Public Works Canada

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Western Region

Region de l'Ouest

VOLUME XI

GEOTECHNICAL INVESTIGATION

MILE 725 TO MILE 936
MACKENZIE HIGHWAY

TIEDA RIVER BRIDGE - MILE 763.4

PUBLIC WORKS CANADA

WESTERN REGION

REPORT ON
GEOTECHNICAL INVESTIGATION
MILE 725 TO MILE 936
MACKENZIE HIGHWAY

VOLUME XI
FOUNDATION INVESTIGATION
TIEDA RIVER CROSSING
MILE 763.4

Submitted by R. D. Cook, P. Eng.
Quality Control Engineer
Special Services
Western Region

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APPENDICES

I INTRODUCTION

The subsoil investigation at the Tieda River was undertaken as part of the overall geotechnical investigation on the Mackenzie Highway between Ft. Good Hope (Mile 725), and the junction with the Dempster Highway (Mile 936), in the winter of 1973-74. This crossing site was one of five major stream crossings which were investigated in detail during the course of the field work. General terrain analysis and borrow evaluation along the Highway has been submitted earlier in Volumes I to VIII of a report entitled Geotechnical Investigation - Mile 725 to Mile 936, Mackenzie Highway. This report on the Tieda River crossing comprises Volume XI of that overall report.

All field and laboratory work associated with this investigation was carried out by the Special Services Section, Design and Construction Branch, Western Region, Public Works Canada.

II SITE CONDITIONS

The proposed bridge site is located approximately 5 miles downstream of where the River exits from Yeltea Lake, and is at approximately Mile 763.4 of the proposed Mackenzie Highway. The geographic location of the crossing is shown on the 1" = 90 miles key plan, Drawing No. A-1, Appendix A. Drawing No. A-2, Appendix A, outlines the upstream drainage

area of the Tieda River, and Drawing No. A-3 is a detailed 1" = 1000' mosaic of the proposed crossing site.

The Tieda River drains an area of roughly 320 sq. miles to the Highway in the southern portion of the Anderson Plain - a vast, broadly rolling till plain. The Yeltea Lake - Tieda River depression is developed into the Plain and into underlying shale and siltstone of the Hare Indian Formation. Glacial drift on the uplands adjacent to the Tieda River catchment area is relatively thin ($<$50'), however within the depression the drift cover is thicker and probably exceeds 200'.

At the proposed crossing site, the Tieda River has eroded a trench approximately 2500' wide and 100' deep into ground moraine. The River exhibits a marked meander pattern and straight stretches are very short and infrequent. Valley walls are actively eroding and there are old slide scars evident downstream of the crossing, however the proposed crossing site is stable. The highway crosses the river in a bend and the north bank of the channel, which is on the outside of the bend, is steep, about 6 to 10' high and is very gradually eroding. The river valley is a V-shaped trench with little or no valley 'floor' and continuous slopes to the river. Valley slopes are glacial till with

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some overlying slopewash deposits. No cut sections are proposed in the valley walls and gradients reach a maximum of 6.5% on the south approach to the crossing. Fill heights adjacent to the proposed bridge will be approximately 30-35'. Permafrost is continuous throughout the area.

The stream channel at the crossing is roughly 60-70' in width, and 50 year return flows have been estimated by others (3, 4)* at roughly 2700 cfs. with maximum water levels near elevation 467 (approximately 7' above stream bed). Flows to this level would extend approximately 60' south of the present channel bank, but would be confined on the north by the steep, comparatively high bank. Discharge in the river is controlled by the relatively large Yeltea Lake which is one mile wide and eighteen miles long.

No bridge design details are available at present, although a 270' structure has been recommended by the hydrological consultants (3,4). Excerpts from the hydrological reports are included in Appendix C.

An aerial photographic interpretation of the surficial geology of the general area of the Tieda River crossing is shown on Drawing No. A-3, and the terrain legend describing

* Numbers in parenthesis refer to the List of References presented at the end of this report.

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the symbols used is presented as Drawing No. A-3a. The immediate area of the crossing is shown in profile on Drawing No. A-4.

III EVALUATION OF SUBSOIL CONDITIONS

A. Field and Laboratory Analysis

A total of 18 test holes were drilled in the immediate vicinity of the crossing site. Hole locations are shown on Drawing No. A-3, Appendix A, and borehole logs are included in Appendix B. All holes were drilled by means of a Mayhew 1000 drill rig using compressed air as the drilling fluid. Disturbed samples were obtained at frequent intervals in all holes for water content determinations, ice descriptions and material identification. All samples were returned to Edmonton for analysis in the Departmental Laboratory.

B. Subsoil Profile

The boreholes and the inferred stratigraphic sections are shown on Drawing No. A-4 in Appendix A. This subsoil profile presents a generalized grouping of the soil types encountered and individual borehole logs should be consulted for detail.

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Glacial till underlies the crossing site at shallow depths - less than 10'. Overlying the till are alluvial meander plain deposits consisting primarily of stratified sands and gravels but with some clay-silts. These deposits contain little visible ice and are normally moist on thawing with moisture contents less than 10%.

The till surface conforms approximately to the ground surface contours in the immediate area of bridge site. In composition the till is a low to medium plastic, sandy, silty, clay with pebbles, and occasional cobbles or boulders. Permafrost is present throughout with the possible exception of a thaw zone below the present river channel. There is little visible ice in the till, and, upon thawing the material is described as 'damp' or 'moist' with moisture contents varying between 10-15% and generally slightly below the plastic limit. The majority of test holes were terminated at a depth of 30', however two holes, #2 and #15, were extended to a depth of 60' into the till. No appreciable change in composition or moisture (ice) content was evident with depth. The till is a very stiff, dense deposit in the thawed state.

Permafrost was very difficult to detect at this site as visible ice in the till was very low or non-existent, and equipment for measuring ground temperatures was not available. Initially, several holes near the crossing indicated the absence of

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permafrost adjacent to the channel (night drilling), and these were subsequently redrilled with very close inspection of cuttings to confirm the presence of ice particles and permafrost. Four holes within the present channel - holes #9, #10, #11 and #12 - encountered frozen ground and visible ice to depths of 6'-9', below which the glacial till contained no visible ice and was reported as unfrozen. Unfortunately these holes were not redrilled to confirm the presence or absence of permafrost. A sketch of the possible thaw zone below the river has been prepared and is included as Drawing No. A-5, Appendix A. The possible thaw zone shown is considered to be the maximum limits of thaw below the channel, and it is the writer's opinion that the actual thaw zone, if in fact there is a thaw zone below the channel, is much smaller. There was no evidence of water in the channel, or in the granular subsoil below the channel, at the time of drilling, and ice was definitely encountered at least 6-7' below the channel. This suggests the channel annually freezes, and as the stream flow is relatively small during the summer, there is a good probability that there is no permanent thaw zone below the channel.

IV FOUNDATION SUPPORT OF BRIDGE STRUCTURE

A. Abutment and Pier Foundations

The permanently frozen glacial till provides the obvious

bearing stratum for the foundation elements, and it is recommended that steel piles frozen into the till be utilized for support of piers and abutments.

Design details for the proposed structure are not available, however an overall bridge length of 270' has been suggested by the hydrology consultants (3, 4). Foundation elements should be located as far back from the present river channel as possible in order to provide ample clearance from the possible thaw zone directly below the river channel. It is recommended the structure consist of a long center span with a minimum length of roughly 160', with shorter end spans as required. Piers should be placed at approximately station 2061+60 and station 2063+20, or roughly 35-40' on either side of the present channel limits. With the exception of some warming of the permafrost soils during pile freeze-back, in the area of the piles, and possibly some surface degradation of permafrost during construction, it is not considered that any significant change in the permafrost conditions will occur as a result of a bridge at this site. Piles installed no closer than 35' to the present channel should not be affected by the possible thaw zone below the channel as there is no reason to expect any significant change in the indicated thaw zone with time.

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It is recommended the foundation elements consist of either steel H-piles (BP 12 @ 53 lbs./sq. ft.), or closed-end steel pipe piles (10" diameter @ 40 lbs./ft.). The piles should be placed in pre-bored holes, the void space backfilled with a sand slurry, and allowed to freeze into place. If H-piles are employed the piles should be driven approximately 10 feet below the depth of pre-boring to provide some immediate load-carrying capacity. Pipe piles should be driven to practical refusal or 5-6' below the pre-boring depth. Load transfer will initially be by end-bearing and friction on the lower part of the pile in the frozen till, and, following freeze-back, by tangential adfreezing along the pile surface.

Tangential adfreezing is dependent upon temperature of the permafrost soils and composition of the backfill material. There is no detailed temperature data with depth for the Tieda River area, however the National Research Council working in conjunction with D.P.W., has installed thermistors at the Eagle River in the Yukon which is at approximately the same latitude as the Tieda River. Available readings from the Eagle River are included in Appendix C and it is considered that temperature data obtained at the North abutment (cable #1) can be applied to the Tieda River (cable #2 at the South abutment is in a thaw zone of a former channel of the Eagle River). This data shows a consistent temperature near 28^{o}F with depth.

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Test data obtained by the U.S. Army Cold Regions Research and Engineering Laboratory from pile load tests in Alaska, indicate a sustained adfreeze strength for a silt-water slurry backfill and steel of more than 25 psi. at 28°F. In addition, adfreeze strengths for a saturated, well-graded sand slurry, vibrated in place, are at least 50% higher. Therefore, if a design adfreeze strength of 10 psi. is assumed, the factor of safety will be at least 3 for a sand slurry backfill. Twelve inch steel H-piles would therefore develop a load carrying capacity of 12" x 12" x 10 psi. x 4 = 5760 lbs. per lineal foot of pile, and 10" diameter pipe piles would develop π x 10" x 12" x 10 psi. = 3870 lbs. per foot.

In order to accommodate a 12" H-pile, an 18" diameter borehole is required, and to accommodate a 10" diameter pipe pile, at least a 14" diameter hole would be required to ensure pile alignment and adequate placement of slurry backfill. Thus the void space, and the slurry requirement, for a pipe pile would be significantly less than for an H-pile. This is important as the slurry introduces heat into the ground and should be kept to a minimum.

It is recommended the backfill consist of a well-graded sand with 100% passing the #4 sieve, and less than 15% passing the #200 sieve. Sufficient water should be added to completely saturate the sand but excess water should be avoided. A concrete mixer will serve to mix the slurry and the temperature of the

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slurry should be as cold as possible to avoid introducing any unnecessary heat into the ground. It is estimated the water content of a well-saturated, well-graded sand will be in the order of 25% and the volumetric latent heat will be in the order of 3000 BTU/cu. ft. For an 18" diameter H-pile hole, the latent heat per foot of pile will be approximately 5500 BTU/foot. In comparison the volumetric latent heat for a 14" diameter pipe pile hole would be approximately 2000 BTU/foot. Based upon CRREL test data, a single H-pile installed in an 18" diameter hole with a slurry as outlined above, would require probably 9-10 days to completely freeze-back at a permafrost temperature of 28°F, whereas a 10" pipe pile in a 14" diameter hole would completely freeze-back in probably 3-4 days. Thus there are obvious advantages to using pipe piling.

Freeze-back time for a group of piles would be greater as more heat is introduced into the subsoil, and therefore the minimum number of piles possible should be used - i.e., the design should utilize heavily loaded, widely spaced piles, as opposed to closely spaced, lightly loaded members. Pile groupings increase the overall temperature of the permafrost within the area of the piles and if spacings are small, the temperature will be raised to the point that freeze-back will cease until the permafrost is made colder - i.e., until winter, if construction is in summer. For 12" H-piles in 18" diameter holes, the pile spacing should be not less than approximately 8' to

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obtain full freeze-back without having to wait a winter season; for 10" pipe piles in 14" diameter holes a pile spacing of not less than approximately 5 feet would be required.

Following are recommended pile lengths and depths of pre-boring for 10" pipe and 12" steel H-piles, assuming a design load in the order of 100 kips per pile. The pipe piles are preferred.

Pile	Effective length below pier or abutment	Depth of Pre-boring	Hole Size
10" pipe @40#/ft.	35'	30'	14-15"
BP12@53#/ft.	30'	20'	18"

Piles should be driven with a fairly high energy hammer below the depth of pre-boring as penetration is expected to be difficult in the dense frozen till - an energy in the order of 20,000 ft. lbs. per blow is recommended. Detailed driving records should be maintained.

B. Bridge Approach Fills

Fill heights immediately adjacent to the abutments will be in the order of 20 to 35' and the permafrost table will likely rise into these embankments, hence stability of the approach fills will not be a problem. Backfill adjacent to the abutments should be well compacted shale borrow which is readily available approximately 3 miles to the south - see Section 10 of Volume I of Report on Geotechnical Investigation, Mile 725 - 936, Mackenzie Highway. Field compaction control is recommended on all backfill associated with piers and abutments.

The nearest source of granular material suitable for concrete aggregate is located near Mile 785, roughly 25 miles distant, with an alternate source near Ft. Good Hope (Mile 725), roughly 40 miles distant (see Section 28 - Surfacing Materials - Volume I of Geotechnical Report). Thus bridge construction should be delayed until road access to either source is completed.

C. Bank Stability

The north bank of the present channel is presently subject to erosion during high water stages. The bank is primarily glacial till but with some overlying slope-wash and/or alluvial

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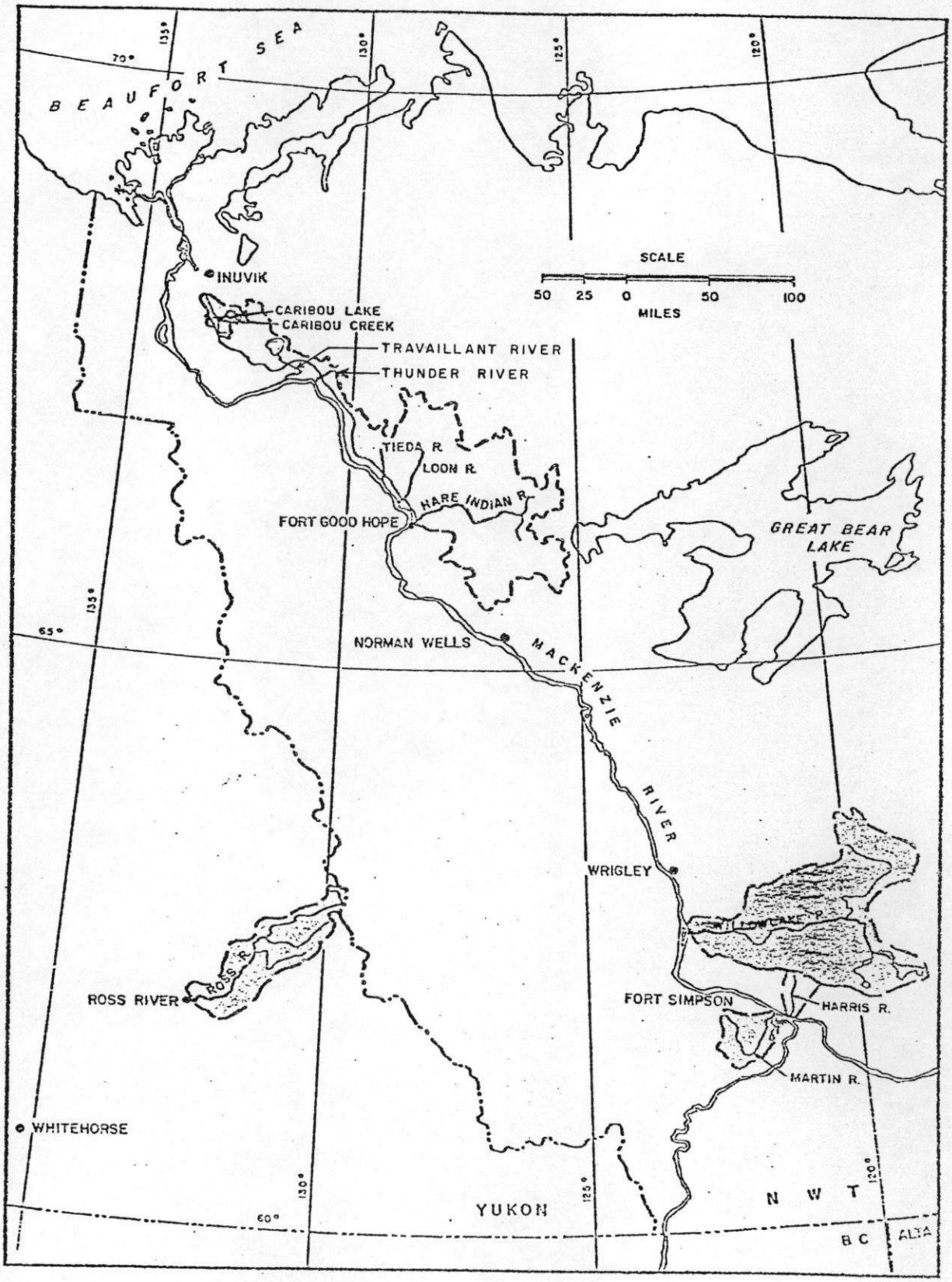
deposits, and the material is permanently frozen. The bank is not unstable but will probably undergo some lateral erosion and hence river training works and/or bank protection should be included in the bridge design.

R D Cook

R. D. Cook
Quality Control Engineer
Special Services
Western Region



Dwg. No. A-1

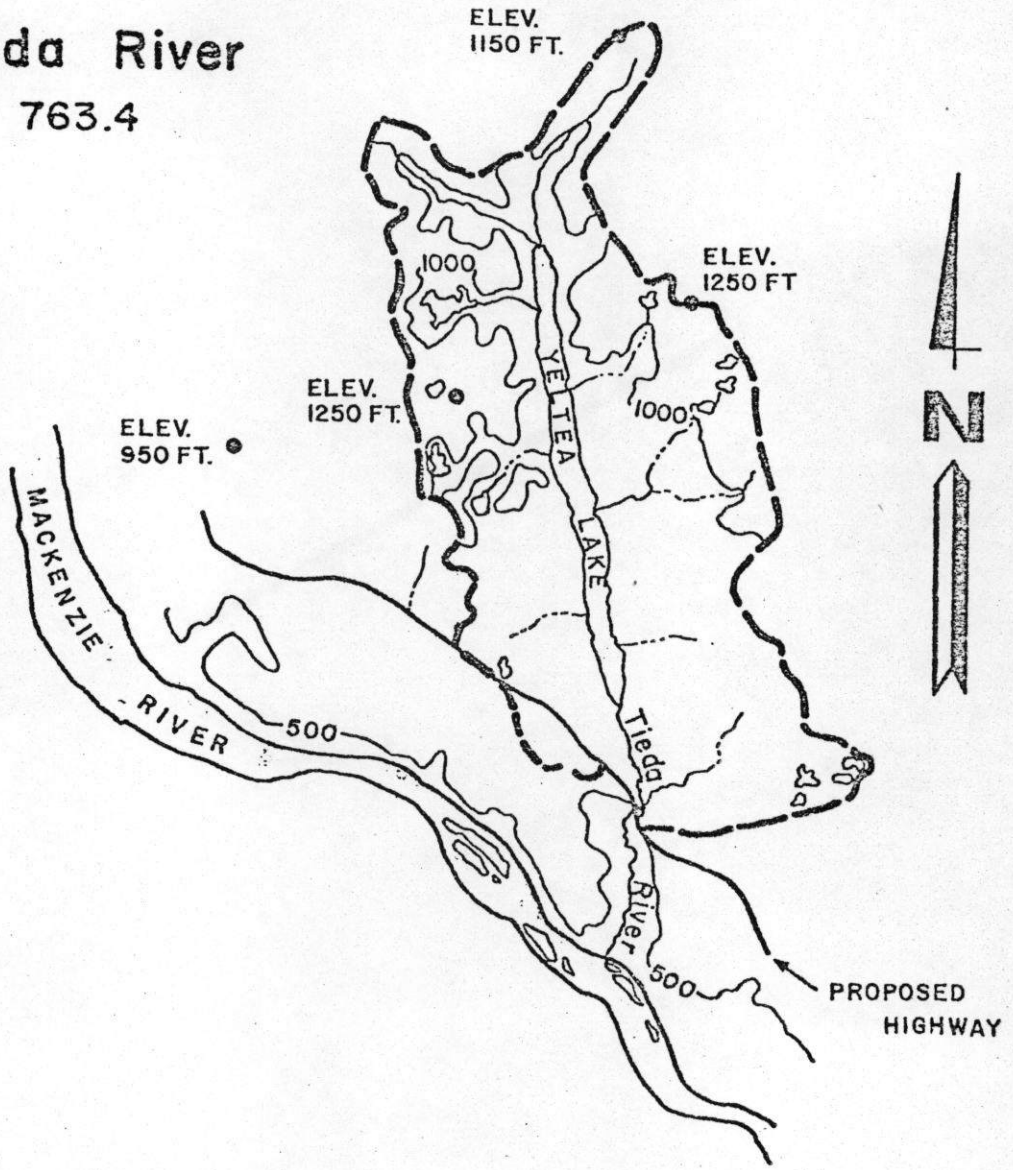
KEY PLAN

MACKENZIE RIVER, N.W.T.

1" = 90 MILES

Tieda River

Mile 763.4



SCALE

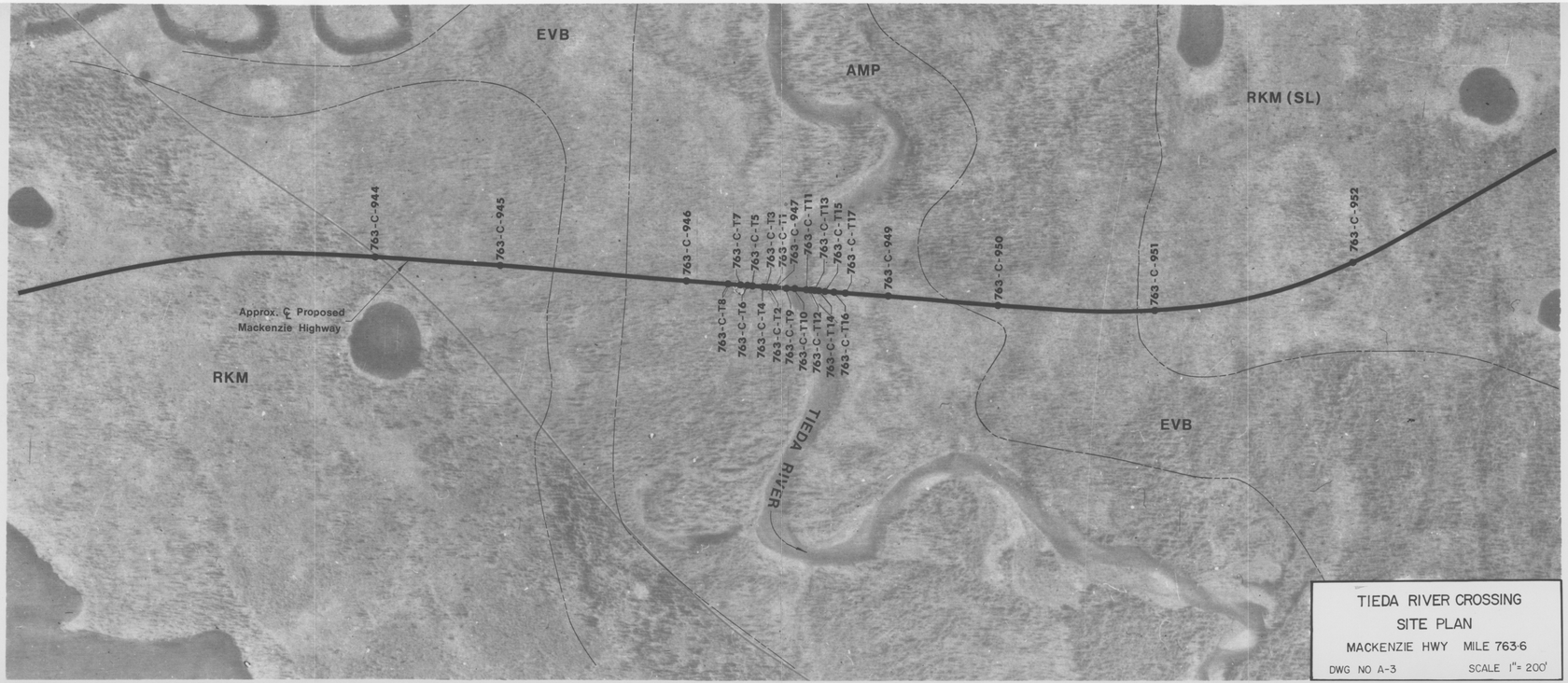
8 6 4 2 0 8 16

MILES

——— Drainage Area to Proposed Highway Crossing 319 sq. miles

Tieda River Basin

Dwg. No. A-2


EVB
AMP
RKM (SL)
763-C-944
763-C-945
763-C-946
763-C-T7
763-C-T5
763-C-T3
763-C-T1
763-C-947
763-C-T11
763-C-T13
763-C-T15
763-C-T17
763-C-949
763-C-950
763-C-951
763-C-952
763-C-T8
763-C-T6
763-C-T4
763-C-T2
763-C-T9
763-C-T10
763-C-T12
763-C-T14
763-C-T16
Approx. ℄ Proposed
Mackenzie Highway
RKM
TIEDA RIVER
EVB
TIEDA RIVER CROSSING
SITE PLAN
MACKENZIE HWY MILE 763.6
DWG NO A-3
SCALE 1"= 200'

TERRAIN TYPING LEGEND

Symbol	Terrain Types
AMP	Alluvial meander plain: ice-rich stratified clay, silt, and fine sand over thin, discontinuous layer of sand and/or gravel over till or glaciolacustrine silt and clay
FFP	Fossil flood plain: ice-rich silty topstratum over sand and/or gravel below the inactive floodplain of relatively high-energy streams
HT	High terraces: silt-covered stratified fluvial and/or outwash sand and gravel along the sides of present river valleys and abandoned meltwater channels
RKM	Ridge-and-knoll moraine: largely rolling ground moraine with and without drumlinoid forms; low to medium plastic till with shallow peat and ponded sediments in depressions

PHASES AND FEATURES

Topographic and drainage features

DR	Drumlinoid forms, including fluting and glacial grooves with linear ridges
EVB	Eroding valley sides and escarpment slopes; mixed clay to boulders and/or bedrock

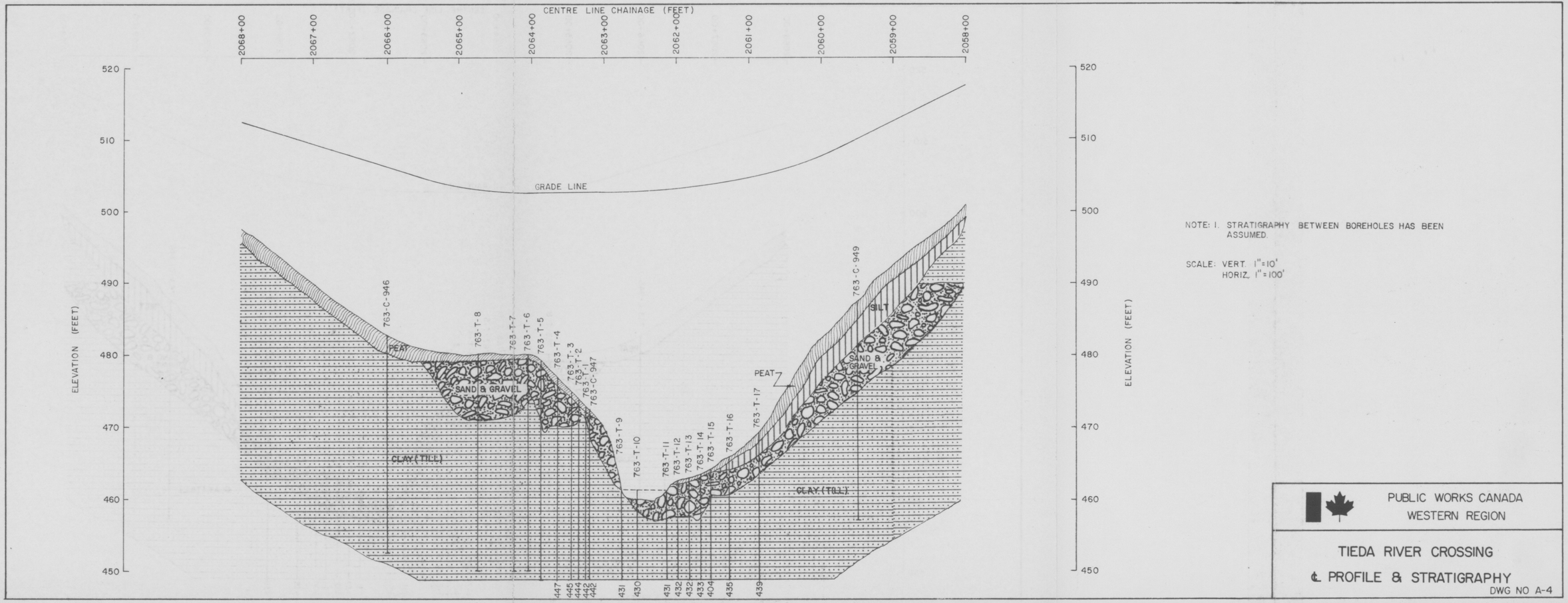
Topstratum phases associated with main terrain types

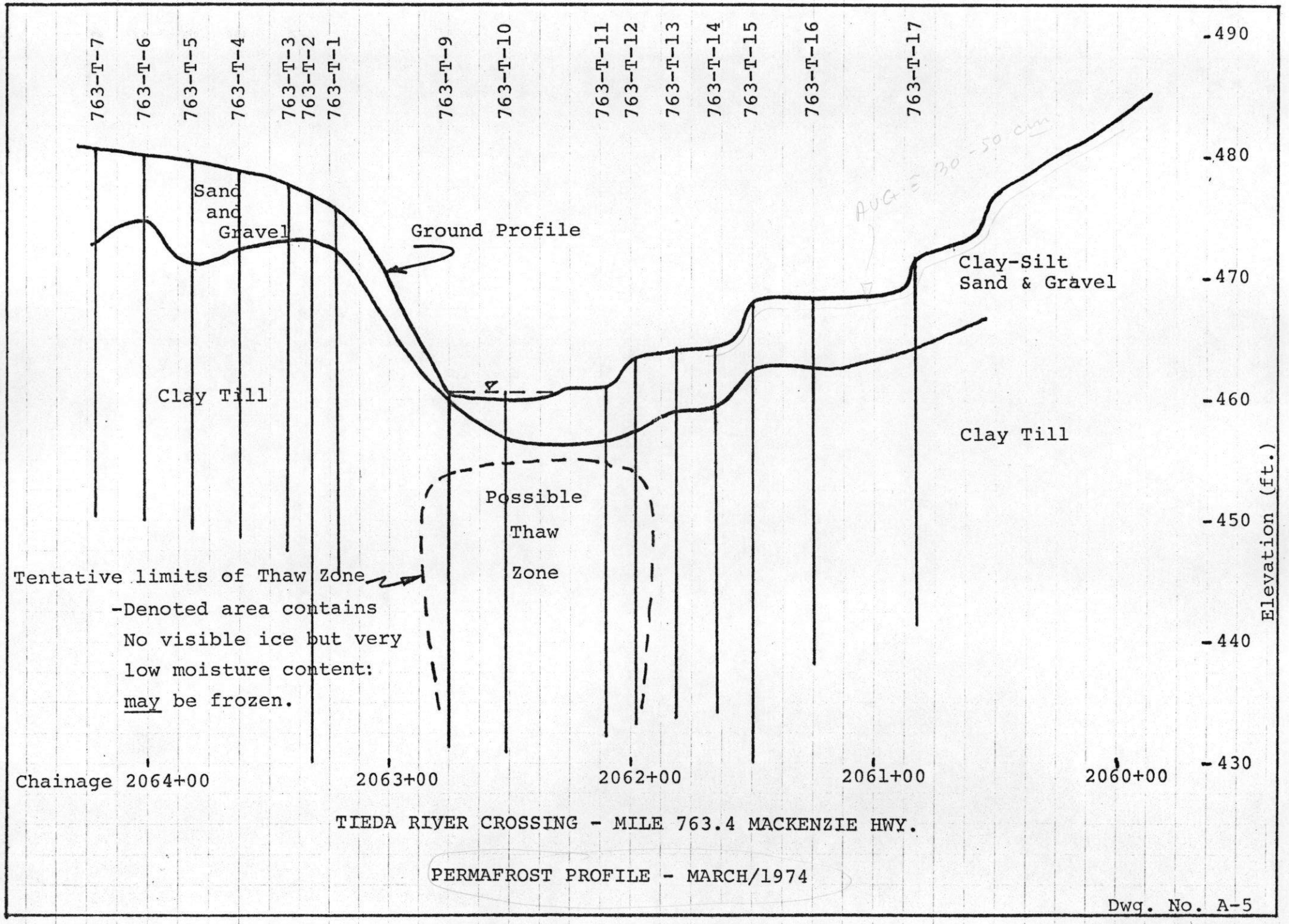
SL	Slopewash deposits and associated sheetwash drainage: top stratum of ice-rich, poorly sorted silty clay and silty sand layers with some gravel sizes and thin organic layers; generally less than 5 ft. thick but may reach 10 ft. locally

COMPLEXES

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

Drawing No. A-3a


CENTRE LINE CHAINAGE (FEET)
2068+00
2067+00
2066+00
2065+00
2064+00
2063+00
2062+00
2061+00
2060+00
2059+00
2058+00
520
510
500
490
480
470
460
450
ELEVATION (FEET)
GRADE LINE
763-C-946
763-T-8
763-T-7
763-T-6
763-T-5
763-T-4
763-T-3
763-T-2
763-T-1
763-C-947
763-T-9
763-T-10
763-T-11
763-T-12
763-T-13
763-T-14
763-T-15
763-T-16
763-T-17
763-C-949
PEAT
SAND & GRAVEL
CLAY (TILL)
SILT
447
445
444
442
442
431
430
431
432
432
433
404
435
439
NOTE: 1. STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN ASSUMED.
SCALE: VERT. 1"=10'
HORIZ. 1"=100'
PUBLIC WORKS CANADA
WESTERN REGION
TIEDA RIVER CROSSING
℄ PROFILE & STRATIGRAPHY
DWG NO A-4



TIEDA RIVER CROSSING - MILE 763.4 MACKENZIE HWY.

PERMAFROST PROFILE - MARCH/1974

Dwg. No. A-5

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: SECTION D

FIELD ENG. N. BURGESS | DATE DRILLED. 17/3/74 | AIRPHOTO NO. A23334 - 226 | CHAINAGE. 2072 + 00 | OFFSET.

TECH. JOHNSON | RIG. 2 | SURFACE DRAINAGE. | VEGETATION. | ELEV.

TEST HOLE 945

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
0					Pt	PEAT 1'		LOW ICE Vx
2						CLAY - SILTY		
4						- SANDY		
6						- PEBBLES		HIGH ICE Vs
8						LOW PLASTIC		
10					Cl			Low ICE Vx
12							F	
14								
16								
18								
20								
22								
24								
26								
28								

DRY DENSITY (lbs/ Ft.³)
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT
40 60 80 100 120 140 100+
0 20 40 60 80 100

GRAIN-SIZE ANALYSIS				RELATIVE THAWED MOISTURE CONTENT	REMARKS
CLAY %	SILT %	SAND %	GRAVEL %		
-72	-	27	1	DAMP	
-59	-	38	3	FREE WATER	
-60	-	40	0	MOIST	
-55	-	41	4	DAMP	
-47	-	48	5	DAMP	

BOTTOM OF HOLE 30'

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: SECTION D

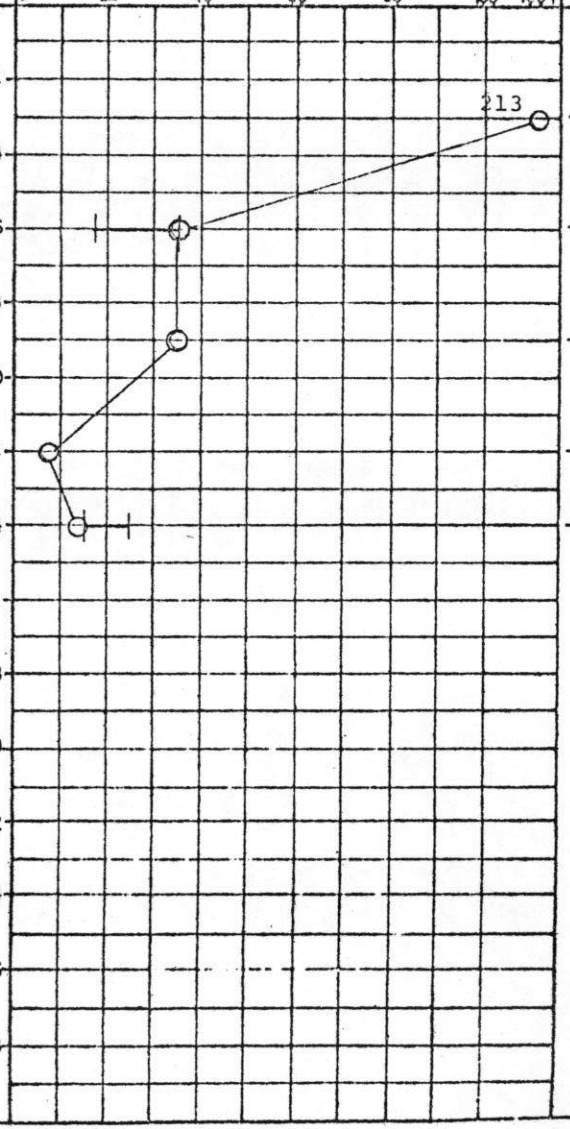
FIELD ENG. N. BURGESS	DATE DRILLED. 17/3/74	AIRPHOTO NO. A23334-226	CHAINAGE. 2066 + 00	OFFSET.
TECH. JOHNSON	RIG. 2	SURFACE DRAINAGE.	VEGETATION.	ELEV.

TEST HOLE 946

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
0–2					Pt	PEAT 2'	F	MOSTLY ICE Vx
2–10						CLAY - SANDY - SILTY - PEBBLES LOW - MED. PLASTIC		HIGH ICE Vs
8					Ci			
12					Cl			LOW ICE Vx

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT



GRAIN-SIZE ANALYSIS				RELATIVE THAWED MOISTURE CONTENT	REMARKS
CLAY %	SILT %	SAND %	GRAVEL %		
95	5	0		FREE WATER	
82	18	0		SAT.	
59	40	1		SAT.	
30	59	11		DAMP	
50	45	5		DAMP	

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: SECTION D

FIELD ENG. N. BURGESS	DATE DRILLED. 17/3/74	AIRPHOTO NO. A23334 - 226	CHAINAGE. 2063 + 20	OFFSET.
TECH. JOHNSON	RIG. 2	SURFACE DRAINAGE.	VEGETATION.	ELEV.

TEST HOLE 947

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
					Pt	PEAT .5'								
2					Gc	GRAVEL - SAND MIXTURE								
4						CLAYEY		LOW	- 7	-	52	41	MOIST	
6						CLAY - SANDY			-21	-	42	37	MOIST	
8						- SILTY	F	ICE						
10					Cl	- PEBBLES			-53	-	42	5	DAMP	
12						LOW PLASTIC		Vx	-54	-	39	7	DAMP	
14						15 CLAY - GRAVEL MIXTURE			-50	-	44	6	DAMP	
16														
18														
20														
22														
24														
26														
28														

DRY DENSITY (lbs./Ft.³)
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170+

BOTTOM OF HOLE - 30'

TIEDA RIVER

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE:

FIELD ENG.	DATE DRILLED. 19/3/74	AIRPHOTO NO.	CHAINAGE. 0+10	OFFSET.	TEST HOLE 1
TECH.	RIG.	SURFACE DRAINAGE.	VEGETATION.	ELEV.	MILE 763

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
0					Pt	PEAT .5'								
4					CL	CLAY - Sandy gravelly to 4' Silty Pebbles Low-med. Plastic - Till		Low Ice	-41-		31	20	Moist	
8									-55-		41	4	Wet	
12					CI		F	Vx	-49-		42	9	Moist	
16									-60-		33	7	Moist	
20						Rock Chips			-65-		31	4	Moist	
24									-59-		34	7	Moist	
28						Bottom of Hole - 29'			-52-		40	8	Moist	
32									-53-		42	5	Moist	
36														
40														
44														
48														
52														
56														

TIEDA RIVER

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE:

FIELD ENG.

TECH. D. Pronych

DATE DRILLED. 18/3/74

RIG. Mayhew #1

AIRPHOTO NO.

CHAINAGE.

OFFSET.

SURFACE DRAINAGE.

VEGETATION.

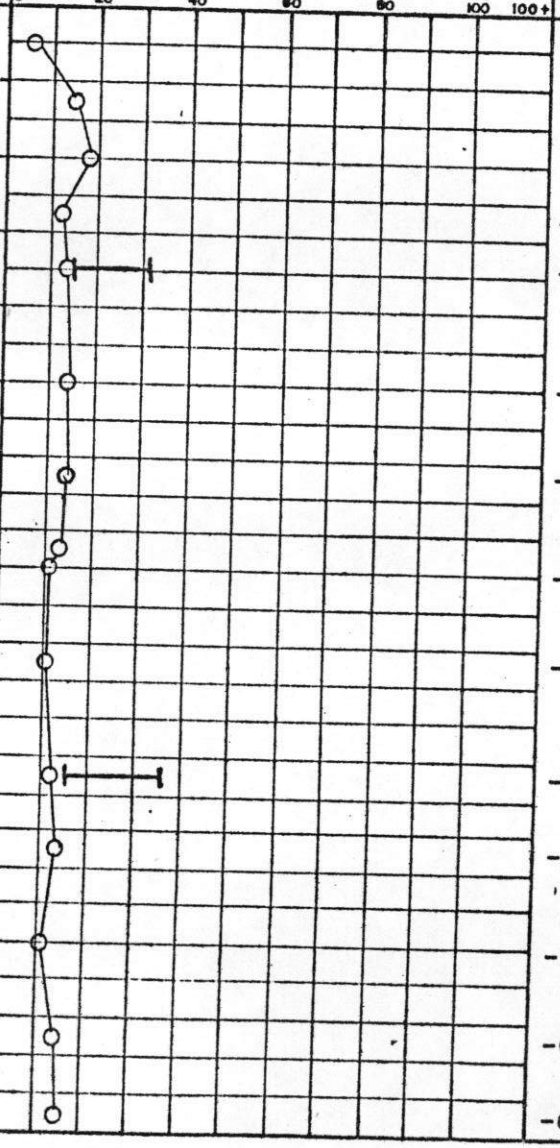
ELEV.

TEST HOLE 2

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
0						PEAT 4"		
						GRAVEL-Sandy, clayey 3'		
4						CLAY - Silty, sandy		
						- Pebbles		Low
8						- Shale fragments		
					CL	Low-med. plastic		Ice
12					CI	- Till	F	
								Vx
16								
20								
24								
						Pebbles & Shale fragments		
28						CLAY - Silty, sandy		
					CL	Pebbles, shale		
32						frag., Low-med. plastic	F	Low
					CI			Ice
36								
40								Vx
44								
48								
52							F	Low Ice
56								Vx
						Bottom of Hole - 59'		

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT



DEPTH (FEET)	CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
4	15	37	48		Moist
8	50	37	13		Moist
12	57	36	7		Wet
	52	36	12		Moist
16	49	40	11		Moist
20					
24	64	28	8		Moist
28	61	29	10		Moist
32	57	30	13		Damp
36	49	33	18		Moist
40					
44	55	35	10		Moist
48	51	33	16		Moist
52	52	39	9		Moist
56	63	30	7		Moist
	65	31	4		Moist

GRAIN-SIZE ANALYSIS

REMARKS

Frozen to 35'
-possible thaw zone 35'-49'
-frozen 49'-59'

TIEDA RIVER

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE:

FIELD ENG.

DATE DRILLED. 20/3/74

AIRPHOTO NO.

CHAINAGE.

OFFSET.

TECH. W. Baine

RIG. Mayhew #1

SURFACE DRAINAGE.

VEGETATION.

ELEV.

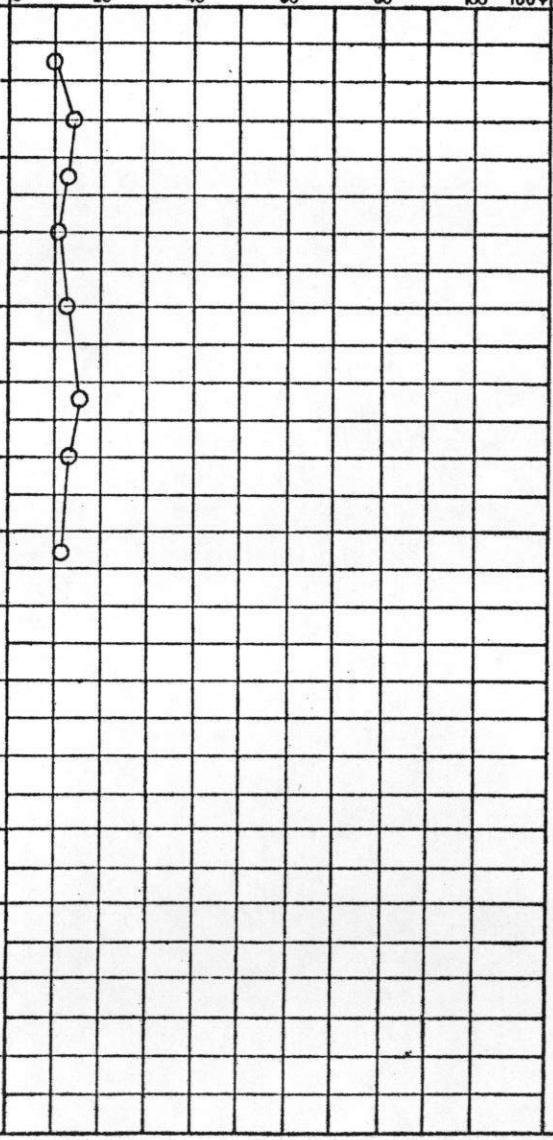
TEST HOLE 3

MILE 763

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
					Pt	PEAT 5'		
4					GC	CLAY - GRAVEL - SAND MIXTURE shale fragments 5'		
8						CLAY - Sandy, silty - Pebbles - Med. plastic shale fragments	F	Low Ice
12					CI	BOULDERS @ 10' - Till		Vx
16								
20								
24								
28						Bottom of Hole - 29'		
32								
36								
40								
44								
48								
52								
56								

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT



GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
29	30	41		Moist
52	44	4		Wet
52	42	6		Moist
60	34	6		Moist
59	35	6		Moist
57	41	2		Moist
51	40	9		Moist
54	43	3		Moist

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TIEDA RIVER

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

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TECH. D. Pronych

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RIG.

AIRPHOTO NO.

SURFACE DRAINAGE.

CHAINAGE.

VEGETATION.

OFFSET.

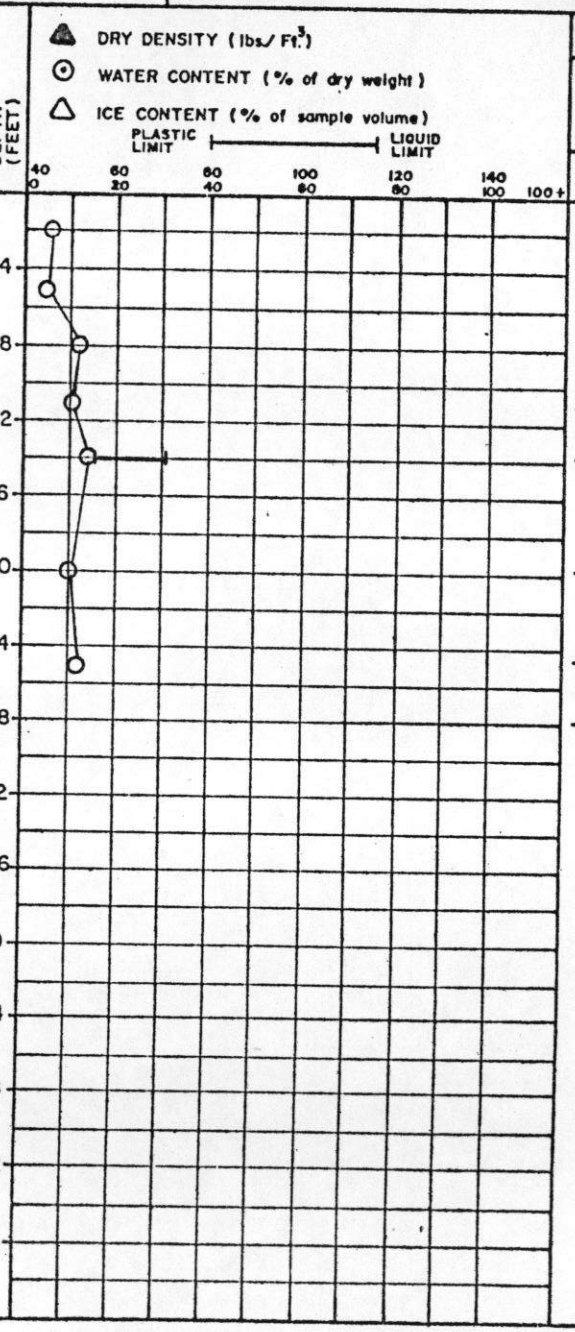
ELEV.

TEST HOLE 4

MILE 763

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
					Pt.	PEAT — 4"		
4					GC	SAND - Clayey - Gravelly Boulders & Cobbles		Low Ice
8					CL CI	CLAY - Silty, sandy — 6.5 - Pebbles Low-med. plastic Few cobbles - Till	F	Vx
12								
16								
20								
24								
28						Bottom of Hole - 28'		
32								
36								
40								
44								
48								
52								
56								



GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
-11-		47	42	Moist
-14-		48	38	Damp
-59-		38	3	Moist
-47-		43	10	Moist
-66-		30	4	Moist
-53-		33	14	Damp
-58-		31	11	Damp
-54-		34	12	

TIEDA RIVER

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SITE:

FIELD ENG.

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TECH. D. Pronych | RIG. Mayhew #1 | SURFACE DRAINAGE. | VEGETATION. | ELEV.

TEST HOLE 5

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
						PEAT 4"		
					CL	CLAY - Silty, sandy 1'		
4						SAND - Gravelly - Clayey		
					SC	Damp to moist on thawing		Low Ice
8						9'	F	
						CLAY - Gravelly - Sandy, silty		
12					CL	Low-med. plastic		
					CI	Pebbles		Vx
16						COBBLES & BOULDERS at 15' & 22'		
20						- Till		
24								
28						Pebbles Bottom of Hole - 29'		
32								
36								
40								
44								
48								
52								
56								

▲ DRY DENSITY (lbs./ Ft.^{3})
⊙ WATER CONTENT (% of dry weight)
△ ICE CONTENT (% of sample volume)

PLASTIC LIMIT — LIQUID LIMIT

40 0 | 60 20 | 80 40 | 100 60 | 120 80 | 140 100 | 100+

DEPTH (FEET): 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56

GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
- 8 -	50	42		Damp	
- 4 -	56	40		Moist	
-21-	65	14		Moist	
-47-	42	11		Moist	
-47-	39	14		Damp	
-51-	34	15		Damp	
-60-	33	7		Damp	
-50-	44	6		Damp	

TIEDA RIVER

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TECH. D. Pronych | RIG. Mayhew #1 | SURFACE DRAINAGE. | VEGETATION. | ELEV.

TEST HOLE 6

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
					Pt	PEAT 4"		
					CL	CLAY-Silty, sandy, pebbles to 1.5'		Low
					GC	GRAVEL-Clayey, sandy 5'		
						CLAY - Silty, sandy - Pebbles, shale fragments to 12' - Med. plastic	F	Ice
					CI	Few Cobbles		Vx
						Pebbles & shale fragments throughout - Till		
						Bottom of Hole - 29'		

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT

DEPTH (FEET)	CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
4	7	29	64		Moist
8	9	41	50		Wet
12	44	35	21		Moist
16	50	39	11		Moist
20	49	33	18		Damp
24	55	31	14		Damp
28	62	28	10		Damp
32	58	35	7		Moist

REMARKS

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MACKENZIE HIGHWAY

DRILL HOLE REPORT

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FIELD ENG.

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CHAINAGE.

OFFSET.

TECH. D. Pronych

RIG. Mayhew #1

SURFACE DRAINAGE.

VEGETATION.

ELEV.

TEST HOLE 7

MILE 763

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
					Pt	PEAT .5'		
						SAND-Silty, clayey 1'		
4					SC	GRAVELLY		Low
8						8'		
						CLAY - Gravelly		
						- Silty, sandy		
12						- Med. plastic	F	Ice
					CI	Pebbles & Rock chips		
16						flat - hard		Vx
20						- Till		
24								
28						Bottom of Hole - 29'		
32								
36								
40								
44								
48								
52								
56								

DEPTH (FEET)

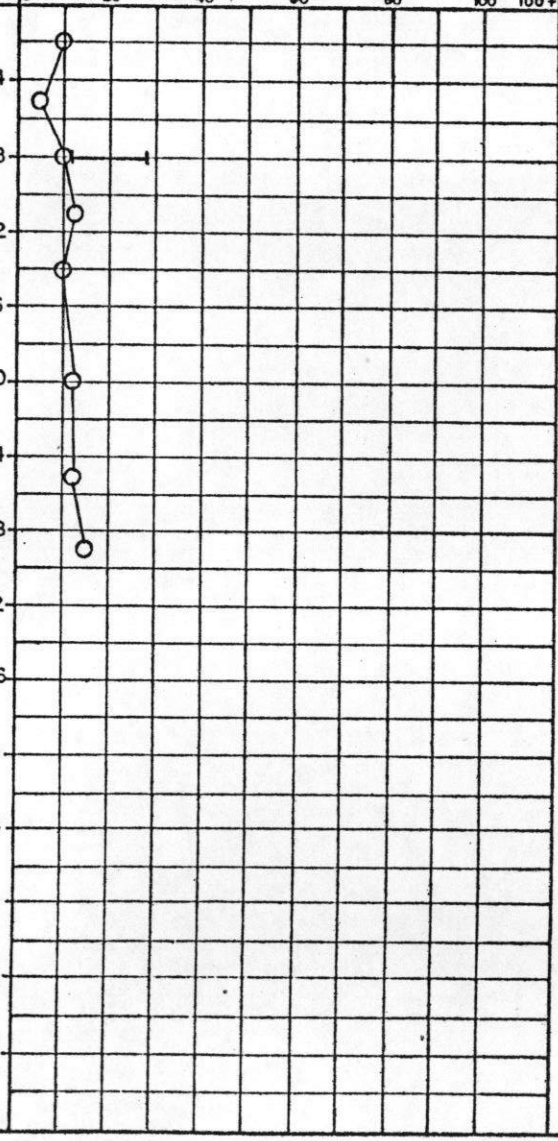
DRY DENSITY (lbs./ Ft.^{3})

WATER CONTENT (% of dry weight)

ICE CONTENT (% of sample volume)

PLASTIC LIMIT — LIQUID LIMIT

40 0 60 20 80 40 100 60 120 80 140 100 100+



GRAIN-SIZE ANALYSIS				RELATIVE THAWED MOISTURE CONTENT
CLAY %	SILT %	SAND %	GRAVEL %	
32	68	0		Moist
12	50	38		Moist
42	45	13		Wet
51	43	6		Moist
60	34	6		Damp
56	36	8		Moist
63	29	8		Damp
75	24	1		Damp

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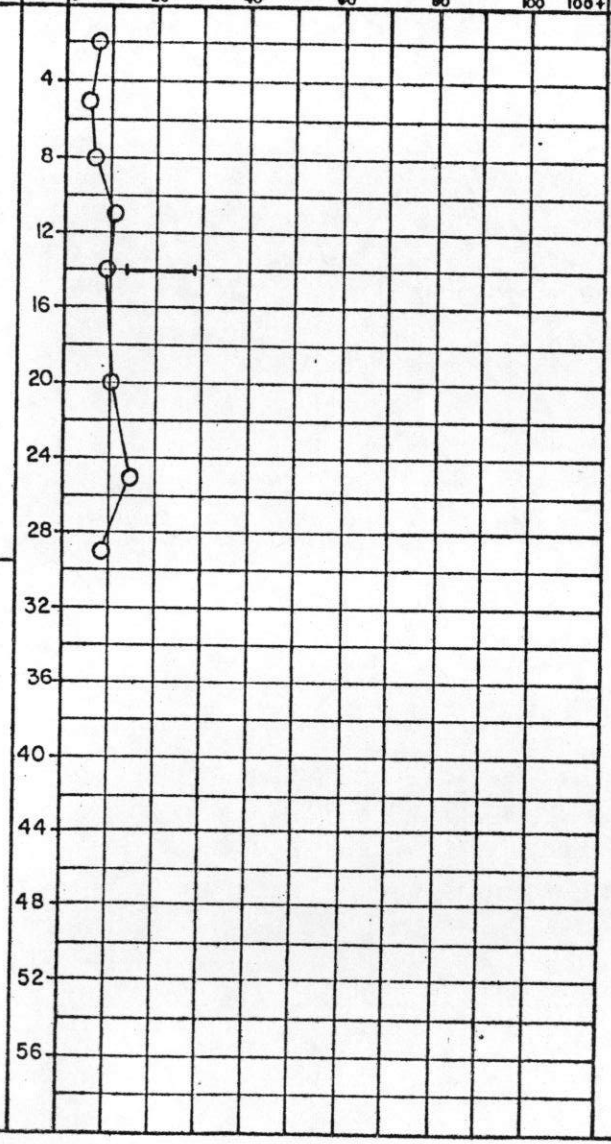
TECH. D. Pronych | RIG. Mayhew #1 | SURFACE DRAINAGE. | VEGETATION. | ELEV.

TEST HOLE 8

MILE 763

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
					Pt	PEAT — 1'		
4					SC	SAND - Clayey - Gravelly — 5'		
8					GC	GRAVEL - Clayey - Sandy — 8'		Low
12					GC	GRAVEL - CLAY - SAND Mixture — 11'	F	Ice
16					CL	CLAY - Gravelly - Silty, sandy Low-med. plastic Cobbles after 12'		
20					CI	Boulders 23'-24' Pebbles throughout - Till		
24								
28						Bottom of Hole - 29'		
32								
36								
40								
44								
48								
52								
56								



GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
-17-		53	30	Moist
-10-		15	75	Moist
-20-		56	24	Moist
-55-		38	7	Moist
-48-		32	20	Damp
-71-		21	8	Damp
-76-		17	7	Damp
-46-		34	20	Damp

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DRILL HOLE REPORT

SITE:

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TECH. W. Baine | RIG. Mayhew #1 | SURFACE DRAINAGE. | VEGETATION. | ELEV.

TEST HOLE 9

MILE 763

DRY DENSITY (lbs/Ft.³) ▲
WATER CONTENT (% of dry weight) ⊙
ICE CONTENT (% of sample volume) △
PLASTIC LIMIT — LIQUID LIMIT

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
						ICE		ICE						
						CLAY - Silty - Sandy - Gravelly Rock chips, pebbles - Med. plastic	F	Low ice Vx	-44-		44	12	Moist	
4														
8						Heavy boulders to 5'			-63-		34	3	Moist	
12					CI	- Till		No Visible ice Frozen?	-61-		33	6	Damp	
									-64-		34	2	Damp	
16									-59-		30	11	Moist	
20														
24									-53-		35	13	Moist	
									-60-		33	7	Moist	
28						Bottom of HOle - 29'								
32									-46-		29	25	Moist	
36														
40														
44														
48														
52														
56														

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TIEDA RIVER

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE:

FIELD ENG.

TECH. W. Baine

DATE DRILLED. 19/3/74

RIG. Mayhew #1

AIRPHOTO NO.

SURFACE DRAINAGE.

CHAINAGE. 0+58

VEGETATION.

OFFSET.

ELEV.

TEST HOLE 10

MILE 763

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
						ICE .5		ICE						
4					GP	GRAVEL-SAND MIX 4'	F	Low Ice Vx	-10-		43	47	Moist	
8					CI	CLAY - Silty - Sandy, pebbles - Med. plastic Shale fragments			-59		34	7	Moist	
12						- Till			-69-		26	5	Moist	
16								No Visible Frost 6'-29' FROZEN?	-54-		41	5	Moist	
20									-57-		36	7	Moist	
24									-59-		35	6	Moist	
28						Bottom of Hole- 29'			-54-		37	9	Moist	
32									-57-		39	4	Moist	
36														
40														
44														
48														
52														
56														

TIEDA RIVER

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DRILL HOLE REPORT

SITE:

FIELD ENG.

TECH. D. Pronych

DATE DRILLED. 18/3/74

RIG. Mayhew #1

AIRPHOTO NO.

SURFACE DRAINAGE.

CHAINAGE.

VEGETATION.

OFFSET.

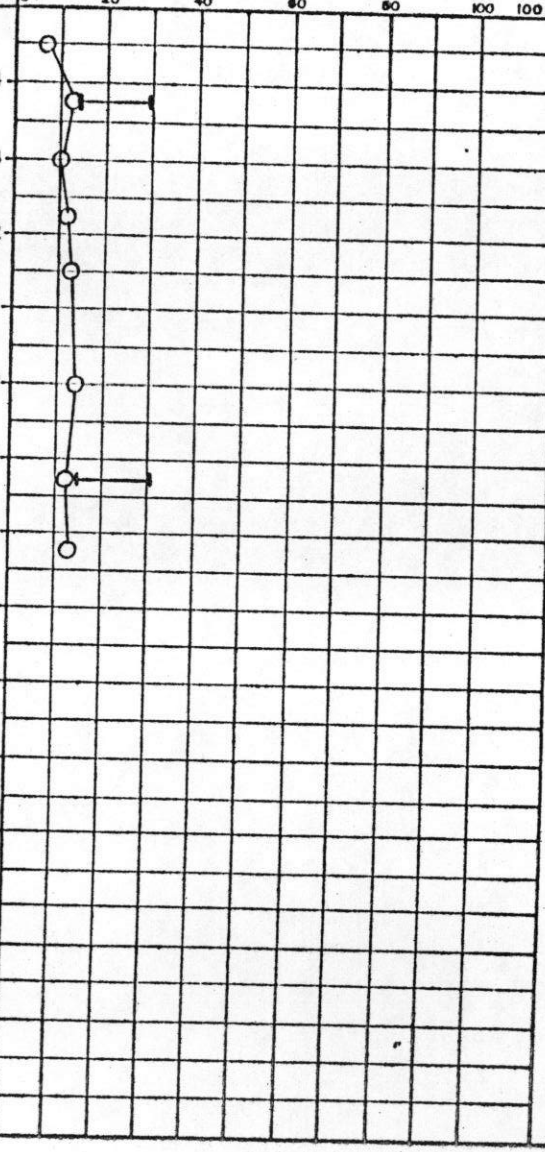
ELEV.

TEST HOLE 11

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
4					SC	COBBLES & BOULDERS SAND-Clayey, gravelly	F	LOW ICE Vx
8					CL	CLAY-Sandy, silty 4.5 Pebbles Cobbles & Boulders @ 6'-6.5' Low-med. plastic - Till		No evidence of frost below 6' FROZEN ?
12					CI			
16								
20								
24								
28						Bottom of Hole - 29'		
32								
36								
40								
44								
48								
52								
56								

DRY DENSITY (lbs./Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT



DEPTH (FEET)	CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
4	-20-		67	13	Moist
8	-55-		41	4	Moist
12	-54-		42	4	Damp
16	-58-		34	8	Damp
20	-55-		41	4	Damp
24	-54-		26	20	Damp
28	-46-		36	18	Damp
32	-58-		23	19	Moist

GRAIN-SIZE ANALYSIS

REMARKS

D3-14-5-74 A

TIEDA RIVER

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

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FIELD ENG.

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AIRPHOTO NO.

CHAINAGE.

OFFSET.

TECH. D. Pronych

RIG. Mayhew #1

SURFACE DRAINAGE.

VEGETATION.

ELEV.

TEST HOLE 12

MILE 763

REMARKS

DRY DENSITY (lbs/Ft.³)
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
					Pt	PEAT 2"							
4					CL	CLAY-silty, sandy pebbles 1'		Vx	6		46	48	Moist
					SC	SAND-Gravelly, Clayey, Cobbles 6'	F	Low	14		54	32	Moist
8					CL	CLAY-Sandy, silty -Pebbles Low-med. plastic		Ice	56		37	7	Damp
12									61		33	6	Damp
16					CI	-Till		No Visible Ice Frozen?	53		43	4	Damp
20													
24									57		32	11	Damp
28						Rock chips - flat hard			50		40	10	Moist
32						Bottom of Hole - 29'			52		37	11	Damp
36													
40													
44													
48													
52													
56													

TIEDA RIVER

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DRILL HOLE REPORT

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FIELD ENG.

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CHAINAGE.

OFFSET.

TECH. W. Baine

RIG. Mayhew #1

SURFACE DRAINAGE.

VEGETATION.

ELEV.

TEST HOLE 13

MILE 763

REMARKS

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
					Pt	PEAT .5'		
4					SM	SAND - Silty, pebbles N.P. Rock chips 5'		
8					CL	CLAY - Sandy, silty - Pebbles Low-med. plastic	F	Nil Ice
12					CI	- Till		Vx
16								Nbn
20								
24								
28						Bottom of Hole - 29'		
32								
36								
40								
44								
48								
52								
56								

DEPTH (FEET)

▲ DRY DENSITY (lbs/ Ft.^{3})

⊙ WATER CONTENT (% of dry weight)

△ ICE CONTENT (% of sample volume)

PLASTIC LIMIT — LIQUID LIMIT

40 0 | 60 20 | 80 40 | 100 60 | 120 80 | 140 100 | 100+

GRAIN-SIZE ANALYSIS				RELATIVE THAWED MOISTURE CONTENT
CLAY %	SILT %	SAND %	GRAVEL %	
22	70	8		Moist
54	45	1		Moist
59	38	3		Moist
58	32	10		Moist
55	28	17		Moist
56	30	14		Moist
57	37	6		Moist
55	36	9		Moist

D3-14-5-74 a

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DRILL HOLE REPORT

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CHAINAGE.

OFFSET.

TECH. W. Baine

RIG. Mayhew #1

SURFACE DRAINAGE.

VEGETATION.

ELEV.

TEST HOLE 14

MILE 763

REMARKS

DRY DENSITY (lbs./ Ft.^{3})

WATER CONTENT (% of dry weight)

ICE CONTENT (% of sample volume)

PLASTIC LIMIT — LIQUID LIMIT

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
0					GW	GRAVEL - SANDY			-	5	42	53	Damp
4						6'			-	7	34	59	Damp
8					GC	GRAVEL - CLAY - SAND MIXTURE		Low	-43		45	12	Damp
						9'		to	-49		24	27	Damp
12					CL	CLAY - Gravelly - Sandy, silty Low-med. plastic		Nil Ice	-41		29	30	Damp
16					CI	- Till		Vx	-52		38	10	Moist
20								Nbn	-49		37	14	Moist
24									-45		38	17	Moist
28						Bottom of Hole - 29'			-51		38	11	Moist
32													
36													
40													
44													
48													
52													
56													

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CHAINAGE.

OFFSET.

TECH. D. Pronych

RIG. Mayhew #1

SURFACE DRAINAGE.

VEGETATION.

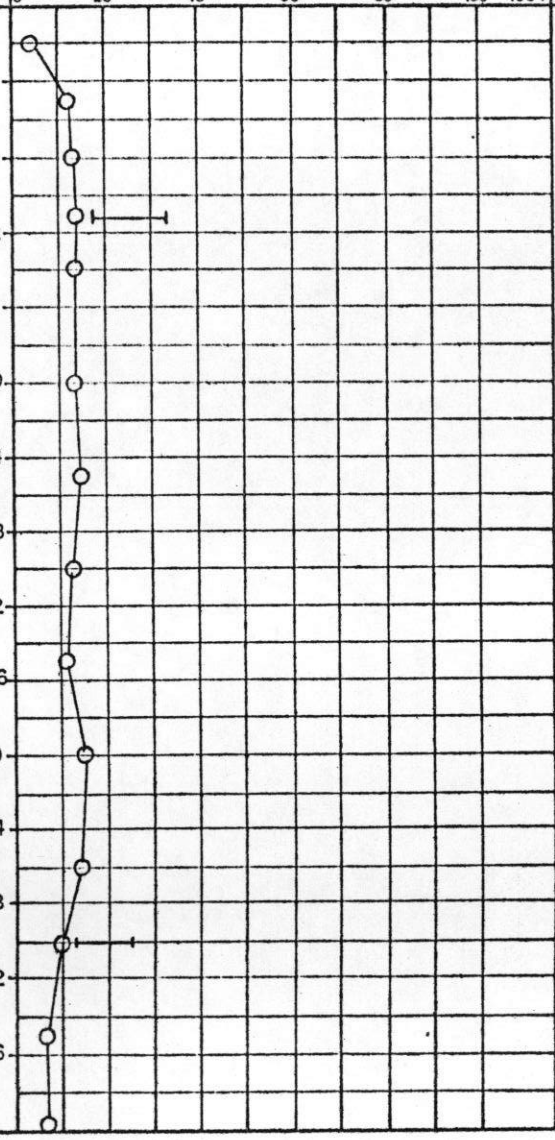
ELEV.

TEST HOLE 15

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
					Pt	PEAT 4"		
					CL	CLAY - Silty, sandy 1'		
						SAND - Gravelly		
4						4.5		
						CLAY - Silty, sandy pebbles, flat rocks &		Low
8					CL	chips, low-med. plastic		Ice
					CI			Nbn
12						- Till	F	Vx
16								
20								
24								
28						CLAY - Silty		
						- Sandy		
32						- Pebbles		
								Low
36					CL			
						Low-med. Plastic	F	Ice
40					CI			
44								
48								
52								
						55'		
56						SAND - Clayey, silty		
						SAND - CLAY - MIXTURE		
						Bottom of Hole - 59'		

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT



GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
- 7 -	63	30		Moist
-5 3 -	32	15		Moist
-5 0 -	42	8		Moist
-4 3 -	44	13		Moist
-5 6 -	35	9		Moist
-5 1 -	33	16		Damp
-5 1 -	41	8		Moist
-4 4 -	42	14		Moist
-4 2 -	41	17		Damp
-5 7 -	35	8		Moist
-5 1 -	45	4		Moist
-4 1 -	57	2		Damp
-3 3 -	65	2		Damp
-3 7 -	62	1		Damp

REMARKS

Possibly reach lower limit of Permafrost at 47'

DS-14-5-74 A

TIEDA RIVER

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE:

FIELD ENG.

DATE DRILLED. 19/3/74

AIRPHOTO NO.

CHAINAGE.

OFFSET.

TECH. D. Pronych

RIG.

SURFACE DRAINAGE.

VEGETATION.

ELEV.

TEST HOLE 16

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
0					Pt.	PEAT 1'		Moderate Ice Vc-Vr
					CL	CLAY-Silty, sandy 2.5'		
4					SP	SAND-Gravelly, silty 6'		Low
8					CL	CLAY-Silty, sandy -Pebbles Low-med. plastic Rock chips flat-hard -Till	F	Ice
12					CI			Vx
16								Nbn
20								
24								
28						Bottom of Hole - 29'		
32								
36								
40								
44								
48								
52								
56								

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT
40 0 60 20 80 40 100 60 120 80 140 100 100+

GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
-65-	35	0		Moist	
-20-	68	12		Moist	
-59-	33	7		Moist	
-56-	34	10		Moist	
-53-	30	17		Moist	
-51-	33	16		Moist	
-56-	35	9		Moist	
-48-	37	15		Moist	

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE:

FIELD ENG.	DATE DRILLED. 18/3/74	AIRPHOTO NO.	CHAINAGE.	OFFSET.
TECH. D. Pronych	RIG. Mayhew #1	SURFACE DRAINAGE.	VEGETATION.	ELEV.

TEST HOLE 17

MILE 763

REMARKS

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT
0					Pt	PEAT 1		Moderate Ice	-50-		50	0	Sat.
4					CL	CLAY - Silty, sandy - Low plastic 4.5		Vc-Vr	-19-		65	16	Wet
8					SC	SAND - Clayey, gravelly Boulders & Cobbles 7.0		Low	-52-		41	7	Moist
12					CL CI	CLAY - Silty, sandy Pebbles, rock chips Flat-subround broken - hard	F	Ice Vx	-60-		37	3	Moist
16									-58-		38	4	Damp
20						- Till			-50-		32	18	Moist
24									-52-		35	13	Wet
28						Bottom of Hole - 29'			-46-		35	19	Moist
32													
36													
40													
44													
48													
52													
56													

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: SECTION D

FIELD ENG. N. BURGESS | DATE DRILLED. 17/3/74 | AIRPHOTO NO. A23334 - 226 | CHAINAGE. 2059 + 50 | OFFSET.

TECH. BAINS | RIG. 1 | SURFACE DRAINAGE. | VEGETATION. | ELEV.

TEST HOLE 949

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION	GRAIN-SIZE ANALYSIS CLAY %	SILT %	SAND %	GRAVEL %	RELATIVE THAWED MOISTURE CONTENT	REMARKS
					Pt	PEAT 1.5'								HOLE IN BAG
2					Ci	CLAY - SILTY SANDY MED. PLASTIC 4'			-70	-	30	0	WET	
4														
6					Sc	SAND - CLAYEY - GRAVELLY		LOW	-17	-	58	25	DAMP	
8						- PEBBLES		ICE						
10						SILT - CLAYEY			-38	-	52	10	DAMP	
12					Ml	- SANDY	F		-68	-	30	2	DAMP	
14						- PEBBLES		Vx	-70	-	27	3	DAMP	
16														
18														
20														
22														
24														
26														
28														

DRY DENSITY (lbs/Ft.³)
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT
40 60 80 100 120 140 100+

BOTTOM OF HOLE - 29'

D3-14-5-74 b

DEPARTMENT OF PUBLIC WORKS, CANADA
MACKENZIE HIGHWAY

DRILL HOLE REPORT

SITE: SECTION D

FIELD ENG. N. BURGESS | DATE DRILLED. 17/3/74 | AIRPHOTO NO. A23334 - 226 | CHAINAGE. 2056 + 00 | OFFSET.

TECH. BAINS | RIG. 1 | SURFACE DRAINAGE. | VEGETATION. | ELEV.

TEST HOLE 950

MILE 763

DEPTH (FEET)	SAMPLE NUMBER	SAMPLE TYPE	% RECOVERY	PENETRATION RESISTANCE	UNIFIED SOIL SYMBOL	SOIL DESCRIPTION	LIMITS OF FROZEN GROUND	ICE DESCRIPTION
0					Pt	PEAT 1.5'		MODERATE ICE
2						CLAY - SILTY		Vc - Vr
4						- SANDY		
6						- PEBBLES		
8						LOW PLASTIC		
10					Cl		F	LOW ICE
12								
14								Vx
16								
18								
20								
22								
24								
26								
28								

DRY DENSITY (lbs./ Ft.^{3})
WATER CONTENT (% of dry weight)
ICE CONTENT (% of sample volume)
PLASTIC LIMIT — LIQUID LIMIT
0 20 40 60 80 100 120 140 160+

GRAIN-SIZE ANALYSIS				RELATIVE THAWED MOISTURE CONTENT	REMARKS
CLAY %	SILT %	SAND %	GRAVEL %		
-68	-	32	0	SAT.	
-60	-	37	3	WET	
-61	-	36	3	DAMP	
-64	-	35	1	DAMP	
-65	-	33	2	DAMP	

BOTTOM OF HOLE - 29'

DS-14-5-74 b

DEMPSTER HIGHWAY, Y.T.
EAGLE RIVER BRIDGE SITE

Initial Ground Temperatures at installation of thermistors- June 7, 1974.

DEPTH	TEMPERATURE ^{o}F	
	SOUTH BANK STA 5091+80	NORTH BANK STA 5094+35
5	30.6	26.0
10	30.7	22.9
20	31.95	24.4
30	32.06	27.0
40	32.2	28.2
50	32.2	28.5
60	32.1	28.6
70	32.1	28.8
80	32.0	28.7
90	32.3	29.0
100	32.1	29.1

DEMPSTER HIGHWAY, Y.T.
EAGLE RIVER BRIDGE SITE

Ground Temperatures - Sept. 29, 1974

Observer - G.H. Johnsto
DBR/NRC

(1) Thermistor Cable No. 1 - North Side - Sta. 5094 + 35
(B.H. #74-BH-Da)

Point No.	Depth Ft.	Temperature °C	Temperature °F
1	5	-0.77	30.6
2	10	-1.71	28.9
3	20	-2.55	27.4
4	30	-2.62	27.3
5	40	-2.35	27.7
6	50	-2.08	28.2
7	60	-1.91	28.6
8	70	-1.79	28.8
9	80	-1.86	28.7
10	90	-1.64	29.0
11	100	-1.72	28.9

(2) Thermistor Cable No. 2 - South Side - Sta. 5091 + 80
(B.H. #74-1)

Point No.	Depth Ft.	Temperature °C	Temperature °F
1	5	-0.14	31.7
2	10	-0.44	31.2
3	20	-0.10	31.8
4	30	+0.06	32.1
5	40	+0.12	32.2
6	50	+0.15	32.2
7	60	+0.02	32.0
8	70	+0.04	32.1
9	80	-0.10	31.8
10	90	+0.15	32.2
11	100	-0.10	31.8

DEMPSTER HIGHWAY, Y.T.
EAGLE RIVER BRIDGE SITE

Ground Temperatures - March 21, 1975

Observers -
J.C. Plunkett, DBR/N
T. Thompson, AES/DOE

Point No.	Depth Ft.	Cable #1 (North) °C	°F	Cable #2 (South) °C	°F
1	5	-5.53	22.0	-0.34	31.4
2	10	-3.78	25.2	-0.37	31.3
3	20	-2.15	28.1	-0.19	31.7
4	30	-2.03	28.3	-0.05	31.9
5	40	-2.11	28.2	+0.04	32.1
6	50	-2.06	28.3	+0.09	32.2
7	60	-1.95	28.5	-0.16	31.7
8	70	-1.80	28.8	0.0	32.0
9	80	-1.84	28.7	-0.23	31.6
10	90	-1.64	29.0	+0.10	32.2
11	100	- *	-	- *	-

Snow Cover - Range 27" - 39" 32" - 36"
- Avge. (~20 obser.) 32" 34"

Air Temperature - 0°C

* Unable to obtain stable reading.

4. Tieda River

Drainage area of this river is 319 square miles. The flow rate calculated using the measured ice marks, 2,015 c.f.s. is much lower than the value of Q_{50}, 4,010 c.f.s. This is because the peak discharge is mainly controlled by the relatively large Yeltea Lake which is one mile wide and eighteen miles long. Sixty percent of the main channel passes through this lake. Therefore, a design discharge of 2,650 c.f.s. which is two thirds of Q_{50}, is recommended as a conservative design discharge value. The average velocity estimated for that discharge is 5.7 feet per second.

III.4 TIEDA RIVER

4.1 Bridge Setting

The bridge lenght is 270 feet based on the centreline groundline profile and the proposed grade line (Fig. 13). However, this lenght may be subject to revision due to certain foundation stability problems discussed below.

Although some of the features of this crossing are undesirable, it appears to be the best available location in the area. The highway crosses the river in a bend. Therefore, water velocity is greater along the north bank. This bank is steep, unstable, about 6 to 10 feet high, and it is gradually eroding.

Further studies of the slope stability are recommended, taking account of the combined effects of the approach embankment and of the scour action of the water. Recommendations are contained herein under the Scour section, pertaining to the action of the water on the bank, and protection requirements after the bank has been stabilized.

The final lenght of the bridge structure would depend on the position and slope of the fill, since such lenght is more than adequate for Hydrological considerations.

4.2 Scour Computations

The mean size of riverbed material estimated is 60 m.m. The water depth and mean velocity at design discharge at the bridge crossing were computed to be 6.3 feet and 4.84 fps respectively (Table 1). Based on this water depth and material size, the non-eroding velocity of 9 fps suggested by Neill[8] is much greater than the mean velocity of 4.84 fps. A top width of 92 feet calculated using Lacey's equation[8] is less than the actual channel width of 94 feet. Thus, no general scour is expected.

The local scour depths around piers were found to be 6 feet, 8 feet and 10 feet corresponding to pier widths of 4 feet, 6 feet and 8 feet respectively (Appendix II). A maximum 5 inch mean stone would be enough to insure

protection of the piers against scour, and 12 inch mean size riprap is recommended. (Table 2).

4.3 Ice Considerations

Numerous ice marks were found on the right bank of the river, on the outer part of the river bend. These marks were found at elevations ranging from 3 feet above the 1973 high water level just after the bend, down to 1 foot at the level of the centreline.

It is therefore indicated that ice pile-up along the river bank is significant and special provisions should be taken in order to insure that the ice can be carried through the structure. Ice pressure on piers can be reduced by using sloped face piers.

I.4 TIEDA RIVER

Design discharge: 2,650 cfs

Elevation corresponding to design discharge: 466.5 feet

Natural channel width at bridge site corresponding to design discharge: 94 feet

Low water elevation: 461.3 feet

Riverbed material: small boulder, D_{50} = 60 m.m.

Average water depth at design discharge: 6.3 feet

Cross-section area at bridge site corresponding to design discharge: 546.5 sq. ft.

Velocity at design discharge: 4.84 fps

Competent velocity suggested by Neill[7] for bed material movement under conditions of material size = 60 m.m. and water depth = 6.3 feet,

$$V_c = 9 \text{ fps}$$

which is greater than the average velocity of 4.84 fps

The water opening required for stable channel estimated by Lacey's equation is:

$$W = 1.8 \times (2{,}650)^{0.5} = 92.6 \text{ feet}$$

which is less than the natural channel width.

Thus, no general scour is expected.

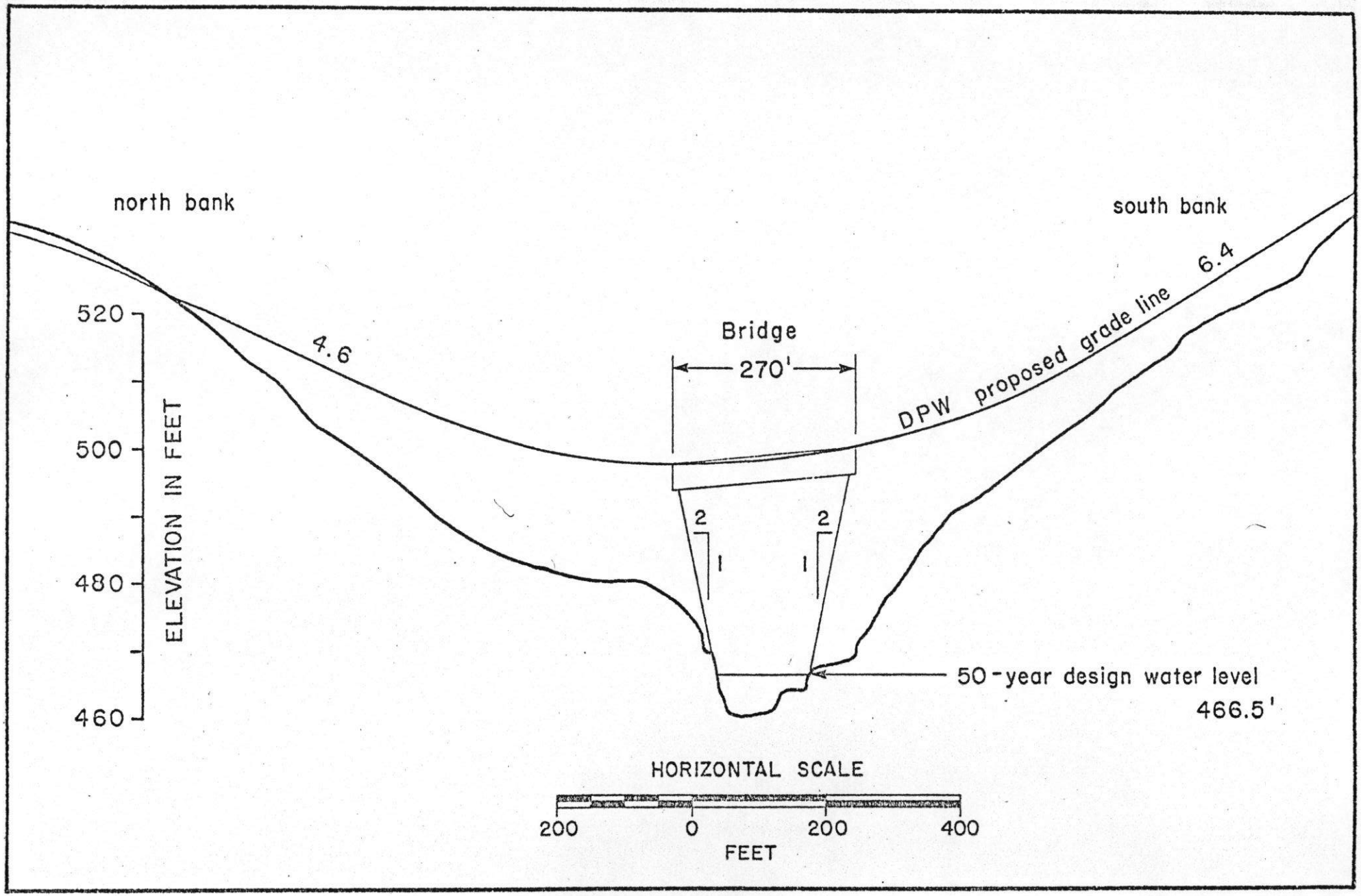


FIGURE 12 TIEDA RIVER BRIDGE
Preliminary Profile

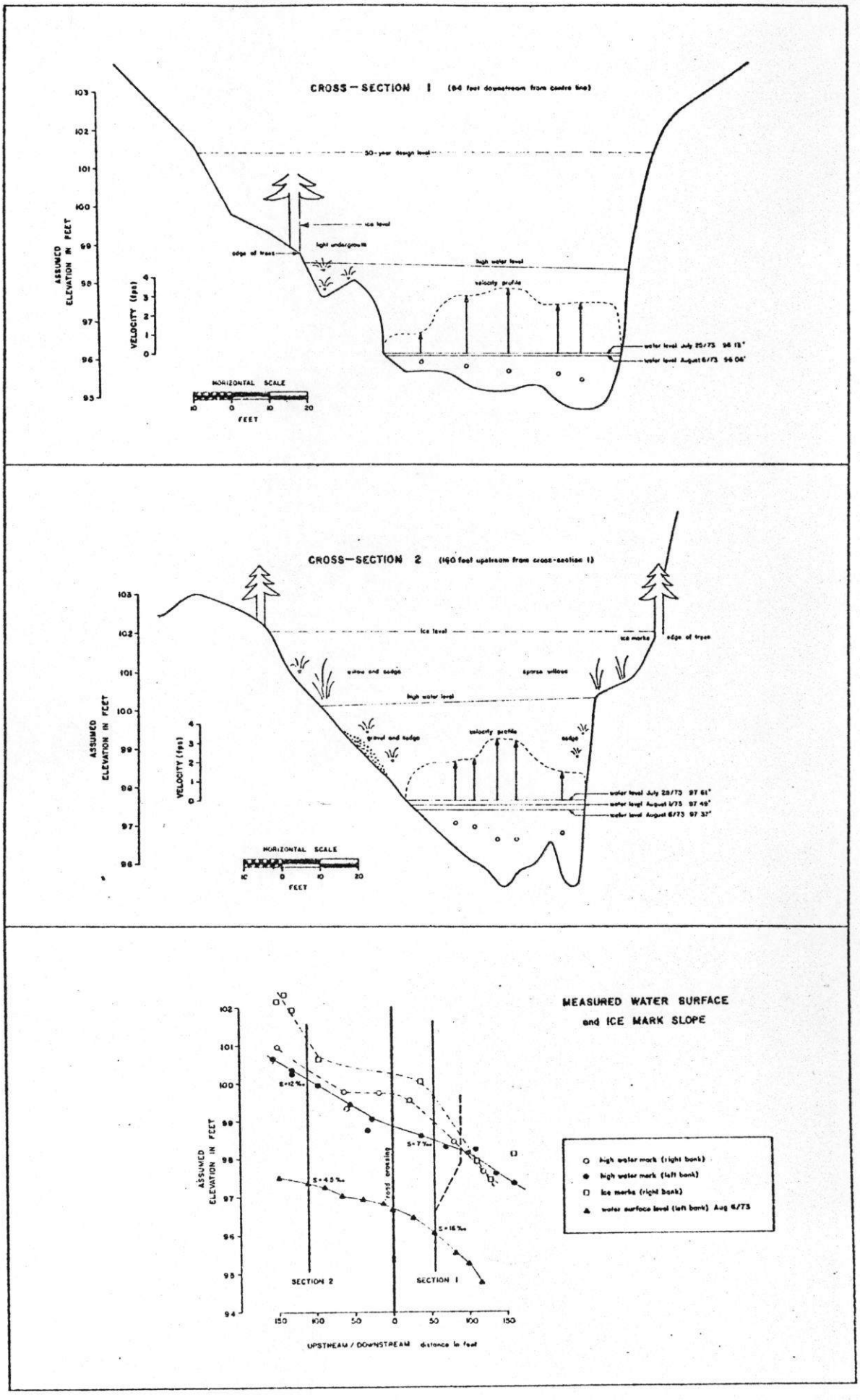


FIGURE 41 Tieda River Hydraulic Data

TIEDA RIVER BASIN

TOTAL DRAINAGE AREA TO HWY 319 SQ MI

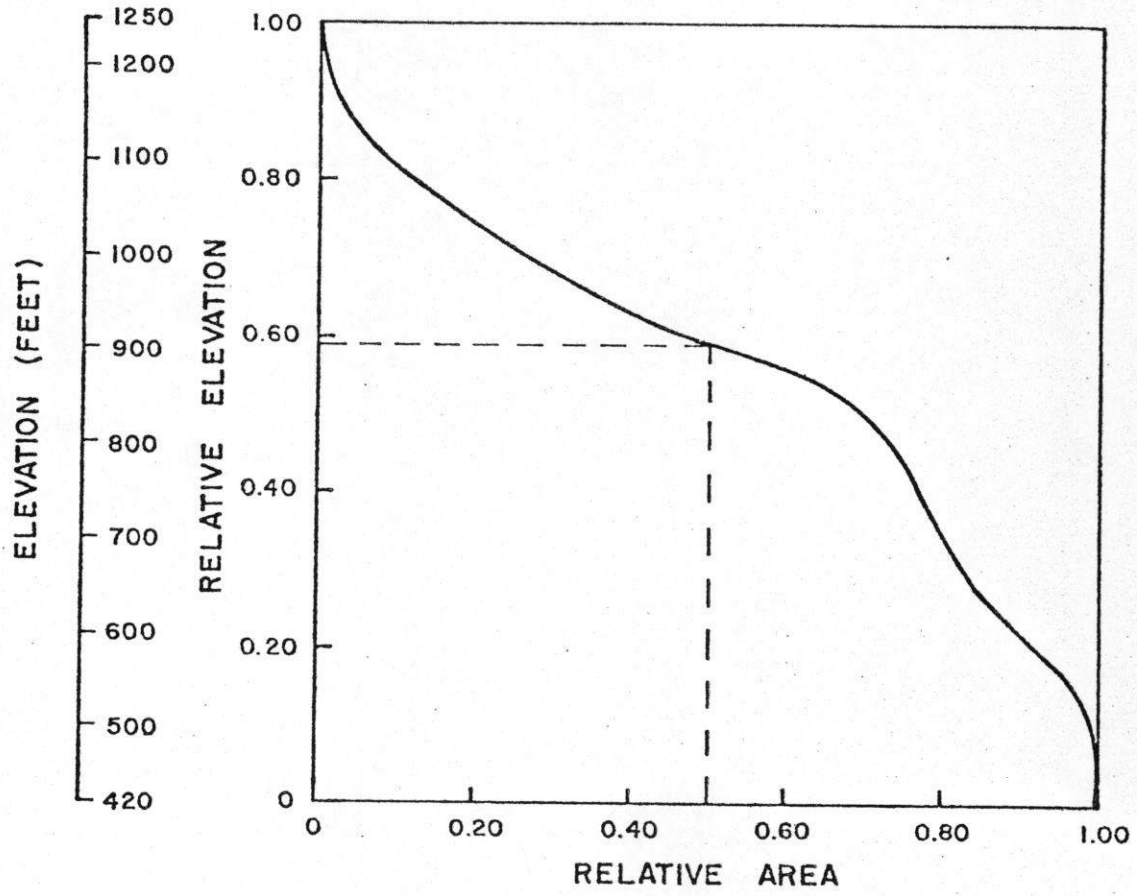


FIGURE 30

FENCO

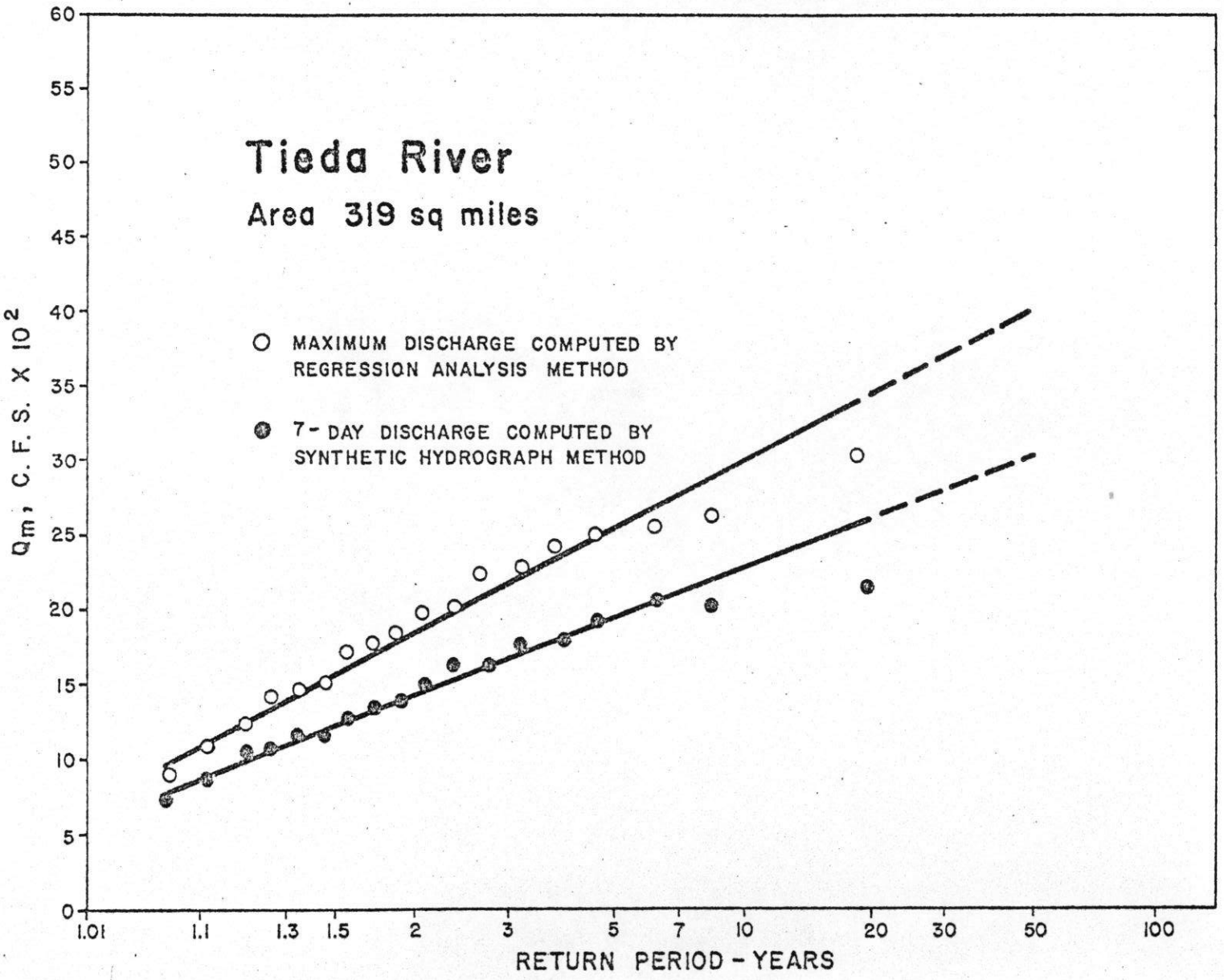


FIGURE 15 Peak and 7-day discharges of the Tieda River

Table E

Local Scour Depth Around Piers

at Tieda River Crossing

Equation Used	Scour Depth in Feet Width of Pier in Feet 4	6	8
Blench	3.8	4.9	5.8
Shen	5.8	7.8	8.8
Larras	5.6	7.6	9.5
Depth Recommended	6.0	8.0	10.0