

G.I.-30 SEPT. 1976

REMARKS: _____

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 80 - 32



Ministry of
Transportation and
Communications



INDEX

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3- 9	Foundation Investigation Report'
	Graham Creek Bridge
	W.P. 129-67-01, Site 21-189
	Hwy. 2, District 7, Port Hope

NOTE: For purposes of the contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above mentioned project.

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 FI-LE 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	MCD. 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. $\bar{C}\bar{U}$ - CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M 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, N_{γ} 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
 C_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 = $\frac{w - w_P}{w_L - w_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{w_L - w_P}$
 A_c ACTIVITY = $\frac{I_P}{w_L - w_P}$ Soil Fraction
 O_m 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

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
 m_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:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

FOUNDATION INVESTIGATION REPORT

For

Graham Creek Bridge
W.P. 129-67-01, Site 21-189
Hwy. 2, District 7, Port Hope

INTRODUCTION

This report updates the results of a foundation investigation carried out during the period from August 28 to 31, 1967 at the above mentioned site. The fieldwork consisted of two sampled boreholes accompanied by dynamic cone penetration tests, plus one individual cone test. The boreholes were advanced by means of a conventional diamond drill adapted for soil sampling purposes to depths ranging from 30 to 35 feet below ground surface. This fieldwork carried out for the initial structure replacement scheme sufficiently covers the present replacement proposal, consequently, no additional investigation was required.

SITE DESCRIPTION AND GEOLOGY

The site is located on the existing Hwy. 2 alignment at the eastern limits of the Town of Newcastle in the Township of Clarke, County of Durham.

The existing structure at the crossing of Hwy. 2 and Graham Creek is a 31' x 7.5' x 33' single span concrete structure.

The topography of the site is undulating, with land use in the vicinity generally utilized for growing cash crops.

The site is located in the physiographic region known as the Iroquois Plains, those lowlands bordering Lake Ontario which were inundated in the late Pleistocene times by Lake Iroquois. The plain in this area is characterized by a mosaic of till plains, drumlins and areas of silty and sandy lacustrine deposits.

SUBSURFACE CONDITIONS

General

An extensive deposit of glacial till explored to a maximum depth of 35 feet was found to underly the site. The details of soil type and groundwater conditions are shown on the attached Record of Borehole Sheets.

The location and elevation of the boreholes, as well as the estimated stratigraphical profile, are shown on Contract Drawing 21-189-2.

Glacial Till

The predominate deposit encountered was a glacial till consisting of a heterogeneous mixture of clayey silt, sand and gravel explored to depths ranging from 30 to 35 feet. Occasional cobbles and boulders in the order of 6 to 9 inches were encountered in the upper 10 feet of one of the borings. Results of grain size distribution testing on representative samples of this deposit are plotted on Figure 1. The 'N' values from the Standard Penetration Test carried out in this material range from 15 blows/foot to greater than 100 blows/foot, but generally in excess of 100 blows/foot, indicating a hard consistency.

Groundwater

Groundwater levels taken during the time of the field investigation were found at depths of 0.3 feet and 4.8 feet corresponding to elevations 298.2 and 299.4 respectively. These generally reflected the upstream and downstream water levels of Graham Creek.

M. Mackean
for

T. Kazmierowski
Project Foundations Engineer

M. Devata

M. Devata
Senior Foundations Engineer

APPENDIX



RECORD OF BOREHOLE No 1

W P 129-67-01 LOCATION Sta. 246+90, 30.6' Lt. ORIGINATED BY DK
 DIST 7 HWY 2 BOREHOLE TYPE Washboring and Cone Test COMPILED BY DK
 DATUM Geodetic DATE August 29 & 30, 1967 CHECKED BY W.S.

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			
304.2	Ground Level														GR SA SI CL
0.0	Glacial Till Grey		1	SS	75		300								
			2	SS	56										
			3	SS	80/	1"									
			4	SS	100/	4"	290								
	Heterogeneous Mixture of Sand, Silt, Clay and Gravel With Occasional Boulders		5	SS	50/	1"									
			6	SS	100/	4"									
	Hard		7	SS	100/	4"	280								
			8	SS	150/	6"									
269.0			9	SS	100/	3"									
35.2	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2

W P 129-67-01 LOCATION Sta. 247+38.5 42' Rt. ORIGINATED BY DK
DIST 7 HWY 2 BOREHOLE TYPE Washboring and Cone Test COMPILED BY DK
DATUM Geodetic DATE August 31 and September 1, 1967 CHECKED BY C.J.

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			20 40 60 80 100						
298.5	Ground Level													
0.0	Glacial Till		1	SS	166									
	Heterogeneous Mixture of Sand Silt, Clay and Gravel		2	SS	100									
			3	SS	100/	3"	290							
	Grey		4	SS	100									
	Hard		5	SS	100/	3"								
			6	SS	100/	6"	280							
			7	SS	100/	4"								
268.0			8	SS	100/	2"	270							
30.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

W P 129-67-01 LOCATION Sta. 246+99 36' Rt. ORIGINATED BY DK
DIST 7 HWY 2 BOREHOLE TYPE Cone Test COMPILED BY DK
DATUM Geodetic DATE September 1, 1967 CHECKED BY e.j.

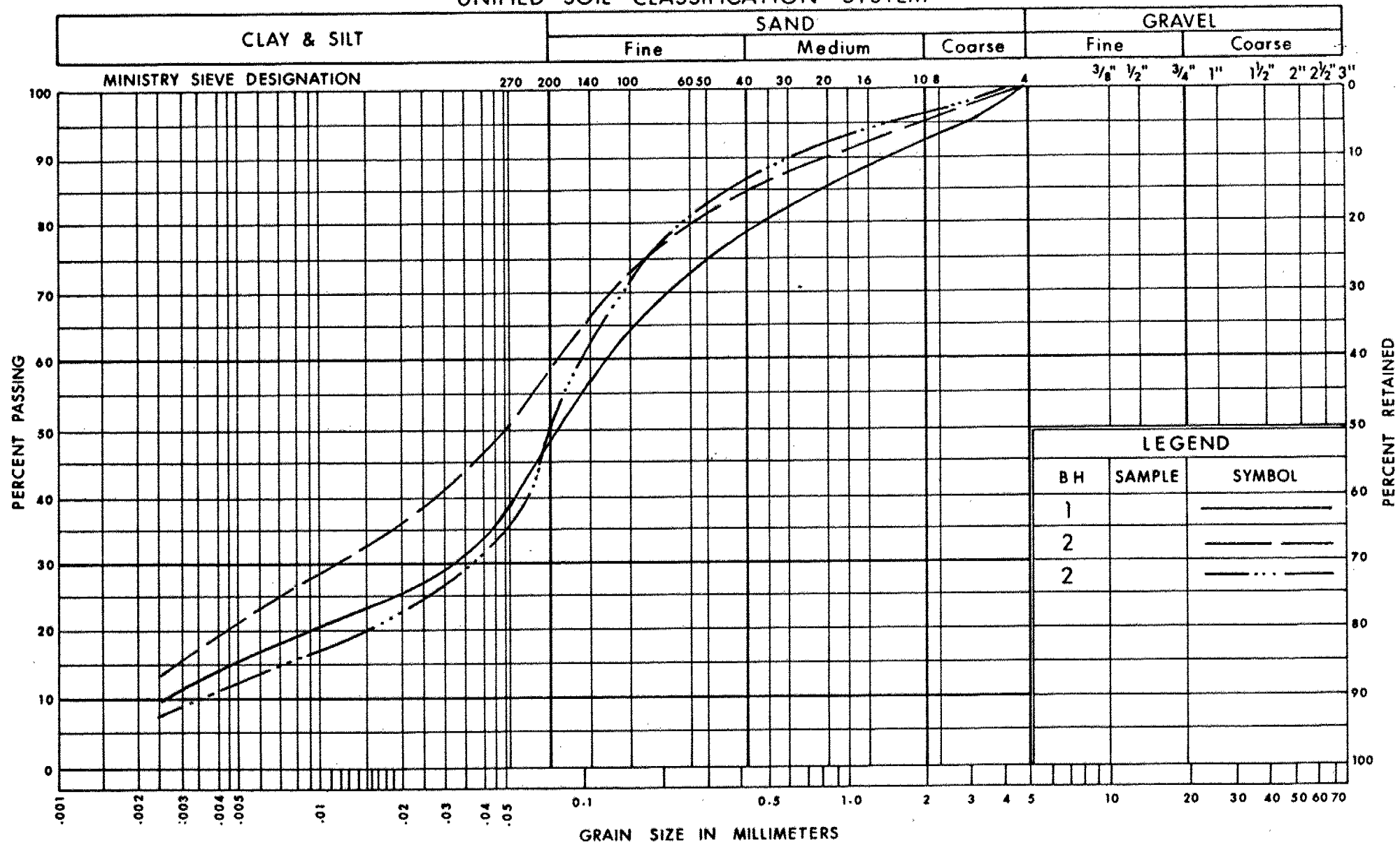
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
302.4							300						
0.0													
294.4													
8.0	End of Cone Test						290						

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 129-67-01 DIST 7
HWY 2 STR SITE 21-189
Graham Creek Bridge

DISTRIBUTION

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R.S. Pillar

R. Hore

R. Fitzgibbon)
J. Anderson) cover only
G. Sloan)

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SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	79 01 31	M.A.
TUBES	—	—
ROCK CORES	—	—

FOUNDATION INVESTIGATION REPORT

For

Graham Creek Bridge

W.P. 129-67-01, Site 21-189

Hwy. 2, District 7, Port Hope

INTRODUCTION

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General

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The location and elevation of the boreholes, as well as the estimated stratigraphical profile, are shown on Drawing No. 1296701-A.

Glacial Till

The predominate deposit encountered was a glacial till consisting of a heterogeneous mixture of clayey silt, sand and gravel explored to depths ranging from 30 to 35 feet. Occasional cobbles and boulders in the order of 6 to 9 inches were encountered in the upper 10 feet of one of the borings. Results of grain size distribution testing on representative samples of this deposit are plotted on Figure 1. The 'N' values from the Standard Penetration Test carried out in this material range from 15 blows/foot to greater than 100 blows/foot, but generally in excess of 100 blows/foot, indicating a hard consistency.

Groundwater

Groundwater levels taken during the time of the field investigation were found at depths of 0.3 feet and 4.8 feet corresponding to elevations 298.2 and 299.4 respectively. These generally reflected the upstream and downstream water levels of Graham Creek.

DISCUSSION AND RECOMMENDATIONS

Due to the deteriorating structural condition of the existing bridge, it is proposed to replace the present Graham Creek structure with a new 50' span concrete structure. A proposed creek diversion would result in the new structure being located approximately 45 feet west of the existing crossing. No change is anticipated in the horizontal alignment of Hwy. 2, however, the new profile grade will be approximately 4 feet higher than the present highway.

Structure Foundations

In view of the uniform deposit of competent glacial till underlying the site, it is recommended that the abutments for the proposed single span structure be founded on spread footings in the hard glacial till stratum at or below elevation 295 or perched on a core of well compacted Granular 'A'. A safe bearing capacity of 3 t.s.f. may be assumed for design purpose.

In order to prevent the softening of foundation base 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 immediately upon excavation.

For frost protection purposes the underside of the footings should have a minimum of 4 feet of earth cover and have a minimum of 10 feet horizontal distance from bottom edge of footing to embankment slope face.

No major dewatering difficulties are anticipated for excavations of abutment footings due to the relatively low permeability of the subsoil. Local seepage into the excavation can be removed by pumping from sumps.

Approaches

No stability problems are anticipated for fill slopes constructed not steeper than 2:1.

Cut river slopes for the stream diversion constructed to $1\frac{1}{2}:1$ slopes will remain stable provided slopes are protected with rip-rap or other measures to a minimum of high water level.

For backfilling of the existing creek channel beneath the proposed east approach embankment insure that:

- 1) all soft and deleterious material is excavated within the planned limits of the embankments
- 2) well compacted granular material is used to within 1 foot above high water level.

MISCELLANEOUS

The fieldwork was performed during the period of August 28 to 31, 1967 using equipment owned and operated by Master Soil Investigation Limited under the supervision of Mr. D. Katauskas, Project Engineer.

This report was updated and written by Mr. T.J. Kazmierowski, Project Engineer and reviewed by Mr. M. Devata, Supervising Engineer.



T. J. Kazmierowski
T. J. Kazmierowski, P. Eng.
Project Engineer

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

January, 1979

APPENDIX

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 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

STRENGTH PARAMETERS

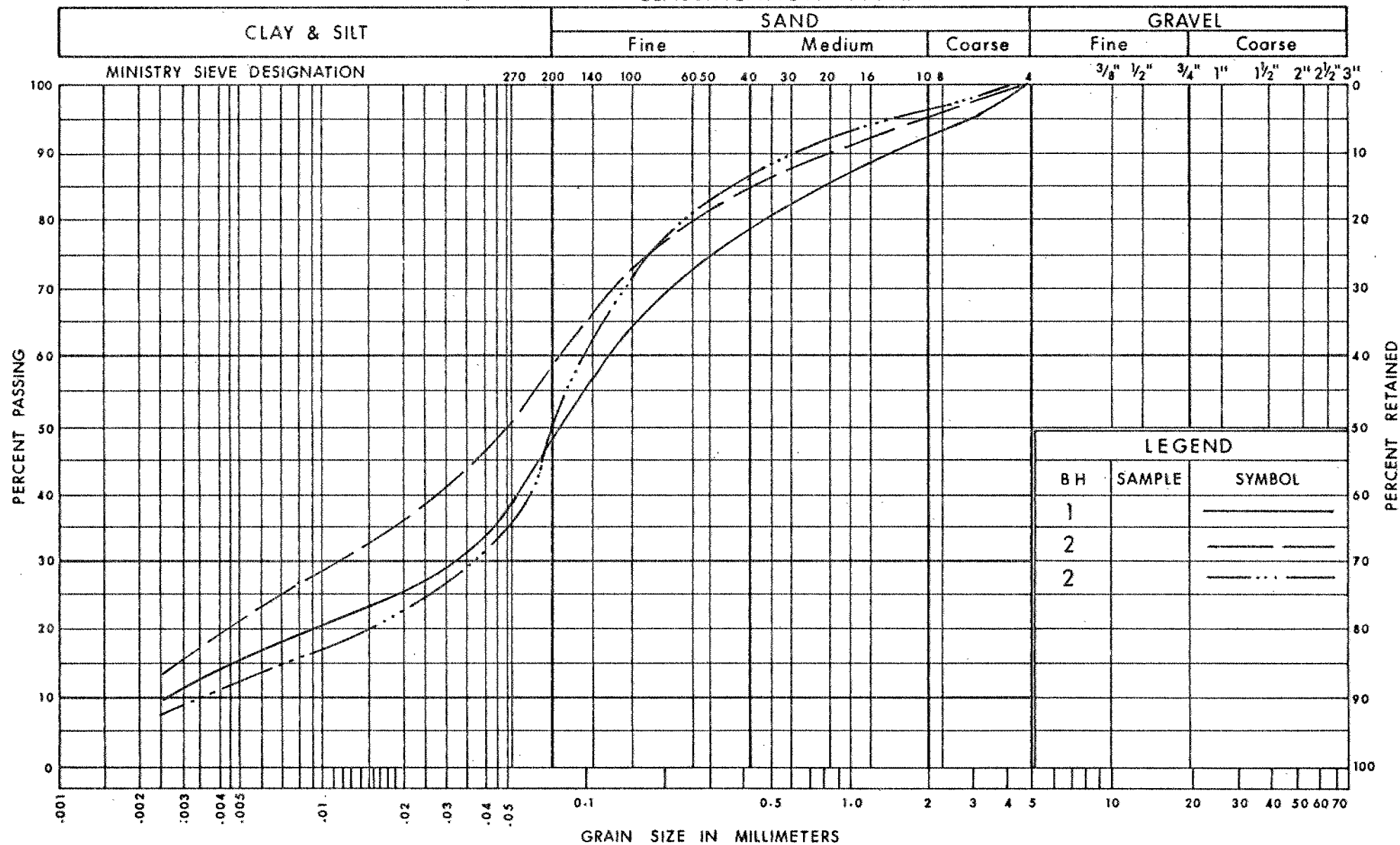
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 τ_R RESISTUAL SHEAR STRENGTH
 c COHESION INTERCEPT
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UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

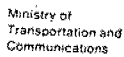
ENGINEERING SERVICES BRANCH

 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
GLACIAL TILL
HETEROGENEOUS MIXTURE OF SAND SILT CLAY & GRAVEL

FIG No 1

W P 129-67-01



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

W P 129-67-01 LOCATION Sta. 246+99 36' Rt.

ORIGINATED BY DK

DIST 7 HWY 2 BOREHOLE TYPE Cone Test

COMPILED BY DK

DATUM Geodetic DATE September 1, 1967

CHECKED BY W.L.

SOIL PROFILE						SAMPLES		ELEVATION SCALE ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	20 40 60 80 100		W_p	W	W_L	WATER CONTENT (%)		
							SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
302.4														
0.0								300						
294.4														
8.0	End of Cone Test							290						

+3, x5: Numbers refer to Sensitivity

20
15 ϕ S (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2

W P 129-67-01 LOCATION Sta. 247+38.5 42' Rt. ORIGINATED BY DK
DIST 7 HWY 2 BOREHOLE TYPE Washboring and Cone Test COMPILED BY DK
DATUM Geodetic DATE August 31 and September 1, 1967 CHECKED BY *DK*

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			20	40	60	80	100					
298.5	Ground Level																
0.0	Glacial Till		1	SS	166												
	Heterogeneous Mixture of Sand		2	SS	100												
	Silt, Clay and Gravel		3	SS	100/	3"	290										
	Grey		4	SS	100												
	Hard		5	SS	100/	3"											
			6	SS	100/	6"	280										
			7	SS	100/	4"											
268.0			8	SS	100/	2"	270										
30.5	End of Borehole																



RECORD OF BOREHOLE No 1

W P 129-67-01 LOCATION Sta. 246+90, 30.6' Lt. ORIGINATED BY DK
DIST 7 HWY 2 BOREHOLE TYPE Washboring and Cone Test COMPILED BY DK
DATUM Geodetic DATE August 29 & 30, 1967 CHECKED BY *D.J.*

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
304.2	Ground Level												
0.0	Glacial Till												
	Grey		1	SS	75		300						
			2	SS	56								
			3	SS	80/	1"							
			4	SS	100/	4"							
	Heterogeneous Mixture of Sand, Silt, Clay and Gravel With Occasional Boulders		5	SS	50/	1"	290						
			6	SS	100/	4"							
	Hard		7	SS	100/	4"	280						
			8	SS	150/	6"							
269.0			9	SS	100/	3"							
35.2	End of Borehole												

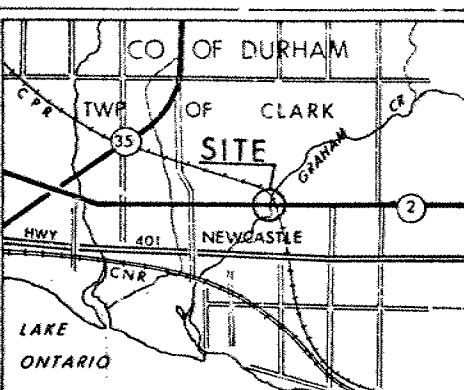
CONT No
WP No 129-67-01

GRAHAM CREEK BRIDGE

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



KEY PLAN
0 0.5 1 MI

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)
- W.L. at time of investigation
AUG & SEPT 1967

No	ELEVATION	STATION	OFFSET
1	304.2	246+90	30' 6" LT
2	298.5	247+38.5	42' RT
3	302.4	246+99	36' RT

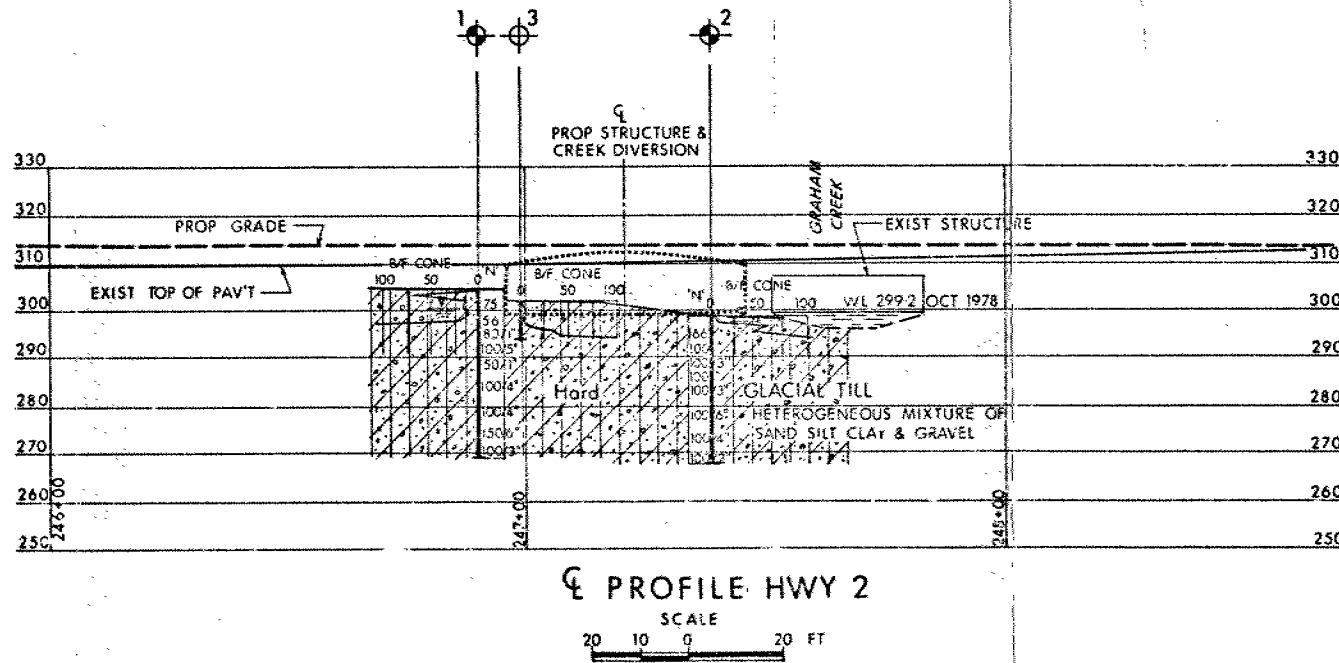
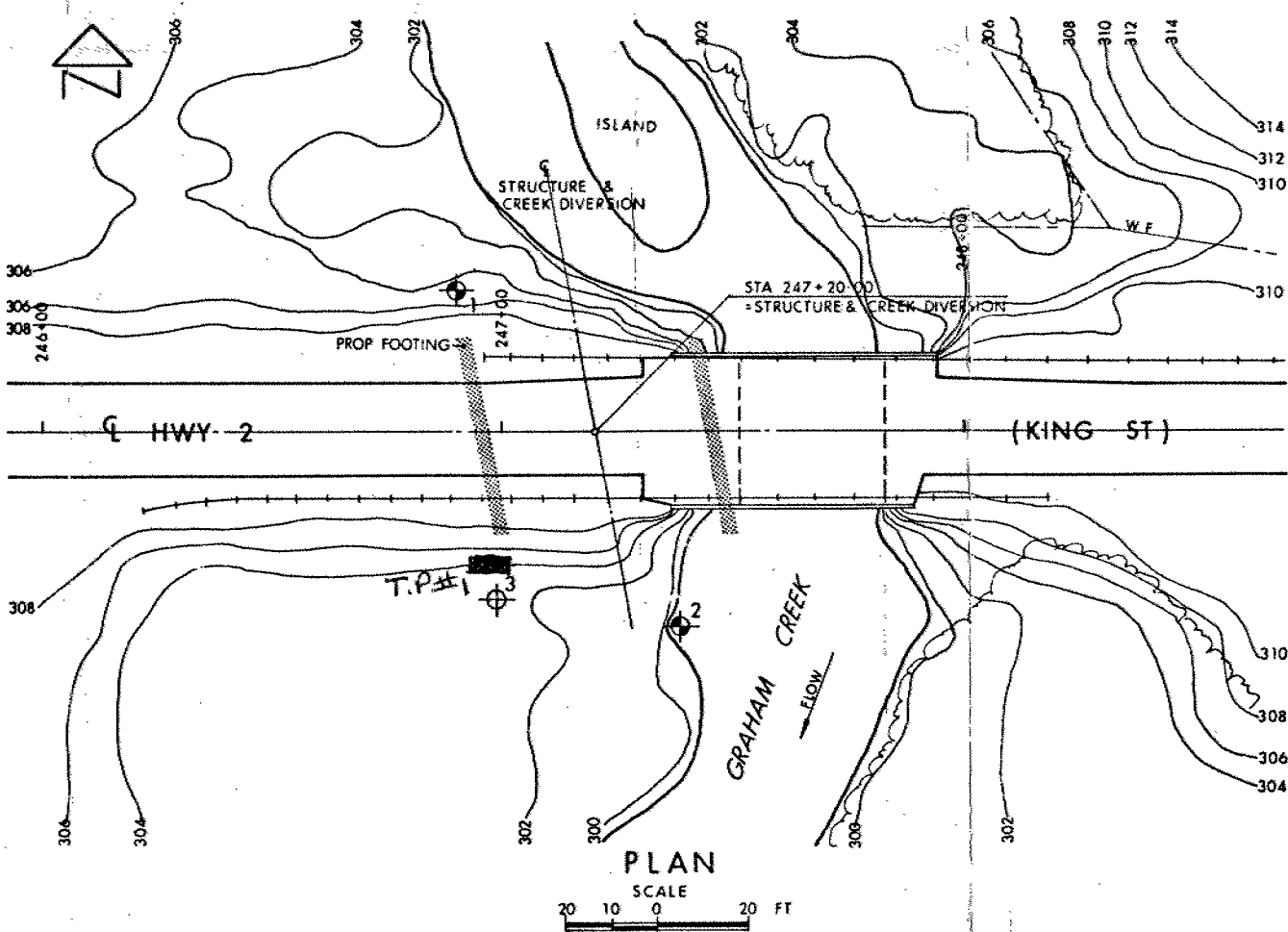
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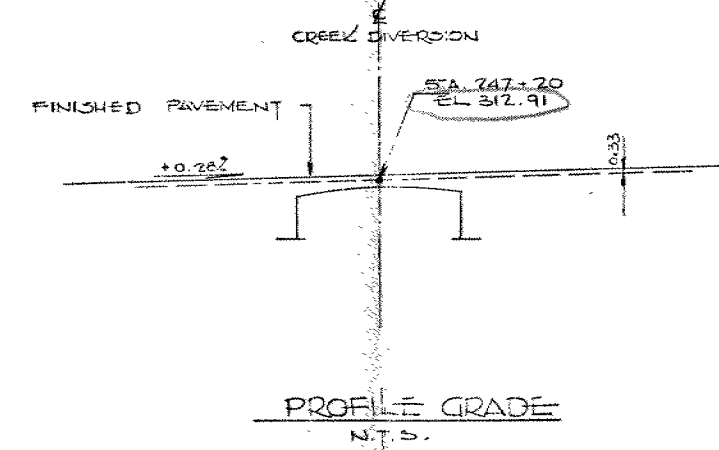
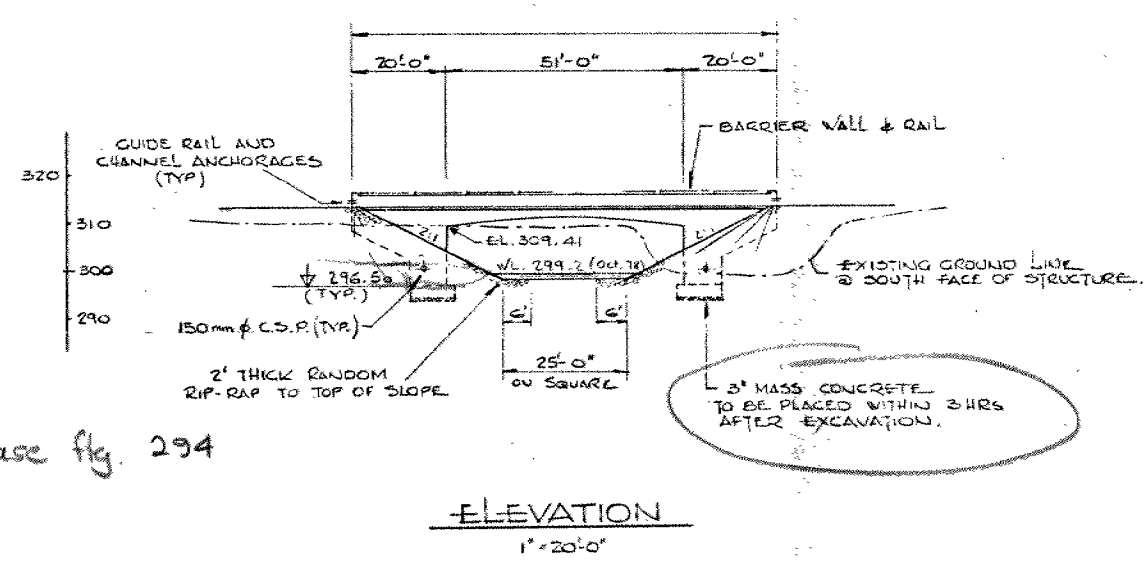
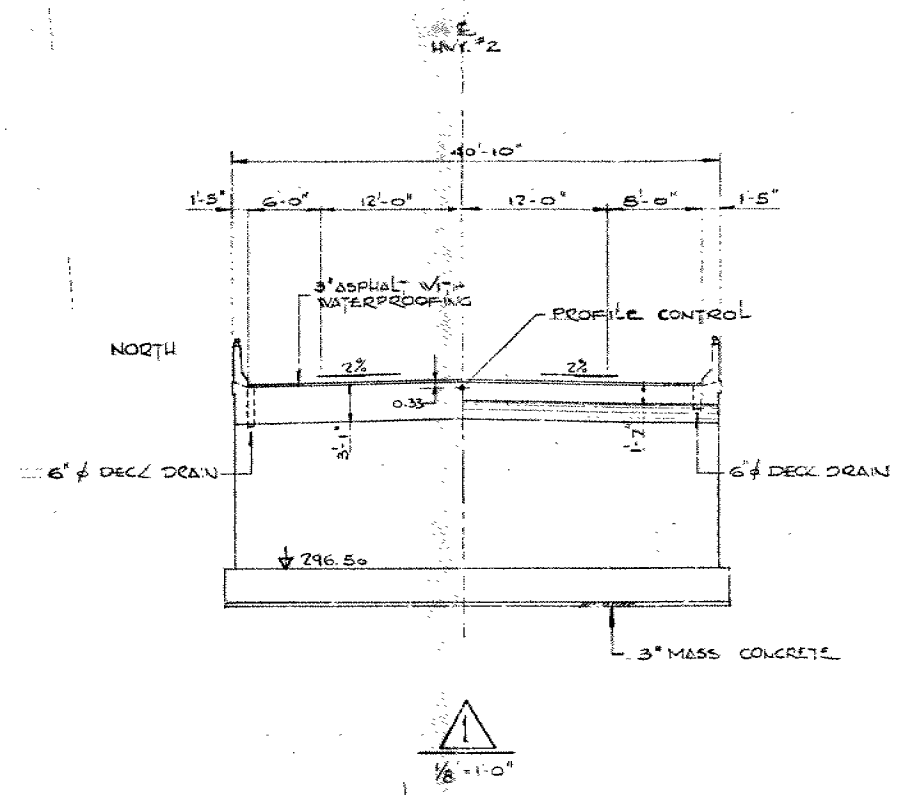
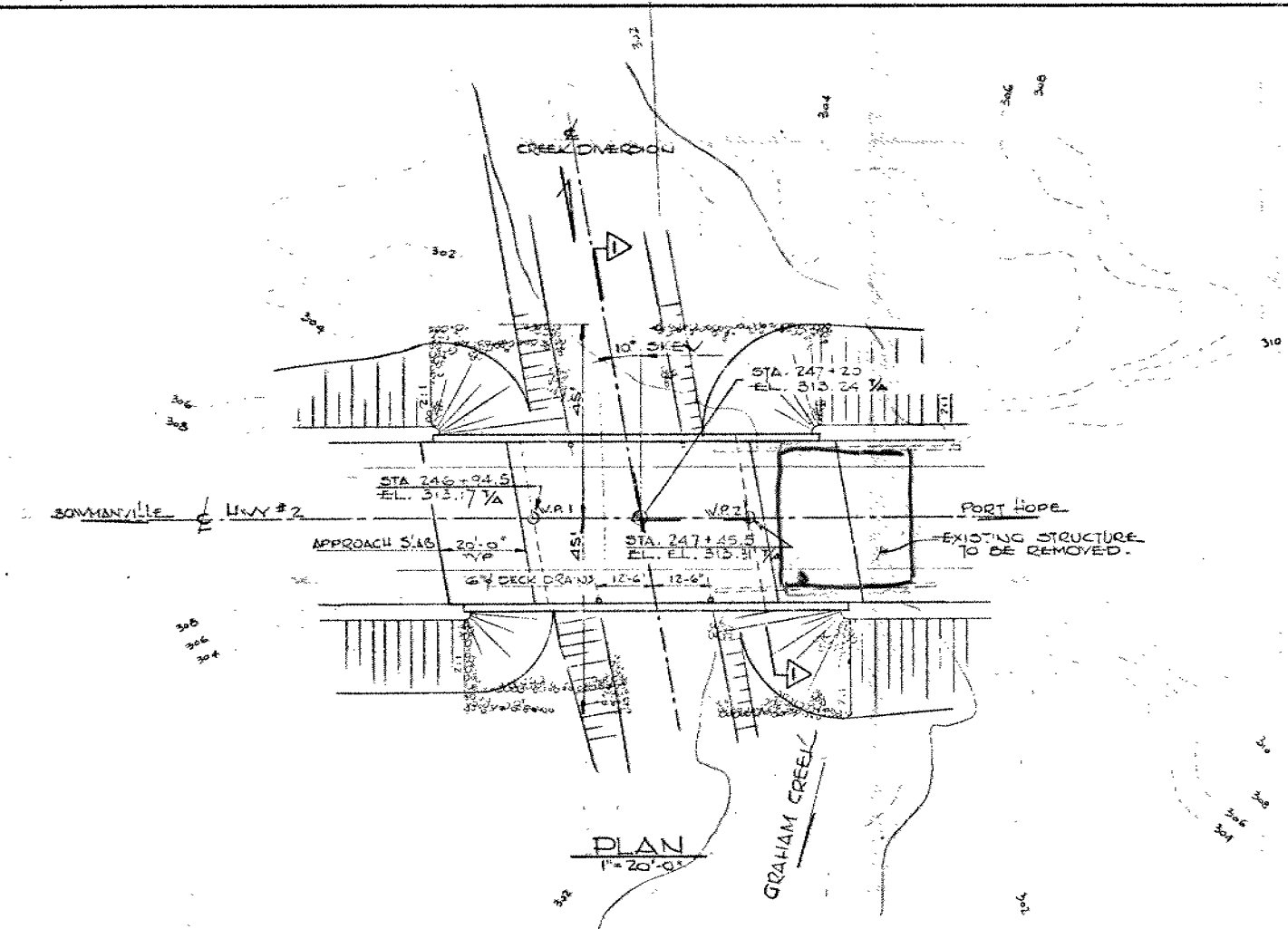
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

REF No E-4776-1 JUNE 1967

HWY No 2
SUBMITTAL D CHECKED DATE 79 01 19
DRAWING J CHECKED
SITE 21-189
DWG 1296701-A





- NOTES**
- CLASS OF CONCRETE
 - STRUCTURE & BARRIER WALLS 30 MPa
 - FOOTINGS 20 MPa
 - REINFORCING STEEL GRADE 400 MPa
 - BAR MARKS WITH THE SUFFIX 'C' INDICATE COATED BARS
 - CLEAR COVER TO REINFORCING STEEL:
 - FOOTINGS 3"
 - ABUTMENTS 3"
 - DECK TOP 2" BOT. 1 1/2"
 - BARRIER WALLS 1 1/2"
 - WING WALLS 2"
 - APPROACH SLABS AND AS NOTED ON DRAWINGS.
 - CONSTRUCTION NOTES
 - FOOTINGS TO BE CAST AGAINST UNDISTURBED GROUND.
 - BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS.
 - AT NO TIME SHALL THE DIFFERENCE IN ELEVATION OF THE OPPOSITE BACKFILLS EXCEED 2 FEET.
 - FALSEWORK SUPPORTING WING WALLS NOT TO BE REMOVED UNTIL CONCRETE IN DECK HAS ATTAINED A STRENGTH OF 20 MPa.
 - FALSEWORK SUPPORTING DECK SHALL NOT BE REMOVED UNTIL AFTER THE BACKFILL HAS BEEN PLACED BEHIND THE ABUTMENTS TO ELEV. 309.00

LIST OF DRAWINGS

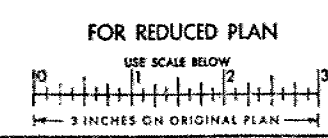
- 21-189-1 GENERAL LAYOUT.
- 2 BOREHOLE LOCATION & SOIL STRATA.
- 3 FOOTING LAYOUT & WING WALLS.
- 4 RIGID FRAME DETAILS.
- 5 BARRIER WALL.
- 6 RAILING FOR BARRIER WALL.
- 7 20 FT. APPROACH SLABS.
- 8 STANDARD DETAILS I
- 9 STANDARD DETAILS II
- 10 AS CONSTRUCTED ELEV. & DIM.

CONCRETE QUANTITIES:

CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS:

CONCRETE IN BRIDGE	328 CY.
CONCRETE IN BARRIER WALLS	14 CY.
CONCRETE IN APPROACH SLABS	41 CY.

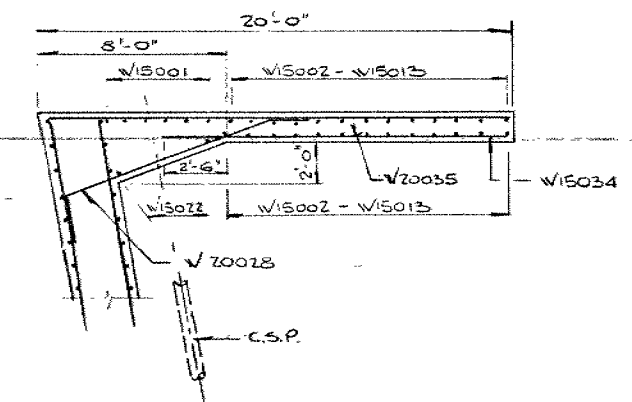
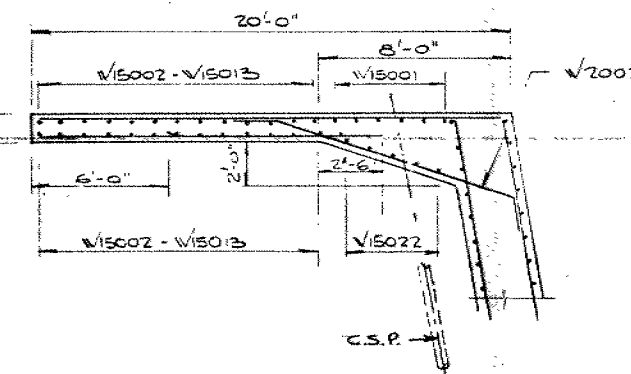
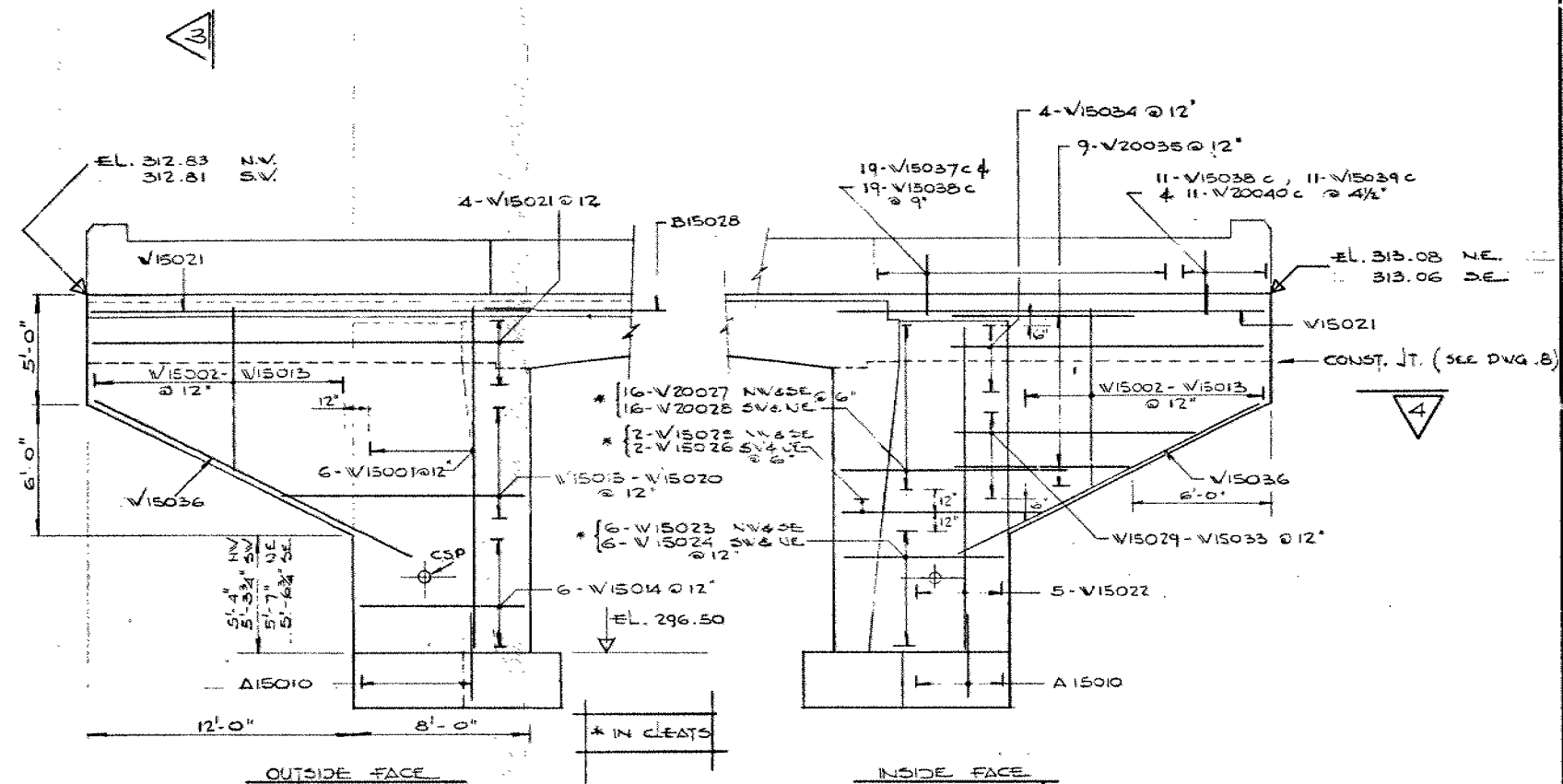
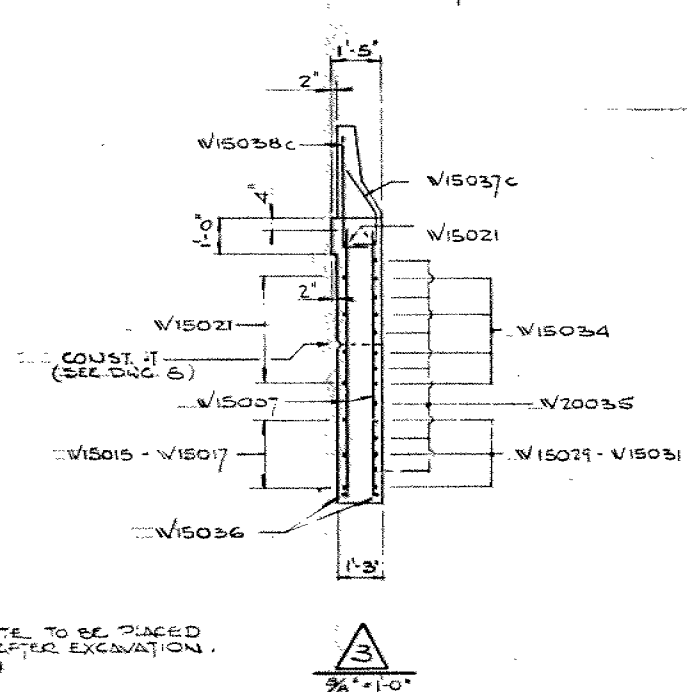
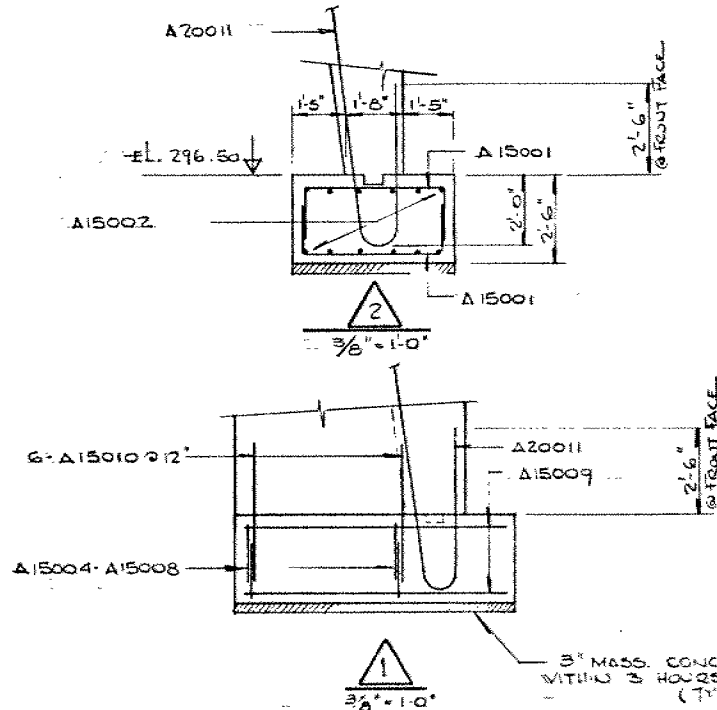
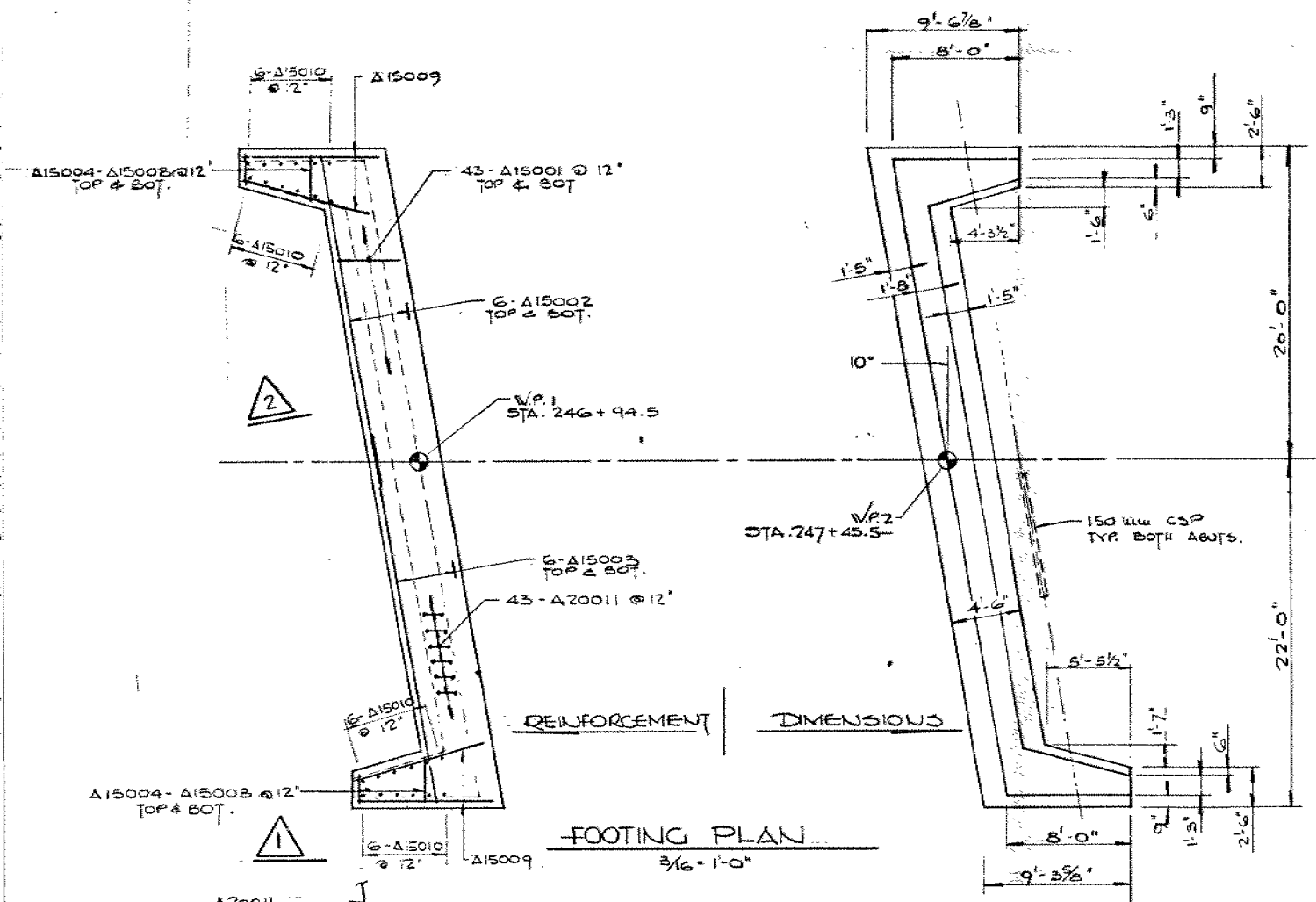
Base fig. 294



REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE NO	DWG



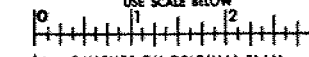
SHEET



WING WALLS
1/4" = 1'-0"

FOR REDUCED PLAN

USE SCALE BELOW



3 INCHES ON ORIGINAL PLAN

3	REVISIONS							
	DATE	BY	DESCRIPTION					
	DESIGN	CHECK	LOADING	50	48	DATE	10/10/88	
	DRAWING	CHECK	SITE No	1	1	DWG	5	

Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 05 15

Re: Graham Creek Bridge
W.P. 129-67-01, Site 21-189
Hwy. 2, District 7, Port Hope

Hydrological requirements dictate that the footings for the above mentioned structure be lowered by approximately one foot to a top of footing elevation of 296.5 for scour protection purposes. This would necessitate abutment footing excavations to be carried down some 7+ feet below the creek water level. In order to anticipate groundwater conditions and prevent any dewatering problems from occurring during construction, this Section has carried out additional field-work at the site on May 3, 1979. A test pit was excavated at Sta. 247+00 o/s 30' rt. of ϕ to a depth of 11 feet. The subsoil conditions encountered are summarized as follows.

0.0	Datum, ground surface elev. 304
0.0'-5.0'	Silty sand fill, compact
5.0'-8.5'	Silty sand with gravel and cobbles (water seepage from 5.0')
8.5'-11.0'+	Grey clayey silt with sand some gravel (glacial till) Very stiff to hard

Due to heavy water seepage into the pit from the coarse granular stratum, the walls of the trench were continually sloughing in.

Although no problems are anticipated with basal heave of footing excavations due to hydraulic head differential, some type of excavation bracing and seepage control will be required to insure the stability of the excavation.

In addition, a working slab of lean concrete should be poured immediately upon completion of footing excavation to prevent any softening of the foundation base.

Should additional information be required, please feel free to contact our office.

T. Kazmierowski
Project Engineer

TK/gs

cc: Files ✓

Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 04 23

Re: Graham Creek Bridge
W.P. 129-67-01, Site 21-189
District 7, Port Hope

We have reviewed the Preliminary Bridge Plan Drawing 21-189-P1 for the above mentioned structure.

Present plans indicate footing excavations will be carried down approximately five feet below the creek water level. In consideration of the marginally cohesive nature of the underlying glacial till and the presence of occasional granular seams, a temporary dewatering scheme is required to prevent water infiltration and possible basal heaving ('boiling') as a result of the unbalanced hydrostatic head.



T. Kazmierowski
Project Engineer

TK/gs

cc: Files J

MEMORANDUM

W.F. 129-67-1

To: Mr. B. R. Davis
Bridge Engineer
Bridge Division
Admin. Bldg.

From: Foundation Section
Materials & Testing Div.
Room 107, Lab. Bldg.

Date: September 25, 1967

One File Rec.

IN REPLY TO

SEP 27 1967

SUBJECT:

FOUNDATION INVESTIGATION REPORT
for
Proposed Graham Creek Bridge
Hwy. #2, East Limits of Newcastle
Dist. #7 (Port Hope)
W.J. 67-P-74 -- W.F. 129-67-1

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil condition existing at the above structure site.

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should additional information be required, please feel free to contact our office.

AGS:mt
Attach.

A. G. Stermac
A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
G. K. Hunter (2)
F. Allen
W. S. Melinysbyn
T. J. Kovich
B. A. Singh

Foundation Files
General Files ✓

TABLE OF CONTENTS

1. INTRODUCTION
2. DESCRIPTION OF THE SITE AND GEOLOGY
3. DESCRIPTION OF FIELD AND LABORATORY
4. SUBSOIL CONDITIONS
 - 4.1) General
 - 4.2) Glacial fill (heterogeneous mixture clayey silt, sand and gravel)
5. GROUNDWATER
6. DISCUSSION AND RECOMMENDATIONS
7. SUMMARY
8. MISCELLANEOUS

FOUNDATION INVESTIGATION REPORT
for
Proposed Graham Creek Bridge
Hwy. #2, East Limits of Newcastle
Dist. #7 (Port Hope)
W.J. 67-P-74 -- W.P. 129-67-1

1. INTRODUCTION:

In a memo dated August 9, 1967, a request to carry out a foundation investigation at the crossing of relocated Graham Creek by Hwy. #2 was received by this section from the Regional Bridge Location Engineer, Mr. W. S. Melnyshyn.

Subsequently, an investigation was carried out at the proposed site to determine the subsoil conditions. Presented in this report are the results of the field and laboratory work, together with discussion and recommendations pertaining to the design of the bridge foundations and stability of the approaches.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located in the Township of Clarke, County of Durham at the eastern limits of the town of Newcastle.

Some 200 feet east from the proposed site the C.P.R., which traverses in a general Northwest - Southeast direction, is supported on an embankment which has a finished grade some 32 feet above the existing grade of Hwy. #2 at the junction of Hwy. #2 and C.P.R. A concrete arch subway accomodates Hwy. #2 traffic at the juncture.

The existing structure at the crossing of Graham Creek by Hwy. #2 is a 30 ft. wide single span structure which appears to be in a statisfactory condition.

The site is located in the physiographic region known as the Iroquois Plains, the lowlands bordering Lake Ontario, which were inundated in late Pleistocene times by Lake Iroquois. The terrain in the vicinity of the site is undulating, and the land is developed basically for growing of cash crops.

3. DESCRIPTION OF FIELD AND LABORATORY WORK:

The field work was carried out by means of a conventional diamond drill adapted for soil sampling purposes.

A total of 2 sampled boreholes and 3 dynamic cone penetration tests was carried out during the investigation. From ground level downwards, samples were recovered by a standard split spoon sampler, driven according to the specification of the Standard Penetration Test.

The recovered samples were visually examined in the field and subsequently identified in the laboratory. Laboratory tests were carried out on selected representative samples to determine, where applicable, grain size distribution and natural moisture content.

Results of the laboratory and field tests, together with the locations and elevations of the boreholes, are presented in the appendix of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The deposit at the site consisted of a deep deposit of Glacial Till (heterogeneous mixture of clayey silt sand and gravel). The deposit, as determined in the boreholes, is shown on the accompanying borelog sheets. The estimated stratigraphical profile contained on Drawing 67-F-74A is based on this information.

4.2) Glacial Till (heterogeneous mixture clayey silt, sand and gravel):

This deposit was intersected in both boreholes and sampled to 35 ft. in BH #1 and to a depth of 30 ft. in BH #2.

The deposit consisted of a heterogeneous mixture of clayey silt, sand and gravel. In the upper 10 ft. of BH #1 occasional boulders in the order of 6-9 in. dia. were encountered

From grain size analysis the glacial till was found to consist of sand, silt, clay and gravel in the following average proportions - 46% Sa., 43% Si., 10% Cl. and 1% Gr.

The 'N' values (No. of blows/ft. obtained in a Standard Penetration Test) ranged in general from 56 blows/ft. to greater than 100 blows/ft. indicating a very dense relative density.

5. GROUNDWATER:

Groundwater level was observed to be at a depth of 4.8 ft. below ground level in BH #1 and 0.3 ft. in BH #2 or at elev. 299.4 and 298.2 respectively, which in general agreed with the upstream and downstream water levels of Graham Creek.

The observed groundwater levels are shown on the record of borehole sheets and on Dwg. 67-P-74A which are included in the report appendix.

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a single span (40' long x 64' wide) structure where Hwy. #2 crosses the Graham Creek Diversion. In this area the existing single span structure (30' long x 32' wide) will be demolished and the existing channel backfilled. The proposed creek diversion will be approximately 45 ft. west of the existing crossing.

The new \pm of Hwy #2 will be the same as the existing one and the new profile grade will be approximately 5 ft. higher than the present highway.

The investigation has disclosed that the very dense Glacial Till (clayey silt with sand and traces of gravel) deposit is the significant stratum for the proposed bridge structure. No details of the proposed stream diversion are available at this time, but the creek bed probably will be at about elev. 296.0, which is the same as the existing creek bed.

In view of the foregoing, it is recommended that the abutments for the proposed single span structure be founded on spread footings in the dense glacial till stratum at or below elev. 292. A safe bearing capacity of 4 t.s.f. may be assumed for design purposes.

In view of the relatively low permeability of the subsoil, no major dewatering problems are anticipated for the footing excavation. In order to prevent any softening of the foundation material by surface run-off, a 12 inch thick granular pad or a concrete working slab should be placed immediately after the completion of the footing excavation. No stability problems are anticipated with regard to the proposed approaches using standard 2:1 slopes. The use of rip-rap protection of approach

6. DISCUSSION AND RECOMMENDATIONS: (cont'd)

side slopes against scour should be based on hydrological considerations.

7. SUMMARY:

A foundation investigation at the site of a proposed bridge on Hwy. #2 crossing the relocated Granam Creek diversion is reported.

Subsoil consists of a very dense Glacial Till (heterogeneous mixture of clayey silt, sand and gravel).

It is recommended to found the bridge abutments on spread footings with a design bearing capacity of 4 t.s.f.

No major dewatering problems are anticipated for the construction of abutment footings.

No stability problems are anticipated for the approach fills of standard 2:1 slopes.

8. MISCELLANEOUS

The field work, performed during the period August 28 to 31, 1967 was undertaken by Mr. D. Katauskas, Project Foundation Engineer who also prepared this report, under the general supervision of Mr. M. Devata, Supervising Foundation Engineer who also reviewed this report.

The equipment was owned and operated by Master Soil Investigation Ltd.

APPENDIX I

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL. THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS -

<u>CONSISTENCY</u>	<u>'N' BLOWS/FT</u>	<u>LB / SQ FT</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

SS	SPLIT SPOON	TW	THINWALL OPEN
WS	WASHED SAMPLE	TP	THINWALL PISTON
SB	SCRAPER BUCKET SAMPLE	OS	OSTERBERG SAMPLE
AS	AUGER SAMPLE	FS	FOIL SAMPLE
CS	CHUNK SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE SAMPLE		
	PH SAMPLE ADVANCED HYDRAULICALLY		
	PM SAMPLE ADVANCED MANUALLY		

SOIL TESTS

CU	UNCONFINED COMPRESSION	LV	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	FV	FIELD VANE
QCU	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
Q	RATE OF DISCHARGE
V	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR $= \frac{C_v t}{d^2}$ (d , DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
	INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_i	SENSITIVITY

GENERAL

π	≈ 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
g	9.81 m/sec^2
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

z	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

◎ 毛泽东与王德安 ◎ 王德安与王德安 一 ◎ 王德安与王德安

RECORD OF BOREHOLE NO.2

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 67-F-74

LOCATION Sta. 147 + 38.5 o/s 42' Rt.

ORIGINATED BY DR.

W. P. 129-67-1

BORING DATE August 31 & Sept. 1, 1967

COMPILED BY **DK**

CATUK: Geodetic

BOREHOLE TYPE Washboring

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L		BULK DENSITY P.C.F.	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT — w_p	WATER CONTENT — w		
298.5												
0.0	Grey Glacial Till (heterogeneous mix. of sand, silt, clay and gravel).		1	SS	166							298.2
			2	SS	100							0.3
			3	SS	100/3"	290						
			4	SS	100							
	Very Dense		5	SS	100/3"							
			6	SS	100/6"	280						
			7	SS	100/4"							
268.0						270						
20.5	End of Borehole		8	SS	100/2"							

◎ 廖亦武的「胡言乱语」 ◎ 尹 明：胡言乱语胡言乱语 ◎ 解严与台湾的

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 67-1571

LOCATION SLA 146 + 99 o/s 36' St.

ORIGINATED BY DE

49

BORING DATE September 1, 1967

COMPILED BY IX

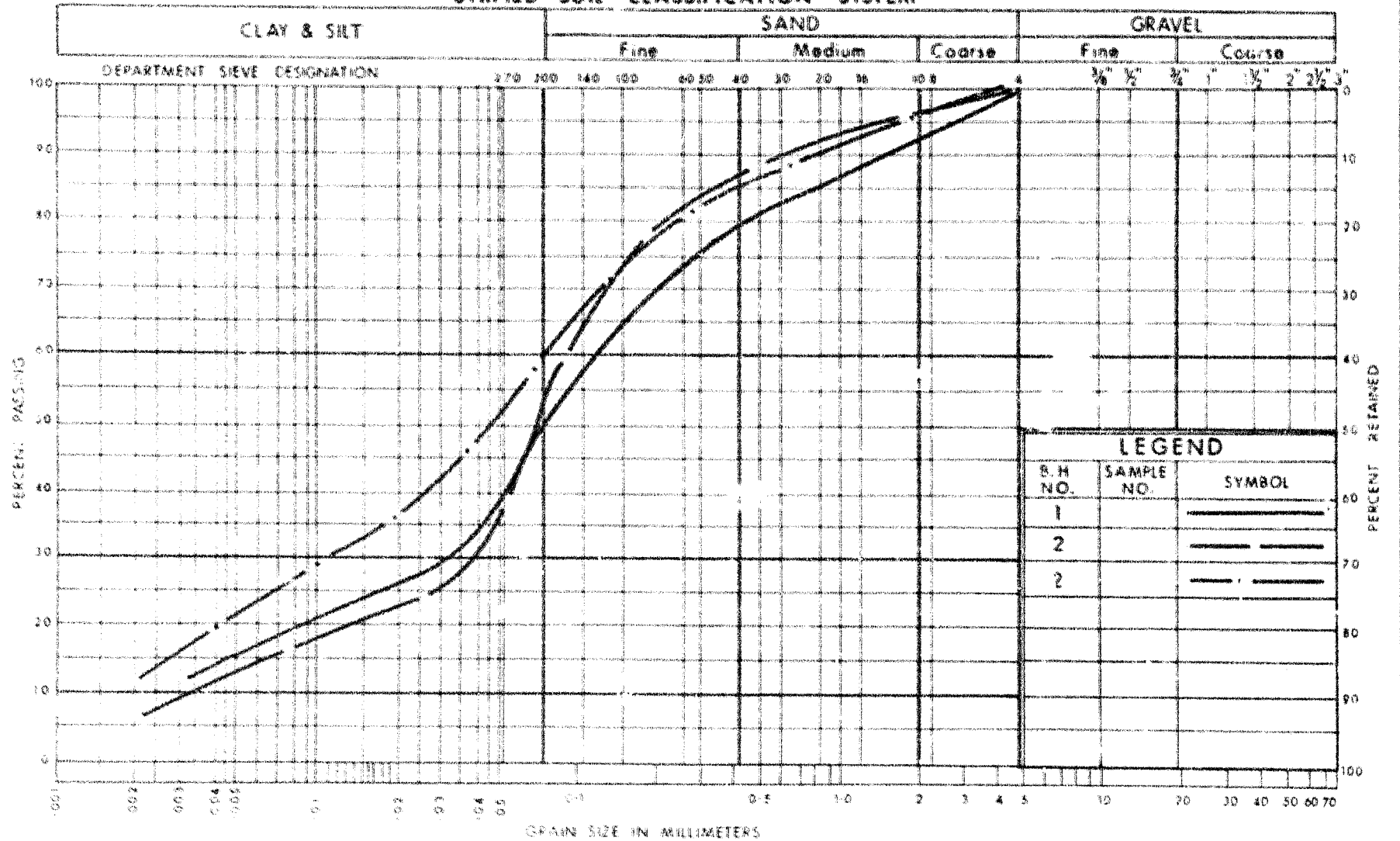
DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P S F.	LIQUID LIMIT ——— % PLASTIC LIMIT ——— % WATER CONTENT ——— % *p ——— *L WATER CONTENT %	BULK DENSITY P C F	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE					
302.4	Ground Level								
300									
290						100/9			

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

WP No. 129 - 67 - 01
JOB No. 67 - F - 74

DEPARTMENT OF HIGHWAYS ONTARIO
MEMORANDUM

67-F-79

To: Mr. A. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Bldg.

From: Bridge Division,
Downsview, Ontario.

Date: August 9th. 1967.

Our File Ref.

In Reply To

Subject: W.P. 129-67-1,
Graham Creek Culvert,
Hwy. #2 - Dist. #7.

Please find enclosed the Preliminary Structure Site Report and two copies of plan E-4776-1 on which we have marked the proposed location of the above structure.

This structure is in the close vicinity of the proposed C.P.R. subway (W.P. 50-65) and the two projects will be awarded under the same contract.

Would you please make the necessary arrangements for a foundation investigation.

NZ/ss
Encl.

cc. R. Forrest

N. Zoltay
N. Zoltay,
for W. S. Melinyshyn,
Regional Bridge Location Engineer.

67-F-74

WP. # 129-67-1

HWY #2

GRAHAM CREEK

