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"Report on Helicopter Drilling Program - Mile 351.5 to Mile 492.8 - Mackenzie Highway, N.W.T. - January, 1974."

This report contains the additional soils information which we indicated as deficient on the Final Design Submissions, Camsell Bend to Blackwater River.

The review of the Final Design Submission should take this report into account.

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J W. Twach A/Project Manager NWT Roads Western Region

SUBJECT *OBJET*

REPORT ON

HELICOPTER DRILLING PROGRAM

M. 351.5 (CAMSELL BEND) TO M. 492.8 (BLACKWATER RIVER) MACKENZIE HIGHWAY, N.W.T.

JANUARY, 1974

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I INTRODUCTION

I INTRODUCTION

This report summarizes field exploration carried out on the Mackenzie Highway between Camsell Bend and the Blackwater River in October/1973. The drilling program was directed toward providing some subsoil data on proposed route revisions, and toward investigation of potential borrow sources in areas where insufficient borrow was provem during previous geotechnical work.

A helicopter borne Mayhew 250 "air" drill (Heli-drill) was used for all borings. This rig was adequate in all but unfrozen cohesionless deposits where sloughing materials prevented drill advance. Sampling was limited to 'grab' samples of air blown cuttings.

Borehole locations were pre-selected by highway designers and landing sites cleared by field personnel. Because of time and cost limitations each area of concern, such as proposed cut sections and potential borrow sources, could be investigated with only one borehole.

Borehole locations are shown on $l^{n} = 1000^{\circ}$ airphoto mosaics in Appendix II, and borehole logs with laboratory test results are included in Appendix I. The subsequent pages of this report include comments on each site and/or feature investigated.

II SITE COMMENTS

- Hole #1 Approx. Mile 351.5 Borrow Area approx. 800 to 1300; Rt. & Area is poplar treed and slightly higher than surrounding terrain. Borehole shows low-medium plastic silty sandy <u>clay</u> with pebbles probably glacial till. No evidence of permafrost to 15' and moisture contents are below plastic limit. Considered to be a good borrow source.
- Hole #2 Approx. Mile 352.2 Borrow Area approx 600' Lt. b.

Area is poplar treed and slightly higher than surrounding terrain. Borehole reveals low-medium plastic silty, sandy <u>clay</u> with pebbles to 26' - probably glacial till. No evidence of permafrost and moisture contents are near 10%. Considered to be a good borrow source.

- Hole #3 Approx. Mile 353.5 Borrow Area approx. 800 1000' Rt. &. Small, elongated poplar treed ridge (approx 1200' x 500') parallel to highway route. Borehole reveals low-medium plastic silty, sandy <u>clay</u> with pebbles to approx. 15' over silty <u>sand</u>. Upper clay material is at moisture content below plastic limit, but free water encountered at 17'. No permafrost reported. Considered to be usable borrow to approx. 15'.
- Hole #4 Approx. Mile 355.5 on b @ Sta. 448 + 00. Borehole is on a small treed rise which is one of several in the area. Subsoil consists of sand-silt to approx. 9' over low plastic sand-siltclay with pebbles to 16'. No permafrost evident and moisture contents are below 10%. Boulders are evident on the surface. This rise is suitable for a cut section if required - although upper sand-silt is not good fill material in low-lying terrain.

Hole #5 - Approx. Mile 355.4 - Borrow area 400 - 500' Rt. b.

Area is small elongate treed rise roughly 800' x 300', parallel to the route, and is dissected from the feature at hole #4 by a narrow drainage channel. Borehole reveals low plastic sandy clay-<u>silt</u> to 16'. Permafrost was not encountered and moisture contents range from 12 to 20%. This area is considered to be borderline as a borrow source - sandy zones may be above optimum moisture and low plastic silts are poor fill material especially in low lying areas.

- Hole #6 Approx. Mile 364.2 Borrow Area 700' 900' Lt. E. Borehole is located on a small rise approximately 700' x 300'. Subsoil is very low plastic silty sand to 16'. Moisture contents are low. This area is considered to be a usably borrow source if more acceptable material is not available nearby in sufficient quantity.
 - Hole #7 Approx. Mile 364.8 Borrow Area 600' 800' Rt. E.
 Borehole is located on one end of a long narrow ridge which intersects the highway route and is dissected by small stream channels. Subsoil consists primarily of low-medium plastic, sandy, silty clay with pebbles with a sand layer from 22' to 24'. Permafrost was encountered below 10', however the temp is near 32° and the subsoil is slightly plastic in the frozen state-no ice lenses were evident. Moisture contents are at or below the plastic limit. This feature is considered to be a usable borrow source, although it is anticipated that more extensive permafrost does exist in the low areas adjacent to the

ridge and probably in isolated pockets within the ridge itself. Ridge area available for borrow measures roughly 1500' x 500' and more drilling prior to opening a pit is recommended here to determine most suitable pit area and shape.

Hole #8 - Mile 368.0 - Borrow Area - approximately 1000' Rt.

Hole is located in treed area between two drainage channels, proposed borrow area is only slightly above general terrain but is above drainage channels. Subsoil is low-medium plastic sandy silty <u>clay</u> with pebbles and cobbles below 8'. No permafrost was evident and moisture contents are below the plastic limits. Material is considered to be good borrow however the available area is limited by the drainage channels. Similar features are available in the area and other possible borrow sources do exist with slightly longer haul distances should the proposed area be of insufficient size.

Hole #9 - Mile 370.4 - Borrow Area approx. 600 - 800' Lt - b.

Borehole is located on a portion of an elongate ridge dissected by drainage channels, the shape of which suggests sandy or semigranular subsoil. Test hole reveals silty sands with some gravel and cobbles below 3'. Bottom of hole @ 10' is near the level of surrounding terrain. Moisture content is low and no permafrost was encountered. This area considered to be a good borrow source.

Hole #10 - Mile 376.6 - Borrow Area - approx. 500 - 600' Rt. b. Proposed borrow is in a small (600' x 600') poplar treed area adjacent to a creek. Subsoil consists primarily of sandy silty

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<u>clay</u> with pebbles. Material is low to medium plastic and moisture contents are below the plastic limit - appears to be glacial till. Considered to be a good borrow source. No permafrost evident.

Hole #11 - Mile 378.1 - Borrow Area - approx. 600 - 700' Lt. L.

Borehole is in a treed area which is at or very near the same elevation as the surrounding terrain. Subsoil is low-medium plastic sandy silty clay with pebbles - probably glacial till. Permafrost is present below 3' and ice lenses were evident below 13' - however moisture (ice) contents are low and below the plastic limit. This area could probably be developed as a borrow source if borrow is scarce in the vicinity.

Material will provide a good road embankment following thawing and re-distribution of moisture.

Hole #12 - Mile 382.5 - Borrow Area 600' Rt E.

Proposed borrow area is a poplar clump approx. 700' x 250' very slightly higher than surrounding terrain. Subsoil to 16' is low to medium plastic sandy silty clay with pebbles - glacial till. Permafrost was not encountered and moisture contents are near or below the plastic limit. Considered to be a good borrow source.

Hole #13 - Mile 398.3 - Station 179 + 00 on b.

Hole located on top of steep rise in proposed cut area. Subsoil consists of low to medium plastic sandy silty clay with pebbles to 33', over sandy clay-silt from 33' to 36'. Permafrost was

noted from 5 to 11' and from 33 to 35', however no ice lenses were evident and moisture contents in the clay were below the plastic limits to a depth of 30'. No serious problems are indicated in a cut section to approx. 30' by this borehole, however, as this hole is located on the edge of a south-facing slope, more drilling is recommended back from the slope to confirm the absence of ice lenses throughout the entire cut area prior to excavation.

Hole #14 - Mile 395.1 - Borrow Area - approx. 1500' Rt. & Sta. 997 + 00
Hole is located on bluffs or terrace above a former channel of the Mackensie River. Borehole encountered silty sands with some gravel, cobbles and boulders, however hole would not remain open and drill results were inconclusive below 5 - 6'. These deposits are probably only a thin veneer of outwash granular materials from the Willow Lake River and glacial till is expected at depth. The area drilled is well above the proposed roadway and a borrow pit can probably be developed in the general area, however the immediate area of the test hole may be too close to the edge of the bluffs for a pit, and drilling should be carried out farther back from the edge to confirm the subsoil at depth, and to establish the preferred pit area.

Hole #15 - Mile 401.0 - Borrow area - 500 - 600' Lt. b

Hole is located on small elongate ridge parallel to route approx. 1200' x 400'. Subsoil is glacial till - low to medium plastic, sandy, silty clay with pebbles and occasional cobbles. No permafrost evident and moisture contents are consistent near 10 - 12% to depth of hole at 23'. Good borrow source to at least 20'. Hole #16 - Mile 403.8 - Borrow area - 500' - 600' Rt. b

Hole is located on elengate ridge parallel to route. Subsoil is glacial till - low to medium plastic, sandy clay with pebbles and occasional cobbles. Moisture contents to 26' are below plastic limit. No permafrost evident. Considered to be a good borrow source.

Hole #17 - Mile 405.0 - Borrow area - 500' Lt. &

Hele is located on a treed area which is part of a large elongate ridge suggesting ground moraine. Subsoil is glacial till - low plastic sandy clay with pebbles with moisture contents below 10% to depth of hole @ 26'. - No permafrost evident. Good borrow source.

Hole #18 - Mile 415.7 - Borrow Area - 1600 - 1700' Rt. 5

Hole is located on a portion of one of a series of long ridges which appear to be ground moraine. Subsoil to 21' consists of low plastic sandy clay with some gravel throughout and with a concentration of gravel and cobbles from 14' to 18'. Moisture contents are below 10% and no permafrost was evident. Considered to be a good borrow source.

Hole #19

& #20 - Mile 420 - 422 - on b.

Both holes are located on a treed area which is part of what appears to be a terrace of the Mackenzie River. Drilling in both holes was inconclusive as drill advance was impossible below 6' due to sloughing of cohesionless materials - sands with gravels & cobbles. Surface features on terrace suggests semi-granular or cohesionless materials and a creek gully through the terrace, plus the steep face of the terrace, indicate the same materials extend for significant depths $(40-50^{\frac{1}{2}})$ especially near the River. On centerline the depth of these materials is probably less and estimated at approx. 15'. If advantageous, a cut section could be included here and a usable borrow pit can probably be developed toward the river if required.



Both holes are located on a continuation of the terrace on which holes #19 and #20 were bored. Hole #21 is in an area which has been partially eroded by a tributary stream flowing into the Mackenzie, and hole #22 is on higher ground outside the erosion area of this stream. Both holes encountered sands with gravels and cobbles and drilling results were inconclusive due to sloughing of dry cohesionless materials. In holes #21 the depth of the cohesionless materials was roughly 10-11' and appeared to be underlain by clay. Hele #22 was terminated at 6' in sands with gravels and cobbles, however the depth of these materials in the area of hole #22 is estimated at 20 to 25'. No permafrost was reported and the entire terrace area should be suitable for readway cuts or borrow pits. The very limited drilling results indicate materials are primarily sandy in nature and probably lack sufficient aggregate for use as surfacing. Test pitting is suggested here.

Hole #23- Mile 424.6 - station 1560 on b

This hole is located on a continuation of the terrace investigated in holes #19 to #22 but near the edge of the surface features which suggest granular or cohesionless

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materials. Subsoil consists of sands to a depth of 20' with permafrost below 5'. Moisture contents in the frozen material are near 20% and some free water can be expected upon thawing. This material is not recommended for borrow unless it can be piled and allowed to drain before use. Also the presence of permafrost at depth here suggests the possibility of permafrost sones or pockets throughout the terrace between holes #19 and #23.

Hole #24 Mile 429.2 - Borrow Area approx 500 - 600' Rt. b

Borehole is located on a well drained treed ridge adjacent to the highway. Drilling results were inconclusive - subsoil to 6' consisted of sand or silty sand-further penetration was not possible. No permafrost reported to 6'. This area can <u>probably</u> be developed as a borrow pit although extent and type of material cannot be estimated. Area immediately north of ridge appears to be ice rich silts or clays - maximum depth of borrow estimated at 15 - 20 if no permafrost encountered.

Hales #25

& #26 Mile 429 - 430 - Smith Creek Realignment

Both holes located on Northfacing slope on approach to Smith Creek. Subsoil in both holes is low to medium plastic silty clays with permafrost and ice lenses throughout. The general area appears to be susceptible to sliding upon thawing and cuts are not recommended here.

Holes #27

#27A & 28 These holes located adjacent to Smith Creek - Holes 27A & #27 on South side and #28 on North side. South slope adjacent to the creek appears to be sliding toward the creek as

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permafrost thaws, and the North bank has numerous cracks about 10 - 12' above water level extending 25 - 30' back from the edge of the stream where small slumps occur. A sandy gravel face is exposed on the North bank of Smith Creek roughly 300' upstream from this proposed crossing site. All holes encountered permafrost and ice lenses. Holes 27 and 27A revealed 10 - 11' of sand and gravel over silty clay - hole #28 was inconclusive.

The entire south approach slope and the 'flood plain' areas on both sides of the creek appear to be ice rich. The steep North approach appears to be better material but this program did not include drilling on this bench. The South slope is not suitable for cut sections. Insufficient data was obtained to evaluate the foundation condition at the crossing site.

Hole #32 Mile 442.3 - Borrow Area 900' Rt. b

Borehole is located in a well-treed area which is only slightly above the surrounding wet terrain. The subsoil is medium to highly plastic silty clay with no permafrost evident. Moisture contents are at or below the plastic limit to depth of hole @ 16^{1} . A silt layer was evident near $10 - 11^{1}$. This area can provide usable borrow.

Hole #33A Mile 443.4 - Borrow Area 600 - 700' Rt. 5

Borehole is located on a treed rise which is very slightly higher than surrounding wet terrain. Subsoil is low to medium plastic silty clay with low plastic clay-silt zones. Permafrost was encountered below 8' with ice lenses. Moisture (ice) contents in permafrost zone may be sufficiently above optimum for this low plastic material to create problems on thawing. Not recommended for borrow. Hole #34 Mile 444.7. Borrow Area - 1200' Rt. b

Borehole located in treed area with little relief. Subsoil is low plastic silty clays or clay-silts. Permafrost is present below 11' however temp is close to 32° and ice crystals only are present. Moisture contents below 5' are in the 22 - 25% range and may average above the optimum moisture content. This area considered to be borderline for borrow and should be developed only after more drilling.

Hole #35 Mile 461.8 - Sta 994 on b

Borehole is located on terrace of Mackenzie River adjacent to tributary creek. Subsoil to 8' is clay-silt with some cobbles or boulders. Further drill advance was not possible. Permafrost is present with ice lenses. This area is not recommended for cut or borrow.

Hole #36 Mile 478.3 on b

Borehole is located on the top of North facing slope of a small stream valley in a proposed cut area. Subsoil is medium to highly plastic silty clay. No permafrost was evident to the depth of hole @ 16¹. Moisture contents are below the plastic limit. This immediate area is suitable for cut section at least to the depth of the borehole. If permafrost is encountered in the area it likely will be to the south of hole #36 rather than toward the stream valley on the North. Based upon this hole a cut section should be o.k. here however more drilling is recommended throughout the entire cut section prior to excavation.

Hole #37 & #38

Mile 492.8 - Blackwater River on &

Both hales are located in a proposed cut area on the North side of the Elackwater River Valley. Hole #37 near the edge of the valley slope did not encounter permafrost to a depth of 37' hole #38, 600 feet back from #37 encountered permafrost below 3'. Subsoil in both holes consisted of medium to highly plastic silty clay. Moisture contents in both holes were near the plastic limit @ approx. 20%. More drilling with core sampling in the permafrost sone is recommended to assess potential sloughing problems in a cut section. The low moisture contents suggest that sloughing problems would be minor and associated only with random large ice lenses, however this can be better evaluated after more drilling.

R.D. Cook Quality Control Engineer

APPENDIX I

BOREHOLE LOGS

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0697M (FEET)	NUMBER	SAMPLE TYPE	K RECOVERY	PENETRATION RESISTANCE	UNIFIED BOIL SYMBOL	SOIL	DESCRIPTION		LIMITS OF FROZEN GROUND	ICE DESCRIPTION	DEPTH (FEET)			CONTENT NTENT	NT (9 (%)	6 OF 1 DF SAM	DRY W	EIGHT) VOLUME) T) 100+	% CLAY WW	LYSI:	ONES %	O GRAVEL	WET DENSITY (P.C.F.)	DAY DENSITY (P.C.F.)	MILE E 444.7 RE	B B MARKS	34-
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APPENDIX II

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AIRPHOTO MOSAICS

<u>LEGEND</u>

TESTHOLES DRILLED OCT / 73 (HELICOPTER)

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