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6-1-80 SEP 1976

GEOCRES No. 30M11-177

DIST. 6 REGION Central

W.P. No. 33-76-03

CONT. No. 78-99

W. O. No. _____

STR. SITE No. 37-1055

HWY. No. _____

LOCATION Northwest Metro
Arterial Bridge Over Black
Creek Channel

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 1

REMARKS: documents to be unfolded
before microfilming

memorandum

Contract 78-79



To: Mr. J.K. Livingstone
Asst. Claims Engineer
Engineering Claims Office
Central Building

Date: 1980-05-14

From: Pavement & Foundation Design Section
Room 313, Central Building

Re: Contract 78-99, Structures
at Jane St. Interchange Southerly
to South of Queen's Drive
Hwy. N.W.M.A., District 6, Toronto

As per the recent meeting between yourself and Messrs. M. Devata and T. Kazmierowski, we are submitting our written comments with regards to pile driving difficulties encountered at the above mentioned contract.

During pile driving operations at the east abutment location for the N.W.M.A. Bridge over Black Creek Channel (Site 37-1055, W.P. 33-76-03) and the Ramp Bridge (Site 37-1077, W.P. 33-76-11) breakage of several timber piles occurred. The timber piles for these structure locations were designed as friction piles driven to a specified tip elevation. In determining this driving depth, the results of pile load tests and driving records carried out in this general area by the Ministry were utilized.

In order to fully assess the possible causes for these pile driving difficulties, this section carried out an in depth review of all available data including driving resistance records, subsoil conditions, driving operations and quality of piling material, plus advancing an additional borehole to confirm subsurface conditions. Based on careful review of this information, additional recommendations were provided to the field construction personnel immediately to minimize any construction delays. It is understood, that upon implementation of these recommendations, pile driving operations proceeded satisfactorily.

Difficulties arising during the initial portion of pile driving operations can be attributed to a combination of the following:

- 1) The initial shipment of treated timber piles supplied at the site by Domtar Canada exhibited characteristics of inferior quality both from a visual inspection and driving behaviour point of view. Driving records of the damaged piles reveal that a majority of the piles broke under low driving resistances, i.e. less than 20 blows/foot. In some instances, piles broke prior to actual driving during handling operations. These observations are supported by letters from both Fenco dated March 16, 1979 and Domtar Chemical Group dated March 14, 1979 which are appended to this memorandum.

cont'd...2/

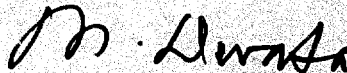
- 2) As a result of the additional investigation carried out during construction operations, the natural subsoil conditions were found to be in agreement with the original information provided in the contract documents. However, in some areas the fill material was found to contain zones of asphalt and other debris which were not identified in the initial investigation. For this reason, it was recommended that pre-augering through the fill should be utilized to assist penetration of the piles through the fill material.
- 3) In our opinion, the piling contractor cooperated with Ministry personnel in carrying out the modified recommendations and went about his operations in a reasonable manner.

Comprehensive data on driving details of individual piles, recommendations provided, photos of the damaged piles, and all related correspondence are retained in our files for further reference.

We trust this letter summarizes our discussion in your office and provides you with the information you required.



Tom Kazmierowski
Project Foundations Engineer



Murty Devata
Senior Foundations Engineer

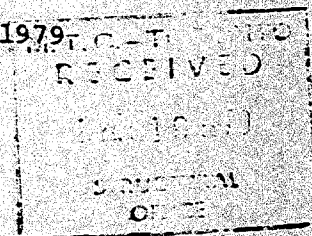
TK:MD:ea
Attach.



FENCO

1 Yonge Street
Toronto, Canada M5E 1E7
416-361-4722
Cable 'FENCOENG'
Telex 06-23765

March 16, 1979



Mr. C.S. Grebski, P.Eng.
Head, Central Section
Structural Office
Ministry of Transportation
and Communications
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Dear Sir,

NORTH WEST METRO ARTERIAL
OVER BLACK CREEK AT JANE STREET
MAIN BRIDGE SITE 37-1055 W.P. 33-76-03
RAMP BRIDGE SITE 37-1077 W.P. 33-76-11

Further to our recent discussions, we confirm herein our opinions and recommendations concerning the driving and breakage of some of the timber piles at the above site.

From the various reports it appears that in certain areas, e.g. north end of east abutment, there was difficulty in driving the piles to the stipulated length of 50 feet and it was decided to bring in a heavy hammer in order to achieve this end. It has been our experience that it should be possible to install timber piles with a hammer delivering approximately 15,000 ft. lbs./blow and a final set of about 4 blows/inch. Once these figures are exceeded the risk of causing breakage or brooming of the piles increases. For the subject piles the reports indicate that these figures have been considerably exceeded in a number of cases. We therefore conclude that the hard driving with the heavy hammer is one of the main contributory factors in the breakage of the piles.

From our cursory examination of the stock pile of timber piles and the top of the broken piles, it is our opinion that the quality of some of the piles is questionable in that they do not conform to the material requirements of CSA Standard 056 "Round Timber Piles". In particular there appears to be unacceptable shakes, splits and checks in the tips, and a number of piles have sweeps, reverse sweeps and short crooks in

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March 16, 1979

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excess of those permitted. The piles are difficult to examine in the creosoted state, which tends to mask the defects, but it would be interesting to review the inspection records of the supplier for the piles in the untreated state. We therefore conclude that the poor quality of some of the piles has contributed to the breakage problems.

From the driving records of the piles, it is apparent that some of the soil conditions encountered are stiffer than was anticipated from the interpretation of the soil borehole logs. It is our recommendation that the stipulation to drive the piles to a predetermined elevation or length should be tempered with judgement as the driving blow counts are established in the field. In our opinion, the blow count record for a particular pile is probably a more reliable measure of the soil stiffness existing at the pile location than is a soil boring taken some distance away. Accordingly, we suggest that some additional criteria based on blow count be used for determining when a pile has been acceptably driven.

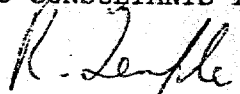
From our discussions, we understand that the Ministry at an internal meeting has decided to proceed as follows:

1. Drive the piles with the Delmag D-12.
2. Pile driving may cease after at least 35 feet of penetration, providing a blow count of at least 50 blows/ft. is attained for the last 3 feet of driving.
3. Pre-auger the piles through the top layer of fill, in order to displace obstructions.
4. Piles to be incorporated in the work will be carefully selected from the stock pile to ensure conformance with the specifications.
5. The pile driving will be supervised by a representative of the Soil Mechanics Section.

We concur with this approach, subject to the procedures being further reviewed if the pile driving becomes difficult at a penetration of less than 35 feet.

We trust this letter satisfactorily summarizes our discussions, and if we can be of further assistance please give us a call.

Yours very truly,
FENCO CONSULTANTS LTD



R. Temple, P.Eng.
CHIEF BRIDGE ENGINEER

RT/sm
8329

3380 Airway Drive, Mississauga, Ontario L4V 1N7
(416) 677-7030

March 14, 1979

Mr. Donald A. MacDonald
Area Construction Engineer
Ministry of Transport and Communications
3501 Dufferin St.
Downsview, Ontario
M3K 1N6

Dear Mr. MacDonald

Further to our meeting on March 5, 1979, we checked the approximately 120 pieces of treated piling at the Maple Leaf Drive site and found thirteen pieces which were not up to specifications. The pieces in question were identified for Mike Wannamaker, who was with us during the inspection period, and will be replaced.

From our discussion and my own observations, it seemed likely that there was a problem with the pile driving equipment. I passed this thought along and we understand that a D.12 was put into action last Friday. The new hammer was working well when I visited the site on Monday and the piles were not breaking.

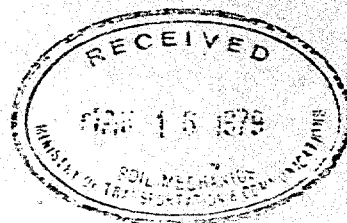
The writer will stay in touch with you regarding this matter. We appreciate your time and courtesy.

Yours truly
DOMTAR CHEMICALS GROUP


W. J. Whelton

cc: Murty Devata
Soil Mechanics Section
Ministry of Transportation & Communications

WJW:SC



ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 33-76-03

DIST 6

HWY NWMA

STR SITE 37-1055

Northwest Metro Arterial Bridge
Over Black Creek Channel

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SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	28 08 15	DD-15
TUBES	-	-
ROCK CORES	-	-

FOUNDATION INVESTIGATION REPORT

For

Northwest Metro Arterial Bridge
Over Black Creek Channel
W.P. 33-76-03, Site 37-1055
N.W.M.A., District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned location. The fieldwork was done during the periods of February 2, 1965, August 22, 1977 and April 24 to May 2, 1978, utilizing both washboring techniques and an auger machine equipped with hollow stem continuous flight augers. The first two periods of fieldwork for both the feasibility study and the supplementary study consisted of single boreholes advanced to depths of 105 feet and 51 feet respectively. The recent fieldwork consisted of 5 sampled boreholes, 4 of which were accompanied by a dynamic cone penetration test, plus 2 individual cone tests. The boring depths ranged from 51.5 feet to 128.5 feet below ground surface.

DESCRIPTION OF THE SITE AND GEOLOGY

The site is located 400 feet southeast of the Hwy. 400 dead end at the Jane St. interchange in Toronto.

Earthfill has been placed at this site on either side of the re-located Black Creek Channel along the initial alignment of the Hwy. 400 extension. Generally, the topography in the area is flat to gently sloping.

Physiographically, the site lies in the South Slope Region which is the south slope of an interlobate moraine. This moraine consists of a clayey silt till deposited during the Pleistocene Ice Epoch.

SUBSURFACE CONDITIONS

The site is covered by an extensive deposit of glacial till extending to depths ranging from about 85.0 ft. to 101.0 ft. Underlying this deposit is a stratum of sandy silt to silty sand whose full

extent was not explored but proven to a maximum depth of 27.5 feet. A surficial fill embankment to a maximum height of 30 feet overlies the site.

The boundaries between the various soil types are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphical profile based on the borehole data, is shown on Drawings 337603-A and B.

The various subsoil types encountered are briefly described in the following paragraphs.

Fill

The earthfill that covers most of the site is composed mainly of clayey silt some sand with a trace of gravel. The thickness varied from a minimum of 6.5 feet at the channel berm to 28 feet at the crest of the channel cut. The physical properties of this fill material are generally similar to the underlying parent till material. The 'N' values from the Standard Penetration Test for this clayey silt fill material ranged from 7 blows/foot to 25 blows/foot indicating the fill was moderately to relatively well compacted.

On the east berm of the channel, the surficial fill material consisted of shallow depths of silty sand to sand and gravel. The 'N' values ranged from 12 blows/foot to 100+ blows/foot indicating this granular material has a denseness ranging from compact to very dense.

Clayey Silt With Sand and Trace of Gravel (Glacial Till)

Underlying the fill material or below ground surface elsewhere, is a glacial till stratum consisting of a heterogeneous mixture of clayey silt with some sand and a trace of gravel. Occasional thin seams of silt and fine sand and distinct layers of silt with sand were encountered in this deposit. In various areas organics were well dispersed in the upper portion of this uniform deposit.

This stratum, where fully penetrated, varies in thickness from 85.0 feet to 101.0 feet. Laboratory testing consisting of Atterberg Limits, moisture contents, grain size analysis and undrained

shear strength measurements performed on material of this deposit gave the following results:

		<u>Range</u>
Natural Moisture Content	(W) %	19-29
Plastic Limit	(W _p) %	10-23
Liquid Limit	(W _L) %	17-38
Undrained Shear Strength	(psf) as performed by:	
In situ field vane		880- >2,000
Lab. unconfined compression test		975- 3,955
Sensitivity		1.0-3.0

In general the W_L was found to be below 35% with testing indicating the clayey silt is inorganic of low to moderate plasticity. However, at isolated locations, between elevation 340 and elevation 360, a more plastic clayey silt to silty clay with little or no sand and gravel was encountered.

The 'N' values for the deposit as a whole range from 9 blows/foot to 80 blows/foot, but average approximately 20 blows/foot. Based on these results and vane tests performed, the consistency of this clay silt stratum is assessed as stiff to hard.

Grain size distribution for this deposit is plotted in envelope form on Figure 1 and a plasticity chart is shown on Figure 3.

Sandy Silt to Silty Sand

Underlying the clayey silt till and penetrated to a maximum depth of 27.5 feet below this deposit, is a stratum of sandy silt to silty sand with traces of clay and gravel. Generally, the percentage of sand was found to increase with the depth of the stratum. The 'N' values range from 50 blows/foot to 250 blows/foot, indicating a relative density for this deposit which varies from dense to very dense. A plot of grain size distribution is shown in envelope form on Figure 2.

Groundwater

Overnight groundwater level readings taken in open boreholes indicated water elevations ranging from elevation 377 to elevation 401 which correspond to depths of 28 feet and 14.5 feet respectively.

It is assumed that these levels did not stabilize over the short period of investigation and that, generally, the water level over the site can be expected to correspond to the water level in the Black Creek Channel.

DISCUSSION AND RECOMMENDATIONS

A 3 span steel girder structure is proposed to carry the Northwest Metro Arterial over the relocated Black Creek channel. The bridge will have a total length of 196 feet with perched type abutments within the geometry of the existing fill. The profile grade will drop at approximately a 3% grade from elevation 429.7 in the centre of the structure to elevation 405.0₊ at Maple Leaf Drive. This would necessitate a cut on the east side of the relocated Black Creek.

In view of the uniform subsoil conditions at this location, recommendations pertaining to the east and west abutments and piers of the proposed structure are as follows:

Structure Foundations

Shallow spread footings are not desirable at this site due to the presence of non-uniformly compacted earthfill on either side of the relocated channel. The structure should be supported on friction piles located in the clayey silt strata or on end bearing piles in the very dense fine granular stratum. In order to develop sufficient capacity for the end bearing piles the piles have to be driven to a maximum depth of 120 feet below ground surface. In view of the length of these piles required, it is recommended that the structure be supported on #14 timber friction piles driven to the following tip elevations:

East Abutment	355.0
West Abutment	358.25
East & West Piers	341.75

A safe bearing capacity of 35 tons can be developed on timber piles driven to the specified elevations in the clayey silt stratum.

The design drawing indicates that the east abutment intersects an existing 54" ϕ sanitary sewer near the centreline of the NWMA. In order to prevent the sewer from being damaged by pile driving operations, piles within a distance of 6 feet from the sewer should be pre-augered with a 10" ϕ auger to a depth of 5 feet below the invert level of the sewer. These pre-augered piles should be designed for a safe bearing capacity of 20 tons/pile.

Settlement of the pile foundations under these recommended loads should not exceed $\frac{1}{2}$ inch. The recommended pile capacity and anticipated settlement are based on the results of a pile loading test conducted in the general area with similar subsoil conditions.

Due to the large number of piles required and the proximity of the individual piles, driving operations may result in disturbance and heaving of previously driven piles. It is recommended that the sequence of pile driving be such that only alternative piles are driven in succession and that all piles are retapped to the specified tip elevations at the completion of initial driving operations.

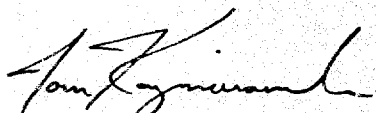
In order to prevent the softening or loosening of foundation material in the excavations by surface water or construction operations, a working pad of granular material or lean concrete should be placed to seal the bottom as soon as possible.

For frost protection purposes, the underside of the pile caps should have a minimum of 4 feet earth cover.

No major dewatering difficulties are anticipated for excavations of the pile caps due to the relatively low permeability of the clayey silt. Local seepage into the excavation can be removed by pumping from sumps. High water levels in Black Creek during pile cap excavation operations for the piers will require more elaborate procedures to prevent water infiltration.

Approaches

No stability problems are anticipated in the cut on the east side of the relocated Black Creek Channel if the slopes are constructed not steeper than 2:1.



T. Kazmierowski,
Project Engineer



M. Devata, P. Eng.
Supervising Engineer



June, 1978



RECORD OF BOREHOLE No 1

W P 33-76-03 LOCATION Coords. N 15,882,579; E 999,095 ORIGINATED BY J.N.
DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger & Dynamic Cone Test COMPILED BY J.N.
DATUM Geodetic DATE August 22, 1977 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF							WATER CONTENT (%)
424.1	Ground Surface							20 40 60 80 100							
0.0	Fill Material		1	SS	11										
	Clayey Silt		2	SS	12		420								
	Trace of Gravel		3	SS	18										
			4	SS	11										
			5	SS	25										
			6	SS	16		410								
			7	SS	16										
	Uniformly Compacted		8	SS	18										
			9	SS	22										
399.1			10	SS	14		400								
25.0	Clayey Silt Some Sand		11	SS	14										
	Trace of Gravel (Glacial Till)		12	TW	PH		390								
	Occasional Sand Seams		13	SS	30										
	Stiff		14	TW	PH		380								
372.6			15	SS	25										
51.5	End of Borehole														



RECORD OF BOREHOLE No 2

W P 33-76-03 LOCATION Coords. N 15,882,469; E 999,058 ORIGINATED BY T.K.
DIST 6 HWY NTMA BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY T.K.
DATUM Geodetic DATE April 25 & 26, 1978 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
404.7	Ground Surface												
0.0	Fill Material												
397.7	Clayey Silt		1	SS	19		400						1 28 41 30
7.0			2	SS	7								17 34 33 16
			3	SS	10								
			4	SS	8								
	With Organics		5	SS	19								
			6	SS	9								
			7	SS	14								11 23 43 23
	Clayey Silt Some Sand Trace of Gravel Grey		8	SS	18								
	(Glacial Till)		9	SS	13								
			10	SS	11								
			11	SS	17								
			12	SS	10								
			13	TW	PM							123	0 3 37 60
	Clayey Silt to Silty Clay		14	SS	18								
	Occasional Sand Seams		15	SS	35								
			16	SS	32								
			17	SS	36								
	Firm to Very Stiff		18	SS	30								2 23 50 25
			19	SS	63								
			20	SS	55								
	Occasional Silt Seams		21	SS	45								1 19 61 19
303.7			22	SS	69								
101.0	Sandy Silt Trace of Clay and Gravel Very Dense		23	SS	175								9 26 55 10
285.7													
119.0													

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

Continued

W. P. 33-76-03 LOCATION Coords. N 15,882,469; E 999,058 ORIGINATED BY I.K.
DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY I.K.
DATUM Geodetic DATE April 25 & 26, 1978 CHECKED BY SP

[illegible]

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

W P 33-76-03 LOCATION Coords. N 15,882,526; E 998,919 ORIGINATED BY T.K.
DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY T.K.
DATUM Geodetic DATE May 1 & 2, 1978 CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		FLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100	W _p	W	W _L		
403.8	Ground Surface							SHEAR STRENGTH PSF		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								400 800 1200 1600 2000		10 20 30				
0.0	Fill Material		1	SS	11		400							
	Clayey Silt		2	SS	12									
397.3			3	SS	14									
6.5			4	SS	13									
	Clayey Silt		5	SS	14									
	Some Sand		6	SS	14									
	Trace of Gravel		7	TW	PH									
	Grey		8	SS	12									
	(Glacial Till)		9	SS	13									
	Firm to Stiff		10	SS	17									
			11	SS	20									
			12	SS	16									
			13	SS	21									
			14	TW	PH									
			15	SS	19									
	Grey		16	SS	PH									
	Clayey Silt to Silty		17	SS	20									
	Clay, Trace of		18	TW	PH									
	Sand		19	SS	70									
	Firm to Stiff		20	SS	68									
	Occasional Silt With		21	SS	80									
	Sand Layers		22	SS	33									
	Stiff to Hard		23	SS	56									
304.8			24	SS	207									
99.0	Sandy Silt													
	Trace of Clay													
	Dense to Very Dense													
287.3														
116.5	End of Borehole													

*³, x⁵: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 5

W P 33-76-03 LOCATION Coords. N 15,882,495; E 999,019 ORIGINATED BY T.K.
DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger COMPILED BY T.K.
DATUM Geodetic DATE April 24 & 25, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	W _p VALUES			20	40	60	80	100					
401.7	Ground Surface																
0.0	Fill Material		1	SS	13		400										
395.7	Silty Sand With Organics		2	SS	12												
6.0	Silty Sand		3	SS	9												
388.7	Grey Compact		4	SS	13												
13.0	Clayey Silt		5	SS	19												
	Some Sand		6	SS	14												
	Trace of Gravel		7	TW	PH												
	Grey (Glacial Till)		8	SS	12												
			9	SS	16												
			10	SS	15												
			11	SS	15												
	Clayey Silt to Silty Clay		12	SS	10												
			13	SS	9												
	Firm to Very Stiff		14	SS	20												
			15	SS	24												
			16	SS	26												
			17	SS	33												
			18	SS	62												
325.2	Silt With Sand Very Dense		19	SS	90												
76.5	End-of Borehole																
	Note: Water Level Not Established																

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

W P 33-76-03 LOCATION Coords. N 15,882,652; E 998,801 ORIGINATED BY T.K.
 DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY T.K.
 DATUM Geodetic DATE April 27, 1978 CHECKED BY CP


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
425.7	Ground Surface												
0.0	Fill Material		1	SS	21								2 25 (73)
	Clayey Silt With Sand		2	SS	16								
			3	SS	15								
			4	SS	15								
	Firm		5	SS	23								
			6	SS	19								1 27 52 20
			7	SS	23								
397.7			8	SS	14								
28.0	With Organics		9	SS	13								0 12 74 14
	Wood Chips		10	SS	2								
			11	SS	16								0 0 66 34
	Clayey Silt Some Sand		12	SS	20								
	Trace of Gravel (Glacial Till)		13	SS	34								
	Grey		14	SS	24								
	Firm to Very Stiff		15	SS	44								1 2 42 55
			16	SS	30								
			17	SS	26								
			18	SS	33								
			19	SS	31								2 28 49 21
339.2			20	SS	23								
86.5	End of Borehole												
	Note: Water Level Not Established												



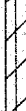



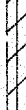

+³, x³: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

W P 33-76-03 LOCATION Coords. N 15,882,608; E 998,972 ORIGINATED BY T.K.
DIST 6 HWY NEMA BOREHOLE TYPE Hollow Stem Auger COMPILED BY T.K.
DATUM Geodetic DATE April 24, 1978 CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
FLEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
401.7	Ground Surface																
0.0	Fill Material Sand and Gravel Compact to Dense		1	SS	25	7"	400										23 66 (11)
394.7			2	SS	25												
7.0			3	SS	16												
			4	SS	12												
	Gravel Seam		5	SS	12												1 25 52 22
			6	SS	14												
	Clayey Silt Some Sand Trace of Gravel (Glacial Till)		7	SS	15												
			8	SS	17												
			9	SS	15												0 31 43 26
	Grey		10	SS	13												
			11	SS	21												
			12	SS	16												
	Clayey Silt to Silty Clay		13	SS	17												0 11 38 51
			14	SS	23												
	Occasional Sand Seams		15	SS	24												
			16	SS	23												
	Firm to Very Stiff		17	SS	42												3 26 51 20
			18	SS	39												
325.2	Silt Some Clay, Trace Sand, Very Dense		19	SS	137												0 2 83 15
76.5	End of Borehole																



RECORD OF BOREHOLE No 9

W P 33-76-03 LOCATION Coords. N 15,882,553; E 999,015 ORIGINATED BY T.K.
DIST 6 HWY NWMA BOREHOLE TYPE Cone Test COMPILED BY T.K.
DATUM Geodetic DATE April 26, 1978 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
402.0	Ground Surface															
0.0							400									
							390									
384.0																
18.0	End of Cone Test															

RECORD OF BOREHOLE No 10

W P 33-76-03 LOCATION Coords. N 15,882,607; E 998,887 ORIGINATED BY T.K.
DIST 6 HWY NWMA BOREHOLE TYPE Cone Test COMPILED BY T.K.
DATUM Geodetic DATE April 26, 1978 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
402.0	Ground Surface															
0.0							400									
							390									
388.1																
13.9	End of Cone Test															

+³, x⁵: Numbers refer to
Sensitivity

20
15-20.5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 14 (Formerly W.O. 65-F-40)

W P 33-76-03 LOCATION Coords. N 15,882,670; E 998,916 ORIGINATED BY H.S.
 DIST 6 HWY 100A BOREHOLE TYPE Washboring & Cone Test COMPILED BY H.S.
 DATUM Geodetic DATE February 2, 1965 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp	W	Wl			
397.0	Ground Surface							SHEAR STRENGTH PSF		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								400 800 1200 1600 2000		10 20 30				
0.0			1	SS	6									
	Silty Sand		2	SS	2									
			3	TW	PM									
			4	TW	PM									
	Clayey Silt With Sand Trace of Gravel (Glacial Till) Grey		5	TW	PM									
			6	SS	17									
			7	SS	22									
			8	SS	25									
			9	SS	38									
	Firm to Hard		10	SS	48									
			11	SS	48									
			12	SS	27									
			13	TW	PM									
			14	SS	31									
			15	SS	32									
			16	SS	49									
			17	SS	50									
			18	SS	101									
312.0			19	SS	21									
85.0	Silty Sand to Sandy Silt Occasional Gravel Compact to Very Dense		20	SS	50									
			21	SS	101									
			22	SS	22									
292.0														
105.0	End of Borehole													

+³, x⁵: Numbers refer to
Sensitivity

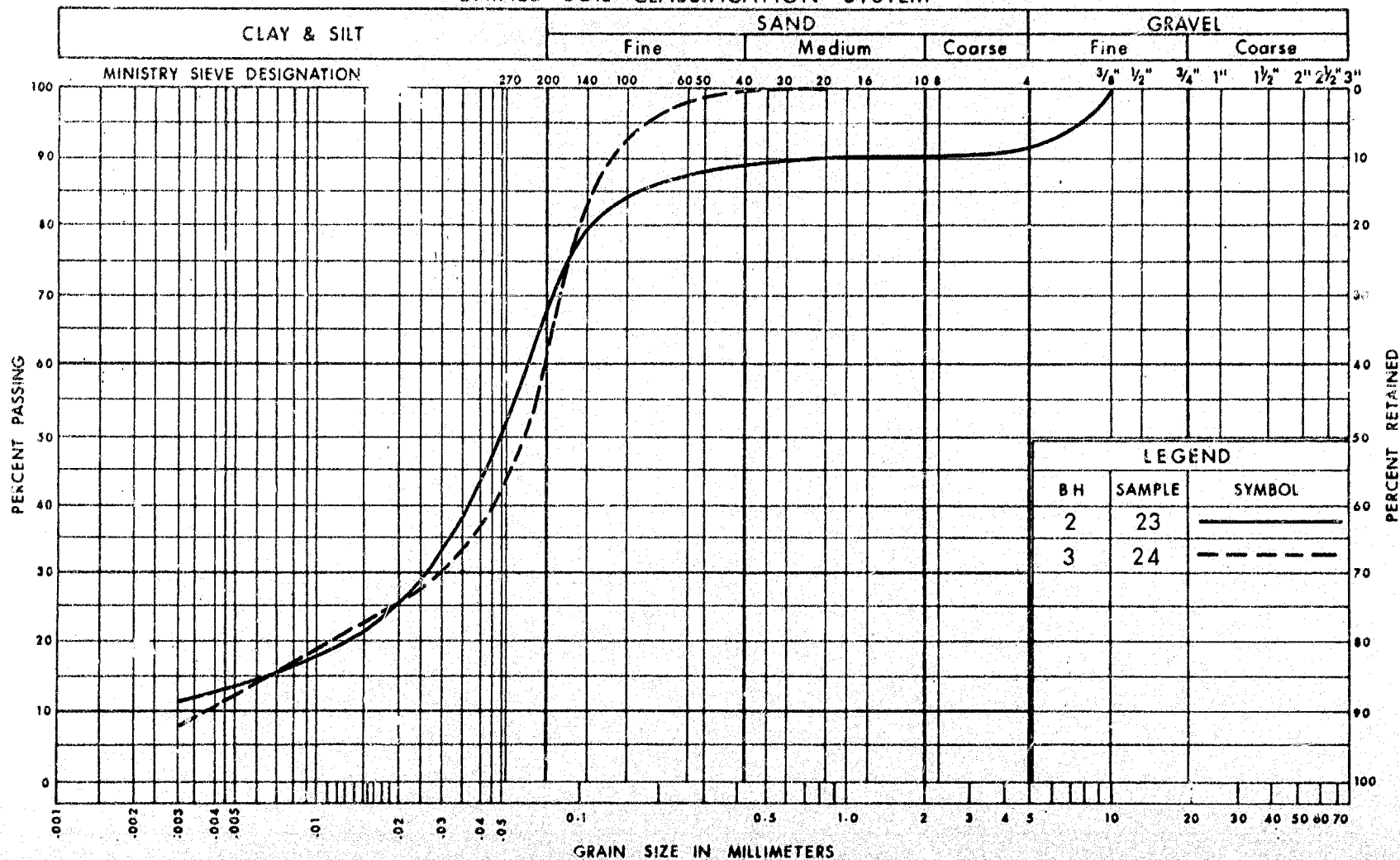
20
15
10
5 (%) STRAIN AT FAILURE



GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SOME SAND, TRACE OF GRAVEL
(Glacial Till)

WP 33-76-03

UNIFIED SOIL CLASSIFICATION SYSTEM

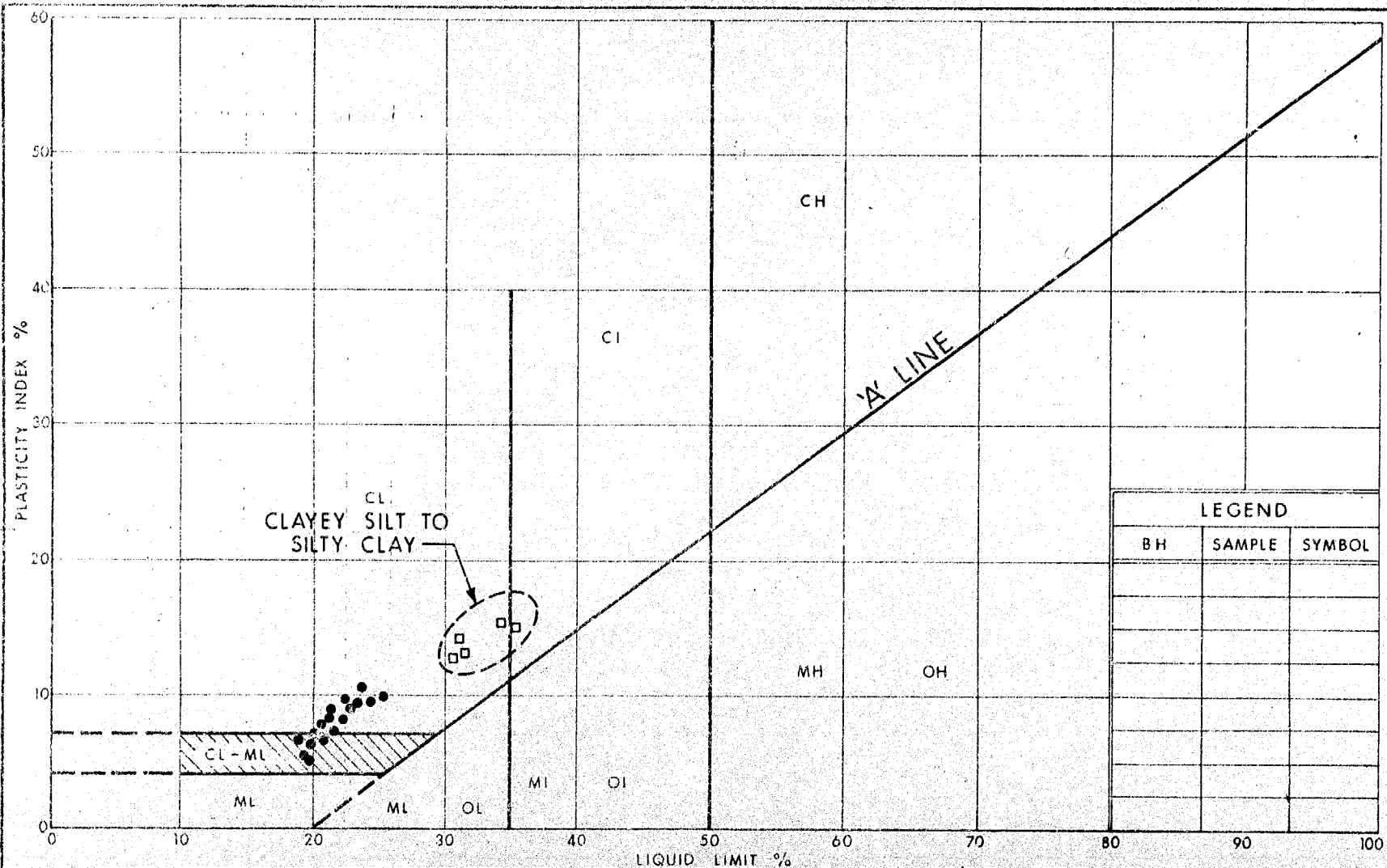


Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SANDY SILT, TRACE OF CLAY & GRAVEL

FIG No 2

W P 33-76-03



Ministry of
Transportation and
Communications

PLASTICITY CHART
CLAYEY SILT, SOME SAND, TRACE OF GRAVEL
(Glacial Till)

FIG No 3

W P 33-76-03

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. CTU = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

SS SPLIT SPOON
WS WASH SAMPLE
ST SLOTTED TUBE SAMPLE
BS BLOCK SAMPLE
CS CHUNK SAMPLE
TW THINWALL OPEN
TP THINWALL PISTON
OS OSTERBERG SAMPLE
FS FOIL SAMPLE
RC ROCK CORE
PH T.W. ADVANCED HYDRAULICALLY
PM T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $\frac{w_P - w_S}{w_L - w_S}$
 I_L LIQUIDITY INDEX = $\frac{w - w_S}{w_L - w_S}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w_P}{w_L - w_S}$
 A_c ACTIVITY = $\frac{I_P}{w_L - w_P}$
 OM ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

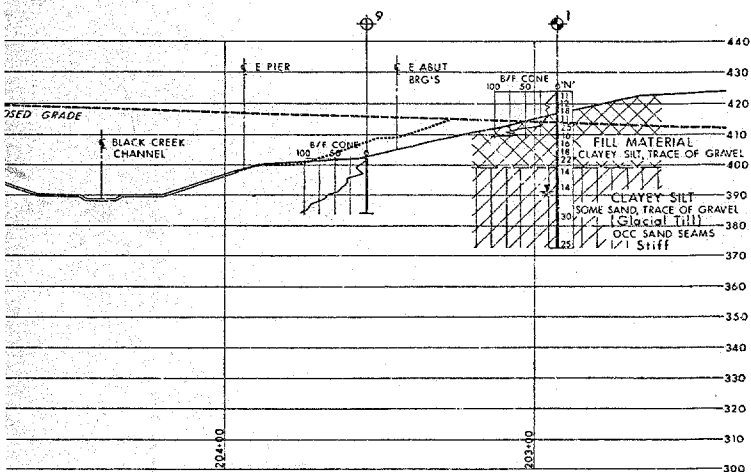
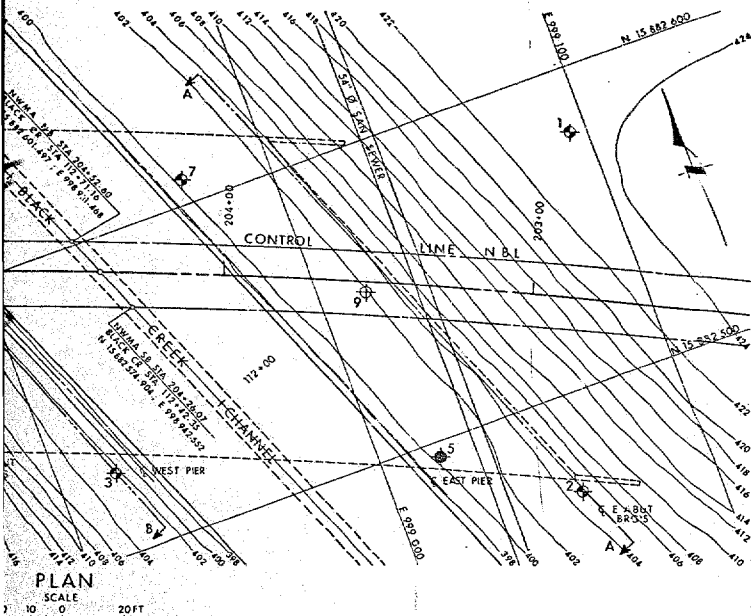
STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_F PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 σ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ'_1 = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 α_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 x_d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_c OVERCONSOLIDATION RATIO (OCR)



HWEST METRO ARTERIAL
SCALE
0 10 0 20 FT

CONT No
WP No 33-76-03



NORTHWEST METRO ARTERIAL BRIDGE
OVER BLACK CREEK CHANNEL
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- "N" Blows/ft (Std. Pen Test, 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- ↓ WL at time of investigation
- WL for BH#1, Aug 1977
- WL Not Established in BH#6

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	424.1	15 882 579	999 095
2	404.7	15 882 469	999 058
3	403.8	15 882 526	998 919
5	401.7	15 882 495	999 019
6	425.7	15 882 652	998 801
7	401.7	15 882 608	998 972
9	402.0	15 882 553	999 015
10	402.0	15 882 607	998 887
14	397.0	15 882 670	998 916

-NOTE-

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

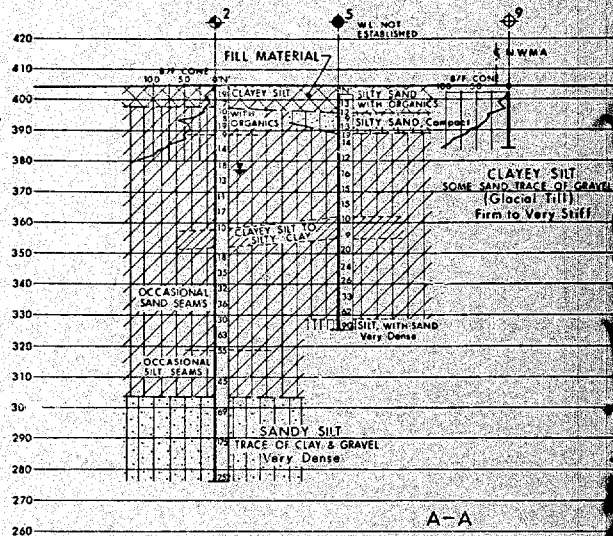
Geocres No 30M11-177

HWST No Prop NWMA

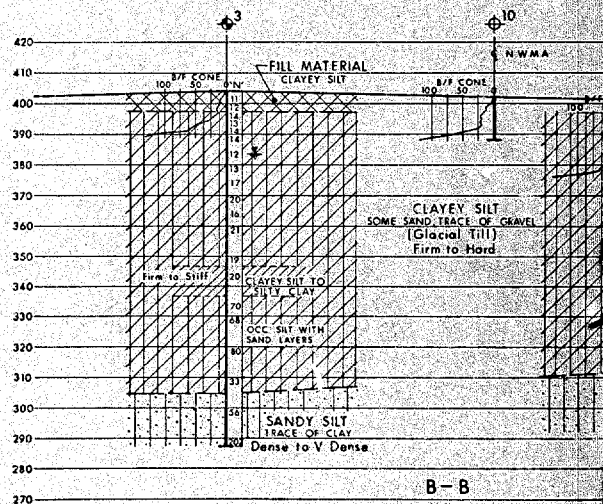
DESIGNED BY: CHECKED BY: DATE: June 2, 1978

DRAWN BY: CHECKED BY: DATE: 37-1053

CWD 337603-A



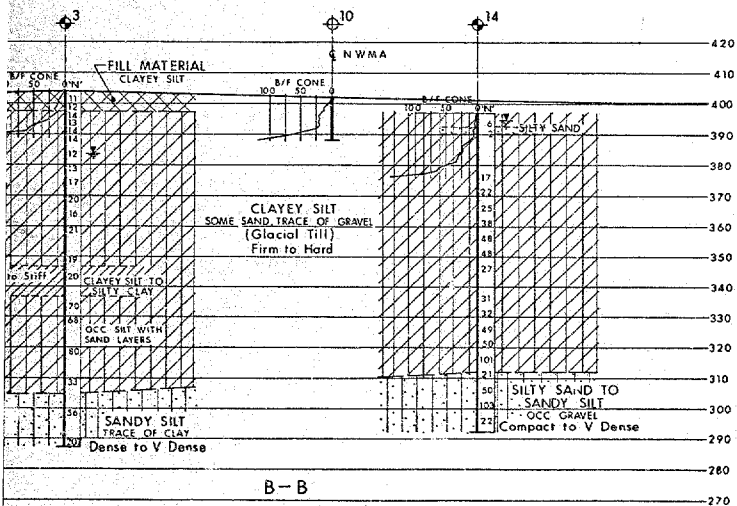
A-A



B-B

SECTIONS

SCALE
20 10 0 20 FT



SECTIONS

SCALE
20 10 0 20 FT

CONT No
WP No 33-76-03

**NORTHWEST METRO ARTERIAL BRIDGE
OVER BLACK CREEK CHANNEL
SECTIONS & SOIL STRATA**

SHEET

SEE DWG 337603-A

KEY PLAN

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊗ Bore Hole & Cone
- N Blows/ft (Std Pen-Test 350ft lbs energy)
- CONE Blows/ft (60° Cone, 350ft lbs energy)
- ↓ WL at time of investigation
- April and May 1978
- WL for BH#14 Feb 1965
- WL Not Established in BH#5

[illegible]

-NOTE-

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

[illegible]

Geocras No 30M11-177

HWY & Prop NWMA	DIST 6
SUBMITTAL CHECKED DATE June 8, 1978	STE 37-1055
DRAWN CHECKED	DWG 337603-8

SEND
TOFred Bennitz, Const. Super
Contract No. 78-99

FROM

BRANCH

DATE

SUBJECT

Tom Kazmierowski Soil Mechanics Section March 21/79.
West Abutment and West Pier, N.W.M.A. Bridge
and NS-E Ramp over Black Creek.

Please find attached our recommendations
regarding pile driving operations at the
above mentioned locations.

REPLY

REPLY FROM

REPLY DATE

RECOMMENDED PILE DRIVING PROCEDURE FOR
WEST ABUTMENT AND WEST PIERS, NWMA
BRIDGE AND RAMP NS-E OVER BLACK CREEK.
CONTRACT NO. 78-99

WEST ABUTMENT

i) all piles for west abutments of both structures should be preaugered for the depth of the fill (10 to 15 feet) using a 12" ϕ auger.

ii) Driving Criteria: drive a 50 ft. long inspected timber pile meeting CSA specs. using a D-12 hammer to 50 feet or to a minimum depth of 35 feet and minimum set for the last 3 feet of driving of 70 blows/foot.

iii) complete pile driving records should be maintained during driving operations, and a copy forwarded to the Soil Mechanics Section.

It is anticipated that the timber piles will penetrate approx. 40 feet on the north end of the abutment, with full penetration in the south half of the abutment.

West Pier

i) all piles should be driven according to the driving criteria previously mentioned. These piles should also be monitored during driving operations.

ii) preaugering is not required for the west pier piles.

It is anticipated that piles driven for the west pier should penetrate to the design tip elevation.

SEND
TOFRED BENNITZ, CONST. SUPER
CONTRACT No. 78-99

FROM

Tom KAZMIEROWSKI

BRANCH

SOIL MECHANICS SECTION

DATE

MAR. 14/79

SUBJECT

Pile Driving for East Abutment N.W.M.A. Ramp NS-E.
OVER BLACK CREEK

As per your urgent request of Mar. 14/79, please find attached our recommendations regarding the pile driving operations for the above mentioned location, based on the field information you forwarded to us. A formal memorandum including these and other recommendations pertaining to the N.W.M.A. Bridge over Black Creek will be forwarded to you in the near future.

REPLY

REPLY FROM

REPLY DATE

RECOMMENDED PILE DRIVING PROCEDURE FOR EAST ABUTMENT N.W.M.A. RAMP OVER BLACK CR. CONTRACT # 78-99.

Pile No.	Pile Driving Details as supplied by field Const. Staff	Recommendations
16	- driven to 30' @ 98 blows/ft - top mushroomed.	- cutoff to required elev. and leave.
12	- driven to 36' @ 75 blows/ft - began to slant north	- cutoff existing pile - preauger through fill ($\approx 10'$) and redrive new pile according to driving criteria.
11	- refusal at 10' depth @ 200 blows/ft.	- attempt to pull-out pile otherwise cutoff - preauger through fill ($\approx 15'$) and drive replacement pile to driving criteria.
15	- pile slanted to south at 37' depth @ 60 blows/ft	- cutoff existing pile - preauger north of existing pile for depth of fill ($\approx 10'$) and drive replacement pile to driving criteria.
9	- driven to 46' - top of pile crushing	- cutoff crushed portion to required elev. and leave
2	- broke at 20'	} - cutoff existing pile - preauger $\approx 15'$ to south of existing piles and drive replacement piles to refusal criteria.
18	- broke at $18\frac{1}{2}'$	

DRIVING CRITERIA: - drive an inspected timber pile meeting CSA specifications using a D-12 hammer to 50 feet or to a minimum depth of 35 feet and minimum set for the last 3 feet of driving of 70 blows/foot. Preaugering should be done using a 12" ϕ auger.

Pile 16 - 98 B/FT AT 30', TOP mushrooming
 - ① cut off and leave

Pile 12 - 75 B/FT AT 36', start to slant north.
 ① cut off existing pile
 ② auger and redrive new pile beside existing to min. 35' and min 70 B/FT.

Pile 11 - refusal at 10', 200 B/FT.
 ① attempt to pull-out pile (otherwise cut off)
 ② auger to 15 ft. beside pile #11 and drive pile to refusal criteria

Pile 15 - pile slanted to south at 37' @ 60 B/FT.
 ① cut off existing pile
 ② auger to north of existing pile for 10 ft and drive pile to refusal criteria.

Pile 9 - refusal at 46', top of pile crushing.
 ① cutoff crushed portion and leave.

Pile 2 - broke at 20'
 ① cut off existing pile
 ② auger to 15' to south of existing and drive new pile to refusal criteria.

Pile 18 - broke at 18.5'
 ① cutoff existing pile
 ② auger to 15' to south of existing and drive new pile to refusal criteria.

Refusal Criteria: Driving an inspected timber pile meeting CSA specs. to a minimum depth of 35 feet and min 70 blows/ft. for last 3 feet with a D-12 hammer.

SEND
TO

Mr. T. J. Korich
Head, Materials and Lab Services
Section

FROM

M. Devata, Soil Mechanics Section

BRANCH

DATE

79 04 02

SUBJECT

Timber Piles, Cont 76-99,

- We had the benefit of reading the ~~to~~ memoranda prepared by your Mr J. D. Henton one on 79 03 12 ^{to you} and the other to Mr D. A. MacDonald on the same date. There will be a claim on this project and without knowing the facts such as Sub-soil conditions, Pile driving equipment, ^{details} etc he should not have made such comments. Dornier Co. Fenton agreed themselves that the piles were not the best quality. A copy of the letter is enclosed for your information. I am sure you will agree with me that we should not prejudice this claim ~~without~~ knowing the facts. We are also enclosing some of our comments.

REPLY

REPLY FROM

REPLY DATE

In reference to letter
by Mr. J.D. Heaton,
dated 79-03-12.

- ① erroneous to state that most piles broke at the 20' → 30' level:
 - ≈ 7 piles broke @ 0 → 10' depth
 - ≈ 3 piles broke @ 11' - 20'
 - ≈ 4 piles broke @ 21' - 30'
 - ≈ 4 piles broke @ 31' - 40'
 - ≈ 2 piles broke @ 41' - 50'
- As of March 16/79.

② Generally, visible failures appeared to be distinct lateral breaks, not telescopic in nature

③ A good number of piles were rejected for not meeting CS4 specs (approx. 15+ piles)

④ "Justification why sub-soil types not compatible with wood pile driving".

⑤ Contractor is using a diesel hammer, not a steam driven hammer as stated in letter

⑥ What does he base his observation on that "the pile driver contractor appears to be doing the best job possible under the circumstances"

⑦ Under what basis does he think "the sub-soil conditions have changed or are different to what was envisaged."

3380 Airway Drive, Mississauga, Ontario L4V 1N7
(416) 677-7030

March 14, 1979

Mr. Donald A. MacDonald
Area Construction Engineer
Ministry of Transport and Communications
3501 Dufferin St.
Downsview, Ontario
M3K 1N6

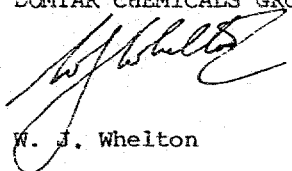
Dear Mr. MacDonald

Further to our meeting on March 5, 1979, we checked the approximately 120 pieces of treated piling at the Maple Leaf Drive site and found thirteen pieces which were not up to specifications. The pieces in question were identified for Mike Wannamaker, who was with us during the inspection period, and will be replaced.

From our discussion and my own observations, it seemed likely that there was a problem with the pile driving equipment. I passed this thought along and we understand that a D:12 was put into action last Friday. The new hammer was working well when I visited the site on Monday and the piles were not breaking.

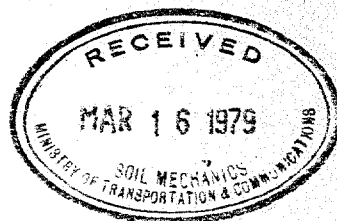
The writer will stay in touch with you regarding this matter. We appreciate your time and courtesy.

Yours truly
DOMTAR CHEMICALS GROUP


W. J. Whelton

cc: Murty Devata
Soil Mechanics Section
Ministry of Transportation & Communications

WJW:SC



Mr. T. J. Kovich,
Head,
Materials & Lab. Services Section.

Chemicals & Metals Unit

1979 03 12

3162-2-2-331

Pressure Creosoted Timber Piles
Contract 78-99

LOCATION: Northwest Metro Arterial Road
P. C. 4864 and 4501

SUPPLIER: Domtar Co., Trenton

✓ CONTRACTOR: Raney Tari Co.

A meeting was held at the construction site office on 79 03 05. Three Domtar representatives and 10 MTC personnel were present. The meeting was called to discuss the cause of pile breakage incurred during pile driving.

At first the contractor used a light hammer and 5 out of 18 piles broke. A heavier hammer was brought in and there were less breakages but the pile driving appears not to be a normal operation. The piles have to be very carefully driven in for the first 10' or so, and not much power can be used because all the piles could be broken if the full capacity of the hammer was used. Most broken piles broke at the 20'-30' level but some breakages occurred at 10'. The failures seem to be of telescopic nature. The original straightness of the piles does not seem to be a factor. Straight piles have been broken. Defects such as knot clusters does not seem to be a cause because some of the fractured surfaces are free of defects. There were a few piles out of spec* delivered to the contract site, e.g., (1) top diameter 7" - 8", (2) slight excessive sweep.

It was felt that the breakages could be caused by -

- (1) Sub-soil conditions not compatible with wood pile driving. Problems in this area cannot be ruled out.
- (2) Defective wood piles.
The inference is that most of the piles conform to the CSA Standard 056-1962.
- (3) Poor pile driving technique.
The contractor is using a steam driven hammer. Normally a diesel powered hammer is used.

Observations

- (1) It has been agreed that Laboratory Services will arrange to have the remaining 350 approx. piles inspected at Dornier's yard in Trenton before shipping. Dornier will sample the damaged piles and have them tested at their Montreal Lab. If defective piles can be ruled out, only the two other reasons for breakages will remain. inspected
7/15/80
- (2) The pile driver contractor appears to be doing the best job possible in the circumstances.
- (3) Although the Ministry has probably performed a thorough soil study of the foundation area, I think the sub-soil conditions have changed or are different to what was envisaged. how?

J. D. Heaton
J. D. Heaton,
Inspector, Miscellaneous Products,
Chemicals and Metals Unit.

JDH:ma

*In 1975 or 1976, Mr. McDonald called John and requested that he
do some [compression and] tests. After the test was done,
he was some [testing in various agencies] and for the Taylor of [something]
Research. He then [something] Taylor, explained what happened at the
construction site and asked Taylor to get in touch with D. McDonald.
John will do the necessary follow-up to see what [something] is going to be done.*
JH

Mr. D. A. MacDonald,
Area Construction Engineer,
Central Region.

Engineering Materials Office,
Mat'ls. & Lab. Services Section.

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Further to our meeting of 79 03 05, we have visited Domtar's treating plant in Trenton and have inspected their stock of treated piles. Although the piles were stocked in such a way that every piece could not be checked, we are sure that almost all the piles in stock meet the CSA Standard 056. The butt and tip diameter appeared to be all within tolerances, also the sweep when present appeared to be all within tolerances. Only one piece was found with a structural defect and this was caused by poor fork lift truck handling. A 3" deep section had been gouged out. This pile would probably have been culled by Domtar at the time of loading shipment.

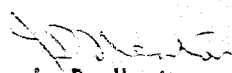
We examined the plant's timber treating records and found the quality control to be good. Some charges required a second treatment because the penetration was less than $2\frac{1}{2}$ ", but a typical treatment result for 50' Red Pine Pressure Creosoted Timber Piles was -

Charge No. 0512 Dated 78 11 01

Retention 8 lbs./cub.ft. (Spec. 8 lbs./cub. ft. min.)

Penetration $2\frac{1}{2}$ " ($2\frac{1}{2}$ " minimum)

Arrangements have been made with our Eastern Region Inspector to be present at the time of loading of shipments at which time other piles can be culled if found necessary.


J. D. Heaton,
Inspector,
Miscellaneous,
Chemicals & Metals Unit

JDH/mm

Contract Meeting

Contract 78-99



PLACE: 108 Maple Leaf Drive

DATE: March 5, 1979

PRESENT: W. Whelton
K. Carley
L. Nelson

Domtar

D. MacDonald
S. Dunham
K. Carter
K. Luczka
J. Kuprevicius
J. Heaton
M. Devata
T. Kazmierowski
M. Wanamaker
F. Bennitz

M.T.C.

Mr. Dunham explained the problems the contractor was having with the piles breaking and that a number of the piles supplied by Domtar not meeting the specifications.

Mr. Devata explained why wooden piles were being used on this contract and that no previous problems had been encountered using wooden piles in the structures built in the area. He also noted that there were a number of shakes and scattered longitudinal cracks in many of the piles that had been supplied on this contract

Mr. MacDonald asked Mr. Whelton what quality control checks were carried out on the timber piles. Mr. Whelton said that after the bark is removed the piles are checked for sweep, shakes and condition of the piles. No checks are made after the piles are creosoted.

Mr. Heaton will have someone from the Kingston Region check on the remaining piles for this contract before they are shipped.

Mr. Whelton said he would look at the piles that are on the contract now and will also check the remaining piles before they are shipped. He said that they have sufficient piles in stock to replace the broken ones.

It was mentioned that the defective piles on the job site will be sorted out and only the piles that appear good will be used.

FB:ja

F. Bennitz
Project Supervisor

Handwritten initials

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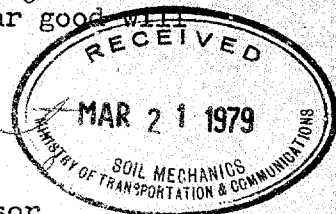
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F. Bennitz
Project Supervisor



ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 33-76-03

DIST 6

HWY NWMA

STR SITE 37-1055

Black Creek Bridge
East of Jane Street

DISTRIBUTION

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R. Fitzgibbon)
J. Anderson) cover only
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SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	Dec 1, 1977	BL
TUBES	Dec 1, 1977	BL
ROCK CORFS		

FOUNDATION INVESTIGATION REPORT
For

Black Creek Bridge
East of Jane Street
W.P. 33-76-03, Site 37-1055
District 6, Toronto, NWMA

INTRODUCTION

This report presents subsurface data and geotechnical recommendations for preliminary studies of this project. At the present time, the design concepts of this project have not yet been finalized.

The subsurface information presented in this report includes the results of a foundation investigation done during February 1965 for the feasibility study of this project, and those of a supplementary investigation carried out recently in August 1977. The fieldwork done for the feasibility study consisted of a sampled borehole advanced by wash-boring techniques to a depth of 105 ft. In the recent supplementary investigation, a sampled borehole was advanced by means of hollow stem augers to a depth of 51 ft.

SUBSURFACE CONDITIONS

The site is covered with a layer of fill. Underlying the fill is a stratum of clayey silt, which is followed by a deposit of silty sand. The various soil strata are described as follows:

Fill

Earthfill has been placed at this site on either side of relocated Black Creek Channel along the proposed alignment of Northwest Metro Arterial (NWMA). This earthfill is composed mainly of clayey silt with a trace of gravel, and has a thickness in the order of 25 ft. The 'N' values of the Standard Penetration Test range from 11 blows/ft. to 25 blows/ft. indicating that the fill was relatively well compacted.

Clayey Silt

Underlying the fill material, or below ground surface elsewhere, is a stratum of clayey silt with sand and gravel. This stratum is about 85 ft. thick. Within this deposit, there are occasional thin layers or seams

of silty sand. Typical identity indices of the clayey silt are tabulated below:

<u>Identity Indices</u>	<u>Ranges</u>
Natural Moisture Content (W) %	9 - 22
Plasticity Limit (W _p) %	10 - 23
Liquid Limit (W _L) %	17 - 32

An unconfined compression test gave an undrained shear strength of the clayey silt in the order of 1300 psf.; whereas, field vane tests yielded an in-situ undrained shear strength in excess of 2000 psf. Based on these results, together with 'N' value of 15 blows/ft. to 50 blows/ft., the consistency of the clayey silt is assessed as stiff to very stiff.

Silty Sand

Below the clayey silt deposit is a stratum of silty sand. This granular stratum was investigated to a depth of 20 ft. The silty sand also contains a trace of gravel. The 'N' values of the Standard Penetration Test range from 20 blows/ft. to in excess of 100 blows/ft. The relative density of this granular deposit, inferred from these 'N' values, varies from compact to very dense.

Groundwater Conditions

The groundwater level at this site was found to be at elevation 393. approximately, which corresponds to the water level in the Black Creek.

RECOMMENDATIONS

A structure is proposed to carry the Northwest Metro Arterial over the relocated Black Creek. The length, number of spans, and footing locations of the structure however, have not yet been finalized. As a result of this, the following recommendations are considered for preliminary studies only, and may be subjected to revision when the structural scheme is finalized.

Structure Foundations

Shallow footing is not practicable because of the presence of fill material at the structure location. In this regard, the structure should be supported on piles. It is, therefore, recommended that the structure be supported on #14 timber friction piles. The safe bearing capacity of such piles can be estimated from:

$$P \text{ (tons)} = 0.6 \text{ (tons/ft.)} \times L \text{ (ft.)}$$

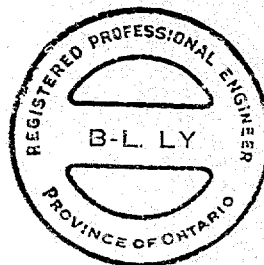
Settlement of the piles foundations under this loading should not exceed 1 inch. The underside of the pile cap should have a minimum 4ft. of earth cover for frost protection purposes. No major dewatering difficulties are anticipated for excavations of the pile caps as the clayey silt is relatively impervious. Seepage into the excavation can be removed by pumping from sumps.

Approaches

The profile grade of the proposed NWMA will require a cut on the east side of the relocated Black Creek up to 16 ft. deep. This cut will be stable if the cut slopes are constructed not steeper than 2:1.

B. Ly

B. Ly, P. Eng.
Senior Engineer



M. Devata
M. Devata, P. Eng.
Supervising Engineer

APPENDIX

RECORD OF BOREHOLE No 1

J 882,578 6989,100

W P 33-76-03

LOCATION Co-ords. N 15862124 E 289450

ORIGINATED BY J.N.

DIST 6 HWY N-W M A Rd BOREHOLE TYPE Hollow Stem Auger & Dynamic Cone Test

COMPILED BY J.N.

DATUM Geodetic DATE August 22, 1977

CHECKED BY EL

SOIL PROFILE

SAMPLES

GROUND WATER
CONDITIONS

ELEVATION SCALE

DYNAMIC CONE PENETRATION
RESISTANCE PLOT

20 40 60 80 100

SHEAR STRENGTH

○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL x LAB VANEPLASTIC LIMIT
W_p NATURAL
MOISTURE
CONTENT
W

WATER CONTENT (%)

10 20 30

UNIT WEIGHT
γREMARKS
&
GRAIN SIZE
DISTRIBUTION
(%)

GR SA SI CL

424.1 Ground Level

0.00 Fill

Clayey Silt
Trace of Gravel

Uniformly Compacted

399.1

25.0

Heterogeneous
Mixture Clayey Silt
Some Sand and Trace
of Gravel With
Occasional Sand
Seams

Stiff

372.6

51.5 End of Borehole

STRAT	PLOT	NUMBER	TYPE	'N' VALUES
		1	SS	11
		2	SS	12
		3	SS	18
		4	SS	11
		5	SS	25
		6	SS	16
		7	SS	16
		8	SS	18
		9	SS	22
		10	SS	14
		11	SS	14
		12	TW	PH
		13	SS	30
		14	TW	PH
		15	SS	25

420

410

400

390

380

106/6"

+> 2000

+³, x⁵: Numbers refer to
Sensitivity20
15
10
5
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14

(formerly job 65-F-40)

W P 33-76-03

LOCATION Co-ords. N 15 882 670 E 999 916

ORIGINATED BY H.S.

DIST 6 HWY N-W M A Rd

BOREHOLE TYPE Washboring & Cone Test

COMPILED BY H.S.

DATUM Geodetic

DATE February 2, 1965

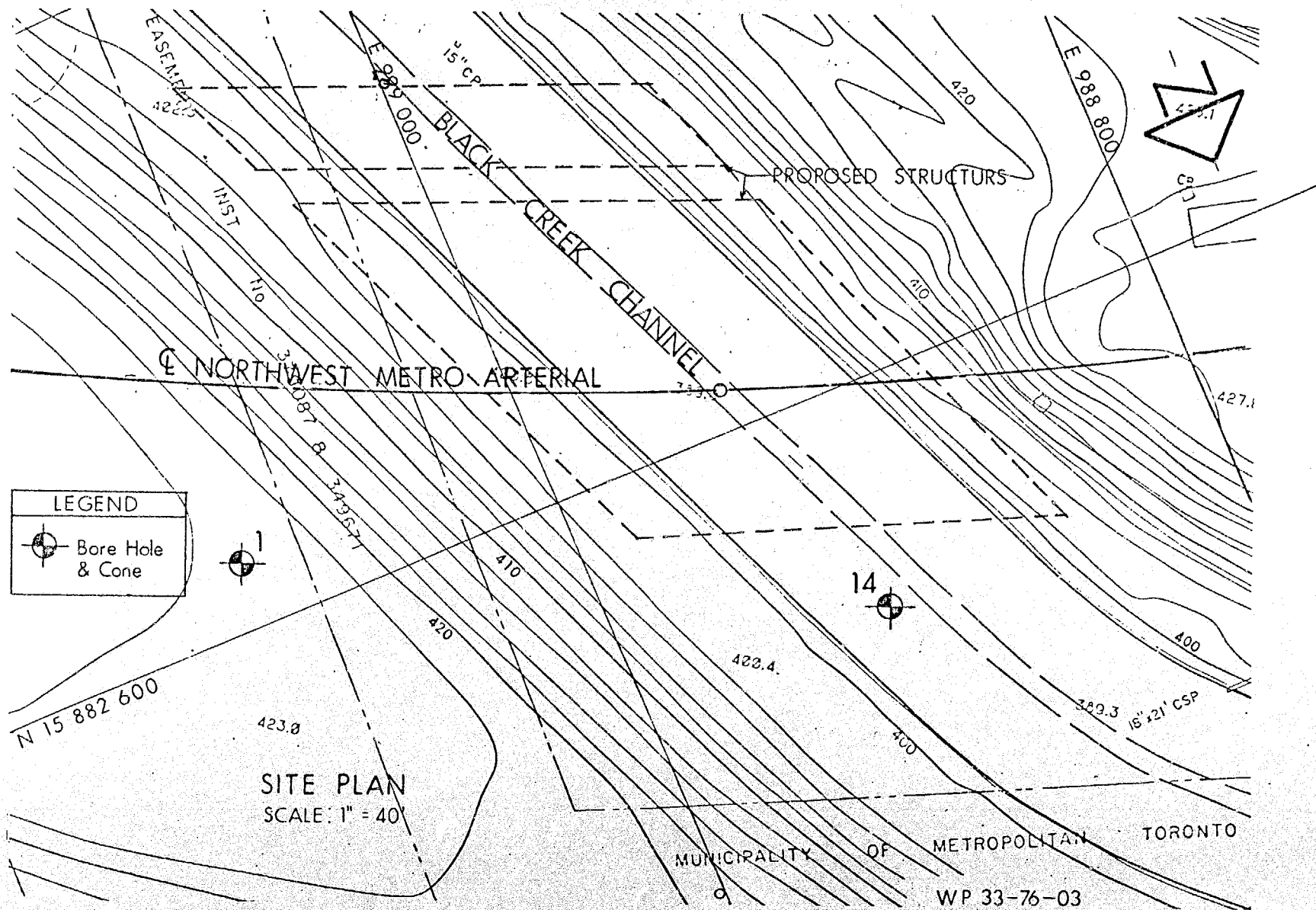
CHECKED BY M.D.

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
397.0	Ground Level													
	Silty Sand		1	SS	6									
			2	SS	2									
			3	TW	PH									
			4	TW	PH									
			5	TW	PH									
			6	SS	17									
			7	SS	22									
	Clayey Silt With Sand and Occ. Gravel		8	SS	25									
			9	SS	38									
			10	SS	48									
			11	SS	48									
			12	SS	27									
			13	TW	PH									
			14	SS	31									
			15	SS	32									
			16	SS	49									
			17	SS	50									
			18	SS	101									
312.0			19	SS	21									
85.0	Silty Sand With Occ. Gravel.		20	SS	50									
	Compact to Very Dense		21	SS	103									
			22	SS	22									
292.0														
105.0	End of Borehole													

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

1 40 53 6



EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	DE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. CIU = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

SS SPLIT SPOON
WS WASH SAMPLE
ST SLOTTED TUBE SAMPLE
BS BLOCK SAMPLE
CS CHUNK SAMPLE
TN THINWALL OPEN
TF THINWALL PISTON
OS OSTERBERG SAMPLE
FS FOIL SAMPLE
RC ROCK CORE
FH T.W. ADVANCED HYDRAULICALLY
PM T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_a COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_p COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N, N_c, N_q BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
 I_c CONSISTENCY INDEX = $\frac{w_p - w}{I_p}$
 A_c ACTIVITY = $\frac{I_c}{I_p}$ of soil
 O_m ORGANIC MATTER CONTENT
 S_z DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_F PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 S_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 n, n_c STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 e_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 σ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

PLANTING AND GROWING INFORMATION

GEOCRES No. 36-111-177

DIST 1 REGION CENTRAL

W.P. No. 35-176-03

CONT. No. 78-00

W. O. No. _____

STR. SITE No. 37-1885

HWY No. _____

LOCATION NORTHWEST METER ACTUAL DOSE

OVER BLACK FREE CHANNEL

