 16 | core | | | | | | | | | | | |
| 7.20- | 7.30 | 16A | | | | | | | | | | | | |
| 7.30- | 7.80 | 17 | core | | | | | | | | | | | |
| 7.80- | 8.10 | 18 | core | | | | | | | | | | | |
| 8.10- | 8.50 | 19 | core | | | | | | | | | | | |
| 8.40- | 8.50 | 19A | | | | | | | | | | | | |

EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 211ES02

PARTICLE - SIZE ANALYSIS OF SOILS



| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| _____ | 86211ES01 | 1.30 - 1.40 | - | 5.8 | 94.2 | 0.0 | 2.2 | .9 | SP-SM |
| ..... | 86211ES01 | 1.70 - 1.80 | - | 7.3 | 92.7 | 0.0 | 2.3 | 1.1 | SP-SM |
| — — — | 86211ES01 | 3.10 - 3.20 | - | 11.2 | 88.8 | 0.0 | - | - | - |
| — — — | 86211ES01 | 5.00 - 5.10 | - | 9.5 | 90.5 | 0.0 | 2.1 | .9 | SP-SM |

JOB NO. 101 -4480

DATE 86-5-15

APPENDIX D
SOURCE 216

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| D.2 | SITE DESCRIPTION |
| | D.2.1 Location and Geological Origin |
| | D.2.2 Summary of Previous Studies |
| | D.2.3 Results of Current Study |
| D.3 | BOREHOLE LOGS |
| D.4 | LABORATORY TESTING |

LIST OF FIGURES

Figure D.1 Site Plan for Source 216



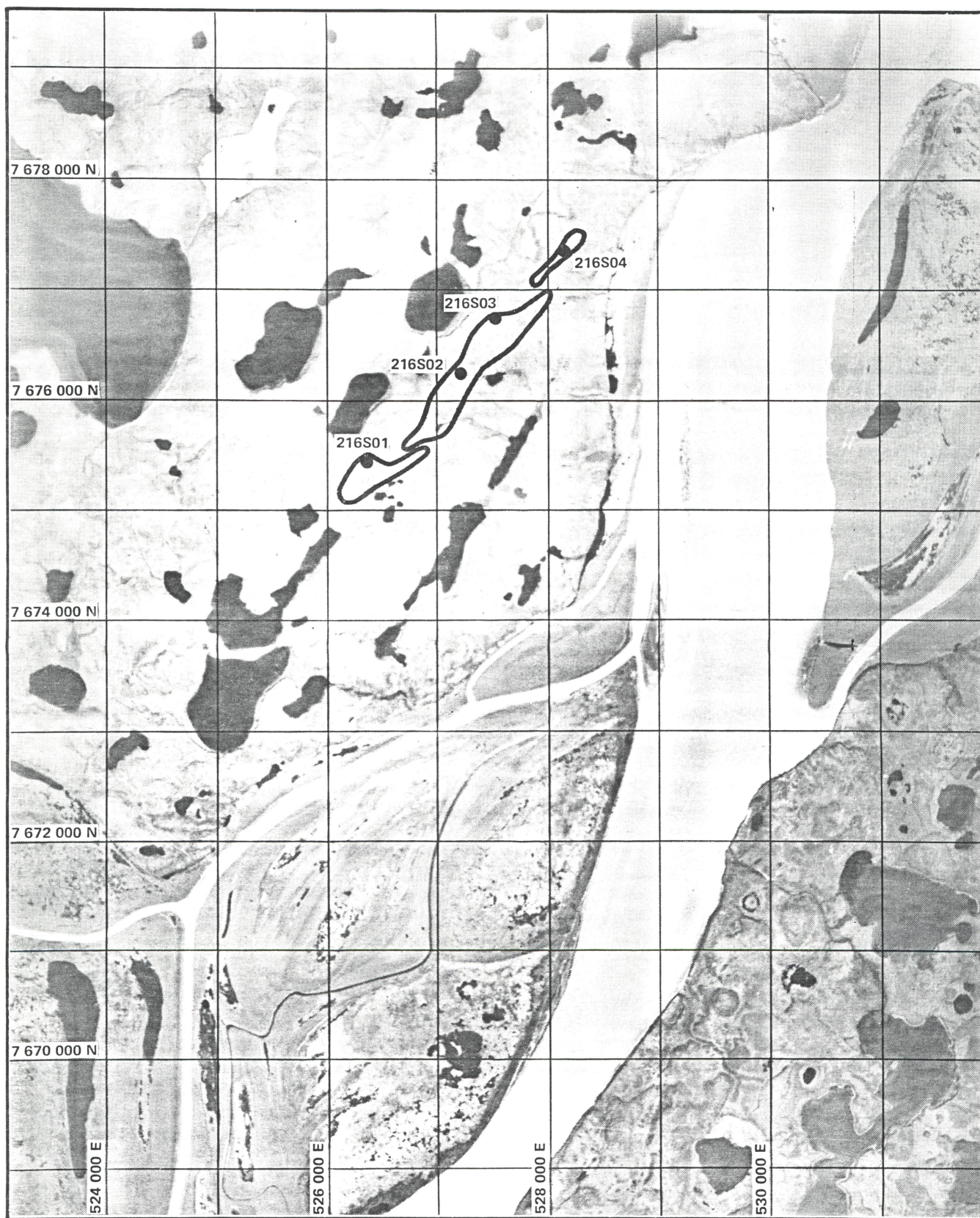


FIGURE D.1 SITE PLAN FOR SOURCE 216

APPENDIX D
SOURCE 216

D.1 SUMMARY

| | | |
|---------------------|----------------------------------------------------------------------|---------------------------------------------|
| Material Type: | fine uniform sand with silt beds | |
| Fines Content: | 3% to 20% in sand | |
| Area of Feature: | 1,000,000 m ² | |
| Developable Area: | 0 | |
| Estimated Volume: | Proven (m ³) 0 | Probable (m ³) rec. reqd. |
| Excavation Depth: | not recommended | |
| Moisture Content: | 5% to 15% above 1.5 m | |
| Borehole Reference: | 2126S01, 216S02, 216S03, 216S04 RKL216-A, B, C; RK216-1,2,3,4,5,6 | |

D.2 SITE DESCRIPTION

D.2.1 Location and Geological Origin

Source 216 is located 28 km northeast of Tununuk Point and 2 km south of Lousy Point, about 3 km west of the East channel. It consists of a steep sided ridge partially dissected by kettle-like lakes. RKL (1972) describe the feature as kame and esker remnants. Its location is shown on Figure 2 and Figure D.1.

D.2.2 Summary of Previous Studies

RKL (1972) has previously investigated this site with seven borings and three test pits. It was found to be a highly variable deposit containing well-graded sand and gravel isolated within silt and massive ice deposits.



D.2.3 Results of Current Study

Four boreholes were drilled on this feature, traversing its length. Boreholes 216S01 and 216S04, drilled at either end of the feature encountered mostly silt and ice plus silt. Two holes, 216S02 and 216S03, located on a small terrace on the east side of the centre of the main feature, found a deposit of poorly-graded sand with a trace of fine gravel. However, thin silty beds with high ice contents were found interspersed throughout the sand. Keeping the silt separate from the granular material during extraction would be difficult, so it is likely that the final silt content of the material would be above allowable limits even for general fill. In addition the area exhibits a highly variable stratigraphy, and airphoto interpretation and winter site reconnaissance was not successful.

The prospect should be considered for a summer reconnaissance because the 1973 RKL identified encountered a well graded sand and gravel in some of their boreholes, and the source is close to the Mackenzie River ice road.

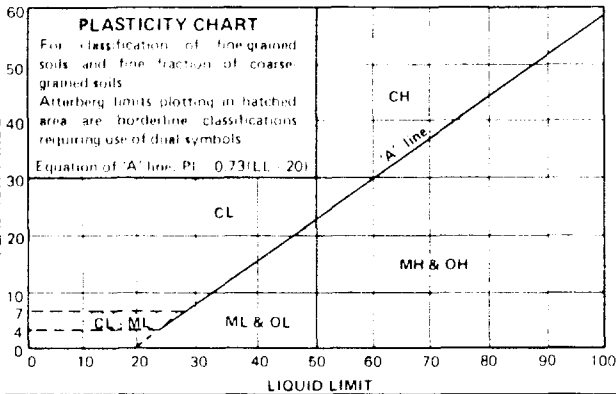


D.3 BOREHOLE LOGS



UNIFIED SOIL CLASSIFICATION†

| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | |
|----------------------|------------------------------------------|-------------------------------------------------------------------|--------------------|---------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| COARSE GRAINED SOILS | More than 50% retained on No. 200 sieve* | GRAVELS 50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS | GW | Well-graded gravels and gravel-sand mixtures, little or no fines | $P_{20} = 16 - 5\sqrt{D_{60}/D_{10}}$ Greater than 4 $\frac{D_{30}}{D_{10}} \geq \frac{D_{60}}{D_{30}}$ Between 1 and 3 |
| | | | GRAVELS WITH FINES | GP | Poorly-graded gravels and gravel-sand mixtures, little or no fines | Not meeting both criteria for GW |
| | | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | GM | Silty gravels, gravel-sand mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 |
| | | | CLEAN SANDS | GC | Clayey gravels, gravel-sand clay mixtures | Atterberg limits plot above "A" line and plasticity index greater than 7 |
| | | | SANDS WITH FINES | SW | Well-graded sands and gravelly sands, little or no fines | $C_u = D_{60}/D_{10}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |
| | | | SANDS WITH FINES | SP | Poorly-graded sands and gravelly sands, little or no fines | Not meeting both criteria for SW |
| | 50% or more passes No. 200 sieve* | SILTS AND CLAYS Liquid limit 50% or less | SANDS WITH FINES | SM | Silty sands, sand-silt mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 |
| | | | SANDS WITH FINES | SC | Clayey sands, sand-clay mixtures | Atterberg limits plot above "A" line and plasticity index greater than 7 |
| | | | SANDS WITH FINES | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | PLASTICITY CHART For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of "A" line: $PI = 0.73(LL - 20)$ |
| | | | SANDS WITH FINES | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | |
| FINE GRAINED SOILS | 50% or more passes No. 200 sieve* | SILTS AND CLAYS Liquid limit greater than 50% | SANDS WITH FINES | OL | Organic silts and organic silty clays of low plasticity | CH A' line MH & OH ML & OL |
| | | | SANDS WITH FINES | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | |
| | | | SANDS WITH FINES | CH | Inorganic clay of high plasticity, fat clays | |
| | | | SANDS WITH FINES | OH | Organic clays of medium to high plasticity | |
| | | | SANDS WITH FINES | PT | Peat, muck and other highly organic soils | |
| | | | SANDS WITH FINES | PT | Peat, muck and other highly organic soils | |



GROUND ICE DESCRIPTION

ICE NOT VISIBLE

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|----------------------------|--|
| N | Nf | Poorly-bonded or friable | |
| | Nbn | No excess ice, well-bonded | |
| | Nbe | Excess ice, well-bonded | |

- NOTE:**
- Dual symbols are used to indicate borderline or mixed ice classifications.
 - Visual estimates of ice contents indicated on borehole logs $\pm 5\%$.
 - This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

LEGEND

Soil Ice

VISIBLE ICE LESS THAN 50% BY VOLUME

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|--------------------------------------------------|--|
| V | Vx | Individual ice crystals or inclusions | |
| | Vc | Ice coatings on particles | |
| | Vr | Random or irregularly oriented ice formations | |
| | Vs | Stratified or distinctly oriented ice formations | |

VISIBLE ICE GREATER THAN 50% BY VOLUME

| ICE | ICE - Soil Type | ICE - Soil Type | |
|-----|-----------------|----------------------------------------------------------------|--|
| ICE | ICE - Soil Type | Ice with soil inclusions | |
| | ICE | Ice without soil inclusions (greater than 25 mm (1 in.) thick) | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | | | |
|------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------|-------------------|--------------|--|--|---------------|------|--|--|--|--|--|
| N7 676 451 E 526 336 Z8 | | | | RELATIVE ELEVATION N.A. | | | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | WATER CONTENT (%) | | | | SPECIAL TESTS | UNIT | | | | | |
| TYP | NO. Q | | | | PLASTIC LIMIT | LIQUID LIMIT | | | | | | | | | |
| 0 | 1 | PEAT (PT) -and root mat | Nbn | | | | | | | | | | | | |
| | 2 | ORGANIC SILT (OL) -sandy, fine-grained, uniform, homogeneous, medium brown | | | | | | | | | | | | | |
| | 3 | -100 mm lens of PEAT (PT) -fibrous, dark brown | | | | | | | | | | | | | |
| | 4 | -100 mm lens of ICE | | | | | | | | | | | | | |
| | 5 | SILT (ML/OL) -some organics, with occasional thinly laminated lenses of coarse to medium-grained sand | Nbn | | | | | | | | | | | | |
| | 6 | PEAT (PT) -fibrous, dark brown to black | Vs 30% | | | | | | | | | | | | |
| | 7 | SILT (ML) -trace fine-grained sand, very thinly bedded, wavy, nonparallel, nonplastic, olive brown | Vs 20% | | | | | | | | | | | | |
| 2 | 8 | -50 mm lens of ICE | | | | | | | | | | | | | |
| | 9 | -ice content decreases with depth, randomly spaced 1 mm stratified lenses | Vs-Vr 40% | | | | | | | | | | | | |
| | 10 | -occasional thinly bedded lenses of medium to fine-grained sand, lenses 10 mm thick | | | | | | | | | | | | | |
| | 11 | SAND (SP) -trace silt, trace fibrous organics, fine-grained, uniform, homogeneous, olive brown | Nbn | | | | | | | | | | | | |
| | 12 | -10 mm lens of petrified wood fragments, dark brown to black | | | | | | | | | | | | | |
| 4 | 13 | -lens of coarse to medium-grained sand | Vr 10% | | | | | | | | | | | | |
| | 14 | SILT (ML) -trace sand, occasional very thinly bedded medium-grained sand lens, 30 mm ice lens running randomly through the sample | Nbn | | | | | | | | | | | | |
| | 15 | -becoming ICE+SILT (ML) | | | | | | | | | | | | | |
| | 16 | ICE-clear | | | | | | | | | | | | | |
| 6 | 17 | END OF BOREHOLE 6.2 m (xx.x m El.) | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |

101C-4480
Completed 00: 50 86/03/23
DRILLING RIG: CME 750
Compiled by MAY

SAMPLE TYPE

CARREL
AUGER

EBA Engineering Consultants Ltd.

BOREHOLE NUMBER
216S01

DRAWING NUMBER

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | |
|------------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 677 265 E 527 077 Z8 | | | | RELATIVE ELEVATION 48 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 0 | | SAND (SP-SM) -trace fine-grained subrounded to subangular gravel at surface, clean, medium-grained sand, medium brown | Nf | | | | | | | | 0 | | |
| 1 | | | | | | | | | | | | | |
| 2 | | -10 mm lens of ORGANIC SILT (OL) -trace fine-grained sand, dark brown to black -silty, medium brown -clean, medium-grained, uniform, trace gravel to 15 mm disseminated throughout, medium greyish brown -becoming: by 1.4 m | Nbn | | | | | | | | | | |
| 3 | | SAND (SM) -silty, medium greyish brown -some silt, trace gravel to 5 mm, medium brown -trace silt, some fine-grained gravel, clasts to 15mm subangular, dark greyish brown | Nf 75: 25 | | | | | | | | 2 | | |
| 4 | | ICE+SILT (ML) SAND (SP) -clean, coarse-grained, light greyish brown SILT TILL (ML) -trace gravel to 5 mm, medium greyish brown SAND (SP/SM) -trace to some silt, medium-grained, iron oxide staining, dark greyish brown -becoming: by 2.8 m | Nbe | | | | | | | | | | |
| 5 | | SAND (SM) AND COAL AND ICE-silty, coal clasts to 20 mm, light greyish brown -becoming: by 3.1 m | Nf-Nbn Nbe | | | | | | | | | | |
| 6 | | SAND (SM) -silty, medium to fine-grained, medium brown, silt content decreases with depth -becoming: by 3.2 m | | | | | | | | | 4 | | |
| 7 | | SAND (SP) -trace silt to clean, trace coal fragments, medium-grained, iron oxide staining, medium grey -coal fragments to 20 mm | | | | | | | | | | | |
| 8 | | ICE SILT TILL (ML) -clayey, blocky, iron oxide staining, dark grey | | | | | | | | | | | |
| 6 | | END OF BOREHOLE 5.6 m (42.4 m El.) | | | | | | | | | 6 | | |
| 8 | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | 8 | | |
| | | | | | | | | | | | 10 | | |

101C-4480
Completed 12: 00 86/03/23
DRILLING RIG: CME 750
Compiled by JGC

SAMPLE TYPE

COREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
216S02

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | | | |
|------------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|--|--|--|--|
| N7 677 610 E 527 782 28 | | | | RELATIVE ELEVATION 32.6 (m) | | | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | | | |
| TYP | NO. Q | | | | | | | | | | | | | | |
| 0 | 1 | SAND (SP) -some gravel to gravelly, trace silt, light brown -becoming by 0.1 m SAND (SM) -some silt, medium-grained | Nf Nf-Nbn | | | | | | | | | | | | |
| | 2 | -some silt, random partings of fine-grained sand | Nbn | | | | | | | | | | | | |
| 2 | 3 | SILT TILL (ML) -clayey, trace gravel to 10 mm, trace coarse-grained sand, iron oxide staining, medium brown | Vr-Vc 15% | | | | | | | | | | | | |
| | 4 | SAND (SP) -trace silt, medium-grained, medium greyish brown -occasional pockets and partings of coarse-grained sand, clean | Nbe, trace Vx Nbe | | | | | | | | | | | | |
| | 5 | SILT TILL (ML) -clayey, trace coarse-grained sand | Vx 5% | | | | | | | | | | | | |
| 4 | 6 | SAND (SP) -trace gravel to 15 mm, rounded to subrounded, trace silt, coarse to medium-grained sand, medium greyish brown -some gravel | Nbe Nbn-Nbe | | | | | | | | | | | | |
| | 7 | SAND (SP-SM) -trace to some silt, trace gravel to 20 mm, subrounded to subangular, medium brown -interbedded lenses of: SAND (SP) -trace gravel to 5 mm, trace silt, medium-grained, uniform, medium greyish brown and SILT TILL (ML) -clayey, trace coal fragments, iron oxide staining, medium greyish brown -becoming by 5.5 m | Nf-Nbn Nbn | | | | | | | | | | | | |
| 6 | 8 | SAND (SM) -some silt to silty, medium greyish brown -silty | Nbe-Nbn | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | | |
| 8 | 10 | -trace gravel to 10 mm, iron oxide staining, occasional cross bedded lenses of coal fragments 3 mm thick at a 45 degree angle -coal content disappears with depth | Nbn | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | | | |
| | 12 | -trace to some silt, medium-grained | Nbn-Nbe | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |

101C-4480
Completed 17: 40 86/03/23
DRILLING RIG: CME 750
Compiled by JGC

SAMPLE TYPE

☒
☐
☐

☐
☐
☒

CARREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
216S03
PAGE 1 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

[illegible]

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | |
|------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 678 407 E 528 040 Z8 | | | | RELATIVE ELEVATION 41 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. G | | | | | | | | | | | | |
| 0 | | SILT (ML) -sandy, fine-grained, uniform, trace rootlets at surface, light brown | Nf | | | | | | | | 0 | | |
| 1 | | | | | | | | | | | | | |
| 2 | | SAND (SM) -silty, fine-grained, uniform, massive, medium greyish brown | Nbn, trace Vs | | | | | | | | | | |
| 3 | | SILT (ML) -clayey, massive, low plastic, dark grey | Vs 40% | | | | | | | | | | |
| 4 | | | Vs-Vr 15% | | | | | | | | 2 | | |
| 5 | | | | | | | | | | | | | |
| 6 | | ICE-cloudy, with soil inclusions | | | | | | | | | | | |
| 7 | | SILT (ML) -clayey, medium grey | | | | | | | | | | | |
| 8 | | SAND (SP) -trace silt, fine-grained, uniform, occasional very thinly bedded wavy lens of silt, dark olive grey | Nbn | | | | | | | | | | |
| 9 | | -becoming: by 4.1 m | | | | | | | | | | | |
| 10 | | SILT (ML) -sandy, fine-grained, uniform, homogeneous, dark olive grey | Vr-Vx 5% | | | | | | | | | | |
| 11 | | ICE+SILT (ML) | 70: 30 | | | | | | | | | | |
| 12 | | -clear | 90: 10 | | | | | | | | | | |
| 13 | | | | | | | | | | | | | |
| 14 | | -trace silt | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | |
| 16 | | SILT (ML) -sandy, trace black organics, trace mica platlets, fine-grained, uniform, homogeneous, nonplastic, dark olive grey | Nbn | | | | | | | | | | |
| 17 | | ICE-clear | | | | | | | | | | | |
| 18 | | -interbedded lenses of: SAND (SM) -some silt and SILT (ML) -sandy, fine-grained, uniform, dark olive grey | | | | | | | | | | | |
| 19 | | ICE+SILT (ML) | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | |
| 21 | | SILT (ML) -sandy, fine-grained, uniform, dark olive grey | Vr 10% | | | | | | | | | | |
| 22 | | ICE+SILT (ML) -trace sand, dark olive grey | 40: 60 | | | | | | | | | | |

101C-4480
Completed 16: 40 86/03/24
DRILLING RIG: CME 750
Compiled by JGC MAV

SAMPLE TYPE

CAREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
216504
PAGE 1 OF 4

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | | | | |
|------------------------------|-----|---|---------------------------------------------------|---------------------------|--------|---------------|--|--|-------------------|--|--|--------------|--|--|---------------|------|
| N7 678 407 E 528 040 Z8 | | | | RELATIVE ELEVATION 41 (m) | | | | | | | | | | | | |
| SAMPLE | | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | | | WATER CONTENT (%) | | | LIQUID LIMIT | | | SPECIAL TESTS | UNIT |
| TYP | NO. | Q | | | | | | | | | | | | | | |
| 10 | 20 | | | | | | | | | | | | | | | |
| | 21 | | | | | | | | | | | | | | | |
| | 22 | | -1 mm thick silt lenses very thinly bedded, even, | 80: 20 | | | | | | | | | | | | |
| | 23 | | | | | | | | | | | | | | | |
| | 24 | | -2 mm thick silt and sand lenses very thinly | | | | | | | | | | | | | |
| 12 | 25 | | -lens of fine-grained sand | | | | | | | | | | | | | |
| | 26 | | | | | | | | | | | | | | | |
| | 27 | | ICE-very thinly bedded, wavy, nonparallel, clear | | | | | | | | | | | | | |
| | 28 | | | | | | | | | | | | | | | |
| 14 | 29 | | | | | | | | | | | | | | | |
| | 30 | | | | | | | | | | | | | | | |
| | 31 | | | | | | | | | | | | | | | |
| | 32 | | | | | | | | | | | | | | | |
| 16 | 33 | | | | | | | | | | | | | | | |
| | 34 | | | | | | | | | | | | | | | |
| | 35 | | | | | | | | | | | | | | | |
| | 36 | | | | | | | | | | | | | | | |
| 18 | 37 | | | | | | | | | | | | | | | |
| | 38 | | | | | | | | | | | | | | | |
| | 39 | | | | | | | | | | | | | | | |
| | 40 | | | | | | | | | | | | | | | |
| | 41 | | | | | | | | | | | | | | | |
| 20 | 42 | | | | | | | | | | | | | | | |

101C-4480
Completed 16: 40 86/03/24
DRILLING RIG: CME 750
Compiled by JGC MAV

SAMPLE TYPE

CRREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
216S04

PAGE 2 OF 4

BOREHOLE LOG AND LABORATORY TEST RESULTS

08-03-1986 16: 26: 56

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-----|---|----------------------------------------------------------------------------------------------------------|---------------------------|--------|---------------|-------------------|--------------|--|---------------|------|--|--|
| N7 678 407 E 528 040 Z8 | | | | RELATIVE ELEVATION 41 (m) | | | | | | | | | |
| SAMPLE | | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | | |
| TYP | NO. | Q | | | | | | | | | | | |
| | 41 | | ICE+SAND ICE | | | | | | | | | | |
| | 42 | | | | | | | | | | | | |
| | 43 | | | | | | | | | | | | |
| | 44 | | | | | | | | | | | | |
| | 45 | | | | | | | | | | | | |
| | 46 | | | | | | | | | | | | |
| | 47 | | | | | | | | | | | | |
| | 48 | | | | | | | | | | | | |
| | 49 | | | | | | | | | | | | |
| | 50 | | | | | | | | | | | | |
| | 51 | | SAND (SM) -some silt to silty, medium to fine-grained -silty, occasional silt partings, mottled light | 50: 50 | | | | | | | | | |
| | 52 | | | | | | | | | | | | |
| | 53 | | | | | | | | | | | | |
| | 54 | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |

101C-4480
Completed 18: 40 86/03/24
DRILLING RIG: CME 750
Compiled by JGC MAV

SAMPLE TYPE

CRREL

AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
216S04

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BOREHOLE LOG AND LABORATORY TEST RESULTS

[illegible]

D.4

LABORATORY TESTING



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES 250 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.30 | 1 | core | | | | | | | | | | F |
| 0.20- | 0.30 | 1A | | 22.0 | | | | | | | | | F |
| 0.30- | 0.75 | 2 | core | | | | | | | | | | F |
| 0.75- | 1.10 | 3 | core | | | | | | | | | | F |
| 1.10- | 1.40 | 4 | core | 80.0 | | | | | | | | | F |
| 1.40- | 2.00 | 5 | core | 44.0 | | | | | | | | | F |
| 2.00- | 2.40 | 6 | core | | | | | | | | | | F |
| 2.40- | 3.00 | 7 | core | | | | | | | | | | F |
| 3.00- | 3.80 | 8 | core | 26.0 | | | | | | | | | F |
| 3.80- | 4.30 | 9 | core | | | | | | | | | | F |
| 4.30- | 4.90 | 10 | core | 45.0 | | | | | | | | | F |
| 4.90- | 5.50 | 11 | core | | | | | | | | | | F |
| 5.50- | 6.20 | 12 | core | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 216S01

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 1.00 | 1 | | | | | | | | | | | F |
| 0.30- | 0.90 | 1A | SP-SM | 5 | | | | | 9.0 | 88.0 | 3.0 | | F |
| 1.00- | 1.50 | 2 | | | | | | | | | | | F |
| 1.10- | 1.40 | 2A | | 6 | | | | | | | | | F |
| 1.50- | 2.50 | 3 | | | | | | | | | | | F |
| 1.80- | 1.90 | 3A | SP | 8 | | | | | 3.0 | 84.0 | 13.0 | | F |
| 2.50- | 3.10 | 4 | | 19 | | | | | | | | | F |
| 2.70- | 2.80 | 4A | SP | | | | | | 1.0 | 98.0 | 1.0 | | F |
| 3.10- | 3.90 | 5 | | | | | | | | | | | F |
| 3.40- | 3.50 | 5A | | 22 | | | | | | | | | F |
| 3.90- | 4.80 | 6 | | | | | | | | | | | F |
| 4.40- | 4.50 | 6A | SP | | | | | | 3.0 | 96.0 | 1.0 | | F |
| 4.80- | 5.00 | 7 | | | | | | | | | | | F |
| 5.00- | 5.60 | 8 | | 47 | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 216502

Page 1 of 1

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 1.00 | 1 | core | | | | | | | | | | | F |
| 0.50- | 0.60 | 1A | | 6.0 | | | | | | | | | | F |
| 1.00- | 1.50 | 2 | core | | | | | | | | | | | F |
| 1.30- | 1.40 | 2A | SM | 15.0 | | | | | 21.0 | 79.0 | 0.0 | | | F |
| 1.50- | 2.50 | 3 | core | | | | | | | | | | | F |
| 2.30- | 2.40 | 3A | | | | | | | | | | | | F |
| 2.50- | 3.00 | 4 | core | | | | | | | | | | | F |
| 2.80- | 2.90 | 4A | | 29.0 | | | | | | | | | | F |
| 3.00- | 3.80 | 5 | core | | | | | | | | | | | F |
| 3.60- | 3.70 | 5A | | | | | | | | | | | | F |
| 3.80- | 4.50 | 6 | core | 17.0 | | | | | | | | | | F |
| 4.10- | 4.20 | 6A | SP | 18.0 | | | | | 2.0 | 82.0 | 10.0 | | | F |
| 4.50- | 5.50 | 7 | core | | | | | | | | | | | F |
| 4.60- | 4.70 | 7A | | 10.0 | | | | | | | | | | F |
| 5.00- | 5.10 | 7B | | 25.0 | | | | | | | | | | F |
| 5.50- | 6.50 | 8 | core | | | | | | | | | | | F |
| 6.30- | 6.40 | 8A | | 19.0 | | | | | | | | | | F |
| 6.50- | 7.50 | 9 | core | | | | | | | | | | | F |
| 7.00- | 7.20 | 9A | | 17.0 | | | | | | | | | | F |
| 7.50- | 8.50 | 10 | core | | | | | | | | | | | F |
| 8.00- | 8.10 | 10A | | 20.0 | | | | | | | | | | F |
| 8.50- | 9.40 | 11 | core | | | | | | | | | | | F |
| 9.00- | 9.10 | 11A | | 18.0 | | | | | | | | | | F |
| 9.40- | 10.30 | 12 | core | | | | | | | | | | | F |
| 9.90- | 10.00 | 12A | | 21.0 | | | | | | | | | | F |
| 10.30- | 10.70 | 13 | core | | | | | | | | | | | F |
| 10.30- | 10.40 | 13A | | 21.0 | | | | | | | | | | F |
| 10.70- | 11.50 | 14 | core | | | | | | | | | | | F |
| 11.10- | 11.20 | 14A | | 13.0 | | | | | | | | | | F |
| 11.50- | 12.30 | 15 | core | | | | | | | | | | | F |
| 11.60- | 11.70 | 15A | | 17.0 | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 216S03

Page 1 of 1

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m ³ | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 1.00 | 1 | core | | | | | | | | | | | F |
| 1.00- | 1.40 | 2 | core | 9.0 | | | | | | | | | | F |
| 1.20- | 1.30 | 2A | | 30.0 | | | | | | | | | | F |
| 1.40- | 1.80 | 3 | core | | | | | | | | | | | F |
| 1.60- | 1.70 | 3A | | 2136.0 | | | | | | | | | | F |
| 1.80- | 2.30 | 4 | core | | | | | | | | | | | F |
| 2.00- | 2.10 | 4A | | 58.0 | | | | | | | | | | F |
| 2.30- | 3.20 | 5 | core | 2109.0 | | | | | | | | | | F |
| 2.50- | 2.60 | 5A | | | | | | | | | | | | F |
| 3.20- | 3.40 | 6 | core | | | | | | | | | | | F |
| 3.40- | 3.80 | 7 | core | 25.0 | | | | | | | | | | F |
| 3.80- | 4.40 | 8 | core | | | | | | | | | | | F |
| 4.10- | 4.40 | 8A | | 42.0 | | | | | | | | | | F |
| 4.40- | 4.70 | 9 | core | | | | | | | | | | | F |
| 4.70- | 5.00 | 10 | core | | | | | | | | | | | F |
| 5.00- | 5.50 | 11 | core | | | | | | | | | | | F |
| 5.50- | 6.10 | 12 | core | | | | | | | | | | | F |
| 6.10- | 6.60 | 13 | core | | | | | | | | | | | F |
| 6.60- | 7.20 | 14 | core | | | | | | | | | | | F |
| 6.80- | 7.00 | 14A | | 31.0 | | | | | | | | | | F |
| 7.20- | 7.60 | 15 | core | | | | | | | | | | | F |
| 7.60- | 7.90 | 16 | core | | | | | | | | | | | F |
| 7.90- | 8.50 | 17 | core | | | | | | | | | | | F |
| 8.50- | 9.10 | 18 | core | | | | | | | | | | | F |
| 9.10- | 9.60 | 19 | core | | | | | | | | | | | F |
| 9.60- | 10.00 | 20 | core | | | | | | | | | | | F |
| 10.00- | 10.40 | 21 | core | | | | | | | | | | | F |
| 10.40- | 11.00 | 22 | core | | | | | | | | | | | F |
| 11.00- | 11.60 | 23 | core | | | | | | | | | | | F |
| 11.60- | 12.20 | 24 | core | | | | | | | | | | | F |
| 12.20- | 12.60 | 25 | core | | | | | | | | | | | F |
| 12.60- | 13.00 | 26 | core | | | | | | | | | | | F |
| 13.00- | 13.60 | 27 | core | | | | | | | | | | | F |
| 13.60- | 14.20 | 28 | core | | | | | | | | | | | F |
| 14.20- | 14.80 | 29 | core | | | | | | | | | | | F |
| 14.80- | 15.20 | 30 | core | | | | | | | | | | | F |
| 15.20- | 15.70 | 31 | core | | | | | | | | | | | F |
| 15.70- | 16.00 | 32 | core | | | | | | | | | | | F |
| 16.00- | 16.50 | 33 | core | | | | | | | | | | | F |
| 16.50- | 16.90 | 34 | core | | | | | | | | | | | F |
| 16.90- | 17.50 | 35 | core | | | | | | | | | | | F |

BA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 216S04

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-----|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 17.50- 18.00 | 36 | core | | | | | | | | | | | | F |
| 18.00- 18.30 | 37 | core | | | | | | | | | | | | F |
| 18.30- 18.60 | 38 | core | | | | | | | | | | | | F |
| 18.60- 19.00 | 39 | core | | | | | | | | | | | | F |
| 19.00- 19.60 | 40 | core | | | | | | | | | | | | F |
| 19.60- 20.00 | 41 | core | | | | | | | | | | | | F |
| 20.00- 20.40 | 42 | core | | | | | | | | | | | | F |
| 20.40- 20.90 | 43 | core | | | | | | | | | | | | F |
| 20.90- 21.30 | 44 | core | | | | | | | | | | | | F |
| 21.30- 21.80 | 45 | core | | | | | | | | | | | | F |
| 21.80- 22.00 | 46 | core | | | | | | | | | | | | F |
| 22.00- 22.40 | 47 | core | | | | | | | | | | | | F |
| 22.40- 22.90 | 48 | core | | | | | | | | | | | | F |
| 22.90- 23.30 | 49 | core | | | | | | | | | | | | F |
| 23.30- 23.80 | 50 | core | | | | | | | | | | | | F |
| 23.80- 24.30 | 51 | core | | | | | | | | | | | | F |
| 26.60- 26.80 | 52 | core | | | | | | | | | | | | F |
| 29.50- 29.70 | 53 | core | | | | | | | | | | | | F |
| 29.70- 30.50 | 54 | core | | | | | | | | | | | | F |
| 30.50- 30.90 | 55 | core | | | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

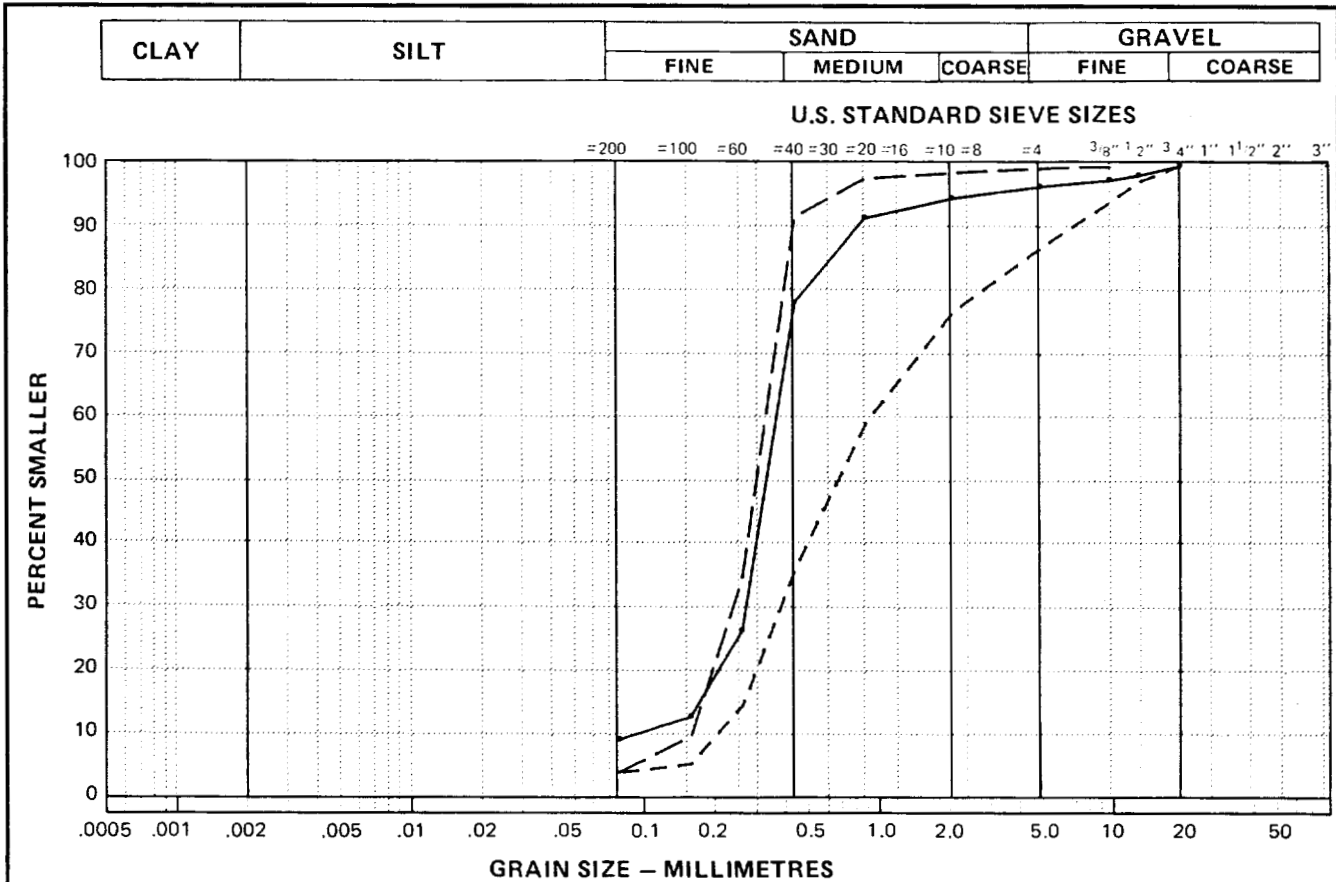
GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 216S04

Page 2 of 2

PARTICLE - SIZE ANALYSIS OF SOILS

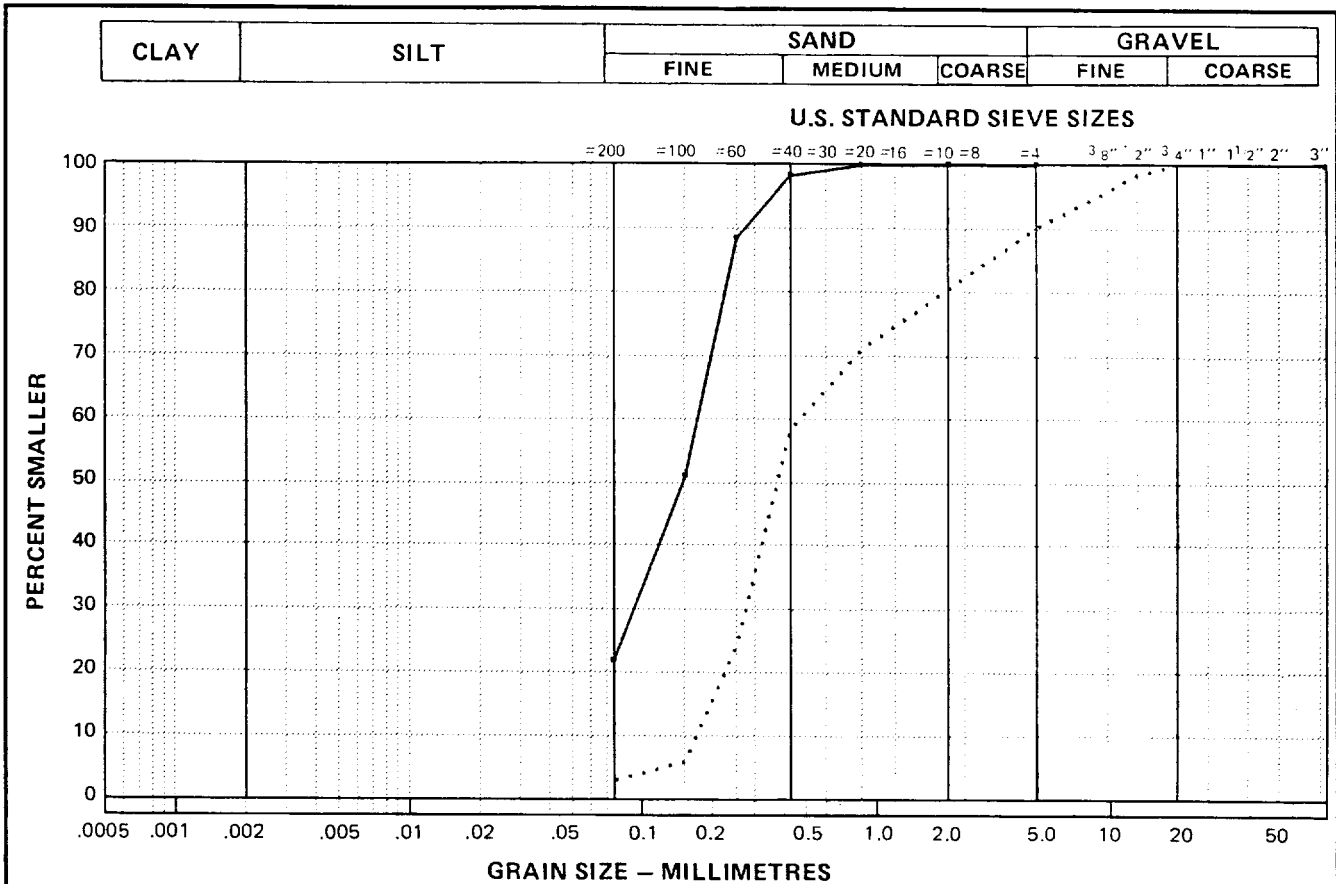


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|---------------|-------------|-------------|-------------|---------------|------|------|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| _____ | 86216S02 | . 30 - . 90 | - | 8. 5 | 88. 2 | 3. 3 | 3. 6 | 2. 0 | SP-SM |
| ..... | 86216S02 | 1. 80 - 1. 90 | - | 3. 2 | 83. 7 | 13. 1 | 4. 4 | . 8 | SP |
| — — — | 86216S02 | 1. 80 - 1. 90 | - | 3. 2 | 83. 7 | 13. 1 | 4. 4 | . 8 | SP |
| — — — | 86216S02 | 4. 40 - 4. 50 | - | 3. 3 | 96. 4 | . 3 | 2. 1 | 1. 1 | SP |

JOB NO. 101 -4480

DATE 86-5-14

PARTICLE - SIZE ANALYSIS OF SOILS



| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| _____ | 86216S03 | 1.30 - 1.40 | - | 20.7 | 79.3 | 0.0 | - | - | - |
| | 86216S03 | 4.10 - 4.20 | - | 1.6 | 88.4 | 10.0 | 2.8 | .9 | SP |

JOB NO. 101 -4480

DATE 86-5-14

APPENDIX E
SOURCE 216South

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| E.4 | LABORATORY TESTING |

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Figure E.1 Site Plan for Source 216South



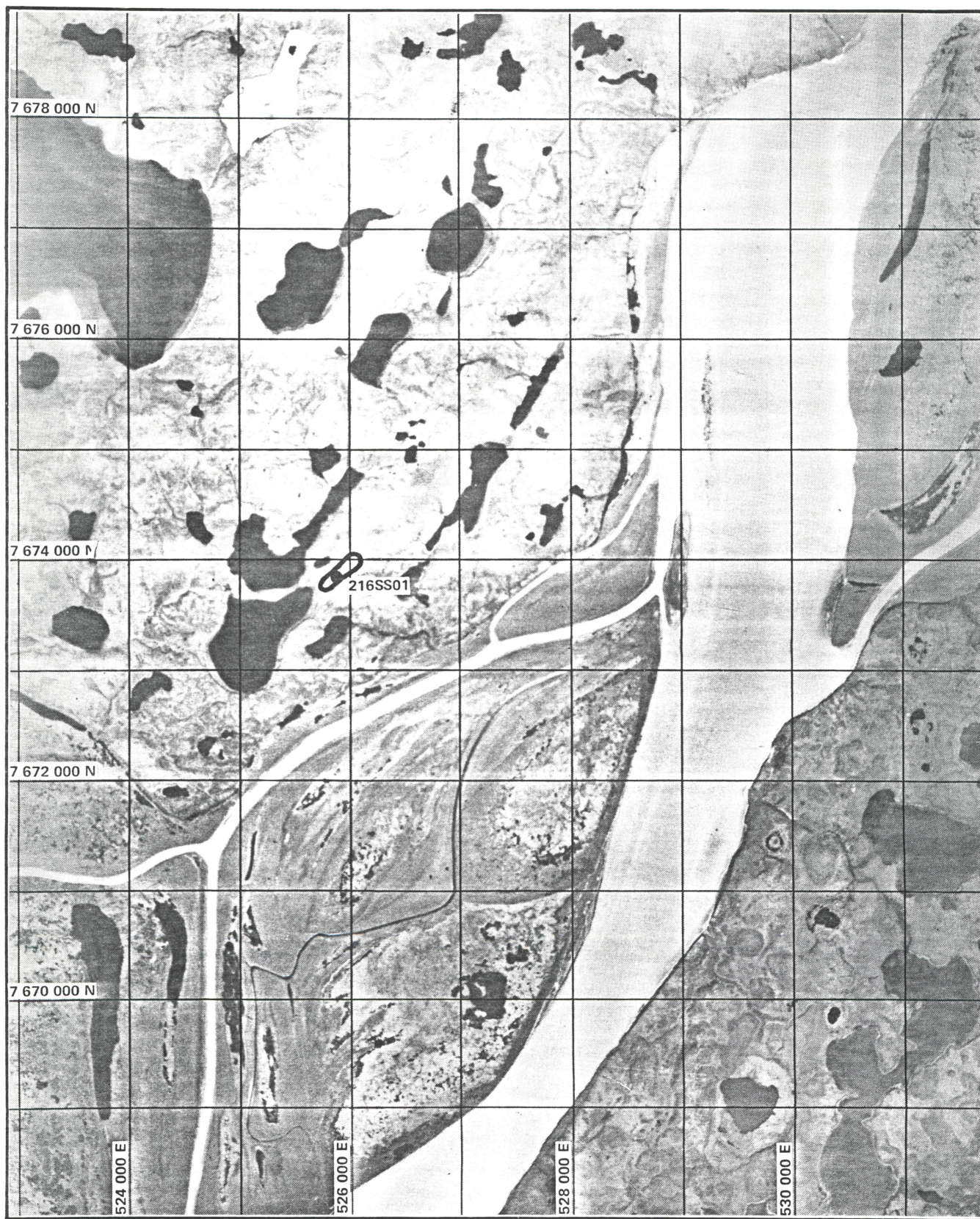


FIGURE E.1 SITE PLAN FOR SOURCE 216S

APPENDIX E
SOURCE 216South

E.1 **SUMMARY**

| | | |
|-----------------------------------|-----------------------------------------|-------------------------------|
| Material Type: | fine sand, some silt | |
| Fines Content: | estimated 10% - 15% | |
| Area of Feature: | 431,000 m ² | |
| Developable Area: | Unknown, summer reconnaissance required | |
| Estimated Volume: | Proven (m ³) | Probable (m ³) |
| type IV borrow w/m.c. over 10% | 0 | rec. reqd. |
| Excavation Depth: | not recommended | |
| Moisture Content: | 15 to 20% | |
| Borehole Reference: | 216SS01 | |

E.2 **SITE DESCRIPTION**

E.2.1 Location and Geological Origin

Source 216South is located 6.5 km south of Lousy Point, about 3 km west of the East channel. This medium sized hillock may be a glacial outwash feature. Its location is shown on Figure 2 and Figure E.1. The site was selected due to its proximity to the Mackenzie River and because of its geomorphological nature.

E.2.2 Summary of Previous Studies

There have been no previous studies conducted at this site.



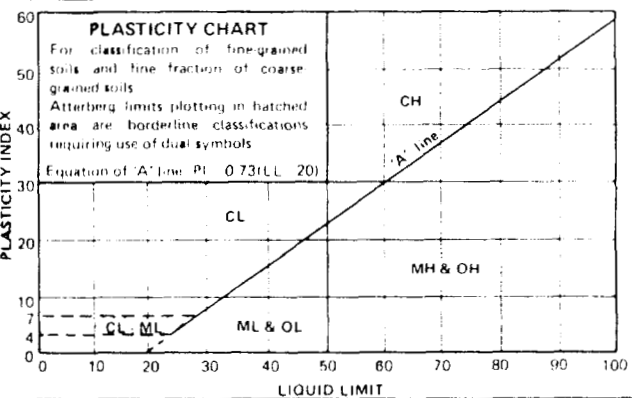
E.2.3 Results of Current Study

One borehole was drilled on this feature. Fine sand with silt and organic lenses was encountered to a depth of 4 m. Below this depth interbedded layers of ice, sand and clay till were encountered to the maximum penetration of 8.0 m. Although some sand exhibited relatively low (8-12%) silt contents, the overall concentration of silt and organic material, plus the moisture content of approximately 20 percent, make the source of little value. If developed in the summer the material may find some utility as pipeline backfill; however, development for any other purpose is not recommended.






E.3 BOREHOLE LOGS



| UNIFIED SOIL CLASSIFICATION† | | | | | | | | |
|------------------------------------------------------------------|-------------------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--|--|
| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | | |
| COARSE GRAINED SOILS More than 50% retained on No. 200 sieve* | GRAVELS 50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS | GW | Well-graded gravels and gravel-sand mixtures with or without fines | $C_u = \frac{D_{60} - D_{10}}{D_{10}}$ greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting both criteria for GW | | | |
| | | | GP | Poorly-graded gravels and gravel-sand mixtures with or without fines | | | | |
| | | GRAVELS WITH FINES | GM | Silty gravels, gravel-sand mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7 | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols | | |
| | | | GC | Clayey gravels, gravel-sand clay mixtures | | | | |
| | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | $C_u = \frac{D_{60} - D_{10}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | |
| | | | SP | Poorly-graded sands and gravelly sands, little or no fines | | | | |
| | | SANDS WITH FINES | SM | Silty sands, sand-silt mixtures | Not meeting both criteria for SW Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7 | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols | | |
| | | | SC | Clayey sands, sand-clay mixtures | | | | |
| | | | | | | | | |
| | | | | | | | | |
| FINE-GRAINED SOILS 50% or more passes No. 200 sieve* | SILTS AND CLAYS Liquid limit 50% or less | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | PLASTICITY CHART For classification of fine-grained soils and fine fraction of coarse-grained soils Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols Equation of "A" line: $PI = 0.73(LL - 20)$  | | | | |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | | | | |
| | | OL | Organic silts and organic silty clays of low plasticity | | | | | |
| | SILTS AND CLAYS Liquid limit greater than 50% | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | | | |
| | | CH | Inorganic clay of high plasticity, fat clays | | | | | |
| | | OH | Organic clays of medium to high plasticity | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| HIGHLY ORGANIC SOILS | | | PT | Peat, muck and other highly organic soils | *Based on the material passing the 3 in. (75 mm) sieve †ASTM Designation D 2487, for classification procedure see D 2488 | | | |


GROUND ICE DESCRIPTION


| ICE NOT VISIBLE | | | |
|-----------------|---------|----------------------------|-------------------------------------------------------------------------------------|
| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
| N | Ni | Poorly-bonded or friable |  |
| | Nbn | No excess ice, well-bonded |  |
| | Nbe | Excess ice, well-bonded |  |





NOTE:



- Dual symbols are used to indicate borderline or mixed ice classifications
- Visual estimates of ice contents indicated on borehole logs $\pm 5\%$
- This system of ground ice description has been modified from NRC Technical Memo 79, *Guide to the Field Description of Permafrost for Engineering Purposes*

LEGEND







Soil 

Ice 

| VISIBLE ICE LESS THAN 50% BY VOLUME | | | |
|-------------------------------------|---------|--------------------------------------------------|---------------------------------------------------------------------------------------|
| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
| V | Vx | Individual ice crystals or inclusions |  |
| | Vc | Ice coatings on particles |  |
| | Vr | Random or irregularly oriented ice formations |  |
| | Vs | Stratified or distinctly oriented ice formations |  |

| VISIBLE ICE GREATER THAN 50% BY VOLUME | | | |
|----------------------------------------|-----------------|----------------------------------------------------------------|---------------------------------------------------------------------------------------|
| ICE | ICE + Soil Type | Ice with soil inclusions |  |
| | ICE | Ice without soil inclusions (greater than 25 mm (1 in.) thick) |  |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | |
|------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 674 817 E 526 053 Z8 | | | | RELATIVE ELEVATION N.A. | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 0 | 1 | SAND (SM) -silty, trace gravel to 10 mm, fine-grained, light brown -occasional very thinly bedded SILT lens 10 mm thick -becoming: by 0.6 m | Nf-Nbn | | | | | | | | 0 | | |
| | 2 | SAND (SP-SM) -trace silt, medium-grained, uniform, medium greyish brown | Nbn | | | | | | | | | | |
| 2 | 3 | -becoming: by 1.8 m SAND (SM) -trace gravel, some silt, rounded to subrounded clasts to 15 mm, medium greyish brown -trace to some gravel, trace silt partings, occasional organic lens 10 mm thick, dark brown | Nbn | | | | | | | | 2 | | |
| | 4 | | | | | | | | | | | | |
| | 5 | -becoming: by 3.4 m SAND (SM) -some silt, medium-grained, medium greyish brown | Nbn-Nbs | | | | | | | | 4 | | |
| 4 | 6 | ICE+SILT (ML) -very thin laminae, parallel, medium greyish brown | 50: 50 Vs | | | | | | | | | | |
| | 7 | SAND (SP) -trace fine-grained gravel to 10 mm, subrounded, clean, medium-grained sand, uniform -gravelly lens 100 mm thick | Nbn | | | | | | | | | | |
| 6 | 8 | | | | | | | | | | 6 | | |
| | 9 | CLAY TILL (CL) -gravelly, silty, clasts to 75 mm SAND (SP) -trace silt to clean, trace coal, massive, medium-grained, medium greyish brown -cross bedded lenses of coal fragments 3 mm in diameter at a 45 degree angle | Nbn | | | | | | | | | | |
| | 10 | ICE | | | | | | | | | | | |
| 8 | 11 | | | | | | | | | | 8 | | |
| | | END OF BOREHOLE 8.0 m | | | | | | | | | | | |
| 10 | | | | | | | | | | | 10 | | |

| | | | | |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-------------------------|
| 101C-4480 Completed 15: 45 86/03/22 DRILLING RIG: CME 750 Compiled by JGC | SAMPLE TYPE    |    CREL AUGER | EBA Engineering Consultants Ltd. | BOREHOLE NUMBER 216SS01 |
| | | | DRAWING NUMBER | |

BOREHOLE LOG AND LABORATORY TEST RESULTS

E.4 LABORATORY TESTING



APPENDIX F
SOURCE 217

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| | F.2.2 Summary of Previous Studies |
| | F.2.3 Results of Current Study |
| F.3 | BOREHOLE LOGS |
| F.4 | LABORATORY TESTING |

LIST OF FIGURES

Figure 1 Site Plan for Source 217



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES 250 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.60 | 1 | core | 16.0 | | | | | | | | | F |
| 0.60- | 1.50 | 2 | core | | | | | | | | | | F |
| 0.80- | 0.90 | 2A | SP-SM | 20.0 | | | | | 8.0 | 92.0 | 0.0 | | F |
| 1.50- | 2.40 | 3 | core | | | | | | | | | | F |
| 1.80- | 1.90 | 3A | SP-SM | 19.0 | | | | | 11.0 | 83.0 | 6.0 | | F |
| 2.50- | 3.40 | 4 | core | | | | | | | | | | F |
| 3.00- | 3.10 | 4A | | 23.0 | | | | | | | | | F |
| 3.40- | 4.00 | 5 | core | | | | | | | | | | F |
| 3.50- | 3.60 | 5A | SM | 23.0 | | | | | 12.0 | 87.0 | 1.0 | | F |
| 4.00- | 4.80 | 6 | core | | | | | | | | | | F |
| 4.50- | 4.60 | 6A | | 64.0 | | | | | | | | | F |
| 4.80- | 5.50 | 7 | core | | | | | | | | | | F |
| 5.00- | 5.10 | 7A | | | | | | | | | | | F |
| 5.50- | 6.30 | 8 | core | | | | | | | | | | F |
| 5.90- | 6.00 | 8A | | 25.0 | | | | | | | | | F |
| 6.30- | 6.90 | 9 | core | | | | | | | | | | F |
| 6.50- | 6.60 | 9A | | | | | | | | | | | F |
| 6.90- | 7.50 | 10 | core | | | | | | | | | | F |
| 7.00- | 7.10 | 10A | | | | | | | | | | | F |
| 7.50- | 8.00 | 11 | core | | | | | | | | | | F |

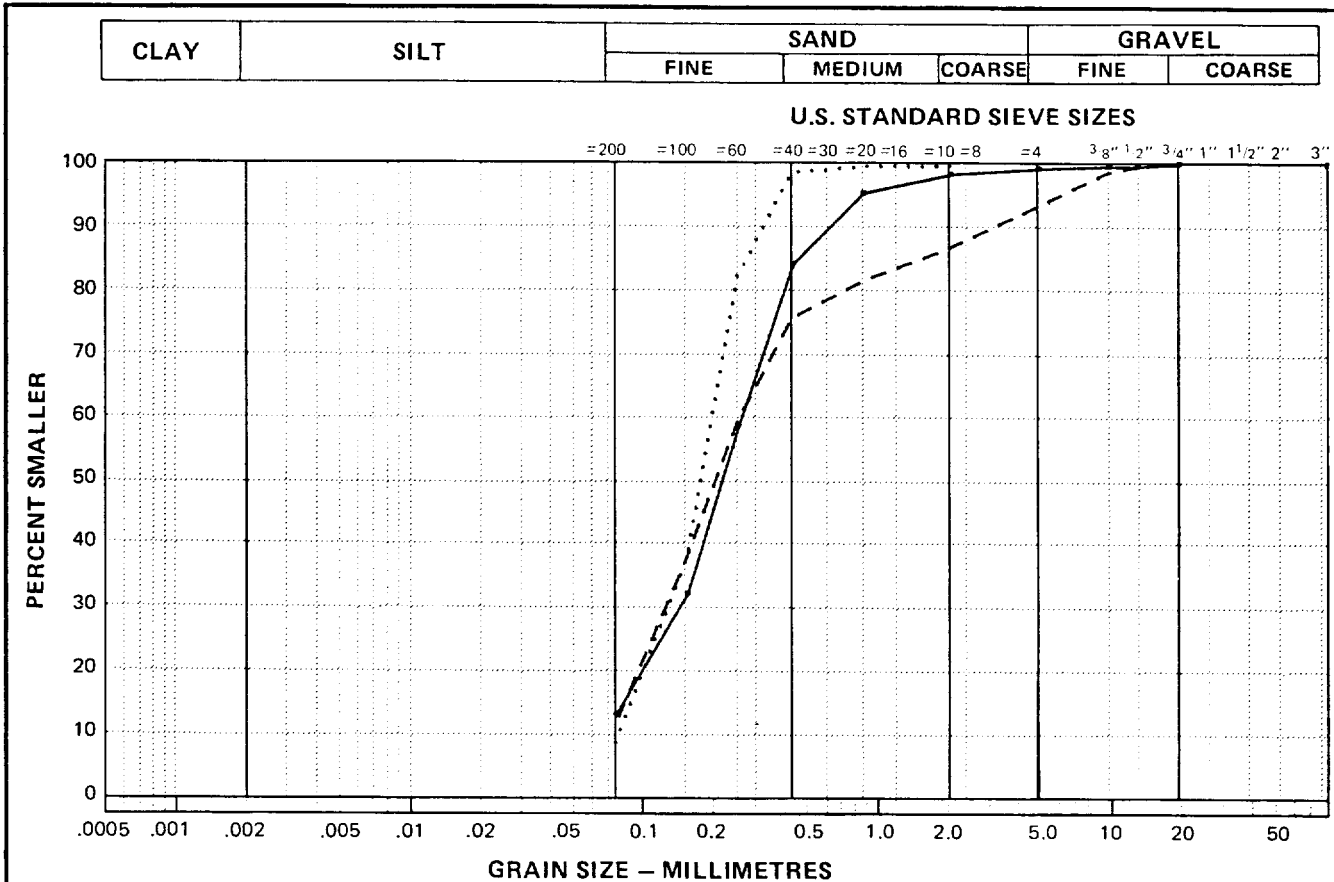
IBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 216SS01

Page 1 of 1

PARTICLE - SIZE ANALYSIS OF SOILS



| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — | 86216SS01 | 3.50 - 3.60 | — | 12.0 | 87.2 | .8 | — | — | — |
| ..... | 86216SS01 | .80 - .90 | — | 7.9 | 92.1 | 0.0 | 2.5 | 1.1 | SP-SM |
| -- -- | 86216SS01 | 1.80 - 1.90 | — | 10.9 | 82.7 | 6.4 | — | — | — |

JOB NO. 101 -4480

DATE 86-5-13

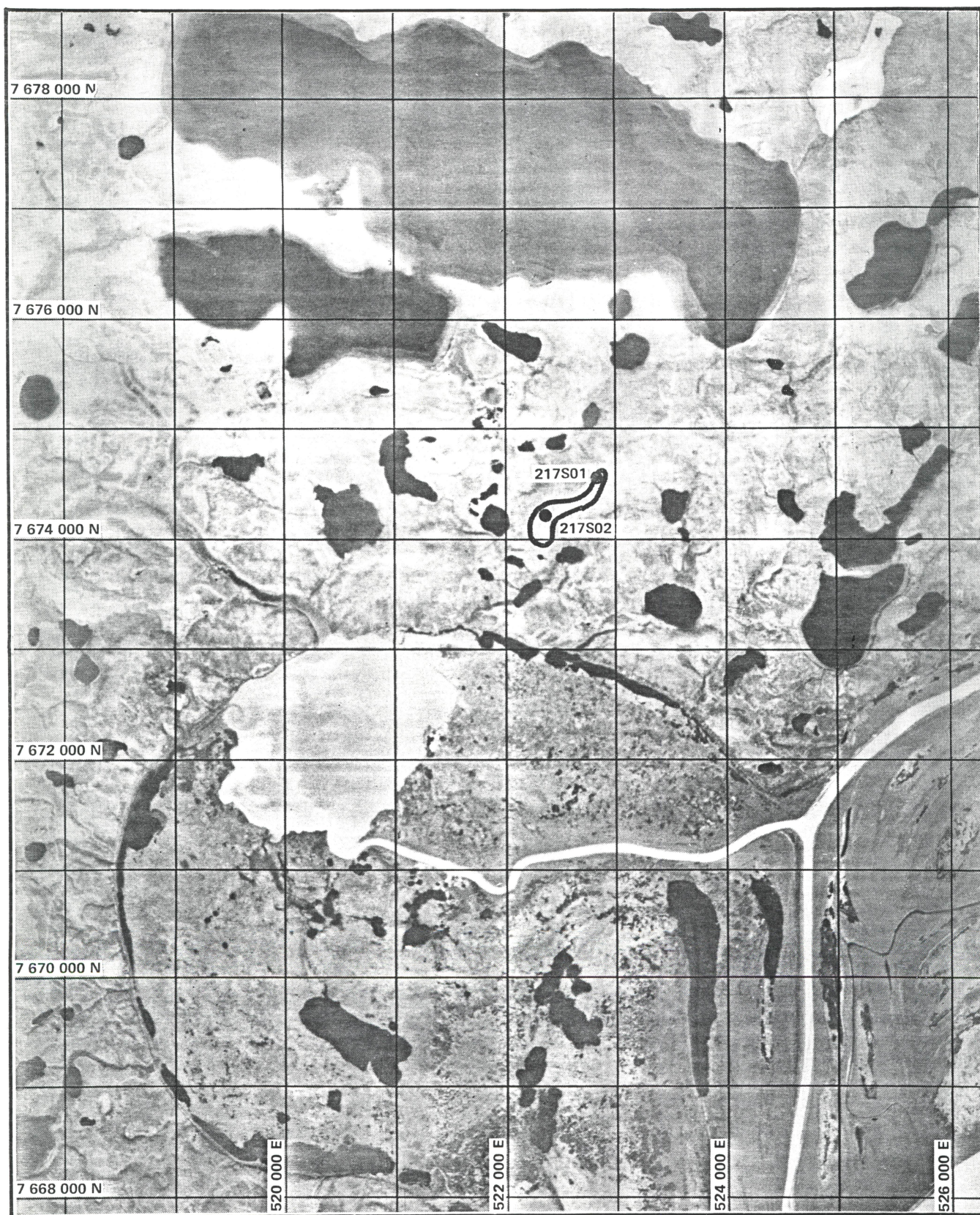


FIGURE F.1 SITE PLAN FOR SOURCE 217

APPENDIX F
SOURCE 217

F.1 SUMMARY

| | | |
|-----------------------------------|----------------------------------|-------------------------------|
| Material Type: | fine uniform sand with silt beds | |
| Fines Content: | 5% | |
| Area of Feature: | 568,000 m ² | |
| Developable Area: | Unknown, rec. reqd. | |
| Estimated Volume: | Proven (m ³) | Probable (m ³) |
| type IV borrow w/m.c. over 10% | 7,500 | rec. reqd. |
| Excavation Depth: | 2 m | |
| Moisture Content: | 25% | |
| Borehole Reference: | 217S01, 217S02 RKL217-A | |

F.2 SITE DESCRIPTION

F.2.1 Location and Geological Origin

This is a portion of a ridge located approximately 6 km west of the East channel. RKL (1972) identified it as an esker, however, current data does not support this interpretation. Its location is shown on Figure 2 and Figure F.1. The source is accessible from the Mackenzie River via frozen streams and lakes. The section identified as source 217 is approximately 2100 m long and 100 m wide.

F.2.2 Summary of Previous Studies

RKL (1972) has previously excavated one test pit 0.75 m deep at the site. The material was found to be a well graded sand.



F.2.3 Results of Current Study

From site reconnaissance it appeared that target materials were draped over the top of a low ridge feature as a second narrow ridge, or in dune-like mounds of variable height. Possibly a summer reconnaissance program would provide insight to the distribution of granular materials.

Two boreholes were advanced on this feature to depths of 4.9 m and 12.6 m. The first borehole encountered only silt and massive ice. The second borehole encountered silty, uniform, fine-grained sand, with a bed of silt between 2 and 3.5 m below surface. Moisture content is high (over 20%) throughout the profile which would make extraction difficult.

In view of the variation between the boreholes, further investigation is required before the site can be recommended for development. Prior to this investigation a summer reconnaissance is suggested. The relatively poor quality of the material found at the second borehole suggests that further investigation of the site should be deferred until other sources have been exhausted.



F.3 BOREHOLE LOGS



UNIFIED SOIL CLASSIFICATION†

| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | | |
|------------------------------------------------------------------|-------------------------------------------------------------------|--------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------|
| COARSE GRAINED SOILS More than 50% retained on No. 200 sieve* | GRAVELS 50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS | GW | Well-graded gravels and gravel-sand mixtures, little or no fines | Classification on basis of percentage of fines: GW, GP, SW, SP GM, GC, SM, SC Borderline - classifications requiring use of dual symbols | $C_u = \frac{d_{60}}{d_{30}} \geq 2$ $C_c = \frac{d_{30}^2}{d_{10} \times d_{60}} \leq 6$ <p>Greater than 6 Between 1 and 3</p> | | |
| | | | GP | Poorly-graded gravel and gravel-sand mixtures, little or no fines | | | | |
| | | GRAVELS WITH FINES | GM | Silty gravels, gravel-sand-silt mixtures | | | | |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures | | | | |
| | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | | | | |
| | | | SP | Poorly-graded sands and gravelly sands, little or no fines | | | | |
| | | SANDS WITH FINES | SM | Silty sands, sand-silt mixtures | | | | |
| | | | SC | Clayey sands, sand-clay mixtures | | | | |
| | | | | | | | | |
| | | | | | | | | |
| FINE GRAINED SOILS 50% or more passes No. 200 sieve* | SILTS AND CLAYS Liquid limit 50% or less | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | | For classification of fine-grained soils and fine fraction of coarse-grained soils. Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: $PI = 0.73(LL - 20)$ | | | |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, silty clays, lean clays | | | | | |
| | | OL | Organic silts and organic silty clays of low plasticity | | | | | |
| | SILTS AND CLAYS Liquid limit greater than 50% | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | | | |
| | | CH | Inorganic clay of high plasticity, fat clays | | | | | |
| | | OH | Organic clays of medium to high plasticity | | | | | |
| | | | | | | | | |
| | HIGHLY ORGANIC SOILS | | PT | | | Peat, muck and other highly organic soils | | *Based on the material passing the 3/16-in. (4.75-mm) sieve. †ASTM Designation D 2487, for identification procedure see D 2488. |

*Based on the material passing the No. 20 sieve.
†ASTM Designation D 2487, for identification procedure see D 2488.

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|----------------------------|--|
| N | Nf | Poorly-bonded or friable | |
| | Nbn | No excess ice, well-banded | |
| | Nbe | Excess ice, well-banded | |

NOTE:

- Dual symbols are used to indicate borderline or mixed ice classifications.
- Visual estimates of ice contents indicated on borehole logs $\pm 5\%$.
- This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

LEGEND

Soil Ice

VISIBLE ICE LESS THAN 50% BY VOLUME

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|--------------------------------------------------|--|
| V | Vx | Individual ice crystals or inclusions | |
| | Vc | Ice coatings on particles | |
| | Vr | Random or irregularly oriented ice formations | |
| | Vs | Stratified or distinctly oriented ice formations | |

VISIBLE ICE GREATER THAN 50% BY VOLUME

| | | | |
|-----|-----------------|----------------------------------------------------------------|--|
| ICE | ICE + Soil Type | Ice with soil inclusions | |
| | ICE | Ice without soil inclusions (greater than 25 mm (1 in.) thick) | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|--|--|
| N7 875 197 E 522 440 Z8 | | | | RELATIVE ELEVATION 44.1 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | |
| TYP | NO. G | | | | | | | | | | | | |
| 0 | | | | | | | | | | | | | |
| | 1 | SAND (SM) - some silt to silty, trace gravel 75 mm, fine-grained, uniform, medium brown | Nbn | | | | | | | | | | |
| | 2 | CLAY TILL (CL) - silty, trace sand, trace gravel, very thinly bedded, wavy, dark grey -very thinly bedded, even, nonparallel | Vr 5% Vs 30% | | | | | | | | | | |
| | 3 | -very thinly bedded, wavy, continuous, with occasional very thinly bedded sand lens | | | | | | | | | | | |
| 2 | 4 | ICE+SILT-clear | 90:10 | | | | | | | | | | |
| | 5 | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | |
| 4 | 8 | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | |
| | 10 | END OF BOREHOLE 4.9 m (39.2 m El.) | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |

101C-4480
Completed 21:50 86/03/21
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

☐ CRREL
☐ AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
217S01

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | | | |
|------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|--|--|--|--|
| N7 675 568 E 522 994 Z8 | | | | RELATIVE ELEVATION 53.2 (m) | | | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | | | |
| TYP | NO. Q | | | | | | | | | | | | | | |
| 0 | 1 | ROOT MAT AND ORGANICS | | | | | | | | | | | | | |
| | 2 | SAND (SM) -some silt to silty, trace 5 mm gravel, fine-grained, uniform, homogeneous, olive brown -silt content decreases with depth -becoming: by 0.6 m | Nbn | | | | | | | | | | | | |
| | 3 | SAND (SP) -trace gravel, trace silt, coarse to fine-grained sand, massive, well-bonded, olive brown | | | | | | | | | | | | | |
| | 4 | -trace fibrous organics | Nbn, trace Vx | | | | | | | | | | | | |
| 2 | 5 | SILT (ML) -some sand, fine-grained, uniform, very thinly bedded, even, parallel, continuous, with very thinly bedded lenses of silt, fine-grained sand and peat, brown | Nbn-Vx<5% | | | | | | | | | | | | |
| | 6 | -ice lens 100 mm thick | Nbn | | | | | | | | | | | | |
| | 7 | SAND (SP-SM) -trace to some silt, fine-grained, uniform, homogeneous, massive, mottled dark olive grey and olive brown -becoming: by 3.8 m | | | | | | | | | | | | | |
| 4 | 8 | SAND (SP) -trace silt | | | | | | | | | | | | | |
| | 9 | -lens of coarse to fine-grained sand, trace gravel, trace silt -pockets of silt disseminated throughout | | | | | | | | | | | | | |
| | 10 | | Nbn | | | | | | | | | | | | |
| 6 | 11 | | | | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | | | |
| | 13 | -occasional very thinly bedded lenses of silt 5mm thick | Vr-Vx 20% | | | | | | | | | | | | |
| 8 | 14 | | Nbn | | | | | | | | | | | | |
| | 15 | | | | | | | | | | | | | | |
| | 16 | trace fibrous organics | Vr 20% | | | | | | | | | | | | |
| 10 | 17 | ice lens 150 mm thick | Nbn | | | | | | | | | | | | |

101C-4480
Completed 04:35 86/03/22
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

CARREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
217502

PAGE 1 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

06-03-1986 13:28:37

F.4 LABORATORY TESTING



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.60 | 1 | core | | | | | | | | | | F |
| 0.00- | 0.30 | 1A | | 17.0 | | | | | | | | | F |
| 0.30- | 0.60 | 1B | | 18.0 | | | | | | | | | F |
| 0.60- | 1.20 | 2 | core | | | | | | | | | | F |
| 0.80- | 1.10 | 2A | | 30.0 | | | | | | | | | F |
| 1.20- | 1.80 | 3 | core | | | | | | | | | | F |
| 1.50- | 1.80 | 3A | | 37.0 | | | | | | | | | F |
| 1.80- | 2.40 | 4 | core | | | | | | | | | | F |
| 2.40- | 2.90 | 5 | core | | | | | | | | | | F |
| 2.90- | 3.40 | 6 | core | | | | | | | | | | F |
| 3.40- | 3.70 | 7 | core | | | | | | | | | | F |
| 3.70- | 4.10 | 8 | core | | | | | | | | | | F |
| 4.10- | 4.60 | 9 | core | | | | | | | | | | F |
| 4.60- | 4.90 | 10 | core | | | | | | | | | | F |

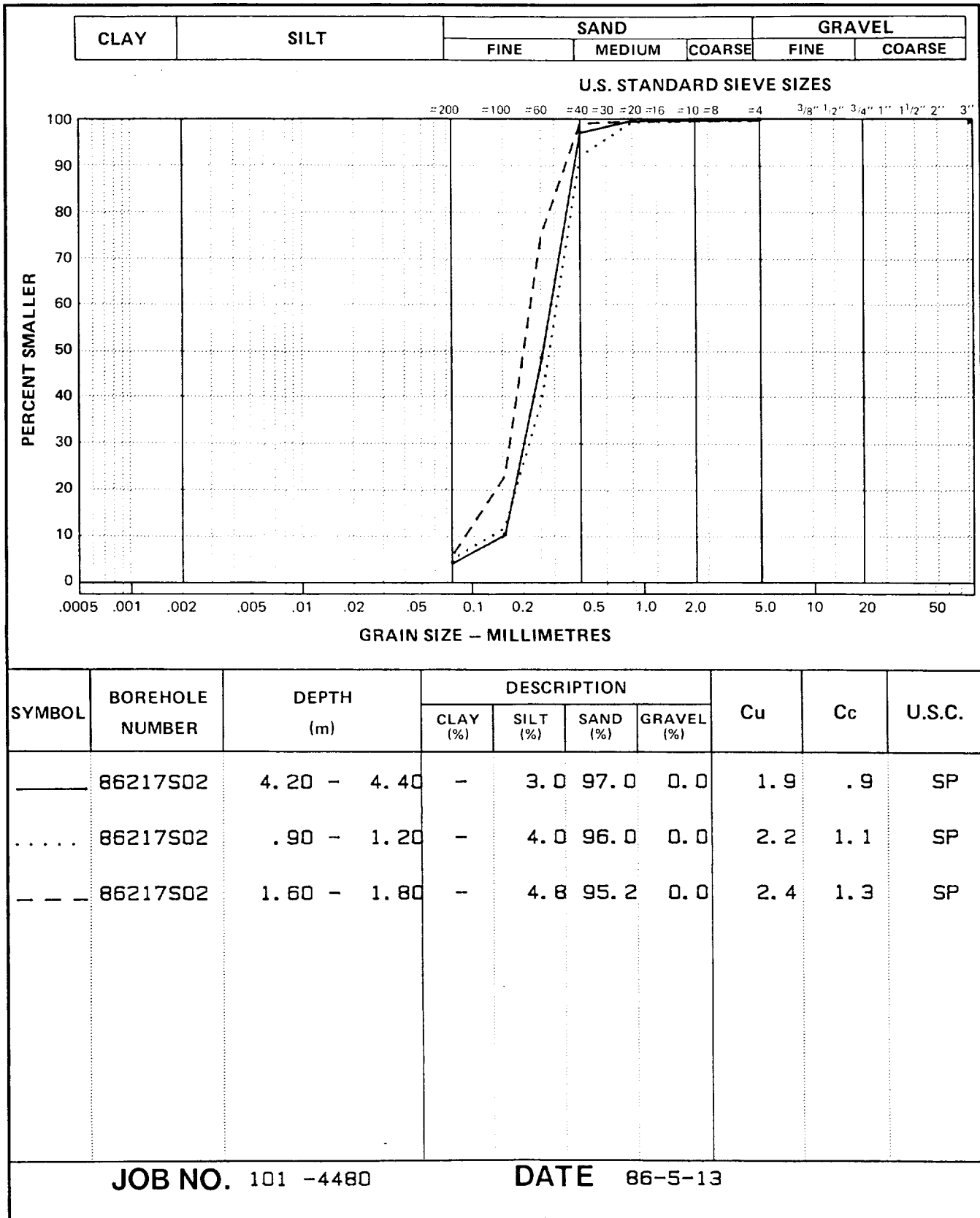
EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 217S01

Page 1 of 1

PARTICLE - SIZE ANALYSIS OF SOILS



APPENDIX G
SOURCE 217East

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| | G.2.1 Location and Geological Origin |
| | G.2.2 Summary of Previous Studies |
| | G.2.3 Results of Current Study |
| G.3 | BOREHOLE LOGS |
| G.4 | LABORATORY TESTING |

LIST OF FIGURES

Figure G.1 Site Plan for Source 217East





FIGURE G.1 SITE PLAN FOR SOURCE 217E

APPENDIX G
SOURCE 217East

G.1 **SUMMARY**

| | | |
|---------------------|----------------------------------|------------------------------------|
| Material Type: | silty sand and sandy silt | |
| Fines Content: | estimated average 50% | |
| Area of Feature: | 428,000 m ² | |
| Developable Area: | 0 | |
| Estimated Volume: | Proven (m ³) 0 | Probable (m ³) 0 |
| Excavation Depth: | not recommended | |
| Moisture Content: | over 30% | |
| Borehole Reference: | 217ES01 | |

G.2 **SITE DESCRIPTION**

G.2.1 Location and Geological Origin

Source 217East is located about 4 km west of the East channel just east of source 217. Its location is shown on Figure 2 and Figure G.1. The deposit appears to be part of the same feature as deposit 217. It is, however, more kame-like but with hummocky and terrace-like features on the main ridge.

G.2.2 Summary of Previous Studies

There have been no previous studies conducted at this site.

G.2.3 Results of Current Study

One borehole was drilled on this site to a depth of 9.2 m and encountered a sequence of interbedded silty sand and sandy silt. Silt predominates in the sequence, and it is not of engineering value.






G.3 BOREHOLE LOGS



| UNIFIED SOIL CLASSIFICATION† | | | | | | | | |
|------------------------------------------------------------------|-------------------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|--|
| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | | |
| COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve* | GRAVELS 50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS | GW | Well-graded gravels with little or no sand or silt and clay fines | $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{D_{30}^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | |
| | | | GP | Poorly-graded gravels with little or no sand or silt and clay fines | Not meeting both criteria for GW | | | |
| | | GRAVELS WITH FINES | GM | Gravelly sand or sand-gravel mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 | | | |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures | Atterberg limits plot above "A" line and plasticity index greater than 7 | | | |
| | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | $C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | |
| | | | SP | Poorly-graded sands and gravelly sands, little or no fines | Not meeting both criteria for SW | | | |
| | | SANDS WITH FINES | SM | Silty sands, sand-silt mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 | | | |
| | | | SC | Clayey sands, sand-clay mixtures | Atterberg limits plot above "A" line and plasticity index greater than 7 | | | |
| | | | | | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols | | | |
| | | | | | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols | | | |
| FINE-GRAINED SOILS 50% or more passes No. 200 sieve* | SILTS AND CLAYS Liquid limit 50% or less | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | <div><p>PLASTICITY CHART</p><p>For classification of fine-grained soils and fine fraction of coarse-grained soils</p><p>Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols</p><p>Equation of "A" line: $PI = 0.73(LL - 20)$</p></div> | | | | |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | | | | |
| | | OL | Organic silts and organic silty clays of low plasticity | | | | | |
| | SILTS AND CLAYS Liquid limit greater than 50% | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | | | |
| | | CH | Inorganic clay of high plasticity, fat clays | | | | | |
| | | OH | Organic clays of medium to high plasticity | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | HIGHLY ORGANIC SOILS | | PT | | | Peat, muck and other highly organic soils | *Based on the material passing the 3 in. (75 mm) sieve. †ASTM Designation D 2487, for identification procedure see D 2488 | |

GROUND ICE DESCRIPTION

| ICE NOT VISIBLE | | | |
|-----------------|---------|----------------------------|-------------------------------------------------------------------------------------|
| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
| N | Nf | Poorly-bonded or friable |  |
| | Nbn | No excess ice, well-bonded |  |
| | Nbe | Excess ice, well-bonded |  |





NOTE:



- Dual symbols are used to indicate borderline or mixed ice classifications
- Visual estimates of ice contents indicated on borehole logs $\pm 5\%$
- This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes

LEGEND

Soil

Ice

| VISIBLE ICE LESS THAN 50% BY VOLUME | | | |
|-------------------------------------|---------|--------------------------------------------------|---------------------------------------------------------------------------------------|
| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
| V | Vx | Individual ice crystals or inclusions |  |
| | Vc | Ice coatings on particles |  |
| | Vr | Random or irregularly oriented ice formations |  |
| | Vs | Stratified or distinctly oriented ice formations |  |

| VISIBLE ICE GREATER THAN 50% BY VOLUME | | | |
|----------------------------------------|-----------------|----------------------------------------------------------------|---------------------------------------------------------------------------------------|
| ICE | ICE + Soil Type | Ice with soil inclusions |  |
| | ICE | Ice without soil inclusions (greater than 25 mm (1 in.) thick) |  |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | SPECIAL TESTS | UNIT |
|------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---------------|------|
| N7 675 620 E 524 175 Z8 | | | | RELATIVE ELEVATION 58.1 (m) | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | |
| TYP | NO. Q | | | | | | | | | |
| 0 | 1 | ROOT MAT AND ORGANICS SILT (ML) -some organics, trace fine-grained sand, very thinly bedded, wavy, continuous, parallel, medium brown | Vs 30% | | | | | | | 0 |
| | 2 | -sandy, trace organics, mottled orangish brown and olive grey | Nbn | | | | | | | |
| | 3 | -dark brown to black organic lens 20 mm thick | Vc-Vx 10% | | | | | | | |
| 2 | 4 | SAND (SM) -some silt, trace organics, medium to fine-grained, mottled orangish brown and olive grey -fine-grained, uniform, homogeneous -becoming: by 1.9 m | Nbn-Vc trace | | | | | | | 2 |
| | 5 | SAND (SP) -trace silt, trace organics, granular petrified wood fragments disseminated throughout, massive, coarse to fine-grained, dark olive grey | Nbn | | | | | | | |
| | 6 | SILT (ML) -some fine-grained sand, uniform, very thinly bedded, even, nonparallel, nonplastic, dark grey -becoming: by 3.1 m | Nbn | | | | | | | |
| | 7 | SAND AND SILT (SM) -fine-grained, uniform, homogeneous -very thinly bedded organic lenses 2 mm thick, curved, parallel, continuous, woody organics disseminated throughout -sand content decreases with depth | | | | | | | | 4 |
| 4 | 8 | -becoming: by 4.3 m | Vn-Vx 5% | | | | | | | |
| | 9 | SILT (ML) -trace fine-grained sand, uniform, massive, thin laminae, wavy, nonplastic, dark grey -occasional thinly bedded sand lenses 50 mm thick, medium greyish brown -very thin laminae, parallel | | | | | | | | |
| | 10 | | | | | | | | | |
| 6 | 11 | -sandy, massive -trace fine-grained sand | Nbn | | | | | | | 6 |
| | 12 | -interbedded lenses of SILT (ML) -trace sand and SAND (SM) -silty, medium grey to medium greyish brown, lenses 250 mm thick, occasional ice lens 3 mm thick -silt thinly cross bedded, very thin laminae, parallel | | | | | | | | |
| 8 | 13 | SILT (ML) -trace fine-grained sand, occasional 3 mm ice lenses, very thin laminae, parallel, nonplastic, medium grey -iron oxide staining | | | | | | | | 8 |
| | 14 | -organic lens 20 mm thick | | | | | | | | |
| 10 | | END OF BOREHOLE 9.2 m (48.9 m El.) | | | | | | | | 10 |

101C-4480
Completed 09:35 86/03/22
DRILLING RIG: CME 750
Compiled by MAV JGC

SAMPLE TYPE
 CORE
 AUGER

EBA Engineering Consultants Ltd.
(Edmonton)
DRAWING NUMBER

BOREHOLE NUMBER
217ES01

BOREHOLE LOG AND LABORATORY TEST RESULTS

G.4 LABORATORY TESTING



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.60 | 1 | core | 77.0 | | | | | | | | | F |
| 0.60- | 1.20 | 2 | core | 28.0 | | | | | | | | | F |
| 1.20- | 1.70 | 3 | core | 45.0 | | | | | | | | | F |
| 1.40- | 1.60 | 3A | | | | | | | | | | | F |
| 1.70- | 2.40 | 4 | core | 35.0 | | | | | 6.0 | 91.0 | 3.0 | | F |
| 2.40- | 3.00 | 5 | core | | | | | | | | | | F |
| 2.60- | 3.00 | 5A | | 32.0 | | | | | | | | | F |
| 3.00- | 3.50 | 6 | core | | | | | | | | | | F |
| 3.30- | 3.50 | 6A | | 46.0 | | | | | | | | | F |
| 3.50- | 4.10 | 7 | core | | | | | | | | | | F |
| 4.10- | 4.60 | 8 | core | | | | | | | | | | F |
| 4.30- | 4.60 | 8A | | 41.0 | | | | | | | | | F |
| 4.60- | 5.10 | 9 | core | | | | | | | | | | F |
| 4.90- | 5.00 | 9A | | | | | | | | | | | F |
| 5.10- | 5.90 | 10 | core | | | | | | | | | | F |
| 5.30- | 5.40 | 10A | | 31.0 | | | | | | | | | F |
| 5.90- | 6.80 | 11 | core | | | | | | | | | | F |
| 6.10- | 6.20 | 11A | | | | | | | | | | | F |
| 6.80- | 7.50 | 12 | core | | | | | | | | | | F |
| 6.90- | 7.10 | 12A | | 28.0 | | | | | | | | | F |
| 7.50- | 8.30 | 13 | core | | | | | | | | | | F |
| 7.90- | 8.00 | 13A | | | | | | | | | | | F |
| 8.30- | 9.20 | 14 | core | | | | | | | | | | F |
| 8.70- | 8.80 | 14A | | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

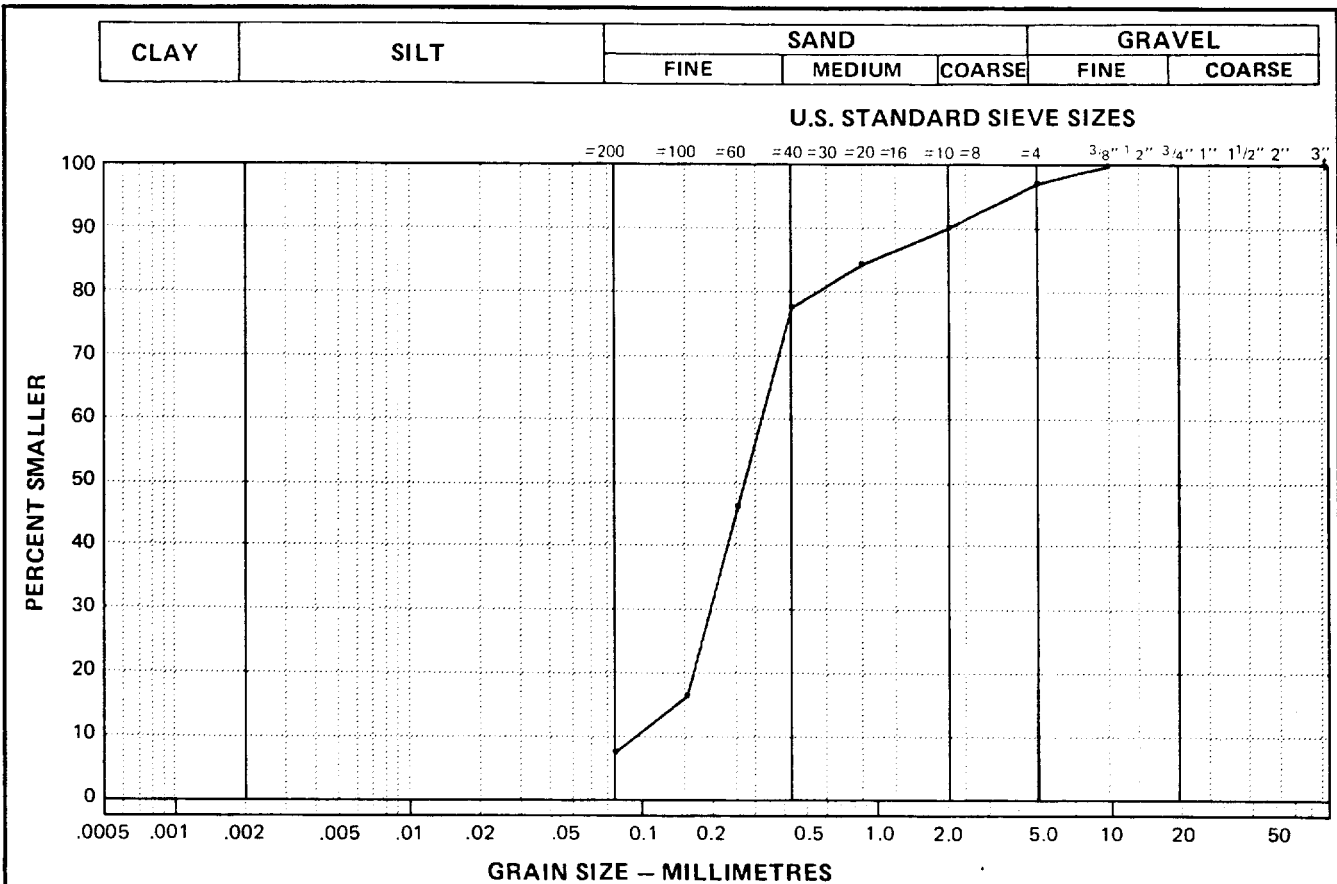
GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 217ES01

Page 1 of 1

PARTICLE - SIZE ANALYSIS OF SOILS



| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| | 86217ES01 | 1.70 - 2.40 | - | 6.4 | 90.8 | 2.8 | 3.2 | 1.2 | SP-SM |

JOB NO. 101 -4480

DATE 86-5-13

APPENDIX H
SOURCE 218

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| H.2 | SITE DESCRIPTION |
| | H.2.1 Location and Geological Origin |
| | H.2.2 Summary of Previous Studies |
| | H.2.3 Results of Current Study |
| H.3 | BOREHOLE LOGS |
| H.4 | LABORATORY TESTING |

LIST OF FIGURES

Figure H.1 Site Plan for Source 218



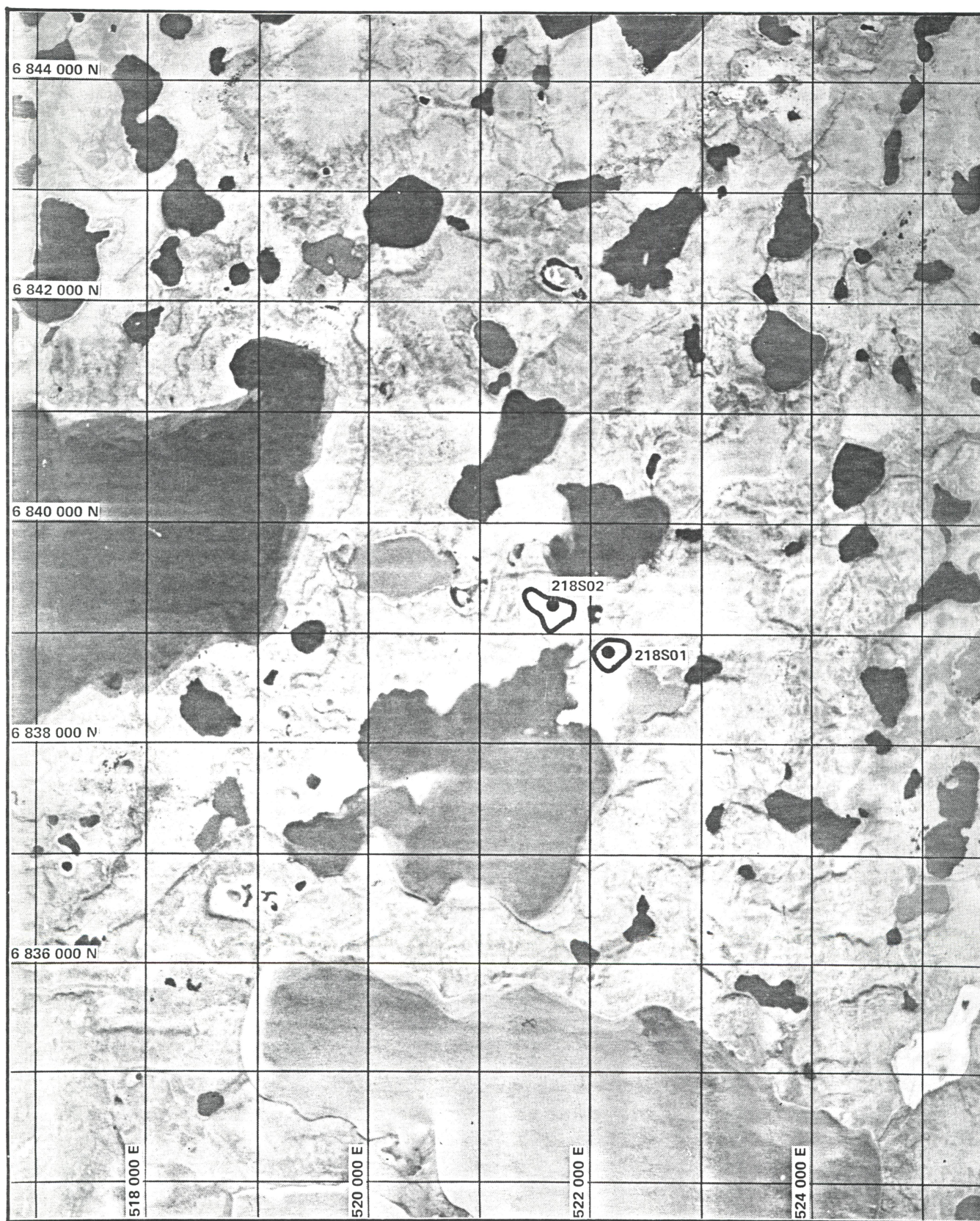


FIGURE H.1 SITE PLAN FOR SOURCE 218

APPENDIX H
SOURCE 218

H.1 SUMMARY

| | | |
|---------------------|-------------------------|------------------------|
| Material Type: | fine sand and silt | |
| Fines Content: | n/a; estimated over 50% | |
| Area of Feature: | 690,000 m ² | |
| Developable Area: | Unknown, rec. reqd. | |
| Estimated Volume: | Proven 0 | Probable rec. reqd. |
| Excavation Depth: | not recommended | |
| Moisture Content: | 20 to 30% | |
| Borehole Reference: | 218S01, 218S02 RKL218-A | |

H.2 SITE DESCRIPTION

H.2.1 Location and Geological Origin

This source is located approximately 30 km north-northeast of Tununuk Point, about 1 km west of Mid Lake. RKL (1972) described the deposit as a glacial outwash. The deposit appears as two flat-topped, steep sided hillocks, each measuring about 1200 m by 300 m by 20 m high. Its location is shown on Figure 2 and Figure H.1.

H.2.2 Summary of Previous Studies

RKL (1972) excavated one test pit to a depth of 1.1 m and found a clean well-graded sand with some fine-grained gravel.



H.2.3 Results of Current Study

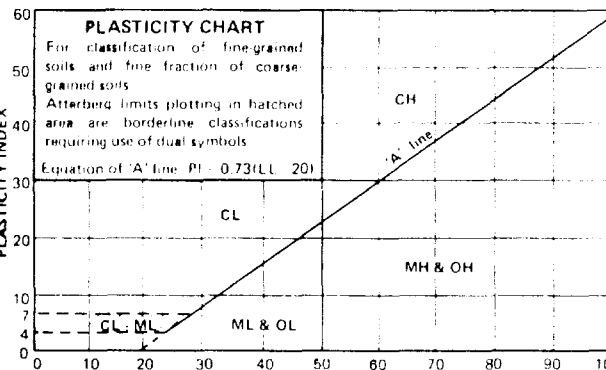
Two boreholes were completed on this site: one on each hillock. Both encountered interbedded deposits of silt, ice, and fine-grained sand. The material encountered is of no engineering value. The RKL test pit indicates that there is some useful material at the site. It seems likely that the material is more localized than previously expected. A summer reconnaissance may be useful to determine whether a sufficient volume of useful material exists.



H.3 BOREHOLE LOGS



UNIFIED SOIL CLASSIFICATION†

| MAJOR DIVISIONS | | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | | | | | | | | | |
|------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--|---------------|---------------|-------------------------------------------------------------------|---------------------------------------------------------|-------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve* | | | | | | GRAVELS 50% or more of coarse fraction finer than No. 4 sieve† | CLEAN GRAVELS | GW | Well-graded gravels and gravel-sand mixtures, little or no fines | $\frac{D_{60}}{D_{10} \times D_{20}} > 10$ Greater than 4 $\frac{D_{60}}{D_{10} \times D_{20}}$ Between 1 and 3 Not meeting both criteria for GW | Fastest meeting both criteria for GW | | | | | |
| | | | | | | | GRAVELS WITH FINES | GP | Poorly-graded gravel and gravel-sand mixtures, little or no fines | | | | | | | |
| | | | | | | | | GM | Clayey gravel - gravel-sand-silt mixtures | | | | | | | |
| | | | | | | | GC | Clayey gravels, gravel-sand-clay mixtures | | | | | | | | |
| | | | | | | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | $C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting both criteria for SW | Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7 | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols | | | | |
| | | | | | | | SANDS WITH FINES | SP | Poorly-graded sands and gravelly sands, little or no fines | | | | | | | |
| | | | | | | | | SM | Silty sands, sand-silt mixtures | | | | | | | |
| | | | | | | | | SC | Clayey sands, sand-clay mixtures | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | FINE-GRAINED SOILS 50% or more passes No. 200 sieve* | | | | | | SILTS AND CLAYS Liquid limit 50% or less | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | <div>PLASTICITY CHART</div> <div>For classification of fine-grained soils and fine fraction of coarse-grained soils: Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of "A" line: $PI = 0.73(LL - 20)$</div>  |
| CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | | | | | | | | | | | | | | |
| OL | Organic silts and organic silty clays of low plasticity | | | | | | | | | | | | | | | |
| SILTS AND CLAYS Liquid limit greater than 50% | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | | | | | | | | | | | | |
| | CH | Inorganic clay of high plasticity, fat clays | | | | | | | | | | | | | | |
| | OH | Organic clays of medium to high plasticity | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| HIGHLY ORGANIC SOILS | | | | | | PT | | | | | | | Peat, muck and other highly organic soils | *Based on the material passing the 3.0 (No. 75) mm sieve. †ASTM Designation D 2487, for identification procedure see D 2488 | | |

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|----------------------------|--|
| N | NI | Poorly-bonded or friable | |
| | Nbn | No excess ice, well-bonded | |
| | Nbe | Excess ice, well-bonded | |

NOTE:

- Dual symbols are used to indicate borderline or mixed ice classifications.
- Visual estimates of ice contents indicated on borehole logs $\pm 5\%$.
- This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

LEGEND

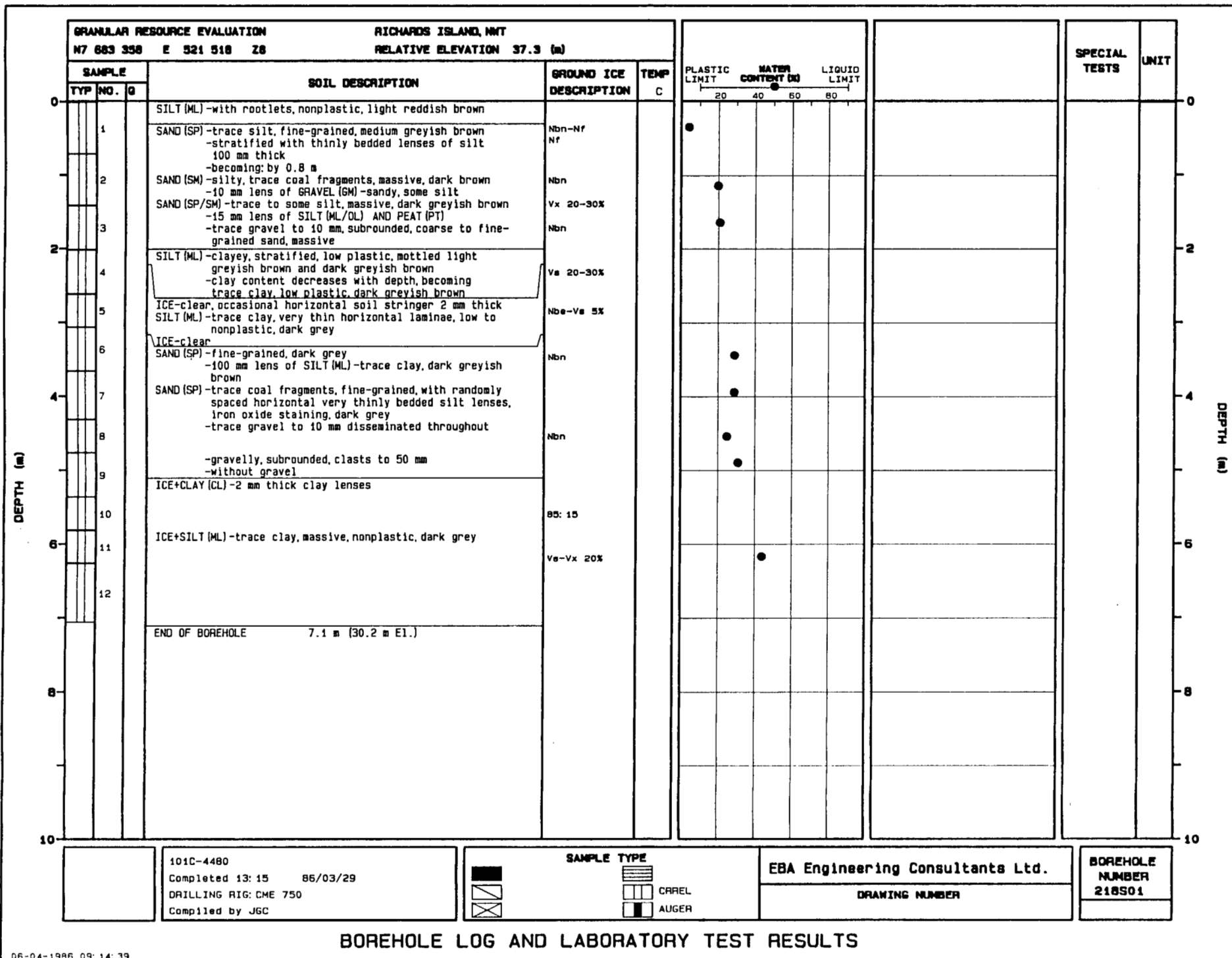
Soil Ice

VISIBLE ICE LESS THAN 50% BY VOLUME

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|--------------------------------------------------|--|
| V | Vx | Individual ice crystals or inclusions | |
| | Vc | Ice coatings on particles | |
| | Vr | Random or irregularly oriented ice formations | |
| | Vs | Stratified or distinctly oriented ice formations | |
| | | | |

VISIBLE ICE GREATER THAN 50% BY VOLUME

| ICE | ICE + Soil Type | |
|-----|----------------------------------------------------------------|--|
| | Ice with soil inclusions | |
| | Ice without soil inclusions (greater than 25 mm (1 in.) thick) | |



| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | | | |
|------------------------------|-----|---|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------|---------------|-------------------|--------------|--|--|---------------|------|-----------|--|--|
| N7 682 786 E 522 243 Z8 | | | | RELATIVE ELEVATION 41.0 (m) | | | | | | | | | | | |
| SAMPLE | | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. | Q | | | | | | | | | | | | | |
| | 1 | | ROOT MAT | Vr-Vs 35% | | | | | | | | | 0 | | |
| | 2 | | ORGANIC SILT (OL) AND PEAT (PT) -fine, fibrous, light greyish brown SILT (ML/OL) -some organics | Vr 20% | | | | | | | | | | | |
| | | | SAND (SM) -gravelly, silty, gravel smooth and subrounded, greyish brown | Nbn | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | | | |
| | 4 | | ICE+CLAY (CL) -silty, clear ice in 2 mm to 10 mm thick stratified lenses, clay in 2 mm thick wavy nonparallel lenses, greyish brown | 70:30 | | | | | | | | | 2 | | |
| | 5 | | SILT (ML) -sandy, trace organics, trace coal, occasional very thinly bedded silt lens 3 mm thick, even, nonparallel, nonplastic, olive brown | Nbn | | | | | | | | | | | |
| | 6 | | SAND (SP) -trace silt to clean, trace coal, medium to fine-grained, uniform, massive, olive grey | Nbn, trace Vc | | | | | | | | | | | |
| | 7 | | ICE-clear | | | | | | | | | | | | |
| | 8 | | ICE+SILT (ML) -trace sand, dark olive grey | | | | | | | | | | 4 | | |
| | 9 | | ICE-clear | | | | | | | | | | | | |
| | 10 | | END OF BOREHOLE 5.2 m (35.8 m El.) | | | | | | | | | | 6 | | |
| | | | | | | | | | | | | | 8 | | |
| | | | | | | | | | | | | | 10 | | |

101C-4480
Completed 08:25 86/03/29
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

CARREL

AUGER

EBA Engineering Consultants Ltd.
(Edmonton)

DRAWING NUMBER

BOREHOLE NUMBER
218S02

BOREHOLE LOG AND LABORATORY TEST RESULTS

H.4

LABORATORY TESTING



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (a) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- 0.70 | 1 | core | | | | | | | | | | | | F |
| 0.30- 0.40 | 1A | | | 4.2 | | | | | | | | | | F |
| 0.70- 1.40 | 2 | core | | | | | | | | | | | | F |
| 1.10- 1.20 | 2A | | SP-SM | 20.0 | | | | | 7.0 | 93.0 | 0.0 | | | F |
| 1.35- 1.40 | 2B | | | | | | | | | | | | | F |
| 1.40- 2.00 | 3 | core | | | | | | | | | | | | F |
| 1.60- 1.70 | 3A | | | 21.0 | | | | | | | | | | F |
| 2.00- 2.60 | 4 | core | | | | | | | | | | | | F |
| 2.60- 3.05 | 5 | core | | | | | | | | | | | | F |
| 3.05- 3.65 | 6 | core | | | | | | | | | | | | F |
| 3.40- 3.50 | 6A | | | 29.0 | | | | | | | | | | F |
| 3.65- 4.30 | 7 | core | | | | | | | | | | | | F |
| 3.90- 4.00 | 7A | | | 29.0 | | | | | | | | | | F |
| 4.30- 4.75 | 8 | core | | | | | | | | | | | | F |
| 4.50- 4.60 | 8A | | | 25.0 | | | | | | | | | | F |
| 4.75- 5.35 | 9 | core | | | | | | | | | | | | F |
| 4.85- 4.95 | 9A | | | 31.0 | | | | | | | | | | F |
| 5.35- 5.80 | 10 | core | | | | | | | | | | | | F |
| 5.80- 6.25 | 11 | core | | | | | | | | | | | | F |
| 6.15- 6.20 | 11A | | | 44.0 | | | | | | | | | | F |
| 6.25- 7.05 | 12 | core | | | | | | | | | | | | F |
| 6.90- 7.00 | 12A | | | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 218S01

Page 1 of 1

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.20 | 1 | core | 88.0 | | | | | | | | | | F |
| 0.20- | 0.90 | 2 | core | | | | | | | | | | | F |
| 0.70- | 0.90 | 2A | | 19.0 | | | | | | | | | | F |
| 0.90- | 1.70 | 3 | core | | | | | | | | | | | F |
| 1.10- | 1.30 | 3A | | 20.0 | | | | | | | | | | F |
| 1.60- | 1.70 | 3B | | 72.0 | | | | | | | | | | F |
| 1.70- | 1.80 | 4 | core | | | | | | | | | | | F |
| 1.80- | 2.40 | 5 | core | 34.0 | | | | | | | | | | F |
| 2.40- | 3.20 | 6 | core | | | | | | | | | | | F |
| 3.20- | 3.80 | 7 | core | 28.0 | | | | | | | | | | F |
| 3.80- | 4.40 | 8 | core | | | | | | | | | | | F |
| 4.40- | 5.00 | 9 | core | | | | | | | | | | | F |
| 5.00- | 5.20 | 10 | core | | | | | | | | | | | F |

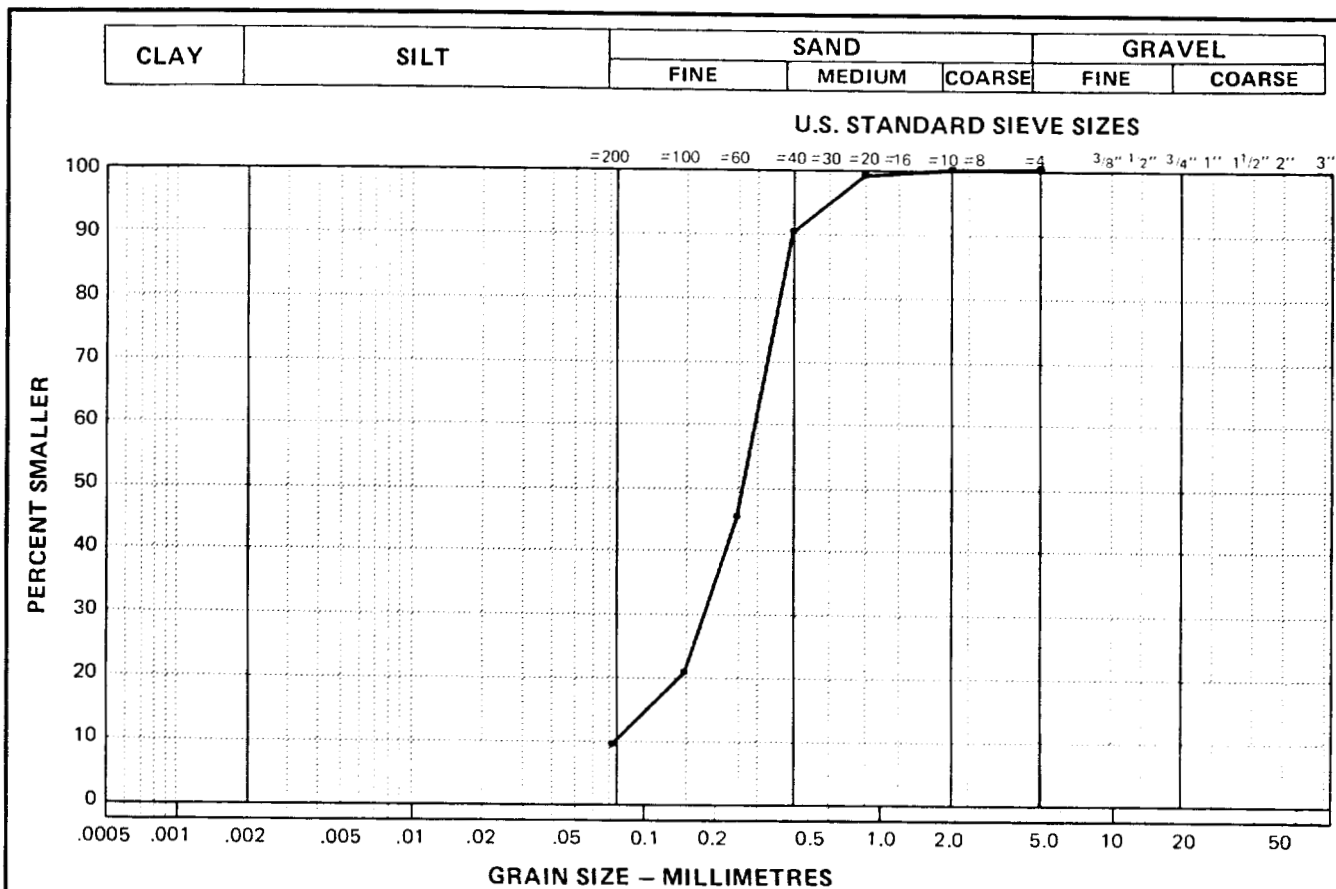
BA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 218S02

Page 1 of 1

PARTICLE - SIZE ANALYSIS OF SOILS



| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| | 86218S01 | 1.10 - 1.20 | - | 7.4 | 92.6 | 0.0 | 3.5 | 1.4 | SP-SM |

JOB NO. 101 -4480

DATE 86-5-14

APPENDIX I
SOURCE 218North

TABLE OF CONTENTS

| | |
|-----|--------------------------------------|
| I.1 | SUMMARY |
| I.2 | SITE DESCRIPTION |
| | I.2.1 Location and Geological Origin |
| | I.2.2 Summary of Previous Studies |
| | I.2.3 Results of Current Study |
| I.3 | BOREHOLE LOGS |
| I.4 | LABORATORY TESTING |

LIST OF FIGURES

Figure I.1 Site Plan for Source 218North



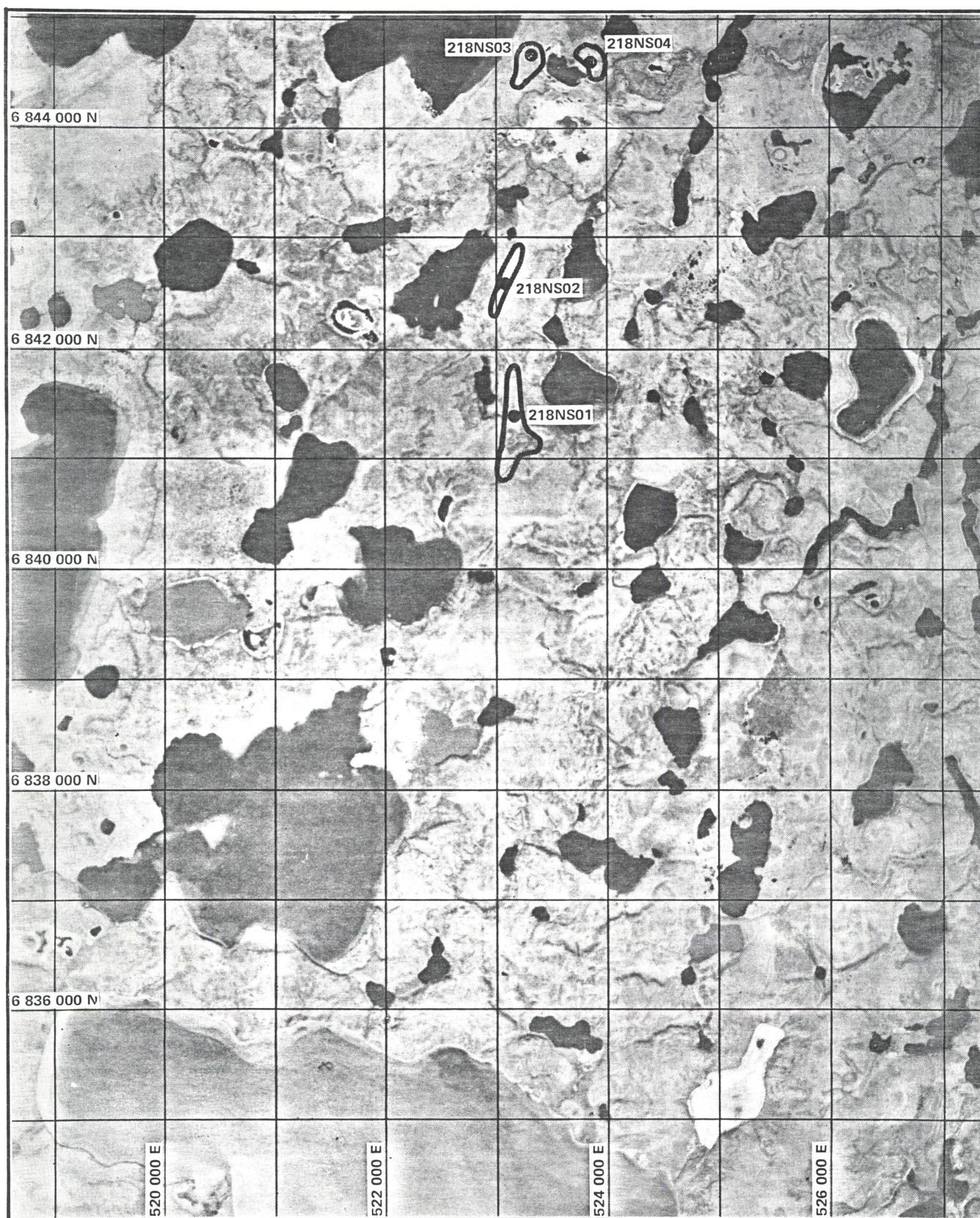


FIGURE I.1 SITE PLAN FOR SOURCE 218N

APPENDIX I
SOURCE 218North

I.1 SUMMARY

| | | |
|---------------------|------------------------------------|------------------------------------|
| Material Type: | sand, silt and ice | |
| Fines Content: | n/a; | |
| Area of Feature: | 1,060,000 m ² | |
| Developable Area: | 0 | |
| Estimated Volume: | Proven (m ³) 0 | Probable (m ³) 0 |
| Excavation Depth: | not recommended | |
| Moisture Content: | 10 to 100% | |
| Borehole Reference: | 218NS01, 218NS02, 218NS03, 218NS04 | |

I.2 SITE DESCRIPTION

I.2.1 Location and Geological Origin

This site consists of a series of small hillocks and ridges stretching north of source 218 towards Willow Lake. Their location is shown on Figure 2 and Figure 1.1.

These sites were identified during the air photo interpretation portion of the study as possibly being related to site 218 in the south and site 211 in the north. As with these two sources, the features that comprise source 218North are likely remnants of glacial outwash features.

Although their limited potential was recognized during the preliminary study, the sites provided a suitable route between the source 218 and source 211 so limited drilling was done.



I.2.2 Summary of Previous Studies

There have been no previous studies conducted at this these sites.

I.2.3 Results of Current Study

Boreholes were drilled at selected locations along the series of ridges that comprise the area. Boreholes 218NS01, 02 and 04 penetrated mainly massive ice although in some holes some sand and gravel was encountered below 1.5 m to 2.0 m of overburden. Borehole 218NS03 encountered silt and some interbedded sand with a 1.5 m thick bed of gravel at a depth of 5.0 m. On the basis of the four widely spaced boreholes, it is unlikely that significant quantities of recoverable granular materials are present at these sites.



I.3 BOREHOLE LOGS

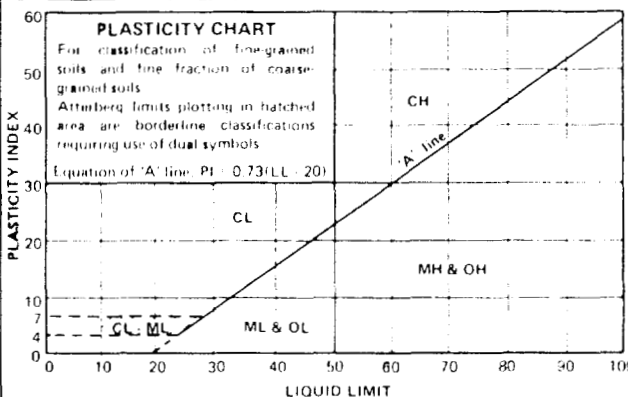


| UNIFIED SOIL CLASSIFICATION† | | | | | | | | |
|------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---------------------------------------------------------------------------------------------------|--|
| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | | |
| COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve* | GRAVELS 50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS | GW | Well-graded gravels with fines less than 5% by dry weight | $C_u = \frac{D_{60} - D_{10}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | |
| | | | GP | Poorly-graded gravels and gravel-sand mixtures with fines less than 5% | | | | |
| | | GRAVELS WITH FINES | GM | Silty gravel, gravel-sand mixtures | Not meeting both criteria for GW Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7 | | | |
| | | | GC | Clayey gravel, gravel-sand clay mixtures | | | | |
| | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | $C_u = \frac{D_{60} - D_{10}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | |
| | | | SP | Poorly-graded sands and gravelly sands, little or no fines | | | | |
| | | SANDS WITH FINES | SM | Silty sands, sand silt mixtures | Not meeting both criteria for SW Atterberg limits plot below "A" line or plasticity index less than 4 Atterberg limits plot above "A" line and plasticity index greater than 7 | | | |
| | | | SC | Clayey sands, sand clay mixtures | | | | |
| | | | FINE-GRAINED SOILS 50% or more passes No. 200 sieve* | SILTS AND CLAYS Liquid limit 50% or less | | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | |
| | | | | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | |
| OL | Organic silts and organic silty clays of low plasticity | | | | | | | |
| SILTS AND CLAYS Liquid limit greater than 50% | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | CH MH & OH ML & OL | | | | |
| | CH | Inorganic clay of high plasticity, fat clays | | | | | | |
| | OH | Organic clays of medium to high plasticity | | | | | | |
| | | | | | | | | |
| HIGHLY ORGANIC SOILS | | PT | | Peat, muck and other highly organic soils | | | | |

Classification on basis of percentage of fines
GW, GP, GM, GC, SW, SP, SM, SC
GM, GC, SM, SC
Borderline classifications requiring use of dual symbols

Less than 5% pass No. 200 sieve
More than 12% pass No. 200 sieve
5% to 12% pass No. 200 sieve

*Based on the material passing the 3/16 x 7/8 mm sieve
†ASTM Designation D 2487; for identification procedure see D 2488



*Based on the material passing the 3.0 x 75 mm sieve
 †ASTM Designation D 2487 for the classification procedure see D 2488

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|----------------------------|--|
| N | NI | Poorly-bonded or friable | |
| | Nbn | No excess ice, well-bonded | |
| | Nbe | Excess ice, well-bonded | |

NOTE:

- Dual symbols are used to indicate borderline or mixed ice classifications
- Visual estimates of ice contents indicated on borehole logs $\pm 5\%$
- This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes

LEGEND

Soil Ice

VISIBLE ICE LESS THAN 50% BY VOLUME

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|--------------------------------------------------|--|
| V | Vx | Ind. vertical ice crystals or inclusions | |
| | Vc | Ice coatings on particles | |
| | Vi | Random or irregularly oriented ice formations | |
| | Vs | Stratified or distinctly oriented ice formations | |

VISIBLE ICE GREATER THAN 50% BY VOLUME

| ICE | ICE + Soil Type | ICE | |
|-----|----------------------------------------------------------------|-----|--|
| | Ice with soil inclusions | | |
| | Ice without soil inclusions (greater than 25 mm (1 in.) thick) | | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | | | |
|------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|--|--|--|--|
| N7 685 431 E 523 172 Z8 | | | | RELATIVE ELEVATION 35.2 (m) | | | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | | | |
| TYP | NO. Q | | | | | | | | | | | | | | |
| 0 | 1 | ROOT MAT ORGANIC SILT (OL) -with rootlets, light brown ICE+ORGANIC SILT (OL) -light brown | Nbn-Nf 90: 10 | | | | | | | | | | | | |
| | 2 | SILT (ML) -some clay, massive, nonplastic, light greyish brown -trace fine-grained sand, dark greyish brown -occasional very thinly cross bedded lens of SILT (ML), clayey, 30 degree angle | Vr-Vx 20-30% | | | | | | | | | | | | |
| | 3 | | Vs 40% | | | | | | | | | | | | |
| 2 | 4 | SAND (SP) -trace silt, fine-grained, occasional 15 mm thinly cross bedded coal lens at a 30 degree angle, dark greyish brown ICE+SAND (SP) -trace silt | Nbn 50: 50 | | | | | | | | | | | | |
| | 5 | SAND (SM) -silty, occasional silt pocket ICE+SILT (ML) -trace sand | Vs 50% | | | | | | | | | | | | |
| | 6 | SAND (SM) -some silt, fine-grained, occasional 20 mm silt pockets SILT (ML) -trace sand, fine-grained, massive, occasional 20 mm thinly bedded lens of SILT (ML) -clayey | | | | | | | | | | | | | |
| 4 | 7 | -10 mm lens GRAVEL (GP) -sandy, subangular -becoming: by 4.4 m ICE+SILT (ML) | Vs-Vx 40% Vx 20% 50: 50 | | | | | | | | | | | | |
| | 8 | SILT (ML) -sandy, trace clay, dark greyish brown -trace sand, trace clay, massive ICE+SILT (ML) | 70: 30 Vx 15-20% | | | | | | | | | | | | |
| 6 | 9 | SILT (ML) -clayey, massive, nonplastic ICE+SILT (ML) | Vx-Vr 20% 60: 40 | | | | | | | | | | | | |
| | 10 | ICE+SILT (ML) | Vx 20% 80: 20 Vx-Vr 25-30% | | | | | | | | | | | | |
| | 11 | ICE+CLAY (CL) -silty, low plastic | 80: 20 Vr-Vx 30% | | | | | | | | | | | | |
| | 12 | SILT (ML) -trace to some clay, dark greyish brown ICE+SILT (ML) | Vr-Vx 10% 95: 5 | | | | | | | | | | | | |
| 8 | 13 | ICE | 1 | | | | | | | | | | | | |
| | | END OF BOREHOLE 8.5 m (26.7 m El.) | | | | | | | | | | | | | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|--|---------------|------|----|--|
| N7 686 565 E 522 914 Z8 | | | | RELATIVE ELEVATION 27.4 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 0 | | ROOT MAT AND PEAT (PT) ORGANIC SILT (OL) - trace sand, damp when thawed, nonplastic, light greyish brown | Nf-Nbn | | | | | | | | | 0 | |
| 1 | | | | | | | | | | | | | |
| 2 | | GRAVEL (GM) - sandy, trace silt, trace coal, well graded, coarse-grained gravel to fine-grained sand, subangular, occasional thinly bedded lens of GRAVEL (GM) - silty | Nbn | | | | | | | | | | |
| 3 | | -silty, some organics, dark brown | | | | | | | | | | | |
| 4 | | CLAY TILL (CL) - silty, trace gravel, trace sand | 90: 10 | | | | | | | | | 2 | |
| 5 | | -becoming by 1.7 m | 85: 15 | | | | | | | | | | |
| 6 | | ICE+CLAY (CL) - silty, soil particles in small balls disseminated throughout | | | | | | | | | | | |
| 7 | | -soil particles maximum 1 mm in diameter, dark olive grey | 90: 10 | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | 4 | |
| 10 | | | 85: 15 | | | | | | | | | | |
| 11 | | -soil particles maximum 10 mm in diameter | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | |
| 14 | | END OF BOREHOLE | 6.2 m (21.2 m E1.) | | | | | | | | | 6 | |
| 10 | | | | | | | | | | | | 10 | |

101C-4480
Completed 06:20 86/03/30
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE

CRREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
218NS02

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | | | |
|------------------------------|-------|-----------------------------------------------------------------------------------------------------|--|-------------------------|--|------|--|---------------|--|-------------------|--|--------------|--|---------------|--|
| N7 888 773 E 523 205 Z8 | | | | RELATIVE ELEVATION N.A. | | | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | | GROUND ICE DESCRIPTION | | TEMP | | PLASTIC LIMIT | | WATER CONTENT (%) | | LIQUID LIMIT | | SPECIAL TESTS | |
| TYP | NO. Q | | | | | C | | | | | | | | | |
| 0 | | ORGANIC SILT (OL) AND PEAT (PT) -with roots at surface | | Nr | | | | | | | | | | | |
| | 1 | -fine-grained, olive brown | | Nbn | | | | | | | | | | | |
| | | -becoming: | | Vs-Vr 15% | | | | | | | | | | | |
| | 2 | SILT (ML) -trace sand, fine-grained, uniform, thinly bedded | | Vs 30% | | | | | | | | | | | |
| | | 30 mm to 50 mm thick, even, parallel, with thin laminae, wavy, nonparallel, nonplastic, olive brown | | | | | | | | | | | | | |
| 2 | 3 | SAND (SP) -trace silt, fine-grained, uniform, occasional very | | Nbn | | | | | | | | | | | |
| | | thinly bedded silt lens, olive brown | | | | | | | | | | | | | |
| | 4 | -with cross bedded lenses of SILT (ML), 50 mm to | | Vc 15% | | | | | | | | | | | |
| | | 100 mm thick at a 30 degree angle | | | | | | | | | | | | | |
| | 5 | -trace gravel, with wood fragments 25 mm thick | | Vr-Vc 10% | | | | | | | | | | | |
| | | -becoming: by 2.5 m | | | | | | | | | | | | | |
| | 6 | SILT (ML) -some sand, fine-grained, uniform, thinly bedded, wavy, | | | | | | | | | | | | | |
| | | nonparallel, olive grey | | | | | | | | | | | | | |
| | 7 | -some sand to sandy, trace coal, with very thin beds | | | | | | | | | | | | | |
| | | and pockets of medium-grained sand | | | | | | | | | | | | | |
| 4 | 8 | ICE+CLAY (CL) -silty | | 70: 30 | | | | | | | | | | | |
| | 9 | SILT (ML) -some sand, with thinly bedded lenses of GRAVEL (GP), | | Vr 5% | | | | | | | | | | | |
| | | sandy | | | | | | | | | | | | | |
| | 10 | -wood, 75 mm in diameter on a 45% angle | | | | | | | | | | | | | |
| | | -olive grey | | | | | | | | | | | | | |
| 6 | 11 | SAND AND GRAVEL (SW/GW) -trace silt, fine-grained gravel, | | Vc 10% | | | | | | | | | | | |
| | | coarse to medium-grained sand, occasional very | | | | | | | | | | | | | |
| | 12 | thinly bedded lens of medium to fine-grained sand, | | | | | | | | | | | | | |
| | | olive - becoming: by 5.5m | | | | | | | | | | | | | |
| 8 | 13 | GRAVEL (GW) -sandy, trace silt, well graded, coarse-grained gravel | | Vc 15% | | | | | | | | | | | |
| | | gravel to fine-grained sand, gravel to 50 mm, angular | | | | | | | | | | | | | |
| | | to subangular, smooth, light greyish brown | | | | | | | | | | | | | |
| 10 | 14 | SAND (SW/SP) -trace fine-grained gravel, trace silt, coarse to | | Nbn | | | | | | | | | | | |
| | | fine-grained sand, massive, olive brown | | | | | | | | | | | | | |
| | 15 | -trace coal fragments | | | | | | | | | | | | | |
| | 16 | ICE+SAND (SP) -fine-grained, very thinly bedded lenses 1 mm | | | | | | | | | | | | | |
| | | to 3 mm thick, even, nonparallel | | | | | | | | | | | | | |
| | 17 | END OF BOREHOLE 8.4 m | | | | | | | | | | | | | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-------|------------------------------------------------------------------------------------|------------------------------|-------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 688 758 E 523 975 Z8 | | | | RELATIVE ELEVATION N.A. | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 0 | 1 | PEAT (PT) AND ORGANIC SILT (OL) -fibrous, dark brown, vertically bedded ice lenses | Vr 20% | | | | | | | | 0 | | |
| | 2 | SILT (ML) -trace clay, massive, nonplastic, light greyish brown | Vs-Vr 20-30% Vr-Vs-Vx 35% | | | | | | | | | | |
| | 3 | | Vs-Vr-Vx 35% | | | | | | | | | | |
| 2 | 4 | -trace coal fragments, occasional pockets of iron oxide staining | Vx-Vr-Vs 35% | | | | | | | | 2 | | |
| | 5 | -trace fine-grained sand | Vx-Vr-Vs 20% | | | | | | | | | | |
| | 6 | -trace clay, trace sand, massive, mottled medium grey and iron oxide staining | Vx-Vr 15-25% | | | | | | | | | | |
| 4 | 7 | -trace gravel to 5 mm, subrounded | | | | | | | | | 4 | | |
| | 8 | ICE-clear, crystalline, air bubbles disseminated throughout | | | | | | | | | | | |
| | 9 | -with occasional soil particles | | | | | | | | | | | |
| | 10 | -becoming dirty with depth | | | | | | | | | | | |
| 6 | 11 | ICE+SAND (SM) -silty, fine-grained, massive, medium greyish brown | 50:50 90:10 | | | | | | | | 6 | | |
| | 12 | ICE+SILT (ML) -2 mm diameter soil particles disseminated throughout | | | | | | | | | | | |
| | 13 | -clear, clean | | | | | | | | | | | |
| 8 | 14 | END OF BOREHOLE 8.0 m | | | | | | | | | 8 | | |
| 10 | | | | | | | | | | | 10 | | |

101C-4480
Completed 16:00 88/03/30
DRILLING RIG: CME 750
Compiled by JGC

SAMPLE TYPE

CAREL
AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
218NS04

BOREHOLE LOG AND LABORATORY TEST RESULTS

I.4

LABORATORY TESTING



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.50 | 1 | core | | | | | | | | | | | F |
| 0.15- | 0.25 | 1A | | | | | | | | | | | | F |
| 0.25- | 0.50 | 1B | | | | | | | | | | | | F |
| 0.50- | 0.90 | 2 | core | | | | | | | | | | | F |
| 0.70- | 0.80 | 2A | | 53.0 | | | | | | | | | | F |
| 0.90- | 1.50 | 3 | core | | | | | | | | | | | F |
| 1.10- | 1.20 | 3A | | 35.0 | | | | | | | | | | F |
| 1.50- | 2.40 | 4 | core | | | | | | | | | | | F |
| 2.20- | 2.40 | 4A | | 32.0 | | | | | | | | | | F |
| 2.40- | 3.20 | 5 | core | | | | | | | | | | | F |
| 2.90- | 3.00 | 5A | | 39.0 | | | | | | | | | | F |
| 3.20- | 4.00 | 6 | core | | | | | | | | | | | F |
| 3.60- | 3.70 | 6A | | 46.0 | | | | | | | | | | F |
| 4.00- | 4.60 | 7 | core | | | | | | | | | | | F |
| 4.35- | 4.45 | 7A | | 70.0 | | | | | | | | | | F |
| 4.45- | 4.60 | 7B | | | | | | | | | | | | F |
| 4.60- | 5.40 | 8 | core | | | | | | | | | | | F |
| 4.60- | 5.00 | 8A | | | | | | | | | | | | F |
| 5.00- | 5.20 | 8B | | | | | | | | | | | | F |
| 5.20- | 5.30 | 8C | | 44.0 | | | | | | | | | | F |
| 5.40- | 6.20 | 9 | core | | | | | | | | | | | F |
| 5.70- | 5.80 | 9A | | 75.0 | | | | | | | | | | F |
| 6.00- | 6.20 | 9B | | | | | | | | | | | | F |
| 6.20- | 6.70 | 10 | core | | | | | | | | | | | F |
| 6.30- | 6.60 | 10A | | 55.0 | | | | | | | | | | F |
| 6.60- | 6.70 | 10B | | | | | | | | | | | | F |
| 6.70- | 7.30 | 11 | core | | | | | | | | | | | F |
| 7.10- | 7.20 | 11A | | 47.0 | | | | | | | | | | F |
| 7.30- | 7.90 | 12 | core | | | | | | | | | | | F |
| 7.40- | 7.50 | 12A | | | | | | | | | | | | F |
| 7.70- | 7.90 | 12B | | | | | | | | | | | | F |
| 7.90- | 8.50 | 13 | core | | | | | | | | | | | F |
| 8.20- | 8.30 | 13A | | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 218NS01

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | | F |
| 0.80- | 0.90 | 1A | | 11.0 | | | | | | | | | | F |
| 0.90- | 1.20 | 2 | core | | | | | | | | | | | F |
| 1.00- | 1.20 | 2A | | 12.0 | | | | | | | | | | F |
| 1.20- | 1.80 | 3 | core | | | | | | | | | | | F |
| 1.40- | 1.60 | 3A | | | | | | | | | | | | F |
| 1.80- | 2.10 | 4 | core | | | | | | | | | | | F |
| 2.10- | 2.60 | 5 | core | | | | | | | | | | | F |
| 2.60- | 2.90 | 6 | core | | | | | | | | | | | F |
| 2.90- | 3.40 | 7 | core | | | | | | | | | | | F |
| 3.40- | 3.80 | 8 | core | | | | | | | | | | | F |
| 3.80- | 4.30 | 9 | core | | | | | | | | | | | F |
| 4.30- | 4.70 | 10 | core | | | | | | | | | | | F |
| 4.70- | 5.00 | 11 | core | | | | | | | | | | | F |
| 5.00- | 5.50 | 12 | core | | | | | | | | | | | F |
| 5.50- | 5.90 | 13 | core | | | | | | | | | | | F |
| 5.90- | 6.20 | 14 | core | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 218NS02

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | | F |
| 0.50- | 0.70 | 1A | | 28.0 | | | | | | | | | | F |
| 0.70- | 0.80 | 1B | | | | | | | | | | | | F |
| 0.90- | 1.40 | 2 | core | | | | | | | | | | | F |
| 1.20- | 1.40 | 2A | | 44.0 | | | | | | | | | | F |
| 1.40- | 2.10 | 3 | core | | | | | | | | | | | F |
| 1.90- | 2.10 | 3A | | 24.0 | | | | | | | | | | F |
| 2.10- | 2.40 | 4 | core | | | | | | | | | | | F |
| 2.30- | 2.40 | 4A | | 24.0 | | | | | | | | | | F |
| 2.40- | 3.20 | 5 | core | | | | | | | | | | | F |
| 2.90- | 3.10 | 5A | | 55.0 | | | | | | | | | | F |
| 3.20- | 4.00 | 6 | core | | | | | | | | | | | F |
| 3.50- | 3.60 | 6A | | 28.0 | | | | | | | | | | F |
| 3.70- | 3.80 | 6B | | | | | | | | | | | | F |
| 4.00- | 4.70 | 7 | core | | | | | | | | | | | F |
| 4.10- | 4.20 | 7A | | | | | | | | | | | | F |
| 4.50- | 4.70 | 7B | | 35.0 | | | | | | | | | | F |
| 4.70- | 5.50 | 8 | core | | | | | | | | | | | F |
| 4.90- | 5.20 | 8A | | | | | | | | | | | | F |
| 5.50- | 6.20 | 9 | core | | | | | | | | | | | F |
| 5.80- | 6.00 | 9A | | | | | | | | | | | | F |
| 6.20- | 7.00 | 10 | core | | | | | | | | | | | F |
| 6.60- | 6.80 | 10A | | | | | | | | | | | | F |
| 7.00- | 7.80 | 11 | core | | | | | | | | | | | F |
| 7.80- | 8.40 | 12 | core | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 218NS03

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Kg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.80 | 1 | core | | | | | | | | | | | F |
| 0.80- | 0.70 | 1A | | 2295.0 | | | | | | | | | | F |
| 0.80- | 1.60 | 2 | core | | | | | | | | | | | F |
| 1.30- | 1.40 | 2A | | 39.0 | | | | | | | | | | F |
| 1.60- | 1.95 | 3 | core | | | | | | | | | | | F |
| 1.80- | 1.85 | 3A | | 29.0 | | | | | | | | | | F |
| 1.95- | 2.55 | 4 | core | | | | | | | | | | | F |
| 2.20- | 2.30 | 4A | | 34.0 | | | | | | | | | | F |
| 2.55- | 3.15 | 5 | core | | | | | | | | | | | F |
| 2.90- | 3.00 | 5A | | 31.0 | | | | | | | | | | F |
| 3.15- | 4.10 | 6 | core | | | | | | | | | | | F |
| 3.50- | 3.60 | 6A | | 37.0 | | | | | | | | | | F |
| 4.10- | 4.70 | 7 | core | | | | | | | | | | | F |
| 4.70- | 5.30 | 8 | core | | | | | | | | | | | F |
| 5.30- | 5.75 | 9 | core | | | | | | | | | | | F |
| 5.65- | 5.75 | 9A | | | | | | | | | | | | F |
| 5.75- | 6.35 | 10 | core | | | | | | | | | | | F |
| 6.35- | 6.65 | 11 | core | | | | | | | | | | | F |
| 6.65- | 7.10 | 12 | core | | | | | | | | | | | F |
| 7.10- | 7.60 | 13 | core | | | | | | | | | | | F |
| 7.60- | 8.00 | 14 | core | | | | | | | | | | | F |

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GRANULAR RESOURCE EVALUATION

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APPENDIX J
SOURCE 219

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Source 219

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FIGURE J.1 SITE PLAN FOR SOURCE 219

APPENDIX J
SOURCE 219

J.1 SUMMARY

| | | |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Material Type: | well graded sand, some gravel uniform sand | |
| Fines Content: | 0 to 17%, average 4% | |
| Area of Feature: | 1,500,000 m ² | |
| Developable Area: | 7,500 m ² | |
| Estimated Volume: | Proven (m ³) | Probable |
| type II borrow | 30,000 | |
| type II & type IV borrow w/m.c. over 10% | 200,000 | rec. reqd. |
| Excavation Depth: | varies from 4 m to 8 m | |
| Moisture Content: | 5 to 20% | |
| Borehole Reference: | 219S01, 219S02, 212S03, 219S04, 219S05, 219S06, 219S07, 219S08, 219S09, 219S10, 219S11, RKL219-1 to RKL219-5, RKL219-A, RKL219-B | |

J.2 SITE DESCRIPTION

J.2.1 Location and Geological Origin

Site 219 is a large flat-topped ridge situated to the east of Ya-Ya Lake. Figure 2 and Figure J.1 illustrates its location. RKL(1972) suggests that it may be a crevasse filling. However, the data that has been collected at the site does not support this hypothesis.

Highly variable subsurface conditions were encountered during both the RKL(1972) investigation and the present one. Some borings encountered Type II granular material, while others encountered only silt and ice.



Fine-grained sand was also encountered. One area containing 30,000 m³ of Type II borrow has been identified, however, the rest of the area is too variable for accurate delineation on the basis of the existing borehole coverage. High moisture contents (over 10 percent) are typical throughout most of the source, indicating that more expensive extraction methods will be required. However, the potentially large volume of material may justify the additional expense.

J.2.2 Summary of Previous Studies

RKL(1972) has excavated two test pits and drilled five boreholes at this site. They have determined that the deposit contained a large volume of granular material, but that its distribution was erratic. Some locations contained sandy gravel and others gravelly sand. However, some of the borings encountered massive ice and/or icy silt at relatively shallow depths.

J.2.3 Results of Current Study

Despite the general variability of the deposit, one area appeared to contain a consistent deposit of Type II material to a depth of approximately 4.0 m. The material became siltier (Type III) below this depth. This was evidenced by the borehole data and by material exposed in local slopes. The location of this area is shown as Area A on Figure J.2. The moisture content was less than 5% and therefore extraction should be feasible during the winter months. The volume of material in Area A is approximately 30,000 m³.

Over the rest of the site, conditions were more variable. Many of the boreholes encountered a bed of granular material up to 5 m thick. The material was predominantly medium-grained sand with some gravel to 20 mm. Silt contents average approximately 4%, but are as high as 20%. Some samples exhibited gap-graded grain size distributions and some samples were quite uniform. Since it has not been possible to differentiate between areas of different gradational characteristics, a single grain size envelope



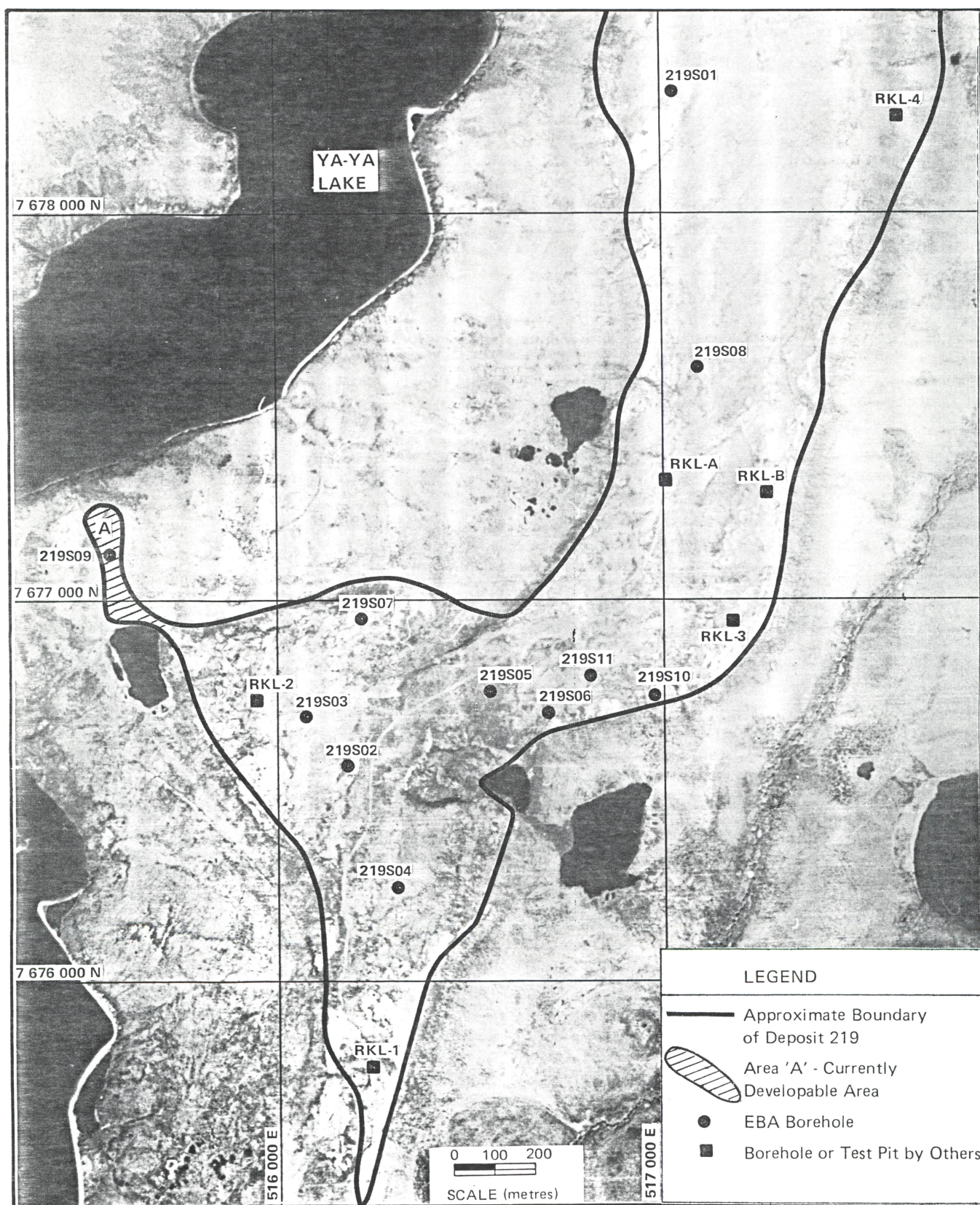


FIGURE J.2 PIT DEVELOPMENT SITE PLAN
SOURCE 219

for the source (Figure J.3) has been produced. Moisture contents to 20% were common in the deposits. Considering these factors, the deposit has been classed as Type III borrow.

The volume of the resource was estimated by determining the area where most boreholes encountered a granular deposit at least 5 m thick. A reduction factor of 50% was applied to account for the fact that the deposit was not continuous.

A portion of the granular material is covered with a veneer of silty till. This till reaches a thickness of approximately 3 m at one borehole location.

A petrographic analysis was made on a sample of material combined from borehole 219S02 and 219S09. The results are presented in Table J.1. The presence of a significant component of chert suggest that the material is not suitable as concrete aggregate, even after washing and screening.

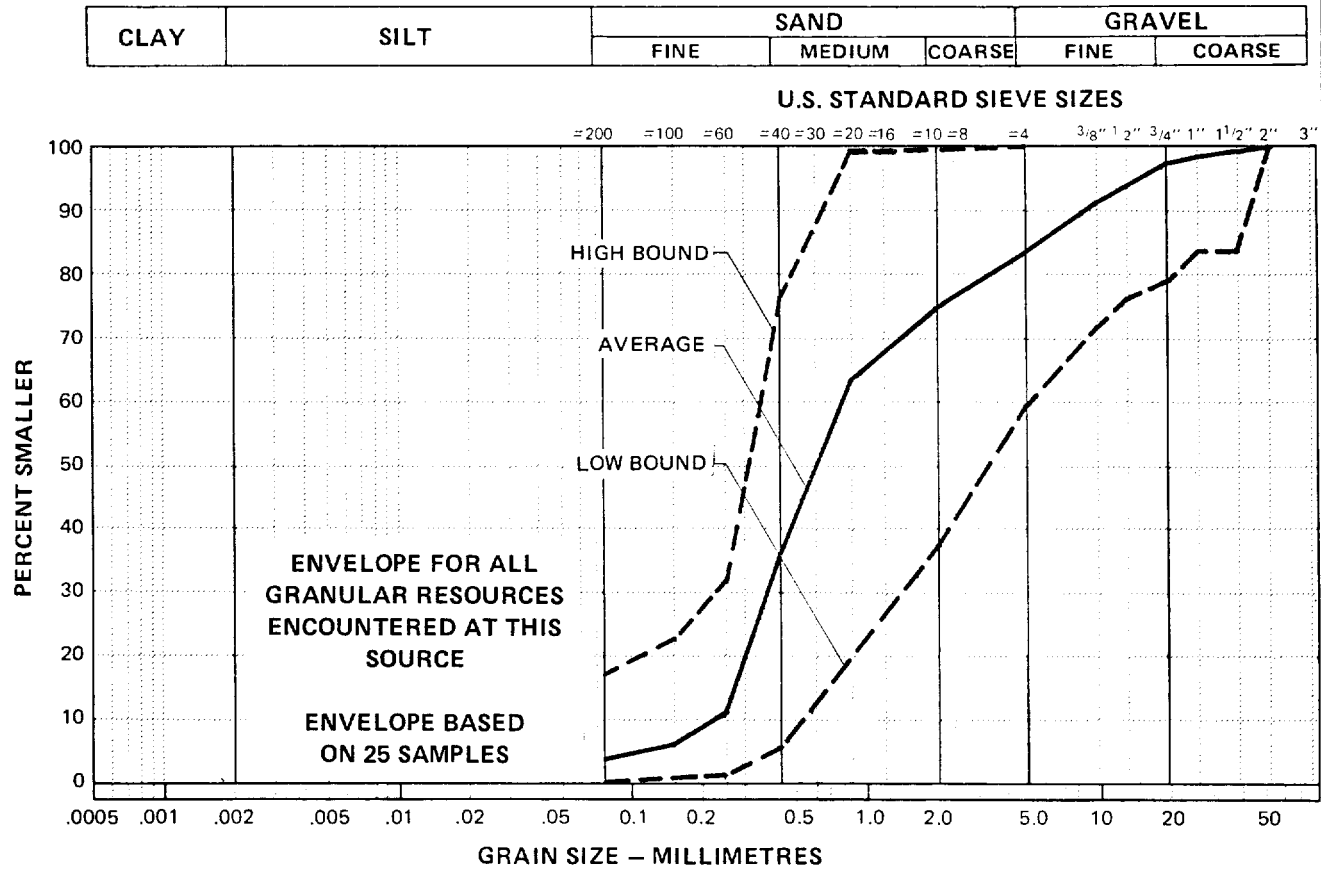
J.3 PIT DEVELOPMENT

This section of the report contains recommendations for development of the area shown as Area A on Figure J.2. It also addresses, in a more preliminary manner, the development of the entire source. Site reconnaissance of the remainder of the source is recommended before development is contemplated. Recommendations presented here must be re-evaluated if additional data becomes available.

J.3.1 Access

Winter access is recommended for this source. The most practical route to the site is from the west by proceeding from the Mackenzie River over Ya-Ya Lake. For a very large operation an all-weather road from shore to the source might be practical.





**FIGURE J.3 GRAIN SIZE ENVELOPE
FOR SOURCE 219 MATERIAL**

TABLE J.1 PETROGRAPHIC ANALYSIS - SOURCE 219

| | | |
|----------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Orthoquartzite | 44.2% | - Silicified fine-grained sandstone and siltstone grading into amorphous silica; various colours; hard and durable; subrounded to angular flakes of larger pieces. |
| Chert | 31.7% | - Amorphous silica to semi-translucent cherts; brown to grey with some black pieces; subangular to subrounded. |
| Quartzitic | 13.8% | - Medium to coarse-grained sandstone; silicified and grades into orthoquartzite; hard; subrounded to angular. |
| Basalt | 6.1% | - Aphanitic (very fine-grained), black, hard, rounded to angular; some particles show moderate weathering. |
| Quartz | 4.2% | - Crystalline fragment that appear to have broken off large clasts; white, hard and angular. |
| <hr/> | | |
| 100% | | |

NOTE: Based on combined sample of 219S02 (0-0.6 m) and 219S09 (1.9-2.6 m).



J.3.2 Site Preparation

Very little overburden was present in Area A. What little is encountered should be stockpiled for use during reclamation. These stockpiles should be situated well away from Ya-Ya Lake so that melt water from the stockpiles does not enter the lake. Similarly, drainage from the deposit itself should be directed away from Ya-Ya Lake.

Over the major portion of the resource, site preparation should consist of stripping the overburden from the area to be developed. The overburden should be placed in stockpiles well away from the working pit, separating the organic material from the inorganic material. As an alternative to stockpiling, the inorganic material may be placed in previously developed portions of the pit as part of the restoration work. This would not be possible if the worked-out portions of the pit were required for access or for impounding of meltwaters.

J.3.3 Extraction Methods

Area A may be developed first because of its proven resources, high quality and low moisture content. On the basis of the single borehole it appears that the resource can be stripped to a depth of 4 m. The moisture contents are approximately 5 percent, so that conventional ripping and stripping methods can be used. The material should be stripped and loaded directly as there is no advantage to be gained from temporary stockpiles.

The remainder of the source has a generally higher moisture content and often a substantial overburden (up to 3 m). The usual practices for granular resource extraction will not be adequate in this case. Considerable extra effort in the planning and execution of the operation will be required. This will be justified only if the extent of the resource can be proven and a large demand exists. Increased supervision of pit operation would also be required.



The areal extent of the deposit is quite large and therefore staged development is recommended. Overburden must first be stripped from the area to be developed and stockpiled, separating the organic topsoil. The cut face of the overburden should be left as nearly vertical as possible. Sufficient overburden should be stripped to leave a buffer zone between the overburden face and the proposed pit to allow for slumping of this material. This buffer zone should be at least three times the height of the overburden face.

When the granular material begins to thaw it can be stripped and placed in windrows to drain. If the thawed material is worked relatively continuously it can be expected that the full 5 m thickness of the deposit can be extracted in two to three summers. Each stage of the development should be sized to provide sufficient material to meet projected annual demand.

J.3.4 Treatment of Ground Ice

Site specific recommendations for treatment of massive ice cannot be made due to the variability of ice bodies. Each occurrence must, therefore be evaluated individually as it is encountered in the pit. Use of a geophysical method, such as ground penetrating radar, may help identify massive ice deposits in the pit planning stage.

No indication of massive ice deposits are evident for Area A of this source. Even so, their occurrence should be anticipated. Where practical, extensive bodies of ice should be avoided. Thin or less areally extensive bodies of ice within the granular materials should be excavated and wasted, or exposed to permit thawing during the summer.

J.3.5 Drainage

Drainage from this source should not be allowed to enter Ya-Ya Lake, which is a valuable resource to the local people. The small lake to the south of Area A is likely of less economic importance and it should be possible to



use this lake to receive water from melting ice and surface runoff. If this is not possible, then an impoundment structure may have to be constructed. The cost of an impoundment structure would have to be weighed against the economic and environmental costs of contaminating Ya-Ya Lake. Gravity drainage of closed depressions caused by thaw may not be possible. Pumps may be required to maintain acceptable trafficability during the summer months. Thaw ponds in the previously worked areas are usually acceptable and convenient destinations for discharge from the active pit.

J.3.6 Waste Material

Development of the major portion of this source will produce substantial amounts of waste material. The waste material should be stockpiled near the overburden for use in pit reclamation. Fine-grained material obtained at depth will undoubtedly have high ice contents; therefore, waste piles may have to be confined by berms of thaw stable material.

J.3.7 Restoration

On opening the first stage of the pit, overburden and organic soil should be stockpiled. When subsequent stages of the pit are opened overburden may be placed in exhausted portions of the pit while organic soil should be added to the existing stockpile. The organic soil should be used to cover stable exposed slopes and hilltops wherever feasible.



J.4

BOREHOLE LOGS



UNIFIED SOIL CLASSIFICATION†

| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | | |
|------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve* | GRAVELS 50% or more of coarse fraction retained on No. 4 sieve | CLEAN GRAVELS | GW | Well-graded gravels and gravel-sand mixtures, little or no fines | $C_u = \frac{D_{60}}{D_{10}} \geq 10$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 *Not meeting both criteria for GW | | | |
| | | | GP | Poorly-graded gravels and gravel-sand mixtures, little or no fines | | | | |
| | | GRAVELS WITH FINES | GM | Silty gravels, gravel-sand silt mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 | | | |
| | | | GC | Clayey gravels, gravel-sand clay mixtures | Atterberg limits plot above "A" line and plasticity index greater than 7 | | | |
| | SANDS More than 50% of coarse fraction passes No. 4 sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | $C_u = \frac{D_{60}}{D_{10}} \geq 10$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | |
| | | | SP | Poorly-graded sands and gravelly sands, little or no fines | Not meeting both criteria for SW | | | |
| | | SANDS WITH FINES | SM | Silty sands, sand silt mixtures | Atterberg limits plot below "A" line or plasticity index less than 4 | | | |
| | | | SC | Clayey sands, sand clay mixtures | Atterberg limits plot above "A" line and plasticity index greater than 7 | | | |
| | | | FINE-GRAINED SOILS 50% or more passes No. 200 sieve* | SILTS AND CLAYS Liquid limit 50% or less | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands | <div>PLASTICITY CHART</div> <div>For classification of fine-grained soils and fine fraction of coarse-grained soils</div> <div>Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols</div> <div>Equation of "A" line: $PI = 0.73(LL - 20)$</div> | |
| | | | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | |
| OL | Organic silts and organic silty clays of low plasticity | | | | | | | |
| SILTS AND CLAYS Liquid limit greater than 50% | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | | | | |
| | CH | Inorganic clay of high plasticity, fat clays | | | | | | |
| | OH | Organic clays of medium to high plasticity | | | | | | |
| HIGHLY ORGANIC SOILS | | PT | Peat, muck and other highly organic soils | *Based on the material passing the 3 in. (75 mm) sieve †ASTM Designation D 2487, for identification procedure see D 2488 | | | | |

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|----------------------------|--|
| N | Ni | Poorly-bonded or friable | |
| | Nbn | No excess ice, well-bonded | |
| | Nbe | Excess ice, well-bonded | |

NOTE

- Dual symbols are used to indicate borderline or mixed ice classifications
- Visual estimates of ice contents indicated on borehole logs $\pm 5\%$
- This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes

LEGEND

Soil Ice

VISIBLE ICE LESS THAN 50% BY VOLUME

| GROUP SYMBOLS | SYMBOLS | SUBGROUP DESCRIPTION | |
|---------------|---------|--------------------------------------------------|--|
| V | Vx | Individual ice crystals or inclusions | |
| | Vc | Ice coatings on particles | |
| | Vr | Random or irregularly oriented ice formations | |
| | Vs | Stratified or distinctly oriented ice formations | |

VISIBLE ICE GREATER THAN 50% BY VOLUME

| | | | |
|-----|-----------------|----------------------------------------------------------------|--|
| ICE | ICE + Soil Type | Ice with soil inclusions | |
| | ICE | Ice without soil inclusions (greater than 25 mm (1 in.) thick) | |

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 878 316 E 517 032 Z8 | | | | RELATIVE ELEVATION 41.3 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 0 | | PEAT (PT) -fibrous, with rootlets, dark brown -silty, trace to some sand, coarse to medium-grained | | | | | | | | | 0 | | |
| 1 | | SAND (SM) -some silt, some gravel, trace to some organics, organic content decreases with depth, gravel to 50 mm, subrounded, smooth, dark brown -DRILLER'S NOTE: hole sloughing -gravel subrounded to subangular, medium to dark brown | Nf Vr-Vc 15% | | | | | | | | | | |
| 2 | | | Nf Vr-Vc 15% | | | | | | | | | | |
| 2 | | SAND (SW) -some gravel, trace silt, coarse to fine-grained sand, gravel decreases with depth, light grey -becoming: by 2.0 m | | | | | | | | | 2 | | |
| 3 | | SAND (SM) -trace silt, trace gravel, medium to fine-grained sand -silt content decreases with depth -becoming: by 2.7 m | Nbn | | | | | | | | | | |
| 4 | | SAND (SP) -trace silt, medium to fine-grained ICE-trace sand and silt | Vc 20% | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| 4 | | SILT (ML) -sandy, very thinly bedded, curved, nonparallel, dark brownish grey -ice content increases with depth | Vr-Vs 15% | | | | | | | | 4 | | |
| 7 | | | Vr-Vs 20% | | | | | | | | | | |
| 8 | | | Vr 30% | | | | | | | | | | |
| 6 | | -trace 5 mm gravel, dark olive grey | | | | | | | | | 6 | | |
| 9 | | | Vr-Vs 40% | | | | | | | | | | |
| 10 | | ICE+SILT (ML) -sandy, dark olive grey | 60: 40 | | | | | | | | | | |
| 11 | | -occasional lens of ICE 100 mm thick | 50: 50 | | | | | | | | | | |
| 12 | | | | | | | | | | | 8 | | |
| 13 | | | | | | | | | | | | | |
| | | END OF BOREHOLE 9.1 m (32.2 m El.) | | | | | | | | | | | |

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SAMPLE TYPE

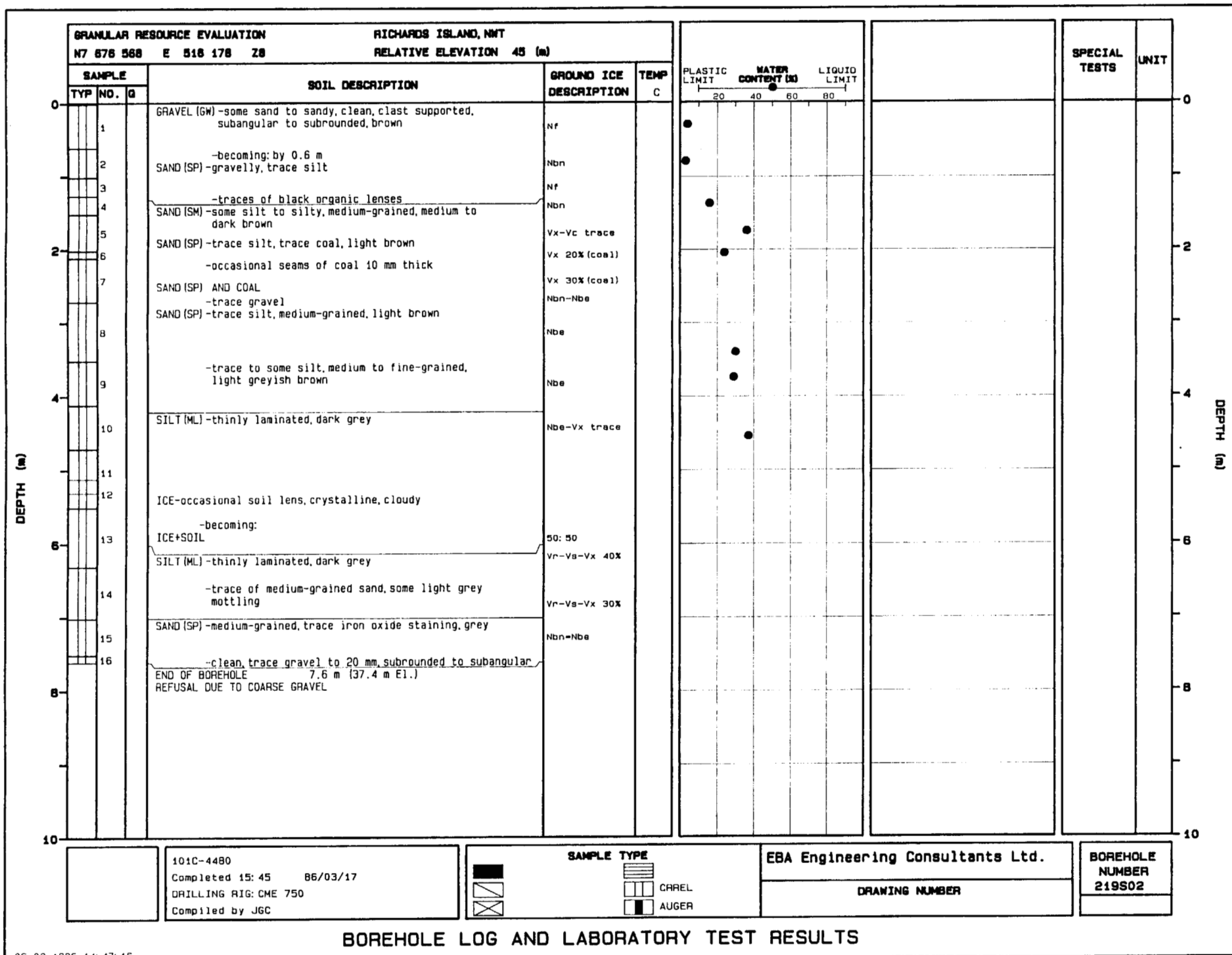
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AUGER

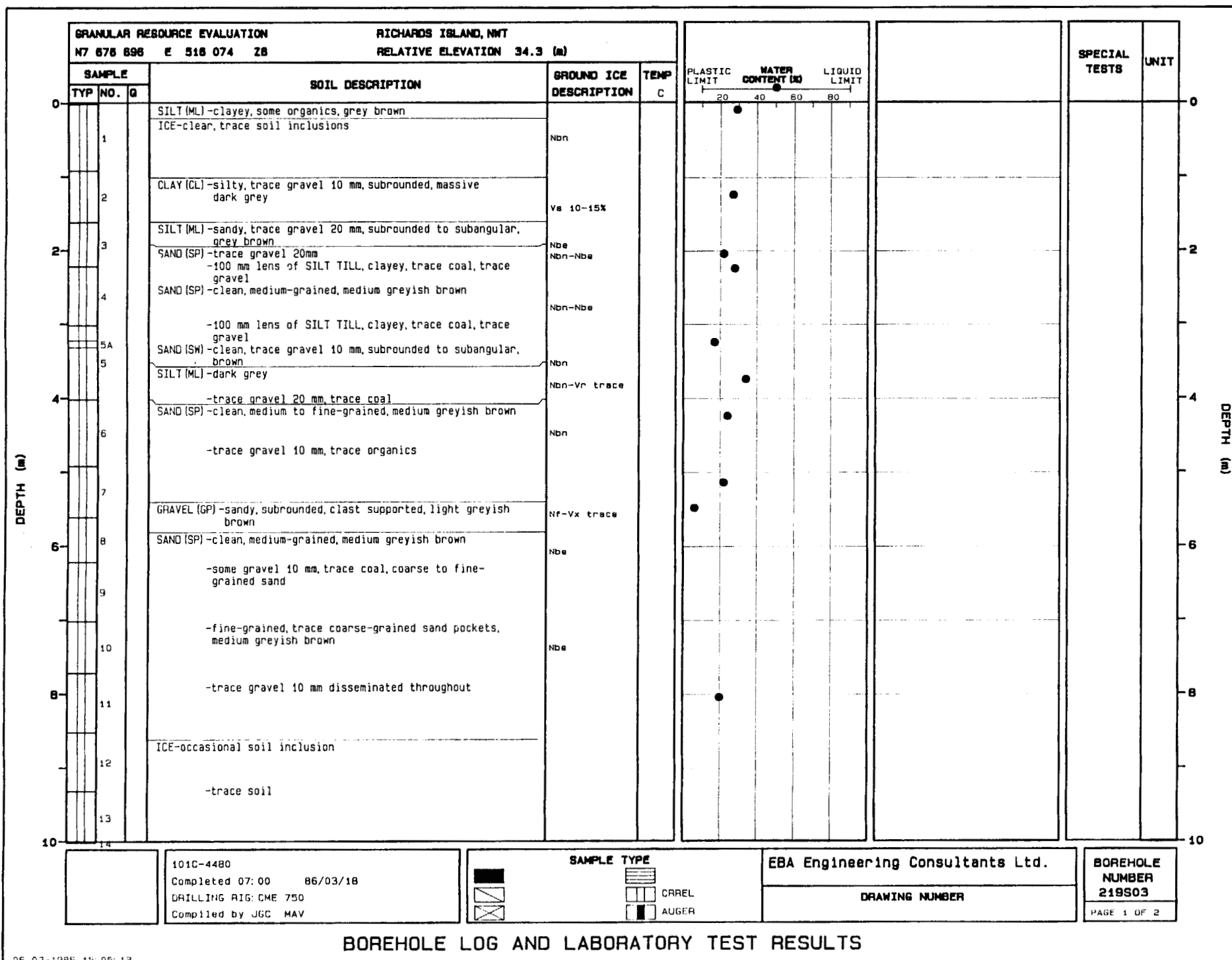
EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER
219S01

BOREHOLE LOG AND LABORATORY TEST RESULTS





| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NMT | | | | | | | | | |
|------------------------------|-------|-------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---------------|------|--|--|--|
| N7 878 896 E 518 074 Z8 | | | | RELATIVE ELEVATION 34.3 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 10 | 13 | | | | | | | | | | | | |
| | 14 | SILT TILL (ML) -some sand, trace to some clay, trace gravel 5 mm, | Vr 30-40% | | | | | | | | | | |
| | 15 | | | | | | | | | | | | |
| | 16 | ICE-very thinly bedded, even, nonparallel | | | | | | | | | | | |
| | 17 | | | | | | | | | | | | |
| | 18 | -100 mm lens of ICE+SILT TILL | | | | | | | | | | | |
| 12 | 19 | | | | | | | | | | | | |
| | 20 | CLAY (CL) -silty, trace to some fine-grained sand, brown organics | 90: 10 | | | | | | | | | | |
| | 21 | ICE+SILT | 80: 20 | | | | | | | | | | |
| | 22 | | | | | | | | | | | | |
| | 23 | -trace fine-grained sand | | | | | | | | | | | |
| | 24 | | | | | | | | | | | | |
| 14 | 25 | | | | | | | | | | | | |
| | 26 | -becoming: | 50: 50 | | | | | | | | | | |
| 16 | 27 | | 70: 30 | | | | | | | | | | |
| | 28 | -very thinly bedded, even, nonparallel, dark grey | | | | | | | | | | | |
| | 29 | | | | | | | | | | | | |
| | 30 | -sandy, trace clay, very thin laminae, wavy | 50: 50 | | | | | | | | | | |
| 18 | 31 | -gravel to 50 mm, subrounded, smooth | | | | | | | | | | | |
| | 32 | | | | | | | | | | | | |
| | | END OF BOREHOLE 19.2 m (15.1 m El.) | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | |

101C-4480
Completed 07:00 86/03/18
DRILLING RIG: CME 750
Compiled by JGC MAV

SAMPLE TYPE

CAREL
AUGER

EBA Engineering Consultants Ltd.

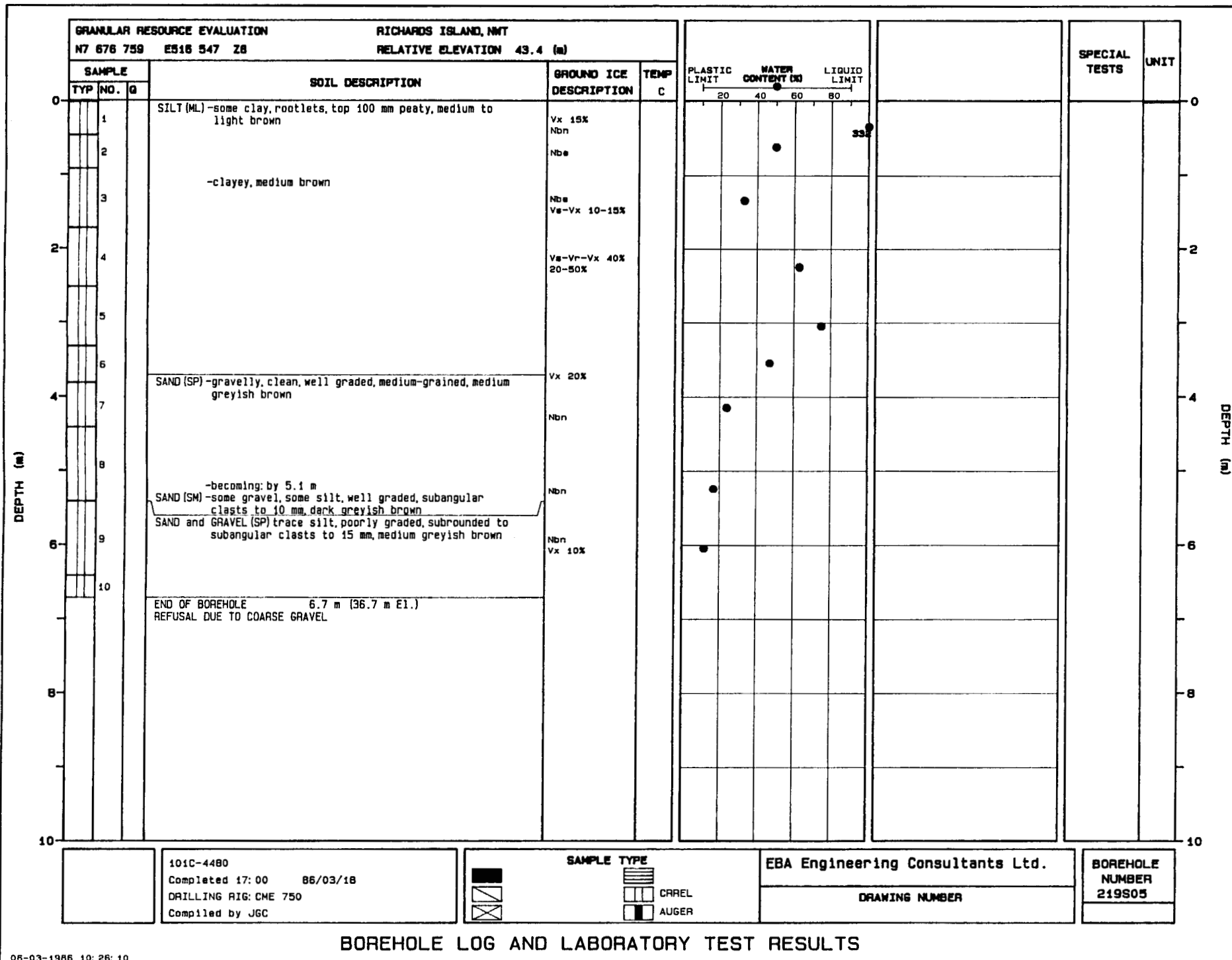
DRAWING NUMBER

BOREHOLE NUMBER
219S03

PAGE 2 OF 2

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|-------------------|--|--------------|---------------|------|--|--|--|--|
| N7 676 251 E 516 309 Z8 | | | | RELATIVE ELEVATION 42 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | WATER CONTENT (%) | | | SPECIAL TESTS | UNIT | | | | |
| TYP NO. | Q | | | | PLASTIC LIMIT | | LIQUID LIMIT | | | | | | |
| 0 | | SILT (ML) -clayey, occasional rootlets throughout, medium brown | Nbn | | | | | | | | | | |
| 1 | | -peaty | Vs-Vr 25% | | | | | | | | | | |
| 2 | | SAND (SP) -trace to some fine-grained gravel, subangular clasts to 10 mm, poorly graded | Nbn | | | | | | | | | | |
| 3 | | -gravelly, clean, well graded, clasts to 20 mm, medium greyish brown | Nbe | | | | | | | | | | |
| 4 | | -100 mm coal lens, fragments 10 mm in diameter | Vr 40% | | | | | | | | | | |
| 5 | | -medium-grained, clean, occasional gravel 20 mm, subrounded to subangular | Nbn | | | | | | | | | | |
| 6 | | -50 mm lens of coal and organics | Vr trace | | | | | | | | | | |
| 7 | | | Nbe, Vs | | | | | | | | | | |
| 8 | | GRAVEL (GM) -sandy, silty -becoming: by 5.4 m | Vx 30% | | | | | | | | | | |
| 9 | | SAND (SP) -trace fine-grained gravel, occasional clasts to 20 mm, predominantly medium-grained sand trace to some coarse-grained, medium greyish brown -trace organics and coal | Nbe | | | | | | | | | | |
| 10 | | -clean, occasional 15 mm clasts, occasional gravelly pockets fine-grained, well graded | Nbe | | | | | | | | | | |
| 11 | | -becoming: by 7.2 m | Vx 15% | | | | | | | | | | |
| 12 | | GRAVEL (GM) -sandy, clean, well graded, gravel 30 mm subrounded, medium-grained sand | 90: 10 | | | | | | | | | | |
| 13 | | ICE-disseminated 3 mm soil particles throughout, clear ice | 95: 5 | | | | | | | | | | |
| 14 | | | | | | | | | | | | | |



| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------|---------------|-------------------|--------------|--|--|---------------|------|--|--|
| N7 676 701 E516 700 Z8 | | | | RELATIVE ELEVATION 36 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 0 | | PEAT (PT) - moss and rootlets | | | | | | | | | | | |
| 1 | | SAND (SP) - trace fine-grained gravel 15 mm, clean, coarse to medium-grained sand, medium greyish brown | Nbn | | | | | | | | | | |
| 2 | | SILT (ML) - medium greyish brown, lens 300 mm thick | | | | | | | | | | | |
| 3 | | SAND (SP) - medium-grained, occasional clasts to 20 mm, subrounded, occasional coal clast to 10 mm, medium greyish brown | Va 30-40% | | | | | | | | | | |
| 4 | | GRAVEL (GW) - sandy, clean, well graded, fine-grained, 20 mm gravel, lens 100 mm thick | Nbn | | | | | | | | | | |
| 5 | | SAND (SP) - coarse to medium-grained | | | | | | | | | | | |
| 6 | | -silty, trace 10 mm gravel, well graded | Nbn | | | | | | | | | | |
| 7 | | -trace gravel disseminated throughout, medium-grained sand | | | | | | | | | | | |
| 8 | | SAND and GRAVEL (SW) trace silt, well graded, subrounded clasts to 20 mm | Nf-Nbn | | | | | | | | | | |
| 9 | | -becoming: by 5.0 m | | | | | | | | | | | |
| 10 | | GRAVEL (GW) - sandy, trace silt, clasts to 75 mm, subangular | | | | | | | | | | | |
| 11 | | -clasts to 30 mm | | | | | | | | | | | |
| 12 | | ICE | | | | | | | | | | | |
| 13 | | END OF BOREHOLE 7.8 m (26.2 m E1.) BOREHOLE TERMINATION DUE TO SLOUGHING GRAVEL. UNABLE TO RE-ENTER HOLE WITH CREL BARREL. | | | | | | | | | | | |

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | |
|------------------------------|-------|-----------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 876 951 E 516 216 Z8 | | | | RELATIVE ELEVATION 37.1 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. Q | | | | | | | | | | | | |
| | 0 | ROOT MAT AND ORGANICS | Nf | | | | | | | | 0 | | |
| | 1 | SAND and GRAVEL (SP) trace silt, poorly graded, coarse to fine-grained gravel, subrounded to subangular, medium brown | | | | | | | | | | | |
| | 2 | | Nbn | | | | | | | | | | |
| | 3 | | | | | | | | | | 2 | | |
| | 4 | ICE-clear | | | | | | | | | | | |
| | 5 | ICE+SILT (ML) - trace to some fine-grained sand | 70: 30 | | | | | | | | | | |
| | 6 | | | | | | | | | | | | |
| | 7 | | 80: 20 | | | | | | | | 4 | | |
| | 8 | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | |
| | 10 | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | |
| | 12 | | | | | | | | | | 6 | | |
| | | END OF BOREHOLE 6.1 m (31.0 m El.) | | | | | | | | | | | |
| | | | | | | | | | | | 8 | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | 10 | | |

101C-4480

Completed 00: 45 86/03/19

DRILLING RIG: CME 750

Compiled by MAV

SAMPLE TYPE

☒
 CRREL

☐
 AUGER

EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE NUMBER 219S07

BOREHOLE LOG AND LABORATORY TEST RESULTS

GRANULAR RESOURCE EVALUATION
N7 677 599 E 517 087 Z8

RICHARDS ISLAND, NWT
RELATIVE ELEVATION 42 (m)

| SAMPLE | | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | | | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT |
|--------|-----|---|-----------------------------------------------------------------------------------------------------------------------|------------------------|--------|---------------|----|----|-------------------|--------------|--|--|---------------|------|
| TYP | NO. | G | | | | 20 | 40 | 60 | | 80 | | | | |
| | 0 | | ORGANIC SILT (OL) AND PEAT (PT) | | | | | | | | | | | 0 |
| | 1 | | SILT (ML) - clayey, trace to some sand, very thinly bedded, even, nonparallel, low plastic | Vs-Vr 30% | | | | | | | | | | |
| | 2 | | -ice content increases with depth | 50: 50 | | | | | | | | | | |
| | 3 | | ICE+SILT (ML) | | | | | | | | | | | |
| | 4 | | SAND (SM) - silty, trace gravel, fine-grained, uniform, medium brown | Vr-Vs 25% | | | | | | | | | | |
| | 5 | | PEAT (PT) - very dark brown to black | Vr 30% | | | | | | | | | | |
| | 6 | | SILT (ML) - sandy, trace clay, thin laminae, wavy, nonparallel, nonplastic, olive brown | Vr 25% | | | | | | | | | | |
| | 7 | | CLAY (CL) - silty, trace fine-grained sand, very thinly bedded, even, nonparallel, medium olive brown | Vs-Vr 15% | | | | | | | | | | |
| | 8 | | ICE+SILT (ML) | Vr 40% | | | | | | | | | | |
| | 9 | | SILT TILL (ML) - sandy, fine-grained, trace angular gravel, very thinly bedded, wavy, nonparallel, medium olive brown | 70: 30 | | | | | | | | | | |
| | 10 | | ICE+SILT (ML) - clear | Vr 5% | | | | | | | | | | |
| | 11 | | | 90: 10 | | | | | | | | | | |
| | 12 | | END OF BOREHOLE 6.2 m (35.8 m El.) | | | | | | | | | | | |

101C-4480
Completed 06:00 86/03/19
DRILLING RIG: CME 750
Compiled by MAV

SAMPLE TYPE



EBA Engineering Consultants Ltd.

DRAWING NUMBER

BOREHOLE
NUMBER
219S08

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NNT | | | | | | | | | |
|------------------------------|-------|--------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------|---------------|-------------------|--------------|--|---------------|------|-----------|--|--|
| N7 877 116 E515 561 Z8 | | | | RELATIVE ELEVATION 24.9 (m) | | | | | | | | | |
| SAMPLE | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | SPECIAL TESTS | UNIT | DEPTH (m) | | |
| TYP | NO. Q | | | | | | | | | | | | |
| 0 | | GRAVEL (GM) - some sand, trace silt, well graded, gravel to 30 mm, subrounded to subangular clasts, medium greyish brown | Nf, Nbn trace | | | | | | | | 0 | | |
| 1 | | -becoming; by 1.0 m | | | | | | | | | | | |
| 2 | | SAND (SP) - gravelly, coarse to medium-grained, subrounded to subangular clasts to 15 mm | Nf | | | | | | | | | | |
| 3 | | -occasional clast to 30 mm | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | Nbe, Vx trace | | | | | | | | | | |
| 6 | | -silt content increasing, clasts to 15 mm | Nbn-Nf | | | | | | | | | | |
| 7 | | CLAY (CL) - silty, massive, dark grey | Vr 15% | | | | | | | | | | |
| 8 | | END OF BOREHOLE 5.8 m (19.1 m El.) | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |

| | | | |
|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------|
| <div>101C-4480</div> <div>Completed 15:30 86/03/20</div> <div>DRILLING RIG: CME 750</div> <div>Compiled by JGC</div> | <div>SAMPLE TYPE</div> <div> <div></div> <div></div> <div></div> </div> <div> <div></div> CRREL <div></div> AUGER </div> | <div>EBA Engineering Consultants Ltd.</div> <div>DRAWING NUMBER</div> | <div>BOREHOLE NUMBER 219S09</div> |
| | | | |

BOREHOLE LOG AND LABORATORY TEST RESULTS

| GRANULAR RESOURCE EVALUATION | | | | RICHARDS ISLAND, NWT | | | | | | | | | | | |
|------------------------------|-----|---|-------------------------------------------------------------------------------------------------------|-----------------------------|--------|---------------|-------------------|--------------|--|--|---------------|------|--|--|--|
| N7 676 746 E 516 977 Z8 | | | | RELATIVE ELEVATION 28.4 (m) | | | | | | | | | | | |
| SAMPLE | | | SOIL DESCRIPTION | GROUND ICE DESCRIPTION | TEMP C | PLASTIC LIMIT | WATER CONTENT (%) | LIQUID LIMIT | | | SPECIAL TESTS | UNIT | | | |
| TYP | NO. | Q | | | | | | | | | | | | | |
| 0 | | | SAND (SP) - some gravel 50 mm, subrounded, clean, coarse to medium-grained sand, medium greyish brown | Nf | | | | | | | | 0 | | | |
| 1 | | | | | | | | | | | | | | | |
| 2 | | | SILT TILL (ML) - sandy, clayey, some gravel to 50 mm, dark greyish brown | Nbn | | | | | | | | 2 | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | Vx 50% | | | | | | | | | | | |
| 6 | | | ICE - trace of soil, ice bulking in core barrel while sampling | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | | | END OF BOREHOLE 4.7 m (23.7 m El.) | | | | | | | | | | | | |

101C-4480
Completed 20: 45 86/03/20
DRILLING RIG: CME 750
Compiled by JGC MAV

SAMPLE TYPE

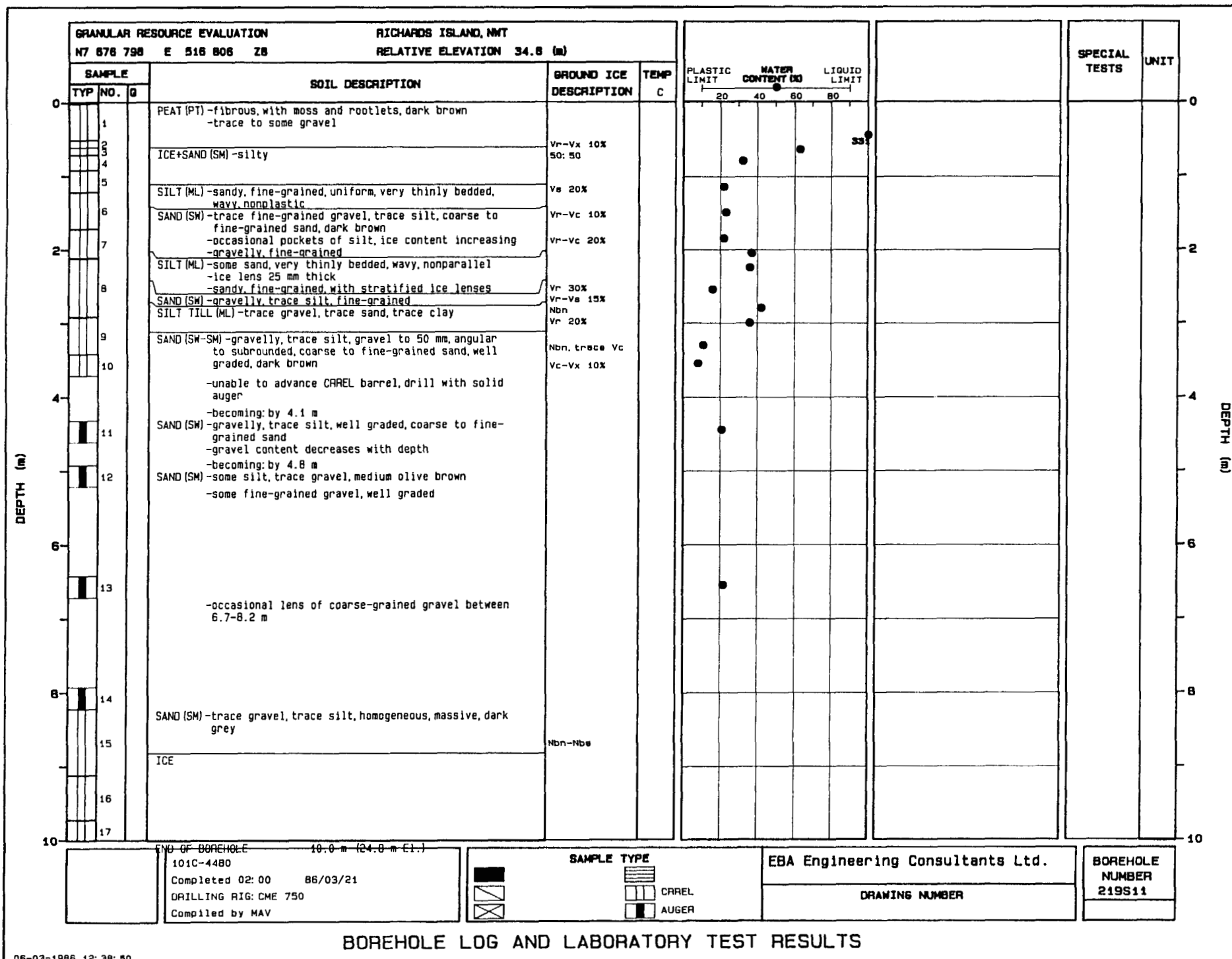
CAREL
AUGER

EBA Engineering Consultants Ltd.
(Edmonton)

DRAWING NUMBER

BOREHOLE NUMBER
219S10

BOREHOLE LOG AND LABORATORY TEST RESULTS



J.5 LABORATORY TESTING



BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m ³ | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|--------------------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | | F |
| 0.30- | 0.60 | 1A | | 19.0 | | | | | | | | | | F |
| 0.90- | 1.80 | 2 | core | | | | | | | | | | | F |
| 0.90- | 1.20 | 2A | SM | 14.0 | | | | | 16.0 | 70.0 | 14.0 | | | F |
| 1.20- | 1.50 | 2B | | 16.0 | | | | | | | | | | F |
| 1.80- | 2.70 | 3 | core | | | | | | | | | | | F |
| 1.80- | 1.90 | 3A | SP-SM | 18.0 | | | | | 5.0 | 90.0 | 5.0 | | | F |
| 2.30- | 2.40 | 3B | SP-SM | 25.0 | | | | | 6.0 | 94.0 | 0.0 | | | F |
| 2.70- | 3.20 | 4 | core | | | | | | | | | | | F |
| 3.00- | 3.20 | 4A | | | | | | | | | | | | F |
| 3.20- | 3.80 | 5 | core | 35.0 | | | | | | | | | | F |
| 3.80- | 4.60 | 6 | core | | | | | | | | | | | F |
| 4.50- | 4.60 | 6A | | | | | | | | | | | | F |
| 4.60- | 5.30 | 7 | core | 36.0 | | | | | | | | | | F |
| 5.10- | 5.20 | 7A | | 28.0 | | | | | | | | | | F |
| 5.30- | 6.10 | 8 | core | | | | | | | | | | | F |
| 6.00- | 6.10 | 8A | | | | | | | | | | | | F |
| 6.10- | 6.70 | 9 | core | 32.0 | | | | | | | | | | F |
| 6.60- | 6.70 | 9A | | | | | | | | | | | | F |
| 6.70- | 7.30 | 10 | core | 34.0 | | | | | | | | | | F |
| 7.20- | 7.30 | 10A | | | | | | | | | | | | F |
| 7.30- | 7.90 | 11 | core | 37.0 | | | | | | | | | | F |
| 7.80- | 7.90 | 11A | | | | | | | | | | | | F |
| 7.90- | 8.20 | 12 | core | 40.0 | | | | | | | | | | F |
| 8.10- | 8.20 | 12A | | | | | | | | | | | | F |
| 8.20- | 9.10 | 13 | core | 31.0 | | | | | | | | | | F |
| 9.00- | 9.10 | 13A | | | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 219S01

Page 1 of 1

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.60 | 1 | core | SW | 4 | | | | 1.0 | 52.0 | 47.0 | | | F |
| 0.60- | 1.00 | 2 | core | SP | 3 | | | | 3.0 | 71.0 | 26.0 | | | F |
| 1.00- | 1.25 | 3 | core | | | | | | | | | | | F |
| 1.25- | 1.50 | 4 | core | | 16 | | | | | | | | | F |
| 1.50- | 2.00 | 5 | core | | | | | | | | | | | F |
| 1.60- | 1.90 | 5A | | | 36 | | | | | | | | | F |
| 2.00- | 2.10 | 6 | core | SP | 24 | | | | 1.0 | 99.0 | 0.0 | | | F |
| 2.10- | 2.70 | 7 | core | | | | | | | | | | | F |
| 2.60- | 2.70 | 7A | | | | | | | | | | | | F |
| 2.70- | 3.50 | 8 | core | | | | | | | | | | | F |
| 3.30- | 3.50 | 8A | SP-SM | 30 | | | | | 5.0 | 95.0 | 0.0 | | | F |
| 3.50- | 4.10 | 9 | core | | | | | | | | | | | F |
| 3.65- | 3.85 | 9A | | 29 | | | | | | | | | | F |
| 4.10- | 4.70 | 10 | core | | | | | | | | | | | F |
| 4.50- | 4.60 | 10A | | 37 | | | | | | | | | | F |
| 4.70- | 5.30 | 11 | core | | | | | | | | | | | F |
| 5.00- | 5.10 | 11A | | | | | | | | | | | | F |
| 5.10- | 5.50 | 12 | core | | | | | | | | | | | F |
| 5.50- | 6.30 | 13 | core | | | | | | | | | | | F |
| 6.00- | 6.30 | 13A | | | | | | | | | | | | F |
| 6.30- | 7.00 | 14 | core | | | | | | | | | | | F |
| 6.60- | 6.80 | 14A | | | | | | | | | | | | F |
| 7.00- | 7.50 | 15 | core | | | | | | | | | | | F |
| 7.30- | 7.50 | 15A | | | | | | | | | | | | F |
| 7.50- | 7.60 | 16 | core | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 219S02

Page 1 of 1

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | 950 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | | F |
| 0.00- | 0.20 | 1A | | 29.0 | | | | | | | | | | F |
| 0.90- | 1.60 | 2 | core | | | | | | | | | | | F |
| 1.20- | 1.30 | 2A | | 27.0 | | | | | | | | | | F |
| 1.60- | 2.20 | 3 | core | | | | | | | | | | | F |
| 2.00- | 2.10 | 3A | | 22.0 | | | | | | | | | | F |
| 2.20- | 3.00 | 4 | core | | | | | | | | | | | F |
| 2.20- | 2.30 | 4A | | 28.0 | | | | | | | | | | F |
| 3.00- | 4.00 | 5 | core | | | | | | | | | | | F |
| 3.20- | 3.30 | 5A | | 17.0 | | | | | | | | | | F |
| 3.70- | 3.80 | 5B | | 34.0 | | | | | | | | | | F |
| 4.00- | 4.90 | 6 | core | | | | | | | | | | | F |
| 4.20- | 4.30 | 6A | | 24.0 | | | | | | | | | | F |
| 4.90- | 5.60 | 7 | core | | | | | | | | | | | F |
| 5.10- | 5.20 | 7A | | 22.0 | | | | | | | | | | F |
| 5.40- | 5.60 | 7B | | 6.2 | | | | | | | | | | F |
| 5.60- | 6.20 | 8 | core | | | | | | | | | | | F |
| 5.90- | 6.10 | 8A | | | | | | | | | | | | F |
| 6.20- | 7.00 | 9 | core | | | | | | | | | | | F |
| 6.40- | 6.50 | 9A | | | | | | | | | | | | F |
| 7.00- | 7.70 | 10 | core | | | | | | | | | | | F |
| 7.50- | 7.60 | 10A | | | | | | | | | | | | F |
| 7.70- | 8.50 | 11 | core | | | | | | | | | | | F |
| 8.00- | 8.10 | 11A | | 20.0 | | | | | | | | | | F |
| 8.50- | 9.30 | 12 | core | | | | | | | | | | | F |
| 9.30- | 10.00 | 13 | core | | | | | | | | | | | F |
| 10.00- | 10.80 | 14 | core | | | | | | | | | | | F |
| 10.50- | 10.80 | 14A | | | | | | | | | | | | F |
| 10.90- | 11.10 | 15 | core | | | | | | | | | | | F |
| 11.10- | 11.50 | 16 | core | | | | | | | | | | | F |
| 11.60- | 11.70 | 17 | core | | | | | | | | | | | F |
| 11.70- | 11.90 | 18 | core | | | | | | | | | | | F |
| 11.90- | 12.20 | 19 | core | | | | | | | | | | | F |
| 12.20- | 12.50 | 20 | core | | | | | | | | | | | F |
| 12.50- | 12.90 | 21 | core | | | | | | | | | | | F |
| 12.90- | 13.20 | 22 | core | | | | | | | | | | | F |
| 13.20- | 13.50 | 23 | core | | | | | | | | | | | F |
| 13.50- | 13.80 | 24 | core | | | | | | | | | | | F |
| 13.80- | 14.10 | 25 | core | | | | | | | | | | | F |
| 15.70- | 16.00 | 26 | core | | | | | | | | | | | F |
| 15.80- | 16.00 | 26A | | | | | | | | | | | | F |

IBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

COREHOLE NO. 219S03

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-----|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 16.00- 16.50 | 27 | core | | | | | | | | | | | | F |
| 16.50- 17.00 | 28 | core | | | | | | | | | | | | F |
| 17.00- 17.40 | 29 | core | | | | | | | | | | | | F |
| 17.40- 17.60 | 30 | core | | | | | | | | | | | | F |
| 17.60- 18.50 | 31 | core | | | | | | | | | | | | F |
| 18.50- 19.20 | 32 | core | | | | | | | | | | | | F |

IBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 219S03

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.90 | 1 | core | | | | | | | | | | F |
| 0.60- | 0.70 | 1A | | 57 | | | | | | | | | F |
| 0.90- | 1.50 | 2 | core | | | | | | | | | | F |
| 1.20- | 1.30 | 2A | | 21 | | | | | | | | | F |
| 1.50- | 2.30 | 3 | core | | | | | | | | | | F |
| 1.70- | 1.80 | 3A | SP | 22 | | | | | 4.0 | 95.0 | 1.0 | | F |
| 2.30- | 3.10 | 4 | core | | | | | | | | | | F |
| 2.60- | 2.70 | 4A | | 14 | | | | | | | | | F |
| 3.10- | 3.90 | 5 | core | | | | | | | | | | F |
| 3.30- | 3.40 | 5A | SP | 22 | | | | | 3.0 | 97.0 | 0.0 | | F |
| 3.90- | 4.70 | 6 | core | | | | | | | | | | F |
| 4.30- | 4.40 | 6A | | 25 | | | | | | | | | F |
| 4.70- | 5.40 | 7 | core | | | | | | | | | | F |
| 4.90- | 5.00 | 7A | SP | 24 | | | | | 2.0 | 98.0 | 0.0 | | F |
| 5.40- | 6.30 | 8 | core | | | | | | | | | | F |
| 5.90- | 6.00 | 8A | | 22 | | | | | | | | | F |
| 6.30- | 7.10 | 9 | core | | | | | | | | | | F |
| 6.70- | 6.80 | 9A | SP | 21 | | | | | 2.0 | 98.0 | 0.0 | | F |
| 7.10- | 7.90 | 10 | core | | | | | | | | | | F |
| 7.40- | 7.50 | 10A | | | | | | | | | | | F |
| 7.90- | 8.50 | 11 | core | | | | | | | | | | F |
| 8.50- | 9.20 | 12 | core | | | | | | | | | | F |
| 9.20- | 9.80 | 13 | core | | | | | | | | | | F |
| 9.80- | 10.30 | 14 | core | | | | | | | | | | F |
| 10.30- | 10.90 | 15 | core | | | | | | | | | | F |
| 10.90- | 11.50 | 16 | core | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 219S04

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USE | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|-------|--------|-------|-----|----------------------|
| 0.00- | 0.45 | 1 | core | | | | | | | | | | | F |
| 0.30- | 0.40 | 1A | | 332.0 | | | | | | | | | | F |
| 0.45- | 0.90 | 2 | core | | | | | | | | | | | F |
| 0.60- | 0.65 | 2A | | 50.0 | | | | | | | | | | F |
| 0.90- | 1.70 | 3 | core | | | | | | | | | | | F |
| 1.30- | 1.40 | 3A | | 33.0 | | | | | | | | | | F |
| 1.70- | 2.50 | 4 | core | | | | | | | | | | | F |
| 2.20- | 2.30 | 4A | | 63.0 | | | | | | | | | | F |
| 2.50- | 3.30 | 5 | core | | | | | | | | | | | F |
| 3.00- | 3.10 | 5A | | 75.0 | | | | | | | | | | F |
| 3.30- | 3.80 | 6 | core | | | | | | | | | | | F |
| 3.50- | 3.60 | 6A | | 47.0 | | | | | | | | | | F |
| 3.80- | 4.40 | 7 | core | | | | | | | | | | | F |
| 4.10- | 4.20 | 7A | SP | 24.0 | | | | | 0.0 | 100.0 | 0.0 | | | F |
| 4.40- | 5.40 | 8 | core | | | | | | | | | | | F |
| 5.10- | 5.40 | 8A | SP | 17.0 | | | | | 3.0 | 61.0 | 36.0 | | | F |
| 5.40- | 6.40 | 9 | core | | | | | | | | | | | F |
| 6.00- | 6.10 | 9A | | 12.0 | | | | | | | | | | F |
| 6.40- | 6.70 | 10 | core | | | | | | | | | | | F |
| 6.50- | 6.60 | 10A | | | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 219S05

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-----|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.80 | 1 | | | | | | | | | | | F |
| 0.50- | 0.60 | 1A | | 18 | | | | | | | | | F |
| 0.80- | 1.70 | 2 | | | | | | | | | | | F |
| 1.50- | 1.60 | 2A | | 20 | | | | | | | | | F |
| 1.70- | 2.10 | 3 | | | | | | | | | | | F |
| 1.80- | 1.90 | 3A | SP | 23 | | | | | 1.0 | 99.0 | 0.0 | | F |
| 2.10- | 2.70 | 4 | | | | | | | | | | | F |
| 2.30- | 2.40 | 4A | | 22 | | | | | 1.0 | 99.0 | 0.0 | | F |
| 2.70- | 3.20 | 5 | | | | | | | | | | | F |
| 3.20- | 3.40 | 6 | | | | | | | | | | | F |
| 3.20- | 3.30 | 6A | | 19 | | | | | 11.0 | 86.0 | 3.0 | | F |
| 3.40- | 4.40 | 7 | | | | | | | | | | | F |
| 4.20- | 4.40 | 7A | | 11 | | | | | | | | | F |
| 4.40- | 5.20 | 8 | | | | | | | | | | | F |
| 4.80- | 4.90 | 8A | SP | 11 | | | | | 0.0 | 59.0 | 41.0 | | F |
| 5.20- | 5.90 | 9 | | | | | | | | | | | F |
| 5.70- | 5.90 | 9A | | 8 | | | | | | | | | F |
| 5.90- | 6.50 | 10 | | | | | | | | | | | F |
| 6.20- | 6.30 | 10A | | | | | | | | | | | F |
| 6.50- | 7.80 | 11 | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 219S06

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|--------------|----------------------|
| 0.00- | 0.75 | 1 | core | 18.0 | | | | | | | | | F |
| 0.75- | 1.60 | 2 | core | 12.0 | | | | | 3.0 | 59.0 | 38.0 | | F |
| 1.60- | 2.40 | 3 | core | | | | | | | | | | F |
| 2.40- | 2.90 | 4 | core | | | | | | | | | | F |
| 2.90- | 3.20 | 5 | core | | | | | | | | | | F |
| 3.20- | 3.40 | 6 | core | | | | | | | | | | F |
| 3.40- | 4.00 | 7 | core | | | | | | | | | | F |
| 4.00- | 4.60 | 8 | core | | | | | | | | | | F |
| 4.60- | 4.70 | 9 | core | | | | | | | | | | F |
| 4.70- | 4.90 | 10 | core | | | | | | | | | | F |
| 4.90- | 5.50 | 11 | core | | | | | | | | | | F |
| 5.50- | 6.10 | 12 | core | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION
INDIAN AND NORTHERN AFFAIRS CANADA

Project Number: 101C-4480
BOREHOLE NO. 219S07

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.60 | 1 | core | 29.0 | | | | | | | | | | F |
| 0.60- | 0.90 | 2 | core | 45.0 | | | | | | | | | | F |
| 0.90- | 1.40 | 3 | core | | | | | | | | | | | F |
| 1.10- | 1.40 | 3A | | 23.0 | | | | | | | | | | F |
| 1.40- | 1.70 | 4 | core | | | | | | | | | | | F |
| 1.70- | 1.90 | 5 | core | | | | | | | | | | | F |
| 1.90- | 2.60 | 6 | core | | | | | | | | | | | F |
| 2.60- | 3.20 | 7 | core | | | | | | | | | | | F |
| 2.80- | 2.80 | 7A | | | | | | | | | | | | F |
| 3.20- | 3.50 | 8 | core | | | | | | | | | | | F |
| 3.50- | 4.30 | 9 | core | | | | | | | | | | | F |
| 4.30- | 4.90 | 10 | core | | | | | | | | | | | F |
| 4.90- | 5.60 | 11 | core | | | | | | | | | | | F |
| 5.60- | 6.20 | 12 | core | | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 219S08

BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|-------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 1.00 | 1 | core | 3 | | | | | | | | | | F |
| 1.00- | 1.90 | 2 | core | 3 | | | | | 3.0 | 65.0 | 32.0 | | | F |
| 1.90- | 2.60 | 3 | core | 2 | | | | | 4.0 | 56.0 | 40.0 | | | F |
| 2.60- | 3.40 | 4 | core | 5 | | | | | 6.0 | 64.0 | 30.0 | | | F |
| 3.40- | 4.40 | 5 | core | | | | | | | | | | | F |
| 4.00- | 4.20 | 5A | SP-SM | 17 | | | | | 11.0 | 67.0 | 22.0 | | | F |
| 4.40- | 5.20 | 6 | core | | | | | | | | | | | F |
| 5.00- | 5.20 | 6A | | 6 | | | | | | | | | | F |
| 5.20- | 5.80 | 7 | core | | | | | | | | | | | F |
| 5.50- | 5.60 | 7A | | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 219S09

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BASIC SOIL CHARACTERISTICS DATA

| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Mg/m ³ | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | D50 | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-----|----------------------------|--------------------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 1.00 | 1 | | 5 | | | | | | | | | | F |
| 1.00- | 1.80 | 2 | SP | 3 | | | | | 4.0 | 82.0 | 18.0 | | | F |
| 1.80- | 2.10 | 3 | | 25 | | | | | | | | | | F |
| 2.10- | 2.30 | 4 | | | | | | | | | | | | F |
| 2.30- | 2.90 | 5 | | 52 | | | | | | | | | | F |
| 2.30- | 2.40 | 5A | | | | | | | | | | | | F |
| 2.90- | 3.20 | 6 | | | | | | | | | | | | F |
| 3.00- | 3.10 | 6A | | 999 | | | | | | | | | | F |
| 3.20- | 3.70 | 7 | | | | | | | | | | | | F |
| 3.70- | 4.00 | 8 | | | | | | | | | | | | F |
| 4.00- | 4.40 | 9 | | | | | | | | | | | | F |
| 4.40- | 4.70 | 10 | | | | | | | | | | | | F |

EBA ENGINEERING CONSULTANTS LTD.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480

BOREHOLE NO. 219S10

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BASIC SOIL CHARACTERISTICS DATA

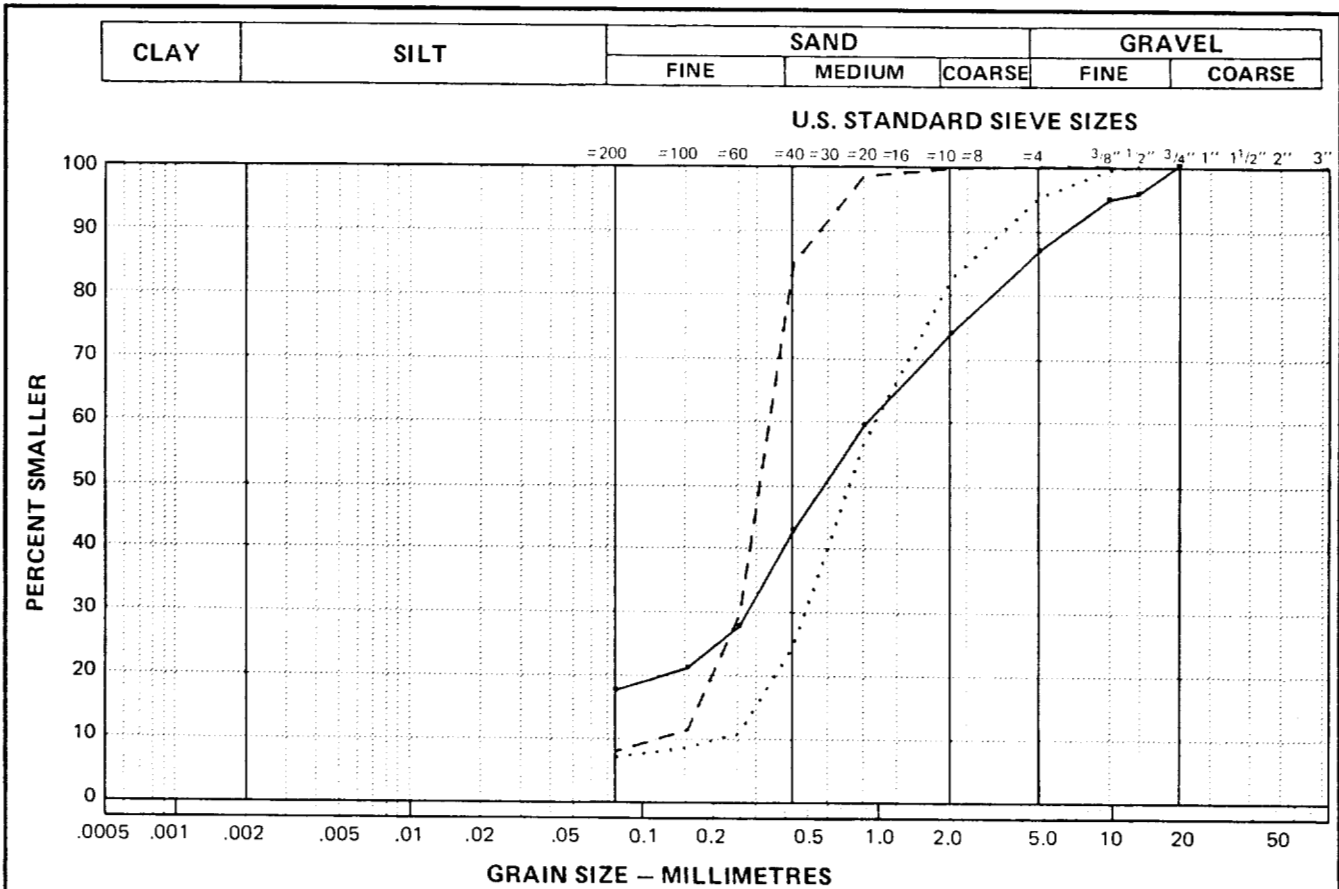
| DEPTH (m) | SAMPLE NUMBER | TEST DESCRIPTION | USC | MOISTURE CONTENT (%) | BULK DENSITY Kg/m3 | LIQUID LIMIT | PLASTIC LIMIT | CLAY | SILT | SAND | GRAVEL | FINES | DSO | FROZEN / UNFROZEN |
|--------------|------------------|---------------------|-------|----------------------------|--------------------------|-----------------|------------------|------|------|------|--------|-------|-----|----------------------|
| 0.00- | 0.50 | 1 | core | | | | | | | | | | | F |
| 0.40- | 0.50 | 1A | | 331.0 | | | | | | | | | | F |
| 0.50- | 0.60 | 2 | core | | | | | | | | | | | F |
| 0.60- | 0.70 | 3 | core | 63.0 | | | | | | | | | | F |
| 0.70- | 0.90 | 4 | core | 32.0 | | | | | | | | | | F |
| 0.90- | 1.20 | 5 | core | | | | | | | | | | | F |
| 1.10- | 1.20 | 5A | | 22.0 | | | | | | | | | | F |
| 1.20- | 1.70 | 6 | core | | | | | | | | | | | F |
| 1.40- | 1.60 | 6A | | 23.0 | | | | | | | | | | F |
| 1.70- | 2.10 | 7 | core | | | | | | | | | | | F |
| 1.80- | 1.90 | 7A | | 22.0 | | | | | | | | | | F |
| 2.00- | 2.10 | 7B | | 37.0 | | | | | | | | | | F |
| 2.10- | 2.90 | 8 | core | | | | | | | | | | | F |
| 2.10- | 2.40 | 8A | | 36.0 | | | | | | | | | | F |
| 2.40- | 2.70 | 8B | | 16.0 | | | | | | | | | | F |
| 2.70- | 2.90 | 8C | | 42.0 | | | | | | | | | | F |
| 2.90- | 3.40 | 9 | core | | | | | | | | | | | F |
| 2.90- | 3.10 | 9A | | 36.0 | | | | | | | | | | F |
| 3.20- | 3.40 | 9B | SW-SM | 11.0 | | | | | 9.0 | 62.0 | 29.0 | | | F |
| 3.40- | 3.70 | 10 | core | 8.1 | | | | | | | | | | F |
| 4.30- | 4.60 | 11 | grab | 21.0 | | | | | | | | | | F |
| 4.90- | 5.20 | 12 | grab | | | | | | | | | | | F |
| 6.40- | 6.70 | 13 | grab | 22.0 | | | | | 17.0 | 77.0 | 6.0 | | | F |
| 7.90- | 8.20 | 14 | grab | | | | | | | | | | | F |
| 8.20- | 9.10 | 15 | core | | | | | | | | | | | F |
| 8.50- | 8.80 | 15A | | | | | | | | | | | | F |
| 9.10- | 9.70 | 16 | core | | | | | | | | | | | F |
| 9.70- | 10.00 | 17 | core | | | | | | | | | | | F |

EBA Engineering Consultants Ltd.

GRANULAR RESOURCE EVALUATION

Project Number: 101C-4480
BOREHOLE NO. 219S11

PARTICLE - SIZE ANALYSIS OF SOILS

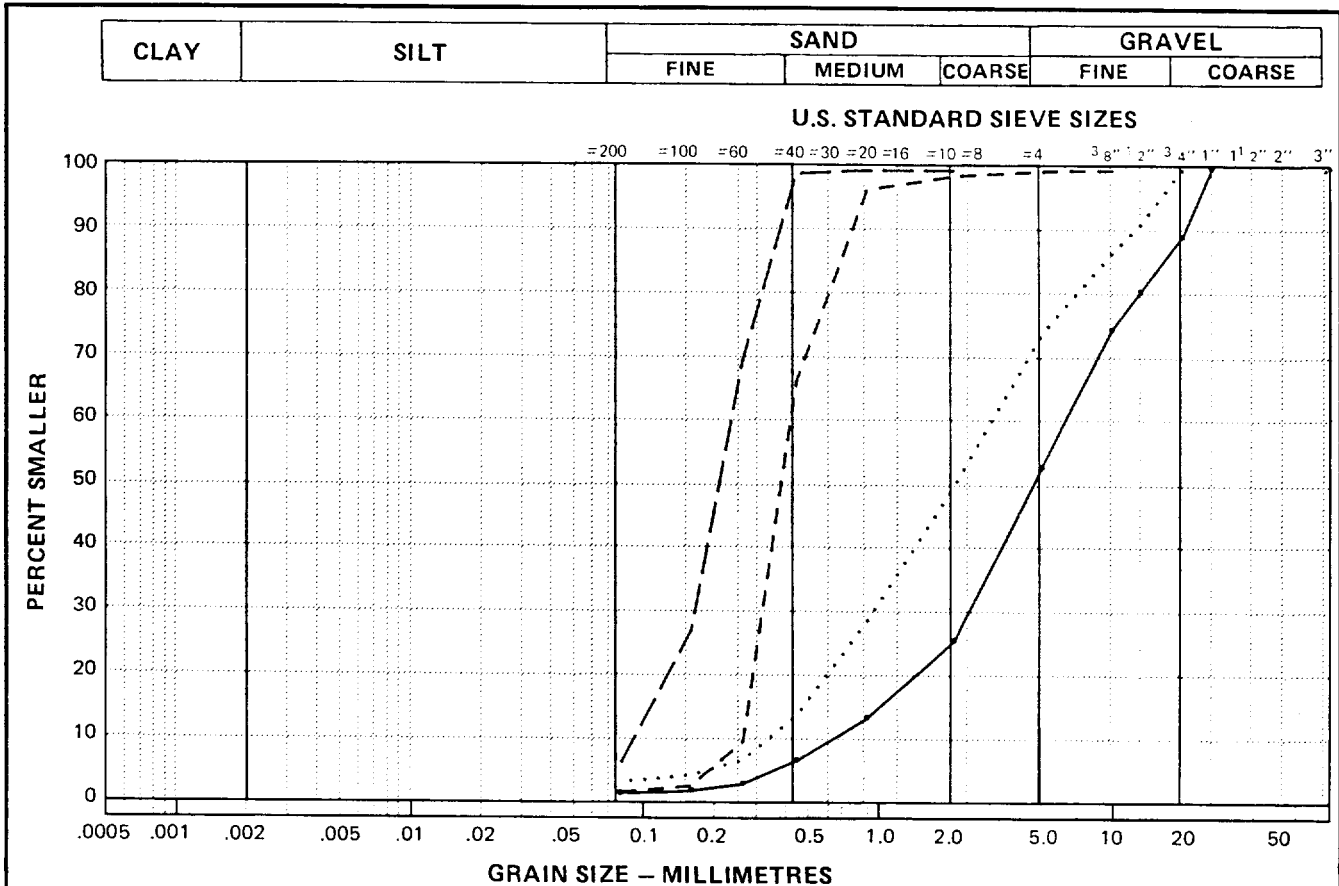


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|---------------|-------------|-------------|-------------|---------------|------|------|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — | 86219S01 | . 90 - 1. 20 | — | 16. 0 | 70. 3 | 13. 7 | — | — | — |
| ..... | 86219S01 | 1. 80 - 1. 80 | — | 5. 4 | 89. 5 | 5. 1 | 3. 8 | 1. 0 | SP-SM |
| — — — | 86219S01 | 2. 40 - 2. 40 | — | 6. 3 | 93. 5 | . 2 | 2. 2 | 1. 3 | SP-SM |

JOB NO. 101 -4480

DATE 86-05-12

PARTICLE - SIZE ANALYSIS OF SOILS

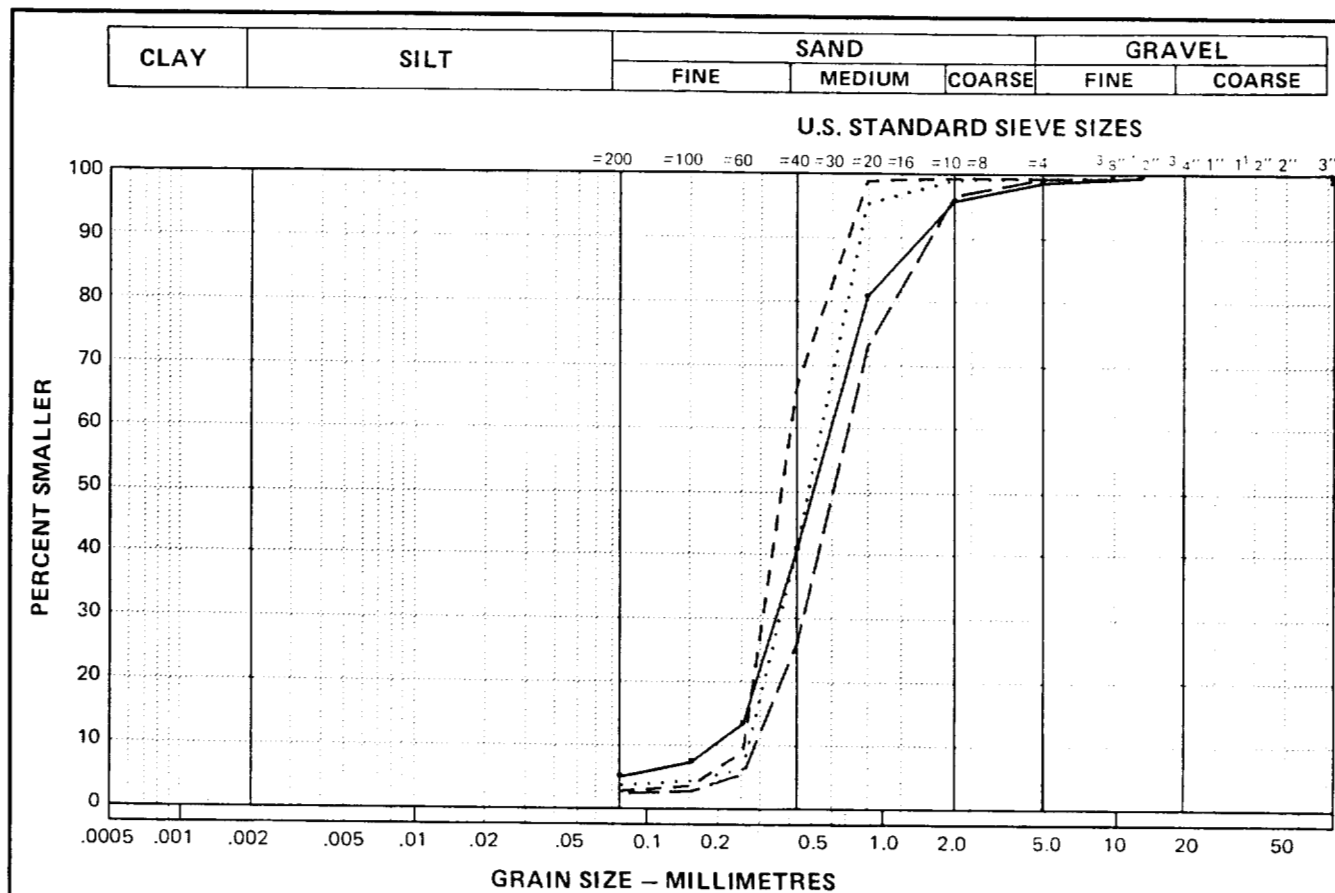


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — | 86219S02 | 0.00 - .60 | — | .6 | 51.9 | 47.5 | 9.3 | 1.4 | SW |
| ..... | 86219S02 | .60 - 1.00 | — | 2.5 | 71.2 | 26.3 | 8.7 | .9 | SP |
| — — — | 86219S02 | 2.00 - 2.10 | — | .8 | 98.9 | .3 | 1.6 | .9 | SP |
| — — | 86219S02 | 3.00 - 3.30 | — | 5.0 | 95.0 | 0.0 | 2.6 | 1.3 | SP-SM |

JOB NO. 101 -4480

DATE 86-5-27

PARTICLE - SIZE ANALYSIS OF SOILS

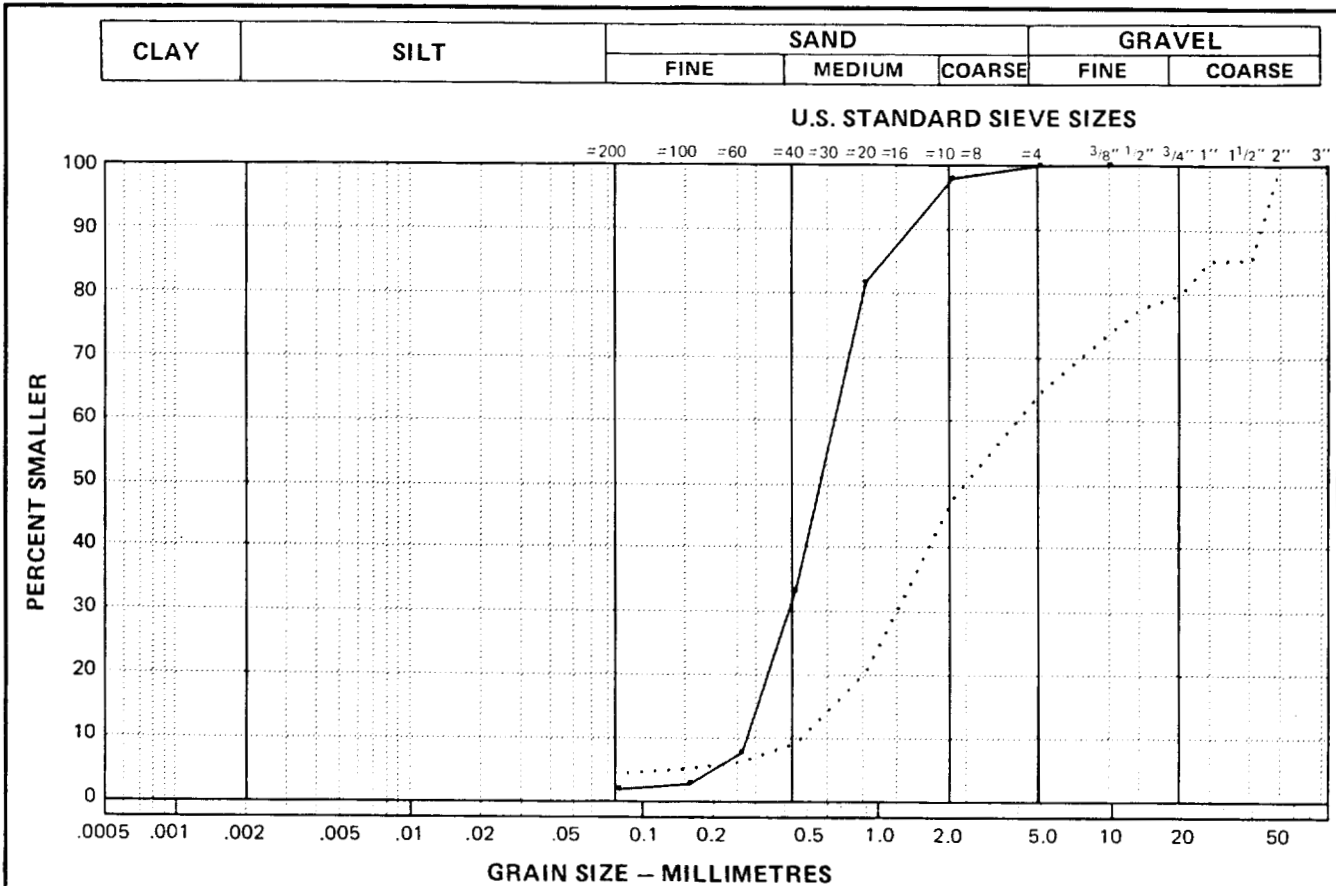


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|-----------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — — — — — | 86219S04 | 1.70 - 1.80 | - | 4.1 | 95.0 | .9 | 3.0 | 1.0 | SP |
| ..... | 86219S04 | 3.30 - 3.40 | - | 2.8 | 97.1 | .1 | 2.0 | .9 | SP |
| - - - - - | 86219S04 | 4.90 - 5.00 | - | 1.8 | 98.2 | 0.0 | 1.6 | .9 | SP |
| — — — — — | 86219S04 | 6.70 - 6.80 | - | 1.5 | 98.3 | .2 | 2.5 | 1.0 | SP |

JOB NO. 101 -4480

DATE 86-5-15

PARTICLE - SIZE ANALYSIS OF SOILS

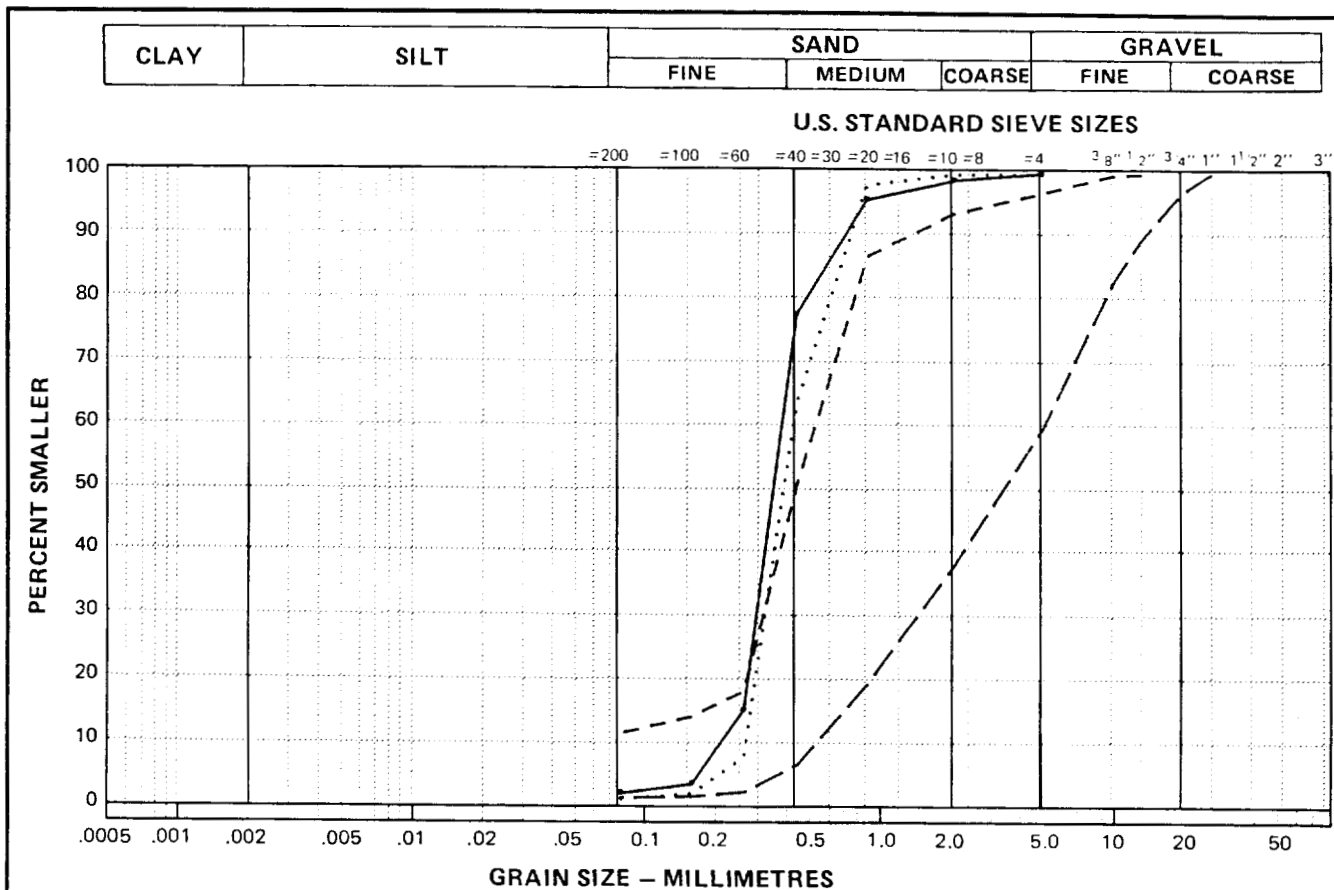


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| _____ | 86219S05 | 4.10 - 4.20 | - | .3 | 99.6 | .1 | 2.3 | 1.0 | SP |
| ..... | 86219S05 | 6.00 - 6.10 | - | 2.9 | 60.9 | 36.2 | 8.1 | .7 | SP |

JOB NO. 101 -4480

DATE 86-5-15

PARTICLE - SIZE ANALYSIS OF SOILS

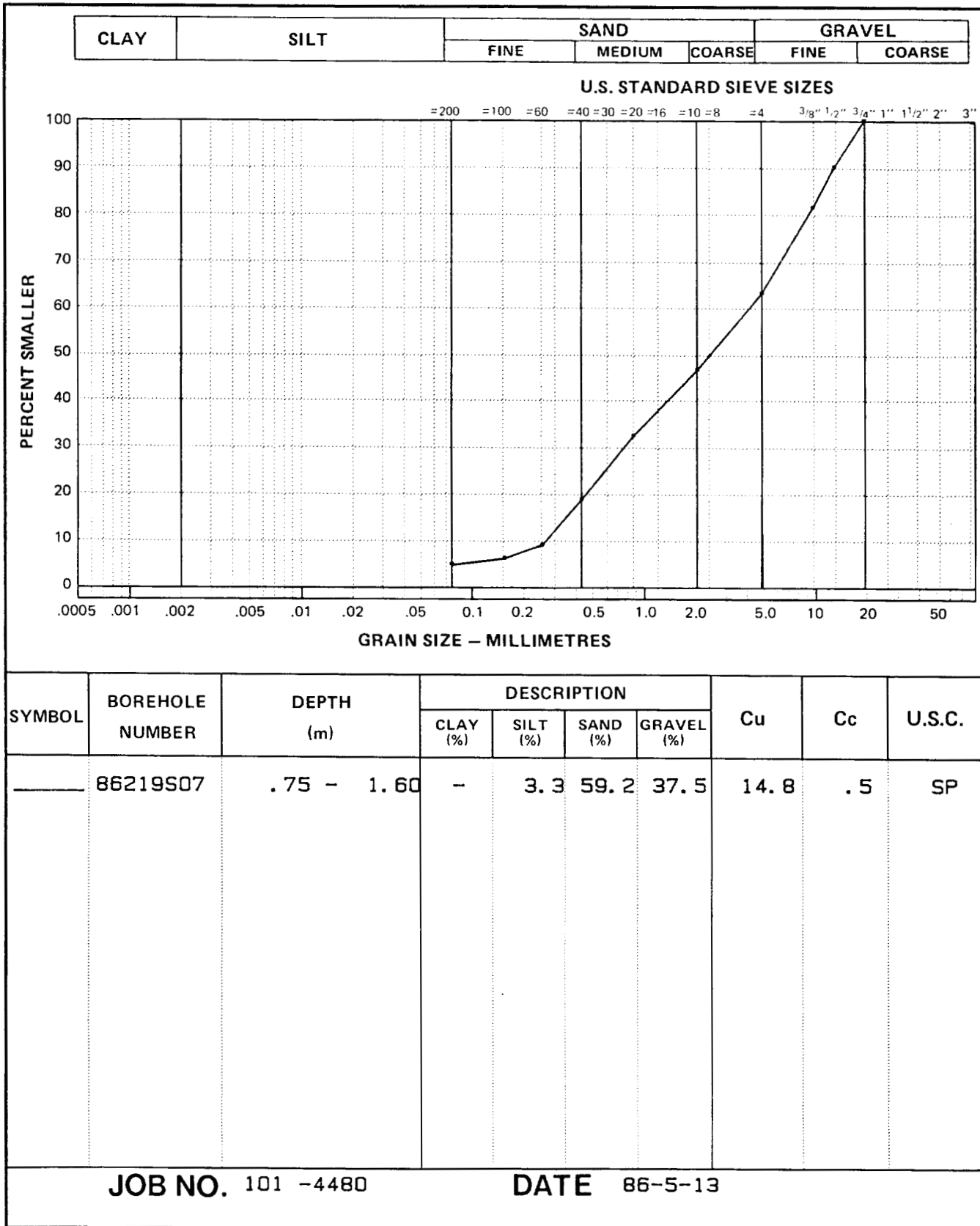


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|-----|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — | 86219S06 | 1.80 - 1.90 | — | 1.2 | 98.8 | 0.0 | 1.8 | 1.1 | SP |
| ..... | 86219S06 | 2.30 - 2.40 | — | .3 | 99.7 | 0.0 | 1.6 | .9 | SP |
| — — — | 86219S06 | 3.20 - 3.30 | — | 10.7 | 86.1 | 3.2 | — | — | — |
| — — | 86219S06 | 4.80 - 4.90 | — | .5 | 58.8 | 40.7 | 9.2 | .8 | SP |

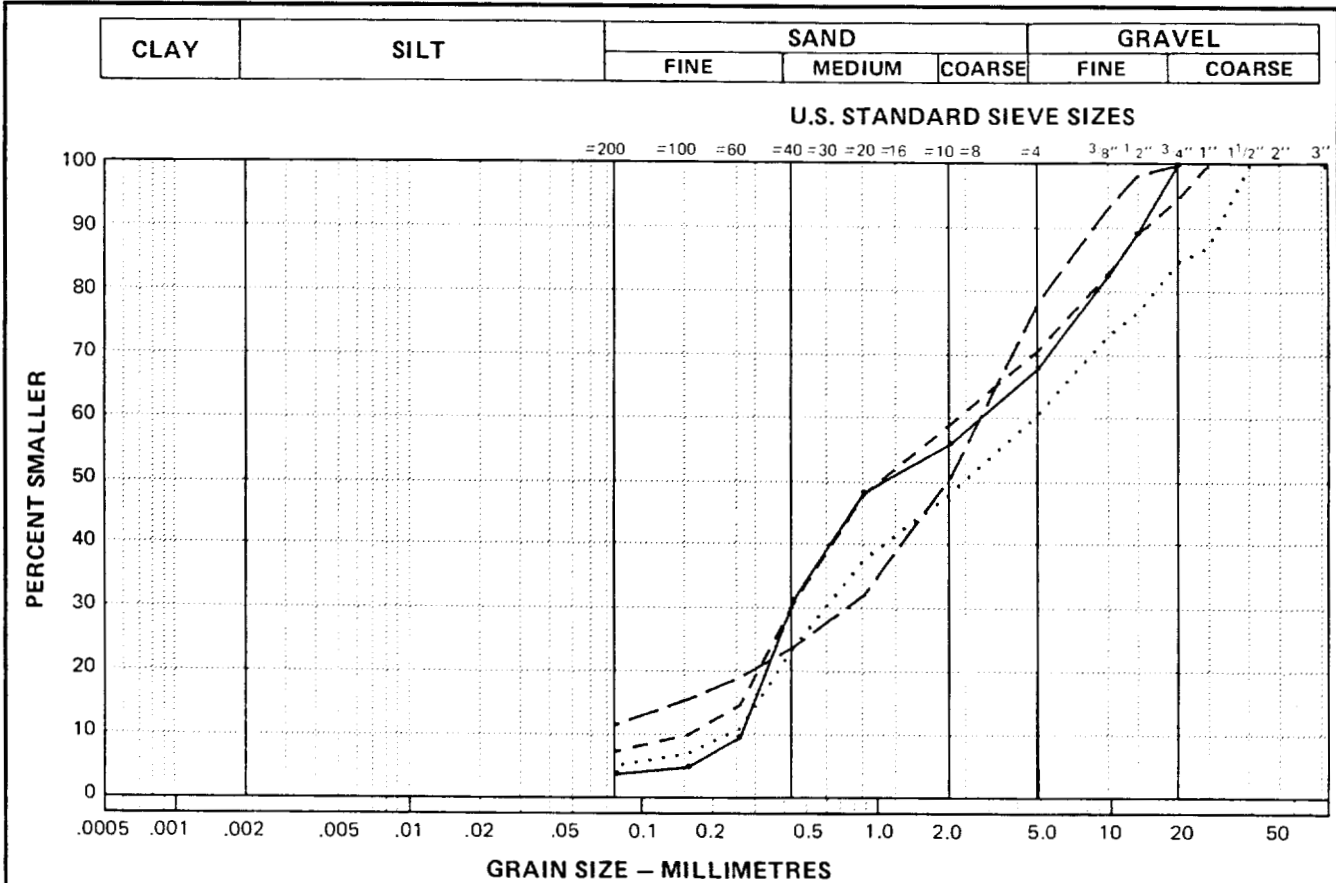
JOB NO. 101 -4480

DATE 86-5-13

PARTICLE - SIZE ANALYSIS OF SOILS



PARTICLE - SIZE ANALYSIS OF SOILS

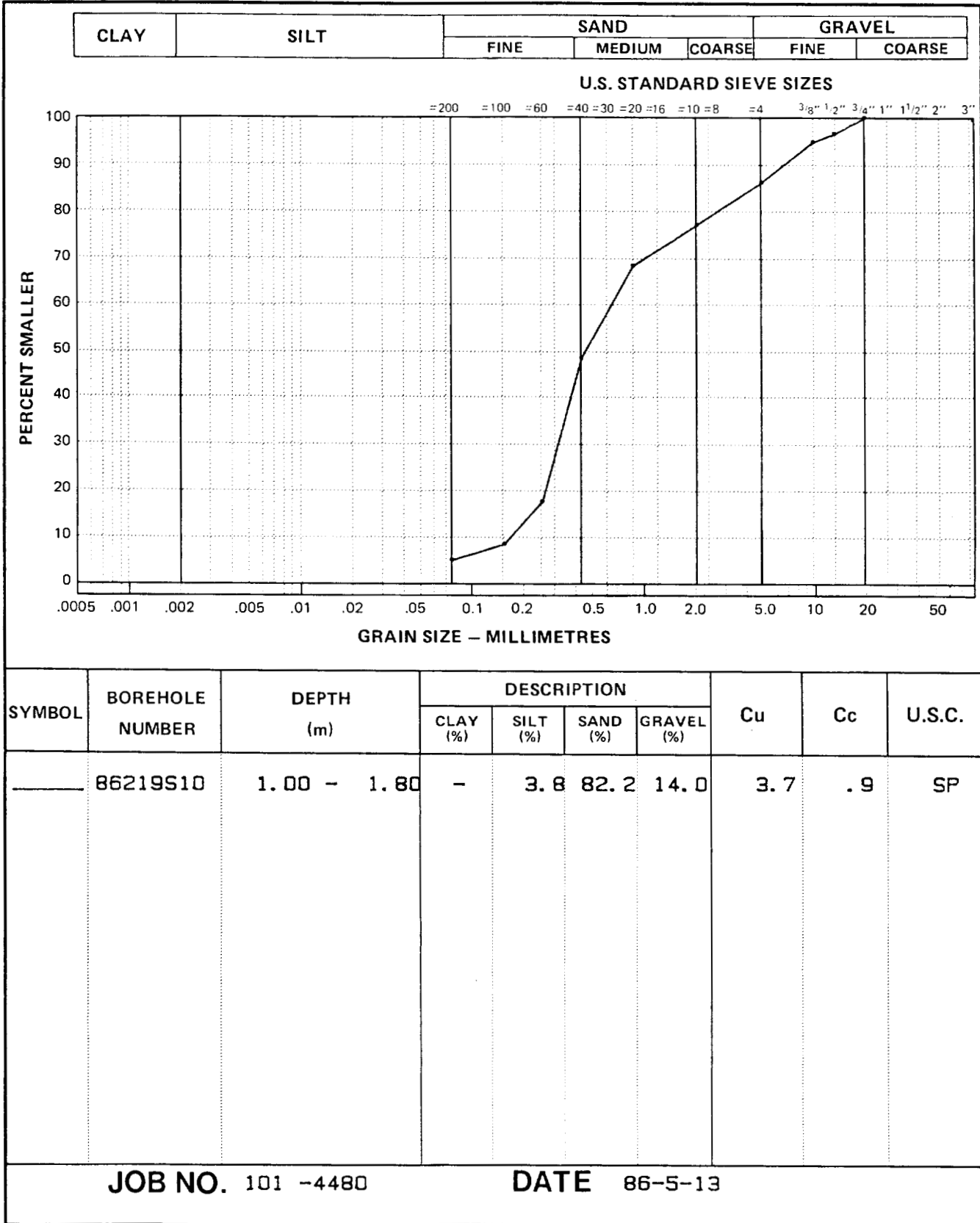


| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|------|----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — | 86219S09 | 1.00 - 1.90 | — | 2.6 | 64.9 | 32.5 | 10.8 | .2 | SP |
| ..... | 86219S09 | 1.90 - 2.60 | — | 4.0 | 56.3 | 39.7 | 18.9 | .3 | SP |
| — — — | 86219S09 | 2.60 - 3.40 | — | 6.3 | 64.2 | 29.5 | 13.3 | .5 | SP-SM |
| — — — | 86219S09 | 4.00 - 4.20 | — | 10.6 | 67.5 | 21.9 | — | — | — |

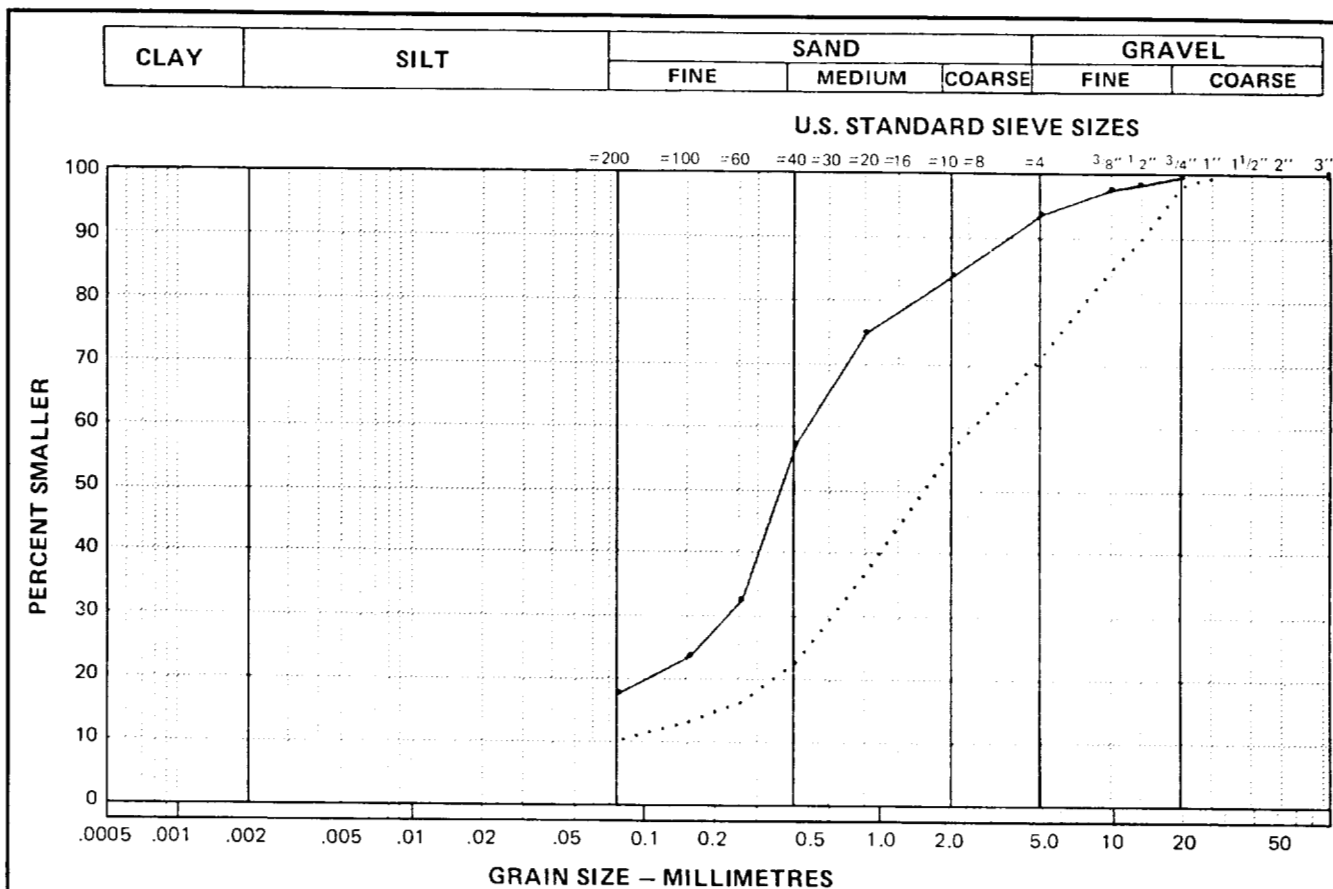
JOB NO. 101 -4480

DATE 86-5-14

PARTICLE - SIZE ANALYSIS OF SOILS



PARTICLE - SIZE ANALYSIS OF SOILS



| SYMBOL | BOREHOLE NUMBER | DEPTH (m) | DESCRIPTION | | | | Cu | Cc | U.S.C. |
|--------|--------------------|--------------|-------------|-------------|-------------|---------------|------|-----|--------|
| | | | CLAY (%) | SILT (%) | SAND (%) | GRAVEL (%) | | | |
| — | 86219S11 | 6.40 - 6.70 | — | 17.0 | 77.0 | 6.0 | — | — | — |
| ..... | 86219S11 | 3.20 - 3.40 | — | 9.5 | 61.7 | 28.8 | 30.1 | 1.9 | SW-SM |

JOB NO. 101 -4480

DATE 86-5-13