

MACKENZIE HIGHWAY GEOTECHNICAL EVALUATION VOLUME XIX HANNA RIVER CROSSING MACKENZIE HIGHWAY

Submitted To:

GOVERNMENT OF CANADA DEPARTMENT OF PUBLIC WORKS CONTRACT NUMBER A10/73 FILE NUMBER 9305-52-307

MARCH, 1974

Engineering Consultants Ltd.

Page

ţ

۱.	INTR	DUCTION			1
11.	GEOTI	CHNICAL DATA AQUISI	TION		1
	2.1	Field Testing Laboratory Testing			1 2
	SITE	CONDITIONS	· · · ·		3
	3.1 3.2	Surface Features an Subsurface Conditio	d Geology ns		3 4
۱۷.	CONC	USIONS AND RECOMMEN	DATIONS		5
	4.1 4.2	Foundation Types Foundation Design			5 6
	· ·	4.2.1 End Beari 4.2.2 Friction	ng Piles Piles	·	7 8
	4.3 4.4 4.5 4.6 4.7 4.8 4.9	Negative Skin Frict Frost Heave of Pile Subgrade Considerat Slope Stability Con Drainage Considerat Cement Type and Cor Additional Studies	ion s ions on Center Line siderations ions rosion Considerations		9 11 13 15 16 16 17
۷.	LIMI	ATIONS	•		18
LIST O	F REFERE	CES			20

APPENDIX A

Drawing No.	A-1	-	Key Plan
Drawing No.	A-2	-	Site & Borehole Location Plan
Drawing No.	A-2a	-	Terrain Legend
Drawing No.	A-3	-	Photographs - Plates 1, 2 & 3
Drawings No.	A-4 & A-4a	-	Stratigraphic Sections

APPENDIX B

Borehole Logs

APPENDIX C

Drawings No.	C-1 t	o C-5'-	Grain Size Curves
Drawing No.	C-6	-	Summary of Laboratory Results

#### I. INTRODUCTION

In conjunction with a geotechnical engineering study carried out from Mile 725 to Mile 632 of the proposed Mackenzie Highway, several major river and stream crossings were investigated. The Hanna River Crossing, whose geographic location is shown on the Key Plan, Drawing No. A-1, Appendix A, is one such site investigated in detail. Details of the investigation, site conditions, geotechnical data and recommendations pertinent to the development of the river crossing, are reported herein.

This work was carried out for the government of Canada, Department of Public Works, and was authorized by Contract Number A10/73, File No. 9305-52-307.

II. GEOTECHNICAL DATA AQUISITION

#### 2.1 Field Testing

The evaluation of subsurface conditions has been based on field data obtained from thirteen boreholes, drilled at the locations shown on the Site Plan, Drawing No. A-2, Appendix A. Of the thirteen boreholes advanced, two were drilled as center line boreholes, in conjunction with the general route evaluation, and the remainder were located and drilled specifically to define subsurface conditions at the river crossing.

The special boreholes consisted of Boreholes 669-S-1, 669-S-2, and 669-S-4 to 669-S-12, inclusive. The two center line boreholes were designated Boreholes 669-C-6 and 669-C-7. Detailed borehole logs are presented in consecutive order in Appendix B.



**900** Engineering Consultants Ltd.

#### E-517

The center line boreholes were drilled with a Texoma Super Economatic power auger, fitted with a 12 inch diameter stub auger. All special boreholes were drilled with a track mounted Mayhew 500 rotary drill rig, using a continuous air return circulation system. Boreholes advanced with this drill rig generally were 4-3/4 inches in diameter. Borehole penetration ranged from 15 feet to 51 feet, and averaged 30 feet in depth. Sampling consisted of representative bag samples, obtained at depths of 2-1/2 and 5 feet, and at depth intervals of about 5 feet, thereafter, to the bottom of each borehole. Two core samples and one Shelby tube sample were obtained from Boreholes 669-S-9 and 669-S-12, respectively.

# 2.2 Laboratory Testing

Laboratory testing was carried out on disturbed soil samples to determine the natural water content profile, Atterberg limits, grain size distribution, soluble sulphate concentration, and pH of the subsoil. The moisture content tests were undertaken in the field laboratory of EBA Engineering Consultants Ltd., while all other testing was confined to the EBA Edmonton laboratory. One unconfined compression test was performed on thawed undisturbed clay, the result of which is noted on Drawing No. C-6, Appendix C. In addition to the laboratory testing outlined above, all samples were visually classified in both the EBA field and Edmonton laboratories. Soil classification was based on plasticity, according to the extended Unified Classification System  $(1)^*$ , and on textural classification according to U.S. Engineers Department (2) textural classification triangle.

\* Superscripted numbers in parentheses refer to the List of References presented at the end of this report.

Frozen ground was classified according to a modification of the NRC system for describing permafrost <sup>(3)</sup>. This modification was necessary because the disturbed nature of the samples obtained did not permit full usage of the NRC system; especially in describing the form of the excess ice. The system used retains the symbols V and N for visible and non-visible ice, respectively, and the modifying symbols B and F for well bonded and poorly bonded non-visible ice, respectively. Excess ice quantities were estimated from visual observations. The results of laboratory tests are presented on the borehole logs (Appendix B), where applicable, and on grain size distribution curves, Drawings No. C-1 to C-5, inclusive, Appendix C. Drawing No. C-6 presents a partial summary of laboratory results.

## III. SITE CONDITIONS

#### 3.1 Surface Features and Geology

The proposed Mackenzie Highway crosses the Hanna River at Mile 669.4, approximately 38 miles north-west of Norman Wells, N.W.T., Drawing A-1, Appendix A, is a Key Plan of the Hanna River area and Drawing No. A-2, Appendix A, presents a detailed Site Plan. Plates 1, 2 and 3, of Drawing No. A-3, Appendix A, show the crossing from the air in both February and June, 1973.

The Hanna River drains a large area extending east of Paige Mountain and south-east of Brokenoff Mountain. Moon Lake appears to be the principle reservoir of the Hanna River system, but several smaller lakes may also contribute substantial base flow, as they are probably spring fed throughout the entire year. The large watershed of the Hanna River results in a substantial stream flow throughout the summer and fall. In the winter there is probably a continuous flow of water under the ice.

Engineering Consultants Ltd.

3%

Aerial photographic interpretation of the surficial geology of the immediate area of the Hanna River Crossing, is shown on Drawing No. A-2, Appendix A. The surficial materials are believed to be glacial lake basin sediments, with peat being noted in depressions. Active flood plain and alluvial meander plain deposits exist in the immediate vicinity of the Hanna River channel. A terrain legend, which describes the symbols used in the terrain analysis, is presented as Drawing No. A-2a, Appendix A.

#### 3.2 Subsurface Conditions

Based on observations from the boreholes, inferred stratigraphic sections along center line and on two cross-section lines have been compiled and are presented as Drawings No. A-4 and A-4a, respectively, Appendix A. The generalized center line stratigraphy noted at the site is summarized in Table 3.2.1, following.

#### TABLE 3.2.1

#### STRATIGRAPHY AT HANNA RIVER CROSSING

MATERIAL	DESCRIPTION	APPROXIMATE AVERAGE DEPTH BELOW EXISTING GRADE (FT)	AVERAGE RANGE OF THICKNESS (FT)
PEAT (BH's 669-S-6 & 669-S-12, only)	black, fibrous, silty V 35% - 40%	0-1.5	1 - 2
CLAY -silt	low to medium plasticity, brown to grey, some sand, M/C 21% - 284% (avg. 48%), unfrozen to frozen, V 0% - ice	Below O	Not Established

DO Engineering Consultants Ltd.

The following additional information, which may influence design or construction decisions, was also obtained during the field investigation.

1. The maximum depth of borehole penetration was 51 feet.

- Partially unfrozen material was observed below 12 feet in depth in Borehole 669-S-6, 30 feet in depth in Borehole 669-S-7, 30 feet in depth in Borehole 669-S-8 and 25 feet in depth in Borehole 669-S-11.
- 3. A silt layer, 9 feet in thickness, was noted at and below the ground surface at the location of Borehole 669-S-2.
- 4. Ice was recorded in the upper 3 feet of Boreholes 669-C-6, 669-C-7 and 669-S-7.
- 5. No borehole information is available in the bottom of the creek channel to indicate the type and nature of underlying subsoil materials.
- IV. CONCLUSIONS AND RECOMMENDATIONS

## 4.1 Foundation Types

At present, preference is given to pile foundation systems supported on bedrock. However, final selection of a foundation system should be determined in conjunction with economic and structural design considerations. The following foundation types are believed to be feasible for a bridge structure at the subject site.

Engineering Consultants Ltd.

- 1. Closed end pipe piles driven in pre-bored holes.
- 2. Driven steel H-Piles.

## 4.2 Foundation Design

Major factors affecting the design of pile foundations at the Hanna River Crossing are the occurrence of unfrozen zones within the subsoil, a high percentage of visible ice, and high natural moisture content at or near the assumed abutment locations of the proposed bridge. Generally, the subsoil was noted to be frozen near the creek. However, the noted unfrozen zones, in the general area of bridge construction, and the possibility of unfrozen subsoil beneath the river flood plain and channel, renders pile design, based on soil adfreeze principles, hazardous. Consequently, it is considered that allowable pile bearing capacities must be determined on the basis of available end bearing support, and/or available skin friction support of existing subsoil material in the unfrozen state. In addition, the existence of frozen zones is considered to preclude the use of dyanamic pile formulae as a rational approach to the determination of pile capacities. However, placement of piles through pile driving techniques will likely be the most expedient method of installation.

Because of a lack of data with respect to soil strength and depth to a frost stable bearing surface, pile designs presented herein are largely based on empirical data, and must be considered, only preliminary in nature. Confirmation of the design parameters presented herein through additional field and/or laboratory testing is considered necessary.

Engineering Consultants Ltd.

The recommended foundation types listed in Subsection 4.1, may be designed in accordance with the following preliminary design parameters. However, it is stressed that the following recommendations are presented without knowledge of final design highway grades, geometrics, or bridge design. Consequently, the recommendations presented may require reconsideration when these factors become known.

#### 4.2.1 End Bearing Piles

It is considered that the only positive method of foundation support, that will permit relatively high loads without excessive settlements at the Hanna River Crossing, is an end bearing pile system achieving support on bedrock existing beneath the site. However, due to equipment limitations the maximum depth of drill penetration was 51 feet, with bedrock not being encountered.

Based on a review of bedrock geology of the area, it is believed that shale and/or sandstone bedrock of Upper to Middle Devonian Age  $^{(4)}$  may be expected at an unknown depth below the approximate abutment locations of the proposed river crossing. It is recommended that consideration be given to the use of steel end bearing piles for bridge foundation support. However, determination of bedrock depth and properties, at the locations of bridge abutments and piers, is a necessary prerequisite to determination of a final design pile capacity.

For preliminary design purposes, it is believed that consideration should be given to the use of closed end pipe piles to provide end bearing support in bedrock. It is recommended that piles with a minimum nominal diameter of 12 inches and a minimum weight of 65 pounds per foot be used. The design length of piles must be confirmed on the basis of additional field drilling.



Engineering Consultants Ltd.

E-517

E-517

Installation of pipe piles will require the use of both drilling and pile driving equipment. It is recommended that the piles be installed in pre-bored holes having a diameter of about 95% of the pile diameter to permit a snug fit. The pile holes should be prebored at least 5 to 10 feet into the bedrock, or until drilling refusal is met, whichever is shallower, and the piles should be driven to at least the full prebored depth. A minimum driving energy of 24,000 foot pounds is recommended. Steel H-piles are presently believed to be less feasible, as preboring would result in loss of lateral support, and installation without preboring to the anticipated depth is expected to meet with high driving resistance. Confirmation of this, however, could be achieved through the driving of test H-piles at the site.

A preliminary design load capacity of about 170 kips may be used for the foregoing recommended pipe pile section, if the piles can be driven to 'refusal' in bedrock. It is considered that 'refusal' will constitute a penetration of less than 0.1 inch per blow, measured over the last foot of driving with the recommended pile driving energy. It is recommended that pile driving records be kept for all piles, for immediate review by the geotechnical consultant. A pile load test is also recommended, prior to or at the outset of pile installation, to confirm the load carrying capacity of the piles and permit a correlation to the driving records.

# 4.2.2 Friction Piles

Based on available geotechnical information at the Hanna River Crossing, it is believed that limited probability exists for the successful installation of piles at the site, achieving their load carrying capacity primarily through skin friction between pile and embedding soil. Hence, the present lack of specific information, with respect to the strength of insitu soils in an unfrozen condition, in combination with the above belief that long term satisfactory performance is a remote possibility, precludes the recommending of skin friction piles.

Page 8

Engineering Consultants Ltd.

E-517

Confirmation of the suitability of friction piles, presentation of more detailed pile designs, and estimates of pile capacities can only be made if additional more detailed geotechnical information of subsurface deposits is obtained at the site.

#### 4.3 Negative Skin Friction

The effect of negative skin friction, on individual piles and pile groups, will be dependent upon the occurrence and magnitude of both consolidation settlement and thaw settlement within the fill surrounding the piles and the natural subgrade soils. At the crossing site, it is considered that all clay and silt materials are thaw unstable and consequently significant negative skin friction effects can be anticipated in these materials if thawing occurs. Substantial skin friction effects will also be mobilized in any road grade fill surrounding piles if loss of subgrade support occurs. To limit the amount of thawing of the subgrade, the loss of subgrade support, and the magnitude of negative skin friction, fills should be placed during the winter season. In order to further limit potential negative skin friction, due to settlement of the fill itself, it is recommended that fills be placed to final grade and pre-boring and installation of piles be carried out through the fill. The maximum time period possible should be allowed between these two phases of construction.

It is extremely difficult to accurately predict the anticipated total magnitude of negative skin friction loads on any pile or pile group that may be installed at the subject site. Negative skin friction develops due to the downdrag effect of the soil around the pile as it thaws and consolidates. Table 4.3.1 presents suggested values <sup>(5)</sup> for negative skin friction in typical soils. At the Hanna River Crossing, the thickness of fill placed and method of placement will significantly effect the depth and rate of thaw wherever the soil is presently frozen.

5



Page 9

ţ

#### TABLE 4.3.

## NEGATIVE SKIN FRICTION OF UNFROZEN SOIL FOR PILE DESIGN (After Woodward Lundgren And Associates, 1971) (5)

Description of Soil Categories	Design Negative Skin Friction
Clean sands and gravels with little or no silt or clay. Typically: GW, GP, SW, SP	$P_{s} = 30d (X^{2} + 2HX)*$
Silty or clayey sand and gravel mixtures with considerable amounts of silt and clay. Typically: GM, SM, GC, SC, SF	700 PSF
Moderately plastic to highly plastic inorganic clays. Typically: CL, CH	800 PSF
Non-plastic to slightly plastic inorganic silts and lean clays. Typically: ML, MH	350 PSF
Organic silts and clays. Typically: OL, OH	150 PSF

\*Load developed on that portion of a pile embedded in granular stratum.

- P d<sup>s</sup> Load developed, 1bs. =
- Diameter of pile, ft. =
- Depth of overburden to top of granular stratum, ft. Н =
- X Length of pile embedded in granular stratum, ft. Ħ

However, for preliminary design purposes and an assumed depth of abutment fill of about 10 feet, it is believed that about 5 feet of thaw may take place in the natural subgrade which will contribute to negative skin friction. This estimate assumes that the fill is placed during the winter on a frozen subgrade.

# 4.4 Frost Heave of Piles

Frost heaving of piles can occur as the active layer freezes each winter. During the cold winter months, the surface soils freeze and bond to the pile at low temperatures. In soils containing silt and clay this shallow surface adfreeze, if accompanied by ice lens formation, exerts a heaving force on the pile which must be resisted by the dead load on the pile, the available adfreeze bond in the permafrost, and/or pile skin friction within unfrozen soil zones in which the pile is embedded.

In order to prevent pile heave, it is necessary to check the pile design to ensure that the available resisting forces provide an adequate factor of safety against seasonal frost heaving. In general, it has been found that slightly deeper pile embeddment is the most feasible means of overcoming undesirable frost heaving stresses, if they exceed the sum of the total resisting forces divided by the factor of safety. Suggested design stresses for general permafrost soils are presented in Table 4.4.1 <sup>(5)</sup> and may be used for preliminary design purposes.



Page 12

#### TABLE 4.4.1

# FROZEN SOIL ADFREEZE BOND STRENGTH FOR PILE DESIGN (After Woodward Lundgren And Associates, 1971) (5)

Desi	Ign Category	Applicable Cri	teria	Design Adfreeze Bond Stress, for Frost Heaving Soils (PSF)
	• • • • •	Segregated Ice W Condition	ater Content of Soll %	
I	-above average soil-ice condition	No visible ice, (< 1%)	15 15 - 40	5000 4000
H	-average soil-ice condition	Little visible ice, (1 - 10%)	15 15 - 40	4000 2000
111	-below average soil-ice condition	Occasional visible ice, (11 - 20%)	15 15 - 40	2000 1500
IV	<pre>-poor soil-ice   condition</pre>	Some visible ice (21 - 35%)	40 15 - 40	1350 1350
V	-very poor soil- ice condition	Considerable visible ice, (>35%)	40 Апу	900 700
		· .		

Applies only for soils containing 5% or more of silt or clay size particles.

Engineering Consultants Ltd.

## E-517

#### 4.5 Subgrade Considerations On Center Line

As indicated in Table 3.2.1, the stratigraphy on center line, on both sides of the creek, is similar. Generally, clay and/or silt were noted from existing grade to the maximum depth of borehole penetration. A thin organic cover was noted at one center line borehole location. Estimated visual excess ice contents are generally high near the surface, becoming lower with increasing depth. Moisture contents are high and it is expected that very soft conditions will probably exist in unfrozen soils during the summer season. A winter construction program is, therefore, advocated to limit undesirable disturbance to the sub-grade thermal regime.

Qualitative evaluation of shear strength of the silt and/or clay can be made, from visual observations, ice content estimates, moisture content profiles, and classification test results. In addition, limited quantitative evaluation of shear strength can be made, based on the single laboratory strength test on thawed undisturbed clay. Based on these factors, it is concluded that on thawing, low shear strength will exist in the silt and/or clay. Generally, below 25 feet from existing grade, the moisture content in the silt and/or clay is low enough that it is expected to have a moderate shear strength on thawing.

A lack of detailed information, with regard to ice contents, and a need for sophisticated testing and detailed computer analyses, makes it impossible to accurately predict thaw settlement of fill on frozen materials with excess ice contents. Therefore, only qualitative estimates of thaw settlement can be made at this time. Based on visual estimates of excess ice content, it is believed that a total thaw settlement on center line (approach fill about 6 feet in thickness) of about 1 to 2 feet can be expected for winter construction, and 2 to 3 feet for



summer construction. This estimate assumes thawing of subgrade soils, but does not take into account normal consolidation settlement of the unfrozen subgrade soils due to the surcharge effects of the road bed fill. In the case of peat soils, normal consolidation settlement can easily reach 50 percent of the original thickness of the deposit and can, as with thaw settlement, occur fairly rapidly.

It is considered that the conventional northern construction practice of placing fill material directly on the organic subgrade is desirable at this site. Fills for bridge approaches should be constructed with allowance being made for the occurrence of thaw subsidence, if sufficient thickness of fill is not placed to preserve the frozen subgrade. Allowance for expected subsidence can be made by either providing extra fill to compensate for the anticipated settlement, or to upgrade as subsidence occurs, or both. A 6 foot thickness of granular fill material (non-plastic) is considered to be the minimum depth for road grade construction on underlying frozen subgrade materials at the Hanna River Crossing. Local fine grained materials, such as silt and silty clay, are not considered suitable for abutment or approach fills. The thickness of road grade material required to prevent degradation of the permafrost can only be predicted after detailed theoretical analysis, which is considered to be beyond the scope of this investigation. It is believed that fill placement should be carried out during the late winter period to minimize thermal disturbance, and possible damage to the existing ground cover and slopes by the construction equipment. Snow clearing should be carried out prior to all fill placement. Placement of the fill should be undertaken by end dumping with subsequent spreading by dozing equipment. A minimum initial lift thickness of 2 feet is suggested. Depending on construction completion schedules, placement of fills may be staged for several seasons or carried to completion as construction progresses.

E-517



It was not possible to drill through the ice into the creek bed. Therefore, the extent and characteristics of the creek bed gravel could not be determined. However, it is believed that gravel underlies the active stream channel. It is impossible to estimate the maximum depth of scour based on the available data.

It was noted at the time of drilling (first week of March, 1973) that the river was covered with ice but there was water flowing under the ice cover. It is probable that water continues to flow throughout the winter. Therefore, a potential icing problem may develop with respect to winter construction and maintenance.

## 4.6 Slope Stability Considerations

No evidence of recent slope instability was detected on either valley wall in the immediate vicinity of the proposed crossing. The slope gradient along center line ranges from about 11 to 22 degrees (about 20 to 40 percent grade) in the immediate vicinity of the Hanna River.

Cursory slope stability calculations, utilizing implied shear strength parameters for thawed materials and the surveyed slope configuration, indicates a marginal factor of safety with respect to slope stability. Consequently caution is advised when constructing on or in the vicinity of slopes immediately adjacent to the Hanna River at the crossing site. Detailed consideration of slope stability conditions at this site are recommended. In any event, it is recommended that excessive fill thicknesses be avoided near the crest of slopes. In addition, cutting or excavating of slope material is not recommended and desired grades should be achieved solely through the placement of fill.



E-517

It is considered that rip-rap protection of the existing defined river channel, upstream and downstream of the bridge crossing, may be necessary to protect the stability of the crossing site. Bridge abutments should be set as far back from the channel banks as is practicable. Fine grained fills should not be used for subgrade construction on the flood plain as they are easily eroded.

## 4.7 Drainage Considerations

Approach fills will concentrate runoff water along the upslope sides of fills. Therefore, it is considered essential that significant effort and care be taken to minimize erosion on the slope parallel to the fill. Every effort should be made to preserve the vegetal lining of all designed water courses and wherever this is impossible, coarse gravel should be used as channel lining. Transverse flow breakers should be provided at frequent intervals to reduce the rate of runoff along the fill and thereby reduce the potential for erosion by running water. Spacing of flow breakers will become apparent in the field when drainage courses and gradients become accurately defined. Ponding of water adjacent to fills should be discouraged as ponded water will act as a heat source for rapid degradation of permafrost. It will also tend to reduce the shear strength of the subgrade soil and road grade fill, unless the road grade is very granular.

# 4.8 <u>Cement Type and Corrosion Considerations</u>

A representative sample from the crossing area was tested to determine the soluble sulphate concentration and soil acidity. The soluble sulphate concentration determined rates as positive and the pH test result indicates a slightly acidic condition. It is recommended that the use of Type V Sulphate Resistant Cement be considered, for preliminary E-517

design purposes, for all concrete in contact with the soil, until further test results are available. Confirmation soil sulphate analyses can be performed prior to construction. A minimum '28 day' compressive strength of 3000 pounds per square inch is recommended for all concrete forming foundation elements.

For steel pipe piles, extending above grade or above the groundwater level, corrosion protection may be achieved by painting or encasement with concrete. In this instance, the protective coating should extend to a minimum distance of 2 feet below final grade or minimum anticipated low water level, whichever is deeper. In the case of pipe piles, protective coating should be provided on the interior of the pipes to prevent possible corrosion. If practical, this may be achieved through filling of the piles with concrete.

## 4.9 Additional Studies

In order to more accurately assess such factors as insitu shear strength, thaw subsidence, and slope stability, it is desirable to obtain additional detailed geotechnical information at the site. Such items as acquisition of representative undisturbed samples of the various soil types, a thorough study of existing local slopes, refined field and laboratory tests to determine shear strength and thaw subsidence factors, and a refined theoretical analysis of these factors, constitute the additional detailed geotechnical information that is considered to be desirable. In addition to the desirability of obtaining further detailed geotechnical information, it is recommended that consideration be given to establishment of a series of closely supervised and documented pile driving and pile load tests. Although preferable, these tests need not be carried out at actual bridge crossing sites, but may be carried out in areas and materials that would be representative of general foundation conditions at most of the proposed bridge sites. Such tests would provide valuable design data on which future designs of pile foundation systems could be established.

#### V. LIMITATIONS

The foregoing recommendations have been prepared based on our knowledge of existing conditions at the Hanna River and the proposed highway crossing. This knowledge has been derived from visual, physical and analytical considerations of existing soil and slope conditions, which were obtained from our field investigation. The findings and comments presented are believed to accurately reflect conditions as they are known to exist.

Due to the general nature of the study, reported herein, the findings cannot be considered to be a comprehensive assessment of slope and foundation conditions at the crossing. Should conditions be encountered other than described herein, the geotechnical consultant should be contacted so that recommendations may be evaluated in light of new findings.

Engineering Consultants Ltd.

ĩ

# Respectfully Submitted,



L.A. Balanko, P. Eng.

GRG:1mh

#### LIST OF REFERENCES

- 1. Yong, R.N. and Warkentin, B.P., 1966: Introduction to Soil Behavior. The MacMillan Company, New York.
- Means, R.E. and Parcher, J.V., 1963: Physical Properties of Soils. Charles E. Merrill Books Inc., Columbus, Ohio.
- 3. Pihlainen, J.A., and Johnston, G.H. 1963: Guide to Field Description of Permafrost. NRC Tech. Mem. 79.
- 4. Hume, G.S. 1953: The Lower Mackenzie River Area, Northwest Territories and Yukon, Geol. Survey Canadian Mem. 273.
- Woodward Lundgren and Associates 1971: Results of Pile and Anchor Installation and Load Tests, and Recommended Design Procedures. Trans Alaska Pipeline System (Unpublished).

i





# TERRAIN LEGEND

SYMBOL	TERRAIN TYPE	PHYSIOGRAPHIC FEATURES	MATERIALS DESCRIPTION
AFP	Active Flood Plain	Exposed bars in stream or river channel	Sand and gravel in high energy streams to silt and sand in low energy streams
AMP-2	Alluvial Meander Plain (excluding the Mackenzie River Plain)	Flood plains filling bottom of the stream	Fine silt, sand or gravel as channel deposits
GLB-1	Glacial Lake Basin (Better drained type)	Lowland occasionally swampy areas	lce-rich to medium plastic silty clay, occasionally with a trace of sand
GLB-2	Glacial Lake Basin (thermo- karst type)	Lowlands usually swampy with thaw lakes	Usually peat covered glacio-lacustrine silty clay

# Topstratum Phases (Associated with Terrain Types)

PT

Mixed bog and fen peats in post glacial ponded depression

Complexes are shown as combinations of two terrain types with or without phases that pertain to the parent type.

Terrain Symbols are modified from Canadian Gas Arctic Study Limited Terrain Study for this area.

## Drawing No. A-2a

E.W.Brooker & Associates Ltd.

![](_page_26_Picture_0.jpeg)

PLATE No. 1

General Site plan of the Hanna River Crossing. North is to the right of the plate. (June, 1973)

PLATE No. 2

Hanna River Crossing. North is to the left of the plate. (Feb., 1973)

PLATE No. 3

Hanna River Crossing. North is to the bottom of the plate. (Feb., 1973)

Drawing No. A-3

E.W.Brooker & Associates Ltd.

![](_page_27_Figure_0.jpeg)

![](_page_28_Figure_0.jpeg)

	Ε	. W	. В	RO	ок	ER	8	AS	ssoci	ATES	LTC	).	DRILL	но	LE	RE	PO	RT				DEI	PAR	TM	ENT MA	OF CKE	PU NZ	BLI IE	C V HIG	VOF SHV	RKS	, CAN	ADA	· · · · · · · ·
	NN: KD		B M	FIEL	D E	NG	GRO HC	D/ RI	ATE DRILL	_ED12/2/	73 AIR!	PHOT	O NO: A22763	<u>8-45</u>		CHAIN	AGE	VEGE	TAT	290	<u>9 +</u> RI	<u>15</u>	10-2			SET	FLE	v:	122	7		TEST	HOLE	:
			<u></u>	RY	NOW	BOL			10/10			ONND	ICE							<u></u>		Spc Spc	irse	<u>v v</u>	dense t	GRA	IN- S	IZE	<u>-154</u>		Ł	MILE	8,C,S	NUMBE
LEAD	FEET	MPLE NBER	r P E E	RE COV	STANC	IFIED	so	ЯL	DESCRIP	TION		10 S.	DESCRIPTION	FEETH		ICE C	R CONT	TENT	NT ( (%	0F 9	F DR Samp	IY W	VOLU	F) ME)		LAY .	111	AND	AVEL	DENS	DENSI C F )	669	с	6
		NC SA	SAT SAT	*	PEN5	SGU	ļ	_	<del>.</del>			FROZ		02		20	PL/ Li	ASTIC	<u>ب</u>	60		LIQUII LIMI 80	р г	100	100 +	%	%	%	%	WET (P	Υ. 4	R	EMARKS	S
	2	1	Ζ			CL	CLA	Υ ·	- Silty - Med. - Low I	. Brown Plasticity	,		ICE	2										2	39%							Top of Hanna	N. Bar River.	nk of
	4	2											∨' 80-85%	4						7	0													
	8	3							- Dark	Rrown		F	√ 20-25%	. 6				2															· .	•
	12	-	_ <b>`</b>			СІ		-	- Silty - Med.	Plasticit	y .		NB	12			$\frac{1}{1}$		-+															•
	4	4	$\overline{\nabla}$					-	- Grey	<i>i</i> .				14	$\left\{ -\right\}$				_	-+-				╋										
	6	-			~		END	OF	HOLE	15'				16			— e	<b></b>															•	
	8						· · ·							18											· · · · · ·		-			-			-	•
1	0													20-																				•
1	2													22				_	<u> </u>					_		{								
2	4						•							24						_														

.

•

•

1

DWN: ALB     FIELD ENG:     GRG     DATE DRILLED12/2/73AIRPHOTO NO:     A22763-45     CHAINAGE:     2918 + 51       CKD     NRM     TECH     HC     RIG     Texoma     SURFACE DRAINAGE: Very Good to NorthVEGETATION: BI.Sp.       Image:     Image:     Image:     Image:     Image:     Image:     2918 + 51       Image:     Image:     Image:     Image:     Image:     Image:     2918 + 51       Image:     Image:     Image:     Image:     Image:     Image:     2918 + 51       Image:     Image:     Image:     Image:     Image:     Image:     2918 + 51       Image:     Image:     Image:     Image:     Image:     2918 + 51       Image:     Image:     Image:     Image:     Image:     2918 + 51       Image:     Image:     Image:     Image:     Image:     2918 + 51       Image:     Image:     Image:     Image:     Image:     1mage:       Image:     Image:     Image:     Image:     Image:     1mage:	MACKENZIE HIGHWAY OFFSET 5-10' Sparse ELEV: 431.8 GRAIN-SIZE ANALYSIS VOLUME) TEST HOLE GRAIN-SIZE ANALYSIS GRAIN-SIZE ANALYSIS GRAIN-SIZE ANALYSIS GRAIN-SIZE ANALYSIS COMPACT CONTROLOGY CONTRO
CKD NRM TECH HC RIG Texoma SURFACE DRAINAGE: 2918 + 51 SOIL DESCRIPTION SURFACE DRAINAGE: Very Good to NorthVEGETATION: BI.Sp. CKD NRM TECH HC RIG Texoma SURFACE DRAINAGE: Very Good to NorthVEGETATION: BI.Sp. CKD NRM TECH HC RIG Texoma SURFACE DRAINAGE: Very Good to NorthVEGETATION: BI.Sp. CKD NRM TECH HC RIG Texoma SURFACE DRAINAGE: Very Good to NorthVEGETATION: BI.Sp. CKD NRM TECH HC RIG Texoma SURFACE DRAINAGE: Very Good to NorthVEGETATION: BI.Sp. CKD NRM TECH HC RIG Texoma SURFACE DRAINAGE: Very Good to NorthVEGETATION: BI.Sp.	OFFSET           5-10' Sparse         ELEV         431.8         TEST         HOLE           GRAIN-SIZE ANALYSIS         MILE         B,C,S         NUM           VOLUME)         3         5         5         5         669         C         7           ID         100         100+         %         %         %         %         %         %         REMARKS
HILDE ICE SOIL DESCRIPTION BE DESCRIPTION E O WATER CONTENT (% OF DRY	WEIGHT }         GRAIN-SIZE ANALYSIS         MILE         B,C,S         NUM           VOLUME )         I
E Soll DESCRIPTION E OF WATER CONTENT (% OF DRY	ANALYSIS         Imile         D, C, S         NOM           VOLUME)         Imile         Imile         C, S         NOM           III         Imile         Imile         C, S         NOM           III         Imile         Imile         C, S         NOM           III         Imile         Imile         C         7           III         Imile         Imile         C         7           III         Imile         Imile         Imile         C         7           III         Imile         Imile         Imile         Imile         C         7
	VOLUME)
	T 100 100+ % % % % % T REMARKS
CLAY - Silty	
2 - Low Plasticity ICF 2	
6 V: 30-35% 6	
- Med. Plasticity 30-35%	
to t	
NB 12	
4 <u>V 60-65%</u>	
16 END OF HOLE 151 IS	
20 20 20	
	-{

.

~

.

\$

Page 1 of 2

١.

	E.V	<i>Ι</i> . Ε	BRC	OK	ER	8	A	ss	DCIA	TES	LTI	D.	DRILL	нс	DLE	E F	REP	OR	T			DI	EPA	RT	MENT MA	OF CKE	PL NZ	IBL IE	IC V HIC	NOF	RKS VAY	, CAN	ADA	
CKE	¥⊧A ) N	LB RM	FIE TE	LD EN CH	VG:	G D	RG D / R	ATE IG	DRILLI Mayh	EDI 8/2/ ew	73 AIR	RFACE	DRAINAGE W	⊩ <u>45</u> ∎II D	rair	∣сн ned	AINA	GE: VE	GET	21 ATION	7 <u>13</u> I: Bl	+ ( ack	50 Spru	ICe	OF	SET	ELE	V:	409.	1		TEST	HOLE	
			RY	N J	ğ							ONNO	ICE													GR/ AN/	AIN- S	SIZE		E	E	MILE	B,C,S	NUMBER
DEPTH FEET)	MPLE NBER	374	ECOVE	TRATI STANC	SYM	:	SOIL	DE	SCRIPT	ION		S OF	DESCRIPTION	EPTH (T33		) = W4 ) = ICI	ATER E CO	CON'	TENT VT (9	" (% % OF	OF I	DRY APLE	WEIG VOL	SHT) Lume	)	LAY	Ę	AND	<b>LAVEL</b>	C ENSI	DENSI	669	S	1
	A S	S. T.	*	PENE RESI	NO S		-					LINIT FROZ					20	LINIT			10	LIQ LIQ B	UID WIT O	10	0 1004	%	%	%	5 %	L A	AO A	F	EMARK	}
2 4 6 8 10 12 14 16 18 20 22	1 2 3			~	OL to ML	CL SI	AY		Dark Sandy Organ Trace Grey Claye Med. (TILL Some	y, San Plastic - LIKE	dy ;ity )	F	V 35-40% V 20-25% NB	2 4 6 8 10 12 14 14 16 18 18											0 100 -	-20	52	24	4		<b>e</b>	North Hanne	Bank c	s sf
24							, 							- 24											·					~				

										ан — <u>-</u>							•												Pa	2 2 05	2
E	E. W	<i>I</i> . B	RO	ок	ER	8 A	SSOCIATES	LTC	).	DRILL	нс	LE	RE	PC	RT				DEI	PA	RTM	ENT	OF	PU	BLI		VOF	RKS	, CAN	ADA	<u> </u>
OWN		LB	FIE	DE	NG	GRG	DATE DRILLED18/2	/73AIR	рнот	O NO: A22763	-45		CHAI	NAG	E :			29	13 +	60	)	OFF	SET						TES	T HOLE	
CKD	N	KM T	TEC	:H ·	<b>_</b>	DY	RIG Mayhew	SUR	FACE	DRAINAGE: W		Jrain T	ed		VEG	ETA	TION	Blo	ick S	oruc	ce		0.04	ELE	V:	409	<u>ب</u> نہ			T	
			RY.	Now	BOL				DNN0	ICE													ANA	LYS	S		Ł	Ł	MILE	B,C,S	NUMBER
DEPTH (FEET)	MPLE	MPLE YPE	LE COVI	ETRAT	L SYN	SOIL	DESCRIPTION		TS OF	DESCRIPTION	DEPTH FEET)		= WATI = ICE	ER C CON	TEN	ENT F (%	(%) 6 OF	OF D SAM	RY W	EIG VOL	HT] UME}		CLAY	3ורד	AND	RAVEL	DENSI C F )	DENSI C F )	669	S	1.
	N SA	45 45	8	PEN	in s				LIMI1 FROZ				20	PL 1	ASTIC	; 	•0	,	LIQUII Limit 60	r r	100	100 +	%	%	%	%	461 (P	087 7	F	EMARK	5
						CLAY	,																	•							
26					<b>C</b>	SILL	Same as Above		F	V-1-5%	26																				
									[	V-1-5,0																					
28	5	$\leq$	1											I																	
						END C	F HOLE 28'				~			Ŭ												i					
30			!								30																				
32											1 30																				
34				ł																											
											34																				
36											76																				
											30															i					
39											30																				
											30																				
40																															
				n							-																				
42			•						·		42																				
											72									Τ											• .
44																															
							· · · ·																								-
46											40																				
48	ļ																										-				
											48																				

5

-

•

Page 1 of 2

	E. V	N.	BR	00	KER	8	AS	ssc	CIAT	ES	LT	D.	DRILL	НС	DLE	E R	EP	OR'	Г			DE	EPA	RTM		OF CKE	PU NZ	BLI IE			RKS	, CA	INA	AC	
DW	NΕA	LB	FIE	LD	ENG	GR	GD	ATE		18/2	/73 AIF	RPHOT	O NO: A22763	-45		СНА	INAG	E 29	15 +	15					OFI	SET						+			
СК	<u> </u>	<u>IRM</u>	ι τε	CH		D١	/ R	IG	Mayhe	w	SU	RFACE	DRAINAGE: V	Vell	Drai	ined		VE	BETA	TION	;	Blac	:k Sj	pruce			ELE	V:	398	.3'			.51	HULE	
			ERY	NO	a la		•					ONNO	ICE													GRA ANA	IN- S	IZE IS		<u>۲</u>	7	MIL	ЕB	,c,s	NUMB
05974	HPLE	NPLE -	Y P E	ETRAT	IFIED	S	OIL	DES	CRIPTIC	<b>N</b>		TS OF	DESCRIPTION	FEET)		) = WAT \= ICE	CON	CONT ITEN	ENT T (9	(% 6 OF	OF I SAN	DRY APLE	VOL	SHT] LUME)		LA LA	31.1	QNV	RAVEL	OENSI C F )	DENSI CF)	669	<b>)</b>	S	2
L	5	s s	*	PEN	S C S							FROZ				2	Р 0	LAST			0	LiQi LiN Bi	UID 41T 0	100	100	%	%	%	%	NET NET	CAY CAY		REM	ARKS	;
2	1					SIL	.T	- [ - \$ - \$	Ok. Bro Sandy Some C Low Pla	own Iay Istici	ty	F	V 510%	2	2	2		-								-		t				Sou Har	ith Bo ana R	ink of	F
6	2		- 1	-	MI				andy	Wed	•		•	6		×		ļ							······										
	3					CL	AY	- (	Grey			÷		8												-								•	
12					CL to CI	SI	.τ	- S - L	Silty Low to 1 Plastici	Med. ity			V 10-1 <i>5</i> %	10											······								•		•
14													V 1-5%	4	Δ.																				•
18	4	И	7					- 1	Med.	'las ti	city			18		· .																	•		
20														20												4							•		
22					+ -		, 			<u> </u>		-		22																		-			

	E.\	N. E	BRO	OK	ER	8	ASSOCIATES	LTD.	DRILL	НС	LE	RE	POF	RT			DEP	ART	MENT	OF CKF	PU N7	BLI IF		NOF	RKS	, CAN	ADA	: ว
DV	(Ne 🌶	ALB	FIE	DE	NG	GRG	DATE DRILLED 18/2	7 JAIRPHOT	0 NO:			CHAI	AGE	291	5 + 1	15			OF	SET		14.0	1.115	2111	<u></u>		ide z or	4
СК	1 0	NRM	TEC	CH ·		DY	RIG Mayhew	SURFACE	DRAINAGE W	ell [	Drain	ed	Tv	EGET	TION	Bla	ck Spi	uce	• · · · · ·		ELE	V:	398	.3		TEST	HOLE	
<b>.</b>			ERY	LION	BOL			F				WATE			(0/	05 0		uout 1		GRA ANA	AIN- S	IZE		È	ž	MILE	B,C,S	NUMBER
0697		APLE VPLE	RECOV	IE TRAT	NIFIED	50	JE DESCRIPTION	TS O		DEPT		ICE	CONT	ENT (	% OF	SAM	PLE V	OLUME	E }	CLAY	SILT	GND	RAVEL	DENS C F )	DENS CF)	669	S	2
L			8	A W	2 O C			LIMI				20	PLAS LIN	STIC 117		<u> </u>	LIQUID		00100	%	%	%	%	WET C	Y RO	R	EMARKS	
					CI	CLA	AY - SILT .				6							_										
2	6			i i	to		- Jame as ADOVE	F	V-I-5%	26					<b>}</b> }					-								
		5	$\mathbf{k}$	-	CI						$ \rightarrow $									-								
2	8	ľ					END OF HOLE 28'			28		0																3
3	<b>.</b>									30										1	ļ							
						•								_	╞──┤	·				4								
3:	2									32	$\left\{ - \right\}$			_				+		{							· ·	
				·								-+						+		1			-				•	
										34																		
3.	5									36																		
· .			[ 								$\left  - \right $									1			:					
3	9									38								+	·····									
44	,	ļ								40										]								
									. •	,				-   ·							ľ						•	2
42		[							2	42										4							•	
											┝──╂								·······	ł							·	
-4-4										44-										·								
46										46																		
											└ <u></u>												:			•		
48										<b>4</b> 8	┝──╁				┝━─┟			+								•		

.

۱.

-

Υ.

,

.

٩

E.W. BROOKER     A ASSOCIATES     LTD.     DRILL     HOLE     REPORT     DEPARTMENT OF PUBLIC WORKS, CANADA       DWN AIB     JFLD ENG     NMM JATE DRILLCG2/1/22] ABPHOTO NO. A227821-45     Canada     SUBSCRIPTION																		•													-		
E.W. BROCKER     A ASSOCIATES     LTD.     DRILL     HOLE     REPORT     DEPARTMENT OF PUBLIC WORKS     CANADA       DWW ALB     FeLD ENG     NMM [ATT OPLILDS/]/27] ARPHOTO NO. A22283 - 45     [CHAINAGE: 2012 + 25]     [OPTSET     [CIV + 423.37]     TEST HOLE       DWN ALB     FELD ENG     NMM [ATT OPLILDS/]/27] ARPHOTO NO. A22283 - 45     [CHAINAGE: 2012 + 25]     [OPTSET     ELV + 423.37]     TEST HOLE       DVB VSU 999     Solu     DESCRIPTION     56     DESCRIPTION     57     0     MALE '93'     0     WILE '8 C.S'     60     NML '82'     60     10'     10'     10'     10'																										÷					-		
E.W. BROOKER & ASSOCIATES LTD.     DRILL HOLE REPORT     DEPARTMENT OF PUBLIC WORKS; CANADA       Image: State of the													÷											1				•					
E.W. BROOKER     B. ASSOCIATES     LTD.     DRILL     HOLE     REPORT     DEPARTMENT OF     PUBLIC WORKS, CANADA       DWL ALB, FELD ENG     NBM [DATE DOILLEGG/1/2] JAMPHOTO NO: A22763 - 45     DIMAMAGE: 2312 + 25     DIFFERENCE										•		•													•								
E.W. BROOKER     & ASSOCIATES     LTD.     DRILL     HOLE     REPORT     DEPARTMENT OF PUBLIC WORKS, CANADA MACKENZIE       DIMAL     FIELD CAN     NRM [ATE DRILLE03/1/23] ARRHOTO NO. A22763 - 45     Chanade: 301 + 35     Defest     Interview													*																				
E.W. BROOKER & ASSOCIATES LTD.         DRILL HOLE REPORT         DEPARTMENT OF PUBLIC WORKS, CANADA           DWM.ALB_FELD FINI         NRM[DATE ORLIE03/1/23 [AIRPHOTO NO. A22/63 - 45]         CHAMAGE 2912 + 25         CHAMAGE 2912 + 25<																																	-
E.W. BROOKER & ASSOCIATES LTD.     DRILL HOLE REPORT     DEPARTMENT OF DUBLIC WORKS, CANADA       DRM ALB     TELD ENG     NRM [ONTE DRILE03/1/73] AIRPHOTO NO: A22763 -45     CHAINAGE 2012 + 25     OFFSET     OFFSET     TEST     HOLE       CON NUM     R.R. Moyher     Samphorate Deallast     Good to South     Visit End Content     Good to South     Visit End Content     Test     HOLE     HILE     For NAM       EXEMPTION     South Description	1						· · ·				· ·· ··												071	41-41-	00			~ .	100				
When ALB         FELD EXE         NIMM DATE DELLEGY//2782 A45         CHAINAGE         Joint 422         Derset         Derset         TEST         HoLE           CR0         NRM         TECH         JK         Right         Suprace         Derset         ELEV:         423:3'         TEST         HoLE         Suprace         Derset         ELEV:         423:3'         TEST         HoLE         Suprace         Derset         ELEV:         423:3'         TEST         HoLE         Suprace         Suprace         Derset         ELEV:         423:3'         TEST         HoLE         Suprace         Suprae         Suprace         Suprace		E	E.۱	N. 8	BRC	)OK	ER	8 A	SSO	CIATES	LT	D.	DRILL	HC	)LE	R	EP(	)RT			Di	EPA	RIN	ΛΕΝΙ ΜΔι		PU N7	IF IF		NOF	KS VAY	, CAN	ADA	
CKDNRMTECHJKRisMayhewSURFACE DRAINAGE Good to SouthVecetrationBlock SpruceEtev423.37Tesh Rock $1$ <td></td> <td>DWN</td> <td>¥⊧ A</td> <td>LB</td> <td>FIE</td> <td>LD E</td> <td>NG</td> <td>NRM</td> <td>ATE OF</td> <td>RILLED3/1</td> <td>/73 AIF</td> <td>PHO</td> <td>TO NO: A22763</td> <td>3 - 4</td> <td>5</td> <td>СНА</td> <td>INAG</td> <td>E: 2</td> <td>912</td> <td>+ 25</td> <td>'</td> <td></td> <td></td> <td>OFF</td> <td>SET</td> <td></td> <td><u></u></td> <td></td> <td>2010</td> <td></td> <td>TEC</td> <td>-</td> <td></td>		DWN	¥⊧ A	LB	FIE	LD E	NG	NRM	ATE OF	RILLED3/1	/73 AIF	PHO	TO NO: A22763	3 - 4	5	СНА	INAG	E: 2	912	+ 25	'			OFF	SET		<u></u>		2010		TEC	-	
Line		CKD	<u>1 - 1</u>	IRM	TE	CH :	· · · · · ·	JK F	RIG	Mayhew	SU	RFACE	E DRAINAGE G	bod	to S	outh		VEG	ETATI	ON: E	lack	Spru	ce		··	ELE	V:	423	1.3		1 E S I		£ 
ELU         EVENTION         B & DESCRIPTION         B & DESCRIPTION         EVENTION         B & DESCRIPTION         D & DESCRIPTIO					2		ы					OND OND	ICE				-								GRA	IN-S			~	<b>&gt;</b>	MILE	B,C,S	NUME
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		HT C		5	o v El	ATIO	E0 YMB	SOIL	DESC	RIPTION		6 or	DESCRIPTION	EE	0	= WAT	ER C	CONTE	INT (9	% OF	DRY	WEIG	HT)		<b>&gt;</b>		6	ц.	NSIT C	NSI T	640		
Image: Section of the section of t	, i	9E (FE	AKP		AEC	VE TR	NIF I					ZEN		CEP (FEE		= ICE	CON	TEN1	. (%	OF SA	MPLE	VOL	UME)		CLA	SIL	SAN	GRAV	00	00		<u> </u>	4
2     1     Silty - Med. Brown - Silty - Silty - Trace of sond     2     0			5	"	8		28					35				2	ר או ה ו	.ASTIC .Imit 40	<b> </b>			UID WIT	100	100.4	%	%	%	%	N N	ξŪ	F	EMARK	S
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			1					CLAY	- M	ad. Brown	) )						Ī	Ť		- <u>Ť</u>	ŢŤ	ŤТ	Ť				<b></b>	<u> </u>	1				
2     1     -     Lowto Med. Plasticity     V     20-25%       2     -     Trace of sond     V     20-25%       4     -     -     -       6     -     -     -       0     3     -     -       12     -     Grey     -       13     -     -     -       14     -     -       16     -     -       18     -     -       20     -     -       21     -     -       14     -     -       16     -     -       18     -     -       20     -     -       22     -     -       24     -     -		_		· ·		1			-	Silty															1						Hanne	ı River	r
4     2     CL     -     Trace of sond     20-25%       4     10     -     Grey     4       6     -     -     Grey       10     3     -     -       12     -     Silty     F       14     -     Silty, Trace of sond     NB       18     -     Silty, Trace of sond     NB       20     -     -     -       22     -     -     -       24     -     -     -		2	11	K	-				- Lo	wto Med	. Plasti	dity	V	2	$\vdash$		$\overline{\Delta}$				+										WESL	UT Y	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$						1			- Tr	ace of sa	ıd		20-25%							A	+				ł						ĺ		
$\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 $		4			_								v	4	-	╁──┨				-+											ŀ	-	
6			2				CL						5-10%			¥∤			<b>#</b>  -						1								
8     - Grey     - Grey       10     3     - Silty       12     - Silty, Trace of sond       14     - Silty, Trace of sond       18     - Silty       20     - Grey       22     - Grey       24     - Silty, Trace of sond		6												6	┿───				<u>/</u>					<u>-</u>					<b>.</b>		l .		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			ŀ		÷.,	1							<u> </u>	-				-+	<u> </u>		-	i			ł						i		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		8	1											6	┢╌┈	<u> </u>		-#						·	ł						l		11
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$									- G	ey .					6-	<b> </b>		<del>/</del> .					— <u> </u> -			İ					Ĺ.	1. T	· .
12     -     Silty, Trace of sond     12     - <t< td=""><td></td><td>10</td><td>  3</td><td></td><td>]</td><td></td><td></td><td></td><td>- Si</td><td>İty</td><td></td><td>F</td><td>V.</td><td>10</td><td></td><td>┝</td><td></td><td><math>\downarrow</math></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>		10	3		]				- Si	İty		F	V.	10		┝		$\downarrow$															
12     - Silty, Trace of sond     NB     12	<b>1</b>												0-5%		<u> </u>	<b>├</b>					-			<u></u>				1.			l		•
14     - Silty, Trace of sond     NB     14     - 49     44     7       18     END OF HOLE 18'     18     - 10     - 10     - 10       20     22     - 10     - 10     - 10       22     - 10     - 10     - 10     - 10       24     - 10     - 10     - 10     - 10		. 12-												12			[														l .		, <sup>1</sup> . <sup>1</sup>
14     - Silty, Trace of sond     NB     14	1	- 14		-															_								ļ						
16     18     NB     16     49     44     7       18     16     18     16     18     16     17       20     22     20     22     16     18     16       22     24     16     16     16     16	·	14							- Si	lty, Trace	of san	d i		14	L																ĺ		
16     18     16     10     10       20     20     20     20     10       22     20     20     10       24     24     24     10	ſ	12	4		1								NB		<b></b>		d								49	44	7						
18     END OF HOLE 181       20     20       22     22       24     24		16	ŧ.		]									16	ļ																l		
18     END OF HOLE 18'       20     20       22     22       24     24				1		<b>-</b>							ł					·							·								
20     <		18	Į																														
						1				F 181				"ו																			
		201																			1				1						• .		
22     22     22     24       24     24     24     24		- [												20.	1																		
24     22     24		20				Ī																										•	
24 24 24 24 24 24 24 24 24 24 24 24 24 2		~		}										22	<b>†</b>						+												
								•							<u>├</u>						+				1	ŀ							
		24			l I									24	<del> </del>	╁──┤	-+				+	┝──╂			1	ŀ							

E.W. BROOKER & ASSOCIATES LTD.     DRILL HOLE REPORT     DEPARTMENT OF PUBLIC WARKS, CANADA       DMM ALB_FIELD ENE     NIMM DATE DMILLED3//73] AIRPHOTO ND: A22763 - 43     DHAMAGE: 2913 + 80     DOWNERT OF PUBLIC VARANCE, CANADA       DMM ALB_FIELD ENE     NIMM DATE DMILLED3//73] AIRPHOTO ND: A22763 - 43     DHAMAGE: 2913 + 80     DOWNERT     MACKENZIE HIGHWAY, CANADA       DMM TECH     JK     NIG     Market: DMILLED3//73] AIRPHOTO ND: A22763 - 43     DHAMAGE: 2913 + 80     DOWNERT     MACKENZIE HIGHWAY, CANADA       DMU     JK     NIG     Market: DMILLED3//73] AIRPHOTO ND: A22763 - 43     DHAMAGE: 2913 + 80     DOWNERT     MARKET SECONDENT (% OF DAMPLE VOLUME)     AMARYSIS     MILE D.C.S. MR       JK     SOLL DESCRIPTION     JK     JK     SOLL DESCRIPTION     JK     JK     JK     MILE D.C.S. MR       JK     SOLL DESCRIPTION     JK     JK <th>-</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>×</th> <th></th> <th></th> <th>•</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>-</th> <th></th> <th>•</th> <th>,</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	-								×			•										-		•	,							
E.W. BROOKER 8 A ASSOCIATES LTD.     DRILL HOLE REPORT     DEPARTMENT OF PUBLIC WORKS, CANADA       DMM ALS FIELD END NEMDIALE03/1/23 JARPHOTO NO. A2253 - 45     CHANAGE 2913 + 80     JOFFST     TEST NOLE       CON NEM (TCC)     JK. RIG Mayhew     SUBMACE COL 6 South VEGETATION Block Spruce     JOFFST     TEST NOLE       CON NEM (TCC)     JK. RIG Mayhew     SUBMACE COL 6 South VEGETATION Block Spruce     GERAMASE COL 6 South VEGETATION Block Spruce     TEST NOLE       V     Soul DESCRIPTION     SUB State And St	<b></b>											· 					•.					<del></del>							I	Page 1 c	of 2	
OWN ALS     FILL DENC     NRM(ART ENLLED2/JZ3)ARPHOTO NO. 222763 - 45     Decknamace: 2913 + 80     Defect     Defect     Test NOLE       CNO     NRM     Test     NRM: Note	E	E. W	V. E	RO	OK	ER	8 A	SS	OCIATE	S LTI	).	DRILL	HC	DLE	RE	POR	T			DE	EPA	RTM	ENT MA	OF CKE	PL NZ	<b>IBLI</b>	C V Hi	VOF SHM	RKS	, CAN/	ADA	
Image: State of Same	DWN	E Al	LB	FIE	LD E	NG	NRM		DRILLED3/	1/73 AIR	PHOT	O NO: A22763	3 - 4	5	CHAIN	AGE:	291:	3 + 8	BO				OFF	SET						TEST	HOLE	
Line         Line         Solution         Sol				2	z	2			Maynew		2			Ť					1. Di	UCK .	sprud	;e	<u></u>	GRA	UN-S	SIZE	406	3		MILE	8.C.S	NUMBE
32       3       3       -       Med. Brown CLAY - Low Plasticity - Low Plasticity - Trace of Fine Sond Near Top       V 30-33% V 30-33%       V 30-33% V 30-33%       V 30-33% V 30-33%       V 4       V 4<	DEPTH (FEET)	MPLE MBER	MPLE YPE	RECOVER	ETRATIO STANCE	LFIED	SOIL	OE	SCRIPTION		S OF	DESCRIPTION	EPTH FEET)	0	= WATE = ICE (	R CON CONTE	ITENT	" (% % OF	OF SAM	DRY MPLE	WEIG VOL	HT) UME)		TAV		QNA	RAVEL	DENSIT) C.F.)	DENSIT	669	S	5
2     1     Med. Brown CLAY     - Low Plasticity - Trace of Fine Sand Near Top     2       4     2     CL to Cl     - Cloy-silty, Trace of Sand, Med. Plasticity     2       6     - Cloy-silty, Trace of Sand, Med. Plasticity     - Cloy-silty, Trace of Sand, Med.		A N NU	₹ ₹	%	PEN	N IOS					LIM17 FROZ		100		20	PLAS L(M)	TiC ⊨		80	-1 LIQI	UID 11T 0	100	100+	%	%	%	5 %	F F F	Λ <sup>R</sup> ,	R	EMARKS	5
- Trace of Fine Sand Near Top V 5-10% - Clay-silty, Trace of Sand, Med. Plasticity - Grey - Low to Med. Plasticity - Grey - Low to Med. Plasticity - V - Sind, Med. - Grey - Low to Med. Plasticity - 22 - 24 -	2						SILT CLAY	-	Med. Brov Low Plasti	vn city		∨" 30–35%					-		-	Ē										Hanna	River	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		1						-	Trace of F Near Top	ine Sand												م										
a       CL	4								•			v 5-10%	4	·				-	-		$\square$											
Image: Clip of Sand, Med. Plasticity       - Clay-silty, Trace of Sand, Med. Plasticity       - Clay-silty, Trace of Sand, Med. Plasticity		2	$\triangleright$			CL to								<b> −</b> Δ				9	F		-		i									
8       - Clay-silty, Trace         of Sand, Med.       -         Plasticity       -         12       -         14       -         4       -         -       -         18       -         20       5         22       -         24       -	Ů					CI							6					1						]								•
10     3     - Clay-silty, Trace of Sand, Med. Plasticity     10	8.												8	i <b> </b>				∦						]						· .		
10     3     - Grey     - Grey <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>_</td><td>Classicalia</td><td></td><td></td><td></td><td></td><td></td><td>┝──┼</td><td></td><td></td><td>┨──</td><td></td><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>								_	Classicalia						┝──┼			┨──						1								
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	10	3	$\vdash$					_	of Sand,	Med.	i   •		10	) <del> </del>	┝╌╢			1-			-+		··	30	65	5						-
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	12-								Plastici	ty			12				17							1								
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$																	₩_		<b> </b>													
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	14								<b>~</b>				14			-	A							{								•
18     F     V     10     III     IIII     IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	16	4						- 1 - 1	Grey Low to Me	ed. Plasti	cFity		1.6	<u> </u>		-  \$	+															
18     0-5%     18       20     5       22     22       24     24					2						F	v	.0											1								
	18											<b>0-5%</b>	t8	<b> </b>									<u></u>									
		_																┼──		┼──┨		·								1		•
22 22 22 22 22 22 22 22 22 22 22 22 22	20	5	$\geq$										20	Ê		-  †-																
24 24	22												22			_																
	24												24				-		<u> </u>													

•

							5																			P	age 2 of	F 2
	E. W	. B	RO	ок	ER	8	ASSOCIATES	LTD.	DRILL	н	DLE	R	EPO	RT			DEI	PART	FMENT	OF	PU NZ	BLI	C V HIG	VOF SHV	RKS	, CAN	ADA	
DWI	i Al	.B	FIEI	LDE	NG	NRM	DATE DRILLED 3/1/	73 AIRPHO	TO NO: A227	63 - 4	45	CHA	NAGE	2913	+ 8	0			OF	FSET			406	5.31		TEST	HOLE	
CKD	N	RM_	TEC	сн 	T	<u> </u>	RIG Mayhew			1000	το s [	outh		VEGE	INTIO	N: Bl	ack S	oruce		GR	IN- S				<b></b>	MILE	BCS	NUMBER
HE E	w e		OVERY	ATION	ED YMBOL	so	DESCRIPTION	0F CEOUN	ICE DESCRIPTIO	N EE	0	= WAT	ER C	ONTEN	т (%	OF C	RY W	EIGHT	)	AN	LYSI	s e	VEL	F)	ENSITY F)	669	\$	5
0EP (FEI	14WDN	TYPE	RC	NETR	UNIFI	· ·		MITS		DEP		= ICE	CON1	TENT ASTIC	(% OF	SAN	IPLE V	OLUM	E!	5	5	\$A!	GRA	10 L 2 L 2 L	RY 0		EN OF	
		ļ	8	22	, in	ļ		5:			<u> </u>	2		40		60	* LINI 80	·	100 100	+ %	1%	%	%	3	<b>•</b>		EMARKS	
	6					SILT	- CLAY				6-		6							-								
26					CL	-	<ul> <li>Same as Above</li> </ul>	F	V- 0-5%	2	5					+				-								
					CI				1 0-570									- +		-								
28				1	1	ENI	D OF HOLE 28'			= 20	<sup>3</sup>										ł							
30										30	,				4_	: ·				4								
		-				•			•											4	-							
32										3	2	+								-								
															+					-								
34	1									3	4					-			1	1								•
10										30												-						
50			ł							Ĩ	<u> </u>								ļ									
38										3	8			_	_					-								•
																				-								
40							N.			4	┥──									-								
						· ·										+				-1								•
42										4	2																•	
44										44																		
																			<u> </u>	-								
46										4	6								·	-								
																	$\left  \cdot \right $			-								· .
48										4	8																	

Page 1 of 2

٤

	E. W	V. E	RO	ок	ER	8	AS	sso	)CIA	TES	LTI	D.	DRILL	нс	DLE	ER	EP	OR	Г			DI	EP/	ART	MEN	T O ACK	F PL	JBI	_IC H	W	OR	KS	, CAN	ADA	
DWI	A	LB	FIEL	DE	NG	NR	M D/	TE	DRILLE	03/1/	73 AIR	PHOT	O NO: A22763	3 - 4	5	СНА	INAG	SE: 2	912	+89	5				0	FFSE	r						TES	т ног	F
CKE	<u>N N</u>	RM	TEC	) H : 1	T	<u>JK</u>	R	G	May	new	SUF	RFACE	E DRAINAGE: GO	od i	to :	South		VE	GETA	TION	Blo	ick S	pru	ce			EL	EV	4	17.	3,				
-		-	ERY	NOU	BOL		~					ROUND								10/		<b>.</b>				GI	AIN-	SIZE				ž	MILE	9,C,S	NUMBE
DEPT	MPLE	APLE YPE	RECOV	ETRA	IFIED	3		DES	CRIPTI	ION		EN G	DESCRIPTION	FET		) = ICE	CON	NTEN	T (9	6 OF	SAI	MPLE	VO	LUME	)		1			DEMS	::	C F.)	669	S	6
	A S	SA SA	*	PEN	SOLUTION SOLUTION			<u></u>				LIMI				2	0	LASTI	°		0			10	0 10	0+ 9	6 %	9/	6 %			Å .		REMARK	s
					Pt	PE/	۸T	- 1 - 1	Black Fibrou	s, Sili	y		√ 35-40%			·					<u> </u>					_							Hann	a River	
2	1			<u> </u>		CL/	λY	- 1	Med.	Brown	-	1	·	2								1	9												
4	1							- ( -	Clayey Low to	y Med.	Plasti	citv		4																					· ·
	2	$\leq$	1																	<b> </b>						_									
6					CL								15-20%	6							$\vdash$	Ł													
			. ·		to										<u> </u>											-									
1	ł													ļ					$\angle$																
10	3							- F	lece	of Woo	bd	F	V <sup>e</sup>	10		≙		4	_							4									
								(	⊉ 10' Этом				5-10%			+										-									
12	1 .						-	- (	Jiey					12						<u> </u>															
14														14																					
	4	$\leq$										F			6			<b>k</b>							<u> </u>							ĺ			
16				2								to		16		_		$\mathbb{H}$				$\left  - \right $				-									1
												ľ	V.		-			$\uparrow$								-									
													0-5%	10					·															• •	
20	5	${\boldsymbol{\triangleleft}}$											to	20	6				<b>b</b>																
													Untrozen		$\vdash$					<b> </b>				<u>├</u>											
22														22	<b>†</b>			$  \uparrow  $								-					ĺ				
24					╞╼┧									24								i.													
L				L										<u> </u>		·	/																		

DEPARTMENT OF PUBLIC WORKS, CANADA MACKENZIE HIGHWAY DRILL HOLE REPORT E.W. BROOKER & ASSOCIATES LTD. DATE DRILLED3/1/73 AIRPHOTO NO: A22763 - 45 CHAINAGE: 2912 + 85 NRM OFFSET TEST HOLE VEGETATION: Black Spruce ELEV: 417.3 Mayhew JK SURFACE DRAINAGE Good to South RIG GRAIN- SIZE OF GROUND 8,C,S NUMBER MILE ANALYSIS WET DENSITY (PC F) ORY DENSITY (P C.F.) 331 DESCRIPTION O = WATER CONTENT (% OF DRY WEIGHT) DEPTH (FEET) SOIL DESCRIPTION GRAVEL. 699 SAND S 6 CLAY SILT △= ICE CONTENT (% OF SAMPLE VOLUME) LIMITS FROZEN PLASTIC LIQUID REMARKS LIMIT 40 LINIT % % % % 20 100 100+ \$0 CLAY - Same as Above 26 26 30 V'-0-5% F 32 to to Unfrozen U 34 36 38 40 42 Hole terminated at 48' due to drill bit mudding up 44

46

46

OWN: ALB

85

26

28

30 7

32

34

36

38

40 9

421

44

46

48

8

CKD NRM TECH

SAMPL SAMPL

6

FIELD ENG

RECOVERY PENETRATIO

\$

UNIFIED

cι to

CI

END OF HOLE 48'

Page 2 of 2

													• •••••••	<u></u>							<u></u>						Page	1 of 2	
E	W	. в	RO	oki	ER	8 A	SSOCIATE	S LTC	).	DRILL	но	LE	RE	PO	RT			DEF	PART		OF <u>CKE</u>	PU NZI	BLI	С V <u>Ніс</u>		KS AY	, CAN/		
DWN	AL	B	FIEL	D EN	IG:		ATE DRILLED 3	/1/73 AIRI	PHOT	O NO: A22763	- 4	5	CHAI	NAGE	29	$\frac{11 + 0}{11 + 0}$	00			OFF	SET	<b>E</b> 1 <b>E</b> 1		21. 2	<u>,                                     </u>		TEST	HOLE	
CKD		<u>M</u>	TEC	H ·			ng Mayhev	, ISOR	FACE	URAINAGE GOI	<u>d t</u>	o So F	uth		EGEI	ALION	· E	llack	Spruc	<u>e</u>	GRA	IN · S	IZE	24.2					
-			ERY	N N	BOL				FOUNI				WATI			r (%	0F 1	RY W	FIGHT	, 1	ANA	LYSI	S		SITY	SITY	MILE	B,C,S	NUMBER
EPT	195 A	PE	ECOV	TRAT	SYM	SOIL	DESCRIPTION		s o EN Ci	DESCRIPTION	EPT)		ICE	CONT	ENT (	% OF	SAM	PLE V	OLUM	, E)	LAY	יורד	AND	RAVE	DEN: C F.)	DEN: C.F.)	669	\$	7.
00	SAN NUN	5AM TY	в %	PENE RESIS	110S				LIMIT FROZI		03		20	PLA Ell	STIC	6	0	LIQUID LIMIT BO		00 100+	%	%	%	。 %	4) 13m	780 7)	R	EMARKS	
						SILT	- Clayey																				Hanna	Piver	
,					ML		- Med. Bro	wn	:	ICE	2																	KI VCI	
	1	И					- Organic				-								_	2848	ġ.								
4	-					CLAY	- Med. Bro	wn			4							$ \rightarrow $	$\perp$	1									
	2				CL		- Silfy - Low to M	d. Plasti	city	v			<u>م ا</u>			$\downarrow 1$	$\square$		_ <u> </u>	ļ	4		、						
6		<b>`</b>			to					10-15%	6				4–					<b> </b>	4								1
					CI	•									/						-								-
8											6			//		-			<u> </u>		-								· .
	-													-						-	1		1						
10	3	$\leq$									10	<b>⊳</b>			<u> </u>														-
																					1								
12											12										1						ĺ		
												┢──								1									
- 14-							<b>C</b>				14	<b> </b>								1	1			ł		-			
	4						- Grey		F	0-3%		β-		-91-		-				1	1								
16			^								16					-				1	1							5	
														-11-							1						•	. •	
181						•					] '8										]								
20					.					v	20																		
20	5									5-10%						_													
22											22	ļ							·	ļ	4								
										v.				$- \downarrow$					_		-	].			-				
24									<b> </b>	0-5%	24	6					ļ				4		]						
		Į	l	<u> </u>		L. <u></u> , _ ,		· · · ·	1											<u> </u>				1	<u> </u>		l		

.

۱ - ·

.

• ·

DEPARTMENT OF PUBLIC WORKS, CANADA MACKENZIE HIGHWAY DRILL HOLE REPORT E.W. BROOKER & ASSOCIATES LTD. DATE DRILLED 3/1/73 AIRPHOTO NO: A22763 - 45 CHAINAGE: 2911 + 00 OFFSET ALB FIELD ENG NRM OWN TEST HOLE Black Spruce 424.2 VEGETATION: RIG Mayhew SURFACE DRAINAGE Good to South ELEV NRM TECH JK CKD GRAIN- SIZE B,C,S NUMBER MILE WET DENSITY (PC F.) DRY DENSITY (P C F.) ANALYSIS ICE O = WATER CONTENT (% OF DRY WEIGHT) DESCRIPTION 5 5 DEPTH (FEET) GRAVEL SOIL DESCRIPTION PENETRATI RESISTANCI UNIFIED SOIL SYME S 7 OEFTH (FEET) SAND 669 CLAY RECOVI SILT △= ICE CONTENT (% OF SAMPLE VOLUME) SAMPLE TYPE LIMITS LIQUID LIMIT BO PLASTIC LIMIT 40 % REMARKS % \* % % 60 100 100+ 20 CLAY 6 - Same as Above 26 26 CL 28 28 to U CI Hole terminated at 7 30 30 to 38' due to drill bit V-0-5% F mudding up to 32 32 Unfrozen 34 34 8 36 36 38 38 END OF HOLE 38' 40 40 42 42 44 44 46 46 48

Page 2 of 2

DEPARTMENT OF PUBLIC WORKS, CANADA MACKENZIE HIGHWAY E.W. BROOKER & ASSOCIATES DRILL HOLE REPORT LTD. NRM DATE DRILLED 3/1/73 AIRPHOTO NO: A22763 - 45 CHAINAGE: 2916 + 55 OFFSET DWN: ALB FIELD ENG TEST HOLE Good to North VEGETATION: Black Spruce & Birch ELEV: 413.4 CKD NRM TECH RIG Mayhew SURFACE DRAINAGE IK GRAIN- SIZE OF GROUND NUMBER MILE 8,C,S WET DENSITY (PCF) DRY DENSITY (PCF) ANALYSIS ICE PENETRATION RESISTANCE UNIFIED SOIL SYMBOL RECOVER DEPTH (FEET) SAMPLE NUMBER SAMPLE TYPE DESCRIPTION O = WATER CONTENT (% OF DRY WEIGHT) DEPTH (FEET) SOIL DESCRIPTION GRAVEL SAND CLAY 669 8 S SILT △= ICE CONTENT (% OF SAMPLE VOLUME) LIMITS FROZEN LIQUID LIMIT 80 PLASTIC REMARKS ጽ % % LIMIT 40 % % 20 60 100 100+ CLAY - Med. Brown - Silty Honna River Silty CL - Low to Med. Plasticity V. 2 2 Δ £ to 35-40% 1 CI 2 ß 6 8 3 10 101 0-5% F 12. 12-V 14 14 5-10% - Grey 4 16 16 18 18-20-20 5 V. 0-5% 22 22. 24 24

Page 1 of 3

Page 2 of 3

	E.W	V. E	RC	юк	ER	8	AS	so	CIA	TES	; LT	D.		DRILL	нс	)LE	R	EP	OR	Т			D	EPA	RT	MENT MA	OF	PU	IBLI IE		NO	RKS	, CAN	ADA	
CKE	<u>₩ A</u> ) N	<u>ILB</u> IRM	FIE TE	LD EI CH	NG	<u>NRM</u> JK	DA	TE D	<u>RILLE</u> Mayt	:03/1 hew	/73 AI SU	RFACE	TO NE DE	NO: A22763 RAINAGE: GO	- 4: ood	5 to 1	CHA Iorti	liNA( h	SE: 2	2916 GET4	+ 5	5 I: Blo	ack	Spru	ce 8	OFF Birch	SET	EI F	V:	413.	4		TEST	HOLE	
			N.	N J	le le le le le le le le le le le le le l							QNO		IÇE													GRA ANA	IN- S	SIZE IS		>	>	MILE	B,C,S	NUMBER
05PTH	NPLE NPLE	10LE	ECOVE	STANC	IFIED SYME	S	DIL I	DESC	RIPTI	ION		S OF	DE	ESCRIPTION	EPTH (EET)		= WA1 = ICE	rer Coi	CON NTEI	TENT NT (9	(% % OF	OF 1	DRY APLE	WEIG	SHT) LUME	:)	AV.	5	Q.	AVEL	ENSIT	DENSIT	669	s	8
	S 2	1 SA	*	PENE	2 CN							LIMIT FROZ			<u>م</u>		2	р Ю	LAST			0	L  Q   L      B	UID MIT 10	10	)0 <del>1</del> 00-1	%	%	а %	5 %	L J	AND A	R	EMARKS	; ;
	6					CLAY							V.	- 0-5%		<u> </u>			}																
26						-	Sam	e as	s Abo	ove					26	; 																	-		
28					С										28																				
	_	L			to											┝			<b> </b>																
30	7	$\vdash$										F		NB	30				₿																
32						•						to U		to Infrozen	32																				
1															_	<u> </u>			╢──							<u></u>									
	8		ł			-									34				<b> </b>																•
36															36 <sup>.</sup>																				
38															70														,					, J	
															36															•					· .
40	9	Ν					~								40				┣							···· ····									
42				`											42																		•		
																																	•		
44	10						-	۰.							44-			··																	
46															46																				
	-																																	· .	
48					- 1							<u>† –  </u>			48																			• .	

Page 3 of 3

	E.W	/. E	RO	ок	ER	& ASSOCIATES	LTD	).	DRILL	нс	)LE	RE	POF	RT				DE	PAI	RTM	ENT MA	OF CKE	PU NZI	BLI	C V HIC		IKS IAY	, CAN		الالارد الأحجان فيستعربون
DW	¥∶A	LB	FIEL	DE	NG:	NRM DATE DRILLED 3/1	/73 AIR	рнот	O NO: A22763	3 - 4	5	CHAIN	AGE	29	216	+ 55	<u>,</u>					SET	<u> </u>			<del>,                                     </del>		TEST	HOLE	
СК	N	RM.	TEC	:H ·	1	JK RIG Mayhew	SUR	FACE	DRAINAGE	iood	- to	North	V	EGE	TAT		Bla	<u>ck S</u>	pruc	e & I	Birch	GRA	ELE	V: 4 IZE	13.4	<b></b>		1411 E	000	
			2	3	5			ON NO	ICE		-					~ •		<b>.</b>	VELO	u <b>w 3</b>		ANA	LYSI	S	<del>r 3-</del>	Ϋ́	11	MILE	0,0,3	NUMBER
E			OVE	ATH	E O SYMB	SOIL DESCRIPTION		101	DESCRIPTION	EET)		= WAIE	R CU		(%	76 U OF 5	SAMI	NJ Y PLE	VOL	UME)		۲۹ I	E1	AND		C EN	C EN	669	S	8
5	AMP	TYPI	RE	NET	UNIF			MITS		δĒ		,	PLA	STIC	·			LIQU	ID			0	s s	2	0 0/	<u>ال</u>	2	F	EMARK	s
			8	a a	Ň			5 5		<u> </u>		20		40		60		- 60 - 1		100	1001	70	70	70	70	<u> </u>	<u> </u>			
				ļ	CL	CLAY		F	NB			+	_  -				-+													<b>-</b> 1.
5	11	K	-		to	- Same as Above		to 11	to Unfrozen	50	<b></b>	+-+										$\frac{1}{2}$						Hole d	rilled t	o 51'
			¥		C			Ľ	0										-+			{						excess	ively.	Over
5						END OF HOLE 51'				52	<u>_</u>	+		_	4												}	bored	hole w	ith
"											ļ	<b></b>				_+	$\rightarrow$					-				1		larger	bit, bu	ut unabli
5					1				-	54	₁┝──	╀╌┾				_+		_		<del> </del>								fo pen	etrote i e to mi	uddina
ľ											<b>_</b>	+				_						-			ľ			condi	ions.	
5		1								5	5 <b>-</b>	╉┈╂					-					-								
Ĩ												╃┈╄				$\rightarrow$						-								
5										5	в <u>├</u>	$\rightarrow$	_			-+						4								
											<u> </u>	╺┨╺╌┥	_								•	4	ł							•
	,]								]	6	<u></u>		_		_						<u></u>			·						
	1										- 							-				4	1							
										6	2	┦─┤										-			ļ					-
	-											_			_						<u></u>	-				1		-		
6				1						6	4	_										4								
			1	<u>`</u>									$\rightarrow$			_						-						1		
							÷.			6	64-											-							•	
	1											_										-								
				1						6	<u></u>			_								4								
6	2										ĨL								ļ	┨──┨-		4				1				
<b> </b> _										7	₀–									┟┈╻┠		4								
1	1							1		1												4				4				
			1						1	7	2	_	$\square$					L		_↓		4								
Ľ	<u></u>								<u> </u>									1					1	<u> </u>				_ <u></u>		

- t

Page 1 of 2

	E.W	V. E	BRO	OK	ER	8	AS	SOCI	ATES	LTC	).	DRILL	HC	LE	RE	POF	T			DE	PA	RTM	ENT MA	OF CKE	PU NZI	BLI	C V HIC	VOF SHV	₹KS VAY	, CAN	ADA	
DWI	A	LB	FIE	DEN	IG:	NRA	A DAT	E DRILL	LED 3/1/	73 AIR	PHOT	O NO: A22763	- 4	5	CHAIN	AGE:	29	17 +	70				OFF	SET						TES	T HOLE	Ξ
CKT	N	RM	TEC	н		JK	RIG	Mayt	new	SUF	FACE	DRAINAGE GOO	d to	No	rth	<u>  v</u>	GEI	ATION	Bli	ack S	Sprug	<u>e &amp; E</u>	<u>Sirch</u>		ELE	V 42	6.7	·	<b></b> !	<b>[</b>		
Γ				2	۱,						R	ICE	ļ									-		GRA ANA	IN- S LYSI	IZE S		2	E	MILE	B,C,S	NUMBE
EE	we		OVER.	ATIO	U BO	so		DESCRIP	TION		GR OL	DESCRIPTION	EE	0	WATE	R COP	ITEN	т (%	OF	DRY	WEIG	HT)		X	F,	0	VEL	ENSI	ENSI	669	S	9
130	J M PL	L PF		E TR	HIFIE L S	· .					TS		190		ICE C			W OF	SAI	WPLE UD		UMEJ		บี	SiL	\$A	GR	00	20	ļ		
	9 ž	- ₹ S	8	RES	Soc						IN B				20	Lim	40		<b>10</b>	LIN		100	100 4	%	%	%	%	3	ä		REMARK	s
-	+	╧	+	1		CLA	Y -	Med	. Brown			1		T				Τ	Ι											Hanna	River	
							-	Some	e Silt								1-	1	1					1			ĺ					
2	,		4		CL		-	Med	. Plastic	sity		V	2	: <b> </b>		-	4		0					1		1	'			East	ofĘ	
		$\vdash$	4									35-40%		-					$   \neq -$					1			ł	1 ·				
4													4	· <del> </del>	+			$+ \neq$	1—					1			1					
	2	k	-												┨──┤-		+-	¥		+-				4								
6	1		1	1								V	6	<b></b>				<u> </u>		+				4			1.		1	-		
												10-15%			6		_	4		-							t i	1				
													1 8				$\downarrow \downarrow$															
1	1																										1					
								-					٦.,				¥															
1	3		4	1			-	Grey	Y					, <u> </u>			Ĭ	_		1												•
					CI		~	· Sury	/ Diasti	-itu				<u> </u>			1		1					1				1			-	
1 12					1		_	MEG	. Flusin	uny		1	1. 12	2	┼─┼		11-	-	+	-†				1								
											F	V V			┼─┼		11-		1	+				1		1	1			1		
14												0-5%	14	•	┼──╁		⊢+		+					-			1				• `	
	4	K	1											<b>A</b>	┟╌┼		\$- -							-								
1.			٦	1.									16	;	<b> </b>				<u> </u>			┝┣-		4								
1			1 ^				-	- Silt	у.										4					4						· .		
			1	1	СН		-	• Trac	e of Sar	nd				₅∟						<u> </u>	ļ											
1	'l c		7								1	V 40%	7 "	1										- 68	31	1	_					
	0	)							•			V 40/8						7-	Ţ					700	1.	"						
20	P R	5											720	' <del>†</del>	1-1						1			7					1			
	E												Į	-			+		-	1.	1.			1	1		1					
22	2	ļ										V 0-5%	2	2 <del> </del>	+				+	+	<u> </u>			-1				1.				
		1													╉╾╉				+			┼──┼		-								
24	<b>.</b>	4-	. 🕂 -	+-	<u> </u>	<u> </u>					-+-	+	- 24	₄	++					<u>-</u>	+	┟╼╾┠		-								
	<u> </u>	1	1		1										1.1						1	بال				<u> </u>	<u> </u>			.l		

Poge 2 of 2

	E.W	<i>I.</i> B	RO	OK	ER	8.4	ASS	OCI	ATES	5 LT	D.	D	RILL	НС	LE	R	EP(	ORT				DE	PAI	RTN	MENT MA	OF CKE	PU NZ	BLI E		VOF	RKS	, CAN	ADA	
DWI	N: A	LB	FIEI	DE	NG	NRM	DATE		LED 3/	1/73 A	IRPHO	TO NO:	A22763	} - 4	5 	CHA	INAG	E: 2	917 ETA1	+ 7	0 Bla	ck S	pruc	e &	OFF Birch	SET	ELE	V:	426	5.7'		TESI	HOLE	
CKE		IRM I	120						dynew		G															GRA	IN- S	IZE S		2	Ł	MILE	8,C,S	NUMBER
11.5			OVER	ANCE	ED YM80	SOIL	L DE	ESCRI	PTION		01	DESC	RIPTION	PTH EET)	0	= WA1 = 10 F	ER (		ENT I F (%	(% ( . OF	DF D SAM	RY V PLE	VEIGI VOL	HT) UME	)	AY	L1	QN	AVEL	DENSI	DENSI	669	S	9
061	SAMP	SAMPL	% REC	PENETA RESIST	CUL S						LIMITS FROZEN			C DE		101	P	LASTIC LIMIT	· · · ·			- LIQU - LIQU 80	10 17	100	001	บ %	تة %	rs %	5 %	KET (P	4	F	EMARKS	
	6	K				CLAY	Y				F	V (	)-5%		6	<b> </b>																		
26	5					-	Sam	e as	Above	:				26	; <b> </b>															-				
28					СІ		- ^	Med.	Plastic	ity		N	В	28																				
	0								• • • • • • • • •							+	┼╌		┥┤							41	55	4	-					
34	E	<u>hund</u>				, E	ND (	OF H	OLE 3	0'				30												]								
-3:	2				{ ·									3		<u> </u>		$\left  - \right $					_										ц	
														34					· _															
	4														'																		•	•
3	6												•	30	5 <b></b> -	+													ľ					
3	8													3	s																			
															-	+																		
4	0			^			<b>、</b> ·							4																1				
4	2													4	2			<b>-</b>								-						1	•	
															.	+																		
4	4											Í		44			-																	
4	6													4	6			+																
																															·			
⁴															Ĭ						L									1	1		Anna - 19 - 19 - 19 - 19 - 19 - 19 - 19 - 1	

											• • •										•									
											•									-										
								•								•														
																			•											
p								<u> </u>		· · · · · · · · · · · · · · · · · · · ·							·		000		ACAIT						NYC.	CAN	100	<del></del>
1	E.V	N.	BR	001	KER	8	ASSOC	IATES	LTC	).	DRILL	HO	LE	REF	POR.	T			UEF	ARI	MA		NZ	E	HIC	HW	AY	, UAN	AUA	
DWA	A I		FI	FLD I	FNG	NRA		LLED3/1/73	AIR	PHOT	O NO: A22763	- 45	5	CHAINA	GE: ;	2917	+ 70	)			OFF	SET						TES	т ног	F
CKD	N N	IRN	Λ Τι	ECH		JK	RIG Mo	ryhew	SUR	FACE	DRAINAGE: Go	od t	o No	rth	VE	GETA	TION	Blac	sk Sp	ruce	& Birch	<b>.</b>	ELE	Į	418	9				··
	T	Τ								Q.	105											GRA	UN-S	IZE S		<u>ج</u>	7	MILE	B,C,S	NUMB
12			100	NOL		so		IPTION		SROU SROU	DESCRIPTION		0=	WATER	CON	TENT	(% (	DF DF	RY WE	EIGHT	1		T_	0	ц,	NSIT	NSI (	669	5	10
EP1	APLE 10E		u č	TRA	STAN	•••				s Z		FEE	_⊳-	ICE CO	ONTEN	NT (9	6 OF	SAMP	LE V	OLUM	E)	CLA	SIL	SAN	GRAV	30 J	<b>6</b> 0			
100	N S	SAN	È	5 3N 3	S S I					TIMI 702		52			PLAST LIMI1	<sup>ic</sup> ⊢			LIQUID			%	%	%	%	NE)	8-	, 1	REMARI	KS
<u> </u>													i	- 20	- <u>-</u> '	10 T		<u> </u>	- 10-	'	0 100									
Į			•			CLA	Y - Me	ed. Brown		-			┝──┼		_		┨			_		-						Hann	a Rive	<b>:</b> ר
2							- 50	iry w Plasticity	,		v	2	<b>  </b>				┨}				1009	Ţ			].			West	ofę	
	1		7		CL		- 0	raanics to 3	1		35-40%				<u> </u>					_	1096	1						ł	-	
							-	0				4			_	<u> </u>				$\downarrow$	Ľ	4						i		
1		k	_	Í														-d	$\triangleleft$		ļ	_								
	2	-	Y															Δ							ļ			l		
6	1.	ļ			.						· .					-		/												
							- M	ad. Plastici	łv													7				1		ĺ		
8							146					8.				17	1				1	1							•	
1																$\checkmark$					1	1			Ì					
10	3		Z	·							V	10	┼──┟	≙- ⊦	-1-7	╡┥						1	i i					1.1		•
										_	10-15%		┝──┦		+ +						+	-								
12							~		· ·	F		- 12-										-			1		<b>I</b> 1	ĺ		
							- Gi	rey I							- <u> </u>	+						-		·						
14							- 31	нy				14			Д-							-		ļ						÷.,
	_⊿	k	_	ł		•		e				1			<u></u>							_								
		F					×.					10											•							
1.16																											1			t
											NB				Π											1		l		. •
18	4	ł		1.	ļ							18	1		11-							7						1		
		1			ļ							1			┤┼╌	+	+					1								
20	5	: []	$\Box$				•					20	+																	
																	+	<u></u> }}				-					•			
22	2	ŀ									:	22	·							<u> </u>		-								
						•							<b></b>	<b>├</b> ─── <b>│</b> ──				<b>├</b>					1	1						
24										1		24	<b></b>				<u> </u>	<b>├</b>				-						1		
					<u> </u>	]					1		1								1			<u> </u>	<u> </u>		<b></b>	<u> </u>		
						CNI		10 261																						

•

•

· · · ·

Page 1 of 2

E	E. W	<i>I</i> . В	RO	OK	ER	8	ASS	OCIATES	LTD	).	DRILL	но	)L	E REP	ORT				DEP	ART	MENT	OF CKE	PU NZI	BLI IE	C V HIG	NOR	KS AY	, CAN	ADA	
OWN	Al	B	FIEL	DE	NG	NRM	DATE	E DRILLED 3/1/7	AIRE	PHOT	0 NO: A22763	- 45	5	CHAINAG	E: 29	17	+ 80	B!a	ck Sr	oruce d	OFF Birch	SET	ELEY	<u>.</u>	427	7.5'		TEST	HOLE	
СКО		<u>km</u>	TEC	н		JK	HIG.	Maynew	150K	2	ICE			NOTEN								GRA	IN-S	IZE S		2	٤	MILE	8,C,S	NUMBER
PTH ET)	¥ تار		OVERY	ATION	ED YMBO	soi	L DI	ESCRIPTION		OF GROU	DESCRIPTION	PTN ETI				NT (	(% 0		RY WE	IGHT )	•	A	5	0	AVEL	ENSI1	C.F.)	669	S	11
DE FE	SAMP	SAMPL	% REC	PENETS	UNIF!					LINITS FROZEN		0E		P 102 001	LASTIC	ب		1	LIQUID		0 1004	บี %	s %	<b>%</b>	*5	WET (	DAY (P	R	EMARKS	
2	1				CL	CLA	( - - -	Med. Brown Silty Low Plasticity			∨ 25-30%	2				<b>9</b>									-			Hanno	River	
6 8	2	Ν			to	•		•				6																-		: ;
10 12	3				СГ		-	Grey		F	V <sup>.</sup> 0–5%	10 12	2	→ → → → → → → → → → → → → → → → → → →																- 
14 16	4	Ν					•					14	€   <u>↓</u>  -	3																
18 20	5							•			•	20	8 - 2 -	<u></u>																
24		-										- 24	4																	

Page 2 of 2

E.W. BROOKER & ASSOCIATES LTD. DRILL										HOLE REPORT DEPARTMENT OF PUBLIC WORKS, C										, CAN	ADA											
DWA	A	LB	FIE	LDE	NG	NRA	1 0	DATE D	RILLED3/	/73 AIF	PHOT	O NO: A2276	3 - 4	15	СНА	INAG	F: 2	2917	+ 8	0		_		4UN		.IC.		2114	<u>YAT</u>			
CKD	N	IRM	TE	CH :		JK	F	RIG	Mayhew	SU	RFACE	DRAINAGE: GO	od t	to No	orth		VEG	ETAT	ION	Blo	ack S	pruce	& Birch	- 32	ELE	EV:	127	<u>,</u>		TEST	HOLE	
FE			/ERY	TION			0	0550	PIRTICN		FOUND					50 0	ONTE		0/ 0					GF Ar	AIN-	SIZE		È	1	MILE	8,C,S	NUMBER
0EPT (FEE	SAMPLE	ANPLE	RECO	NETRA	IL SY			0030	IN P I ION		TS O	DESCRIPTION	DEPT	0	ICE	CON	TENT	: (%	0F :	SAME	PLE		) E)		SILT	ONVS	RAVEL	DENSI C F )	DENS! CF)	669	S	11.
		-	*	<b>a a</b>			<u>.</u>				R C		ļ	ļ	2	PL 0	ASTIC		60		LIQUIC	·	100 100	+ %	o %	%	%	WET (	AND A	R	EMARKS	
	6	$\square$	1	:	CL		-	Same	As Above			V-0-5	4				<b>↓</b>					_										
26	-				ł								26											4				1				
																-								-								
26													28			-	-+	-+	-+	+			<u> </u>	-								
30	7	K						:			F	NB	10						-+-			+		-								
											to	to	<b>J</b>			$\mathbb{T}$											·					
32						ľ							32											]								
											0	Untrozen												4.								
34	8												34		-	-1						-		4								
36	Ĭ																		-	-+-				-							ı	
													36						-			+	<u> </u>	1			ľ					
38													38									-	1									
																								]								
40	9	$\leq$			CL		. =	Low	Plasticit	/			40			_	╏┼	_		_												
				Ì																				-							-	
72	Ì				_	ENI	0 0	F HOI	LE 42'				42	†	-+	-+				+		+		-								
44																	[		-1-	-+-				1				Ì		٠.		
		ļ								ĺ			**											1								
46													46											]								
															_																	
48													48								_											
											t.									_1_				1	1			- 1	- 1			

.

								· .																																																							
																												<u>,</u>																																			
											• •										L.																																										
																				_	-				•																																						
								•																																																							
							•																																																								
								•			•																	Page 1	l of	2																																	
Γ,	- 11		000	01/		<u> </u>	000	ALATEA	1 70		00111			000	001	-			DEP	PART	MEN	C OF	PL	<b>JBL</b>	CV	VOF	RKS	. CAI	NA	DA																																	
1	:. W	. ธ	RO	UK	EK	BAA	SSU	JCIATES	LIL	).	DRILL	HC	ILE.	REP	ORI					• • • •	M	٩CK	ENŽ	IE.	HIC	ŠΗΫ	ŶĂŶ	1																																			
DWN	AL	B	FIEL	D E	NG	NRM	DATE	DRILLED 3/1/	73AIR	PHOT	O NO: A22763	- 45	5 0	HAINA	GE 2	912	+ 25				0	FSET					· · ·																																				
CKD	N	RM	TEC	н		JK I	₹IG	Mayhew	SUF	FACE	DRAINAGE: F	air	to Sc	outh	VEG	ETA	TION	Blac	ck Sr	oruce	& Birch		ELE	EV:	415	. 8'		1 1 2 3	51	HOLE	•																																
		ľ.	†	1						6		Ī.	Ea	ist								GR	AIN-	SIZE		<u> </u>	Γ		Π.																																		
			2	8	ಶ	· .			-	N N	ICE											AN	ALYS	ils		l≿	1	MILE	2	1,0,5	NUMBER																																
EE	w e	ω.	N N	A L	S.¥	SOIL	DES	CRIPTION		5 8	DESCRIPTION	EE	0=	WATER	CONT	ENT	(%.0	FDR	ex wi	EIGHT	) ·	2	F	9	ц ц	S.C.	IS C	669		S	12																																
30	10	APL.	E C	571	5					EN IS		FE P	∆⁼	ICE CO	NTEN	T (%	6 OF 5	SAMP	LE V	/OLUM	E)	5	SIL	SAN	BRA	ခြံပူ	50																																				
1	2 S	45 1	-	S S S	55					Ш Q					PLASTI LIMIT	, °		+	LIQUID	)		0/	0/	0/	0/	5	A C		RE	MARK	5																																
		<b> </b>	• •						_	1		<u> </u>	<u> </u>	20	4	°	60		60		100 IO	2+	70	- 70	70			<b>}</b>			-																																
			L		Pt	PEAT	- Ble	ack, Fibrous		J	V 35-40%															1		East	of	£																																	
						CLAY	- 1	Med. Brown		]							-								1					r.																																	
2	,	<u>k</u>	{	[		-	- 5	Silty				2	┝──┼								1209				ŀ																																						
		$\vdash$	4	1	CL		- 1	Irace of Fine	Sand	ł	v				- <u> </u>	$\Delta$	_					4																																									
							- 1	ow Plasticity	, and		40-50%										$\square$																																										
	2						•	tow ridsheny			40 00/0	-	T						$\mathbb{Z}$	1					]																																						
	<b>-</b>	$\vdash$	•															1			-t	-				1																																					
6											V	6	<b>↓</b>		4	<b>  </b>	,	4				_																																									
											5-10%		4								[				1			ł																																			
			· ·	· ·								ł											1																																								
8												- 6	╉╍┅╋		+		ř																																														
												i i				$\square$				_		_		1		1					· . • ·																																
	2									-														Į.		ł				•																																	
	3		-							r		1 10			T											1					•																																
Ì				1											╉╂╌╢						+				l			1																																			
12			]									12	┢╼╍╌┠								<u> </u>			·	1	1																																					
	· ·			1			•																·								• 1940 -																																
, 1 <sup>1</sup>										1		1							_		1	_																																									
14-												14	<u></u> ++		╉┼╼				-+-																																												
1	4		1				- 9	Shaley 👘			V V		6-1		44																																																
			1.								0-5%													1				1																																			
												10			1.						1							[																																			
·													<b>├</b> ──-}		+								ľ																																								
18			ſ				- (	Grev				1 18	$\downarrow \cdot \downarrow$		4									1						,	1999 - A																																
			ļ.				- 1	ow Plasticity							1						ł					1					ан (с. 1997) 1997 - С. 1997 - С. 1 1997 - С. 1997								-														1				1						
20	5	$\overline{}$										20	╉──╂	<u> </u>			┞──┼				- <b> </b>	_																																									
	3		]																	_			·		1	1																																					
			l			•										j	1	1																																													
22												22	tt-							-1	1			]		1																																					
				ŀ			:						<b>├</b> ──- <b>├</b>		+	<u> </u>	$\vdash$											1																																			
24				1_						<u> </u>	L	200														1																																					
					1							1 **						T	T						]																																						
<u>د</u>		ليستعمل	<u> </u>	L	<u>ن</u>					<u> </u>	L		t		ن	L	L., L.		<u> </u>		1			. <u> </u>	<b>.</b>																																						

E.W. BROOKER & ASSOCIATES LTD. DEPARTMENT OF PUBLIC WORKS, CANADA MACKENZIE HIGHWAY DRILL HOLE REPORT FIELD ENG NRM DATE DRILLED 3/1/73 AIRPHOTO NO: A22763 - 45 OWN: ALB CHAINAGE: 2912 + 25 OFFSET CKD NRM TECH JK RIG Mayhew SURFACE DRAINAGE Fair to South TEST HOLE VEGETATION: Black Spruce & Birch ELEV 415.8 East OF GROUND GRAIN- SIZE RECOVERY ICE MILE B,C,S NUMBER OEPTH (FEET) SAMPLE NUMBER SAMPLE TYPE ANALYSIS WET DENSITY (PCF.) DRY DENSITY (P.CF) PENETRATIO RESISTANCE DESCRIPTION UNIFIED SOIL DESCRIPTION O = WATER CONTENT (% OF DRY WEIGHT ) DEPTH (FEET) GRAVEL CLAY SAND △= ICE CONTENT (% OF SAMPLE VOLUME) 669 S 12 SILT LIMITS FROZE LIQUID LIMIT 80 \* PLASTIC LIMIT % % % % REMARKS 20 60 100 100+ 6 CLAY 26 - Same As Above 26 v qu = 0.11 tsfCL 0-5% F 28 T 28 υ B 9 30 Ε END OF HOLE 292' 30 32 32 34 34 36 36 38 38 40 40 42 42-44 44 46 46 48 48

· Page 2 of 2

![](_page_52_Figure_1.jpeg)

![](_page_53_Figure_1.jpeg)

FIGURE C = 2

![](_page_54_Figure_1.jpeg)

![](_page_55_Figure_1.jpeg)

FIGURE C - 4

![](_page_56_Figure_1.jpeg)

FIGURE C - 5

SUMMARY OF TEST RESULTS

JOB No. \_\_\_\_\_E-517

	BORE		NATURAL	Att	erberg L	imits		MECHANICA		IS		
	HOLE	DEPTH	CONTENT	WL	WP	PI		(M.I.T. CLAS	SIFICATIO		SOIL CLASSIFICATION	REMARKS
		feet	%	%	%	%	% CLAY	% SILT	% SAND	% GRAVEL	(UNIFIED)	
	669-S-1	10	44.0	40.1	26.4	13.7	20	52	24	4	CI	
	-2	18	25.0	38.5	18.4	20.1					CI	
	-3	10	26.0	56.8	27.9	28.9					CI	
	-4	15					49	44	7	0	CL - CI	
	-5	10	50.0	38.8	21.6	17.2	30	65	5	0	C1	
	-9	18-20	33.5	61.0	32.1	28.9	68*	31*	1*	0	СН	*Average of Five Test Results
	-9	28-30		43.5	25.8	17.7	41*	55*	4*	0	CI .	*Average of Five Test Results
	-10	10	26.0	41.4	24.1	17.3					CI	
•	-12	28-29 1/2	31.8	•				-				qu = 0.11 tsf.
i	-											
·												
												• · · · · · · · · · · · · · · · · · · ·
אכ			· · · · · · · · · · · · · · · · · · ·									
ק ק												
וי		1			L	L		ļ	L	L		

![](_page_57_Picture_3.jpeg)

C--6

EBA ENGINEERING CONSULTANTS LTD.