

G.I.-30 SEPT. 1976

GEOCRES No. 3165-87DIST. 9 REGION W.P. No. 10-69-13CONT. No. 73-190W. O. No. STR. SITE No. HWY. No. LOCATION Walkey Rd. & Green CreekNo. of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

MEMORANDUM

3165-87

GEOCRES No.

TO: Mr. T. C. Kingsland,  
Regional Structural Planning Eng.,  
Eastern Region,  
Kingston, Ontario.

FROM: Foundations Office,  
Design Services Branch,  
West Bldg., Downsview.

ATTENTION:

DATE: December 28, 1972.

OUR FILE REF.

IN REPLY TO JAN - 5 1973

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed Structure

At the Crossing of the Walkley Road Extension  
And the Green Creek Diversion  
Twp. of Gloucester, Reg. Mun. of Ottawa-Carleton  
District No. 9 (Ottawa)  
W.O. 72-11088 -- W.P. 10-69-13

3165-87

CONT. 73-190

Attached we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above-mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

*A. G. Stermac*

A. G. Stermac,  
PRINCIPAL FOUNDATIONS ENGINEER.

AGS/ck  
Attch:

c.c. E. J. Orr  
B. R. Davis  
A. Rutka  
A. J. Percy  
J. E. Callaghan  
B. J. Giroux  
E. R. Saint  
G. A. Wrong  
B. A. Singh  
M. M. Dillon - Ottawa

Foundations Files  
Documents

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1. INTRODUCTION:

The Foundations Office was requested to carry out a subsurface investigation for the proposed structure at the crossing of the Walkley Road Extension and the rechannelized Green Creek, in the Township of Gloucester, Regional Municipality of Ottawa-Carleton. The request was contained in a memorandum from Mr. T. C. Kingsland, Regional Structural Planning Engineer, Eastern Region, dated July 18, 1972. Because of the difficulties in obtaining permission to enter private property, the field investigation required to determine the subsoil, bedrock and groundwater conditions across the site, could not be carried out until October 1972.

This report contains the factual results obtained from the investigation, together with the recommendations pertaining to the foundations of the proposed structure as well as the stability considerations associated with the cut sections of the open channelized Green Creek.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The area under investigation is located some 1,200 feet east of the intersection of the existing Walkley Road and Sheffield Road, in the Regional Municipality of Ottawa-Carleton.

The terrain is flat to gently undulating in relief between elevations 216 and 221. The land is being used for farming purposes. The south to north flowing Green Creek is approximately 15 feet wide and 2 feet deep. A north-south running C.N.R. line is located about 600 feet west of the proposed crossing.

The site is situated in the physiographical region known as "Ottawa Valley Clay Plains." In this region, extensive clay deposits are interrupted by ridges of sand and/or bedrock. The sensitive marine clay, which was deposited in the geologic past in the Champlain Sea, varies markedly in thickness over the region. In the vicinity of the site, it is found to be about 20 feet thick. The clay is generally underlain by glacial till followed in turn by shale bedrock.

### 3. FIELD AND LABORATORY WORK:

Two sampled boreholes and one dynamic cone penetration test were put down during the field investigation, using a C.M.E. machine adapted for soil sampling purposes.

Samples of the overburden were obtained by using a 2" O.D. standard split-spoon sampler, which was hammered into the soil in accordance with the specifications for Standard Penetration Test. The same method was used to advance the dynamic cone penetration test. In the cohesive portions of the subsoil, relatively undisturbed samples were obtained in 2" I.D. Shelby Tubes which were pushed down manually or hydraulically. Wherever possible, the undrained shear strength and the sensitivity of the cohesive stratum was measured by performing field vane tests. Bedrock was proven at only one boring location by obtaining 5.5 feet of BX size core samples.

The subsoil, bedrock and groundwater conditions encountered at the boring locations, are presented on the Record of Borehole sheets, located in the Appendix of this report. The locations and elevations of the borings were provided by the personnel from the Eastern Region Engineering Surveys Section. The elevations appearing in this report were referenced to a Geodetic Datum.

The boring locations and elevations are shown on Drawing No. 72-11088A. A stratigraphical profile along the proposed Green Creek diversion, inferred from the boring data, is also included in the aforementioned drawing.

All the samples were subjected to a very careful visual examination at the field and subsequently in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples to determine the following physical properties of the overburden.

- Bulk Density
- Natural Moisture Content
- Atterberg Limits
- Grain-Size Distribution
- Consolidation Characteristics
- Shear Strength

The results of this testing are plotted on the Record of Borehole sheets as well as summarized on Figure Nos. 1, 2, 3 and 4, all of which are contained in the Appendix of this report.

#### 4. SUBSOIL AND BEDROCK CONDITIONS:

##### 4.1) General:

The surficial deposit across the site is a firm to very stiff grey silty clay to clay. The thickness of this deposit varies from 21 feet to 23 feet. The cohesive stratum is underlain by up to 11 feet of very loose to loose silt and fine sand with a trace of clay. Following this granular stratum is a deposit of glacial origin, approximately 14 feet thick. The overburden is underlain by shale bedrock.

The boundaries of the various soil and bedrock types encountered in the boreholes, are shown on the accompanying Record of Borehole sheets. The stratigraphical profile shown on Drawing No. 72-11088A has been inferred from this data. From ground surface downward, the various deposits are described separately as follows.

#### 4.2) Silty Clay to Clay:

Directly beneath a nominal topsoil cover (maximum 1 foot) is a 21 to 23 feet thick sensitive grey silty clay to clay with a trace of sand. Occasional seams of clayey silt, up to 2 inches thick, were encountered throughout the lower zone of this deposit. The engineering properties of the deposit, as determined by field and laboratory testing, are summarized in the following table.

<u>Tests</u>	<u>Range</u>	<u>(Average)</u>
Bulk Density (p.c.f.)	110.5 - 120	(115)
Liquid Limit ( $W_L$ ) %	41 - 56	(47)
Plastic Limit ( $W_P$ ) %	21 - 25	(23)
Natural Moisture Content (W) %	33 - 57.5	(46)
Initial Void Ratio ( $e_o$ )	1.4	
Compression Index ( $C_c$ )	0.72	
Degree of Preconsolidation ( $P_c - P_o'$ ) (p.s.f.)	4,400	
Undrained Shear Strength (p.s.f.)		
i) Field vanes	680 - > 2,000	
ii) Lab. Vanes	465 - 1,285	
iii) Quick Triaxial and Unconfined	625 - 2,970	
Effective Shear Strength Parameters		
i) Apparent cohesion ( $c'$ ) (p.s.f.)	460 - 634	
ii) Apparent frictional angle ( $\phi'$ )	26° - 30°	

The Atterberg Limit tests, summarized in the above table, are also plotted on the plasticity chart, Figure No. 1. These results indicate that the cohesive stratum is inorganic with a plasticity ranging from intermediate to high. In addition, Atterberg Limit tests were carried out on samples of clayey silt seams existing at the lower portion of this deposit. The results were also presented on Figure No. 1.

Based on the results of the undrained shear strength testing carried out, it is estimated that the consistency of the cohesive stratum ranges from firm to very stiff.

The consolidation characteristics of the stratum were determined by carrying out two laboratory tests; the results are shown as Void Ratio vs. Log of Pressure plots on Figure No. 4. This testing indicates that the clay stratum is preconsolidated by at least 4,400 p.s.f. in excess of the existing overburden pressure.

4.3) Silt With Fine Sand:

Underlying the cohesive stratum of silty clay to clay, is a water bearing granular deposit which is up to 11 feet thick. This deposit consists of silt and fine sand, with occasional thin seams of clayey silt. Results of the grain size distribution testing carried out on samples of this stratum are presented on Figure No. 2.

Standard Penetration testing was carried out in this deposit. The results gave 'N' values ranging from less than 1 blow/ft. to 12 blows/foot, with the lower values being dominant. Based on these results, it is estimated that the relative density of this granular deposit varies from very loose to compact.

4.4) Glacial Till - Heterogeneous Mixture of Silt, Sand, Clay and Gravel:

Underlying the silt and fine sand is a deposit of glacial origin consisting of a heterogeneous mixture of silt, sand clay and gravel. This glacial till deposit, which varies from 14 to 15 feet in thickness is basically granular in nature. There are, however, random cohesive layers throughout; in these areas the till has a matrix of clayey silt binding sand and gravel. Typical grain-size distribution curves, obtained from samples of the till, are plotted on Figure No. 2.

The Standard Penetration Tests carried out gave 'N'



ranging from 10 blows/foot to 100 blows per 5 inches. Based on these results, it is estimated that the relative density of the till varies from compact to very dense.

4.5) Shale Bedrock:

The glacial till is directly underlain by bedrock, which was proven in B.H. #2 by obtaining 5.5 feet of BX sized rock core samples. The bedrock surface was found to be at elevation 171, which corresponds to 46 feet below the existing ground surface.

The bedrock is composed of a grey shale which is in a sound state as evidenced by the high percentage of rock core recovered.

5. GROUNDWATER CONDITIONS:

The groundwater level conditions across the site, during the period of the field investigation (October 1972) were observed by taking readings in the open boreholes. The results were plotted on the Record of Borehole sheets, as well as summarized on Drawing No. 72-11088A.

The observations indicate that the groundwater level varies between elevations 210.5 and 212 which corresponds to a depth of 6 feet below the existing ground surface.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

Approximately 1/2 mile east of the intersection of the existing Walkley Road and Sheffield Road, in the Regional Municipality of Ottawa-Carleton, the proposed Walkley Road Extension will cross the diverted Green Creek. It is understood that a 25 feet span and 200 feet long culvert structure will be placed at the crossing. According to available information

("Pre-Engineering Concept Report - Green Creek Culverts - Highway 417" by M. M. Dillon Ltd., dated August 1972), the profile grade of Walkley Road will be at elevation 227, while the invert of the creek will be at elevation 199. At these grades the associated embankment will extend up to 28 feet above the level of the Green Creek Valley floor.

Two structure types are being considered; namely,

- i) a reinforced concrete box culvert, or
- ii) a 'super span' structural plate pipe arch.

The subsoil at the site consists of a 21 to 23 feet thick, firm to very stiff, stratum of silty clay to clay, which is underlain by up to 11 feet of very loose to loose water-bearing silt and sand. Underlying the granular deposit is a glacial till deposit about 15 feet thick, which in turn, is underlain by shale bedrock.

The recommendations pertaining to the two schemes will be discussed separately in the subsections to follow.

#### 6.2) Reinforced Concrete Box Culvert:

The concrete box culvert may be supported on a granular mat within the very stiff to firm silty clay deposit. To fulfill the requirements for frost protection purposes, the total thickness of the granular pad and the base slab of the culvert should be at least 4 feet. An allowable bearing pressure of 1,000 p.s.f. may be used in the design of the culvert.

The foundation excavation will be carried out within the relatively impervious cohesive stratum; the base of the excavation will extend up to 15 feet below the groundwater level recorded at the time of the investigation. Further, the base of the excavation will be only a few feet above the surface of the water bearing silt and fine sand deposit. The bottom of the excavation may, therefore, heave due to the unbalanced hydrostatic water pressure head existing in the granular deposit. In view of this, a positive dewatering scheme should be provided. For example, a scheme utilizing steel sheeting may be used. The penetration of the sheeting, below the bottom of the excavation,

should be at least equal to the unbalanced hydrostatic head existing above this level during the construction period.

Settlement will be induced in the subsoil by the applied mat pressure. This settlement will be elastic in nature; i.e., take place during or immediately following the construction period and should not exceed 1 inch, providing the foundation subsoil is not loosened by the hydrostatic uplift pressure discussed in the previous paragraph.

If the bearing value quoted above is insufficient, then the structure could be supported on end-bearing piles driven to bedrock. For estimating purposes, it can be assumed that the pile tips will be located at elevation 171. The allowable pile load will be dependent on the section chosen. For instance, 12 BP 74 steel H-piles may be designed for 95 tons/pile.

The structure will be designed as a rigid frame; a coefficient of earth pressure at rest ( $K_0$ ) of 0.5 should be assumed for the granular backfill placed behind the wall, when designing the wall sections. In addition, the design should incorporate the full effect of the surcharge located above the walls.

In order to relieve the buildup of excess hydrostatic pressure behind the walls, suitable drainage measures should be provided. Weep holes, located at the base of the walls, could be employed for this purpose; these holes should be spaced not more than 10 feet apart.

#### 6.3) "Super Span" Structural Plate Pipe Arch:

A "super span" structural plate pipe arch could also be employed at this site. The bedding and backfilling for the culvert should be carried out in accordance with current M.T.C. practices. The pertinent standards are DD808B - Type 5 (Bedding) and DD813A (Backfilling). According to available information the bottom of the pipe arch will be at about elevation 197, which is only a few feet above the surface of the water bearing silt

and fine sand deposit. The base of the excavation may heave due to the unbalanced hydrostatic water pressure head existing in the underlying granular deposit. A positive dewatering scheme, similar to the one discussed in Subsection 6.2) will, therefore, be required. Alternatively, the silt and fine sand may be subexcavated completely and backfilled with select granular fill material.

#### 6.4) Open Channel Sections:

Both north and south of the culvert structure the Green Creek diversion will be in open channel sections, the lengths of these sections will be 100 feet and 500 feet, respectively. The invert of the open channel sections will be at about elevation 199; the channels will, therefore, have a maximum depth of 20 feet. Analyses, in terms of effective stresses, have been carried out to determine the long term stability of the cuts, using the following soil properties.

<u>Elevation</u>	<u>Soil Types</u>	<u>C' (p.s.f.)</u>	<u><math>\phi'</math></u>
218 - 210	Silty Clay	500	30°
210 - 196	Silty Clay	500	27°
196 - 185	Silt and Fine Sand	0	20°
185 - 171	Glacial Till	0	35°

The results indicate that cuts, up to 20 feet deep, will be stable with regard to a deep-seated rotational type of failure ( $F.S. \geq 1.3$ ), provided the slopes are no steeper than 2-1/2:1.

As mentioned elsewhere, the bottom of the creek diversion is very close to the surface of the water bearing silt and fine sand deposit located beneath the cohesive stratum. In order to avoid any bottom heave of the diversion channel resulted from the unbalanced hydrostatic pressure head existing in the granular deposit, it may be necessary to concrete-line the channel bottom. The lining should be carried out as soon as the channel invert is reached.

6.5) Other Considerations:

As discussed in the previous subsections, the presence of the water-bearing silt and fine sand deposit a few feet below the invert of the proposed i) culvert structure and ii) open channel sections may cause construction problems which would tend to increase the cost of the overall project. Other investigations carried out in this general area did not encounter this water bearing granular deposit. Based on this information it is inferred that the lateral extent of the granular deposit might be quite isolated.

It may be advantageous to carry out a supplementary investigation, in this area, the purpose of which would be to locate an alternate alignment for the Green Creek diversion where the water bearing granular material is absent. If deemed desirable the Foundations Office would be pleased to carry out such an investigation. The finalized alignment could then be selected on the basis of economic and related considerations.

7. MISCELLANEOUS:

The field work was carried out between October 18 and October 20, 1972, under the supervision of Mr. J. Cortabarría, Student Technician (Field).

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

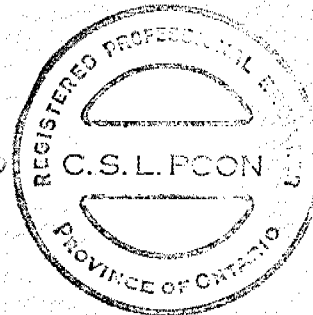
This report was prepared by Mr. C. S. Poon, Project Foundations Engineer. This project was carried out under the overall supervision of Mr. M. Devata, Supervising Foundations Engineer, who also reviewed this report.

*C.S. Poon*

C. S. Poon, P. Eng.

*M. Devata*

M. Devata, P. Eng.



APPENDIX

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 1

JOB 72-11088

LOCATION Co-ords. 498,275 N; 231,995 E.

ORIGINATED BY JC

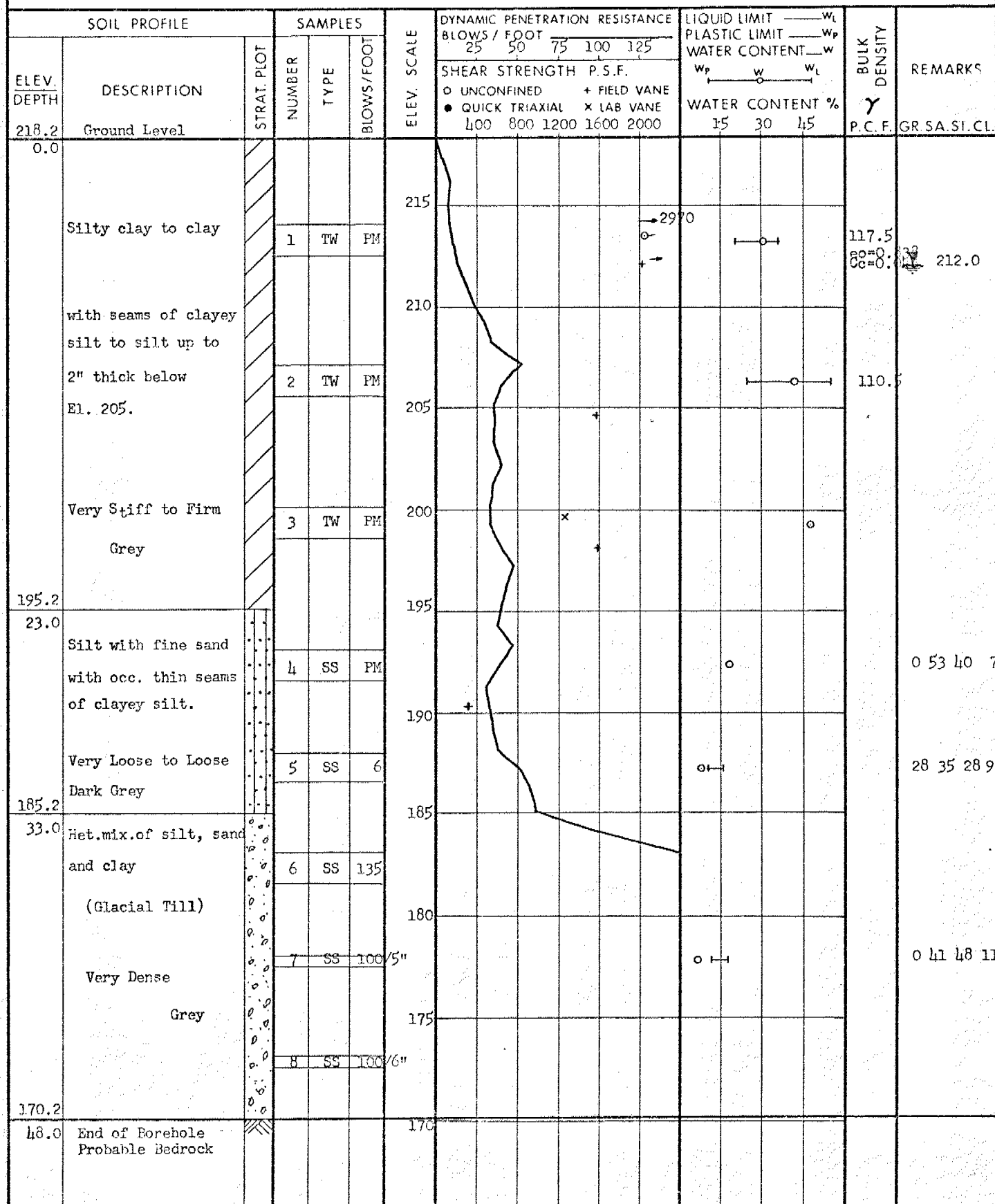
W.P. 10-69-13

BORING DATE Oct. 20/72

COMPILED BY JC

DATUM Geodetic

BOREHOLE TYPE Flight Auger and Cone Test

CHECKED BY *[Signature]*20  
15 5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE N° 1A

JOB 72-11088

LOCATION Co-ords. 498,080 N; 232,010 E.

ORIGINATED BY JC

W.P. 10-69-13

BORING DATE Oct. 20, 1972

COMPILED BY JC

DATUM Geodetic

BOREHOLE TYPE Dynamic Cone Test

CHECKED BY SK

[illegible]

15  $\begin{matrix} 20 \\ \circ \\ 10 \end{matrix}$  5 % STRAIN AT FAILURE



DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 2

JOB 72-11088

LOCATION Co-ord. 498,472 N; 231,916 E.

ORIGINATED BY JC

W.P. 10-69-13

BORING DATE Oct. 18/72

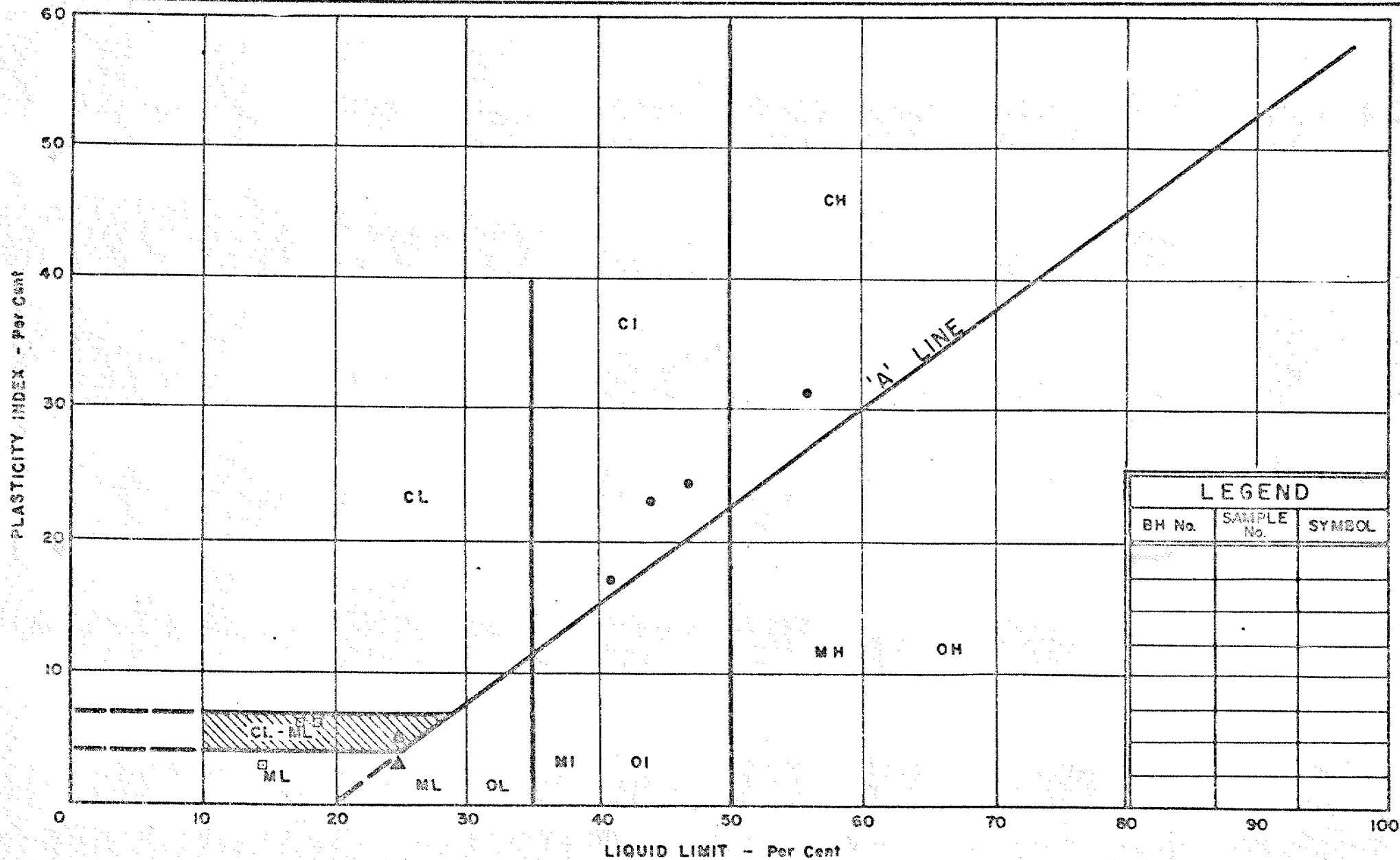
COMPILED BY JC

DATUM Geodetic

BOREHOLE TYPE Flight Auger and BXL Rock Core

CHECKED BY *JR*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$ P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.			$w_p$ ——— $w$ ——— $w_L$						
							O UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE	WATER CONTENT %					
											400	800			1200	1600
216.8	Ground Level													GR SA.SI.CL.		
0.0	Silty clay to clay		1	SS	15	215									210.6	
	with seams of clayey silt up to 2" thick below El. 205.		2	SS	12	210										
			3	TW	PH	205										
	Very Stiff to Firm Grey		4	TW	PM	200										
			5	TW	PM	195										
195.8																
21.0	Silt with fine sand (with occ. thin seams of clayey silt)		6	TW	PM	195								0 33 52 15		
	Very Loose to Compact Dark Grey		7	SS	1/18"	190										
			8	SS	12	185										
			9	SS	1/18"	185										
			10	SS	10	180										
184.8																
32.0	Het. mix. of silt, sand and clay. (Glacial Till)		11	SS	100	180								0 43 52 5		
	Compact to Very Dense Grey		12	SS	125	175										
			13	SS	95	175										
			14	SS	100 1/5"	170										
			15	BXL	91%	170										
170.8																
146.0	Sound Shale		16	BXL	100%	165								0 35 53 12		
165.3																
51.9	End of Borehole					165										



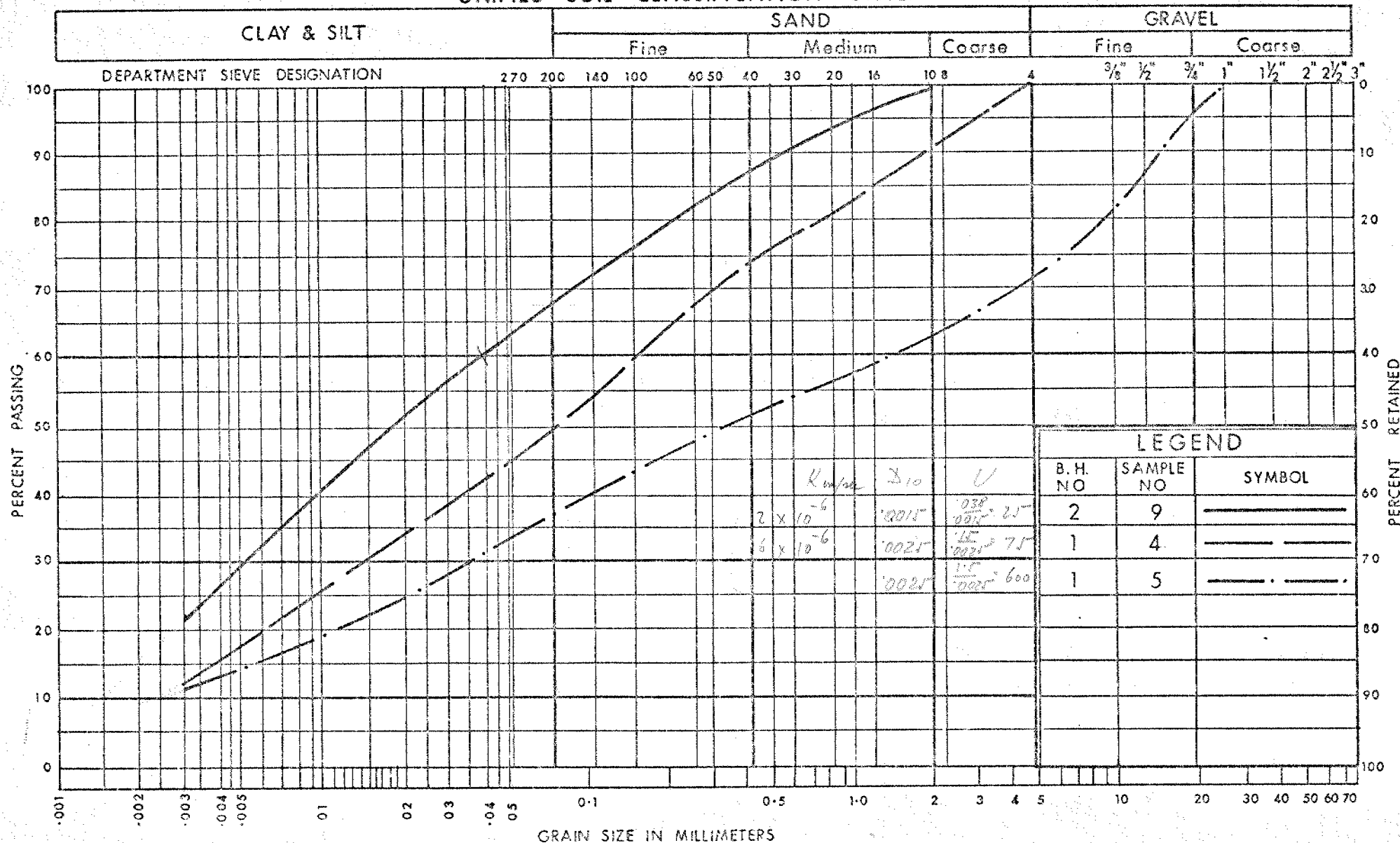
DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

# PLASTICITY CHART

- SILTY CLAY
- ▲ CLAYEY SILT TO SILT SEAMS
- GLACIAL TILL

W.P. No. 10-69-13  
JOB No. 72-11088  
FIG. No. 1

# UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT  
OF  
TRANSPORTATION AND COMMUNICATIONS



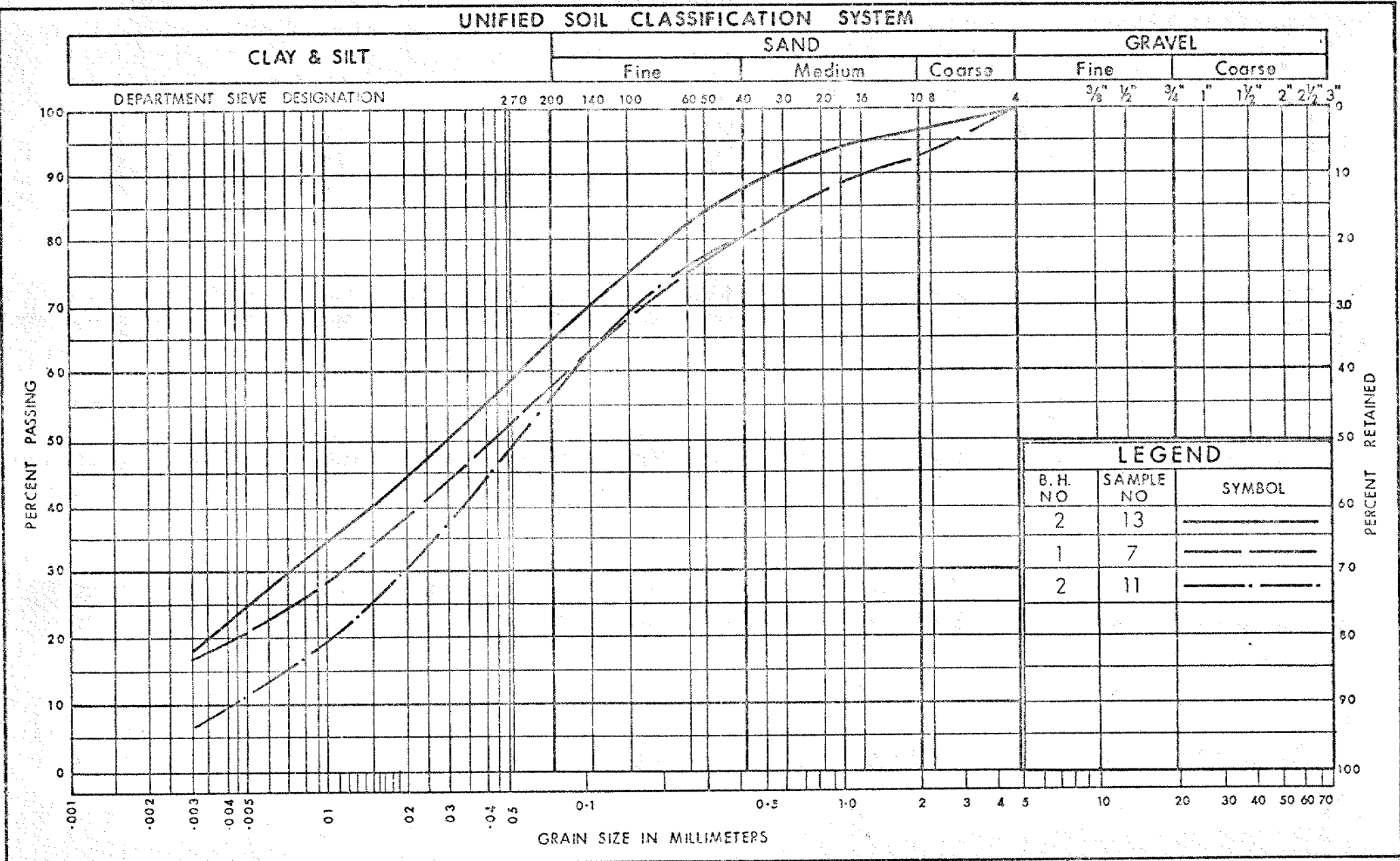
DESIGN SERVICES  
BRANCH

GRAIN SIZE DISTRIBUTION  
SILT  
WITH FINE SAND

W.P. No. 10-69-13

JOB No. 72-11088

FIG No. 2



4, ~~8~~, 9, 7, 7, 10, 12, 18, 3

32, 34, 53, 40, 36, 36, 35, 40, 34, 34, 34,  
39, 47, 43, 40, 38, 46, 38, 31, 32, 34, 39,  
50, 56, 60, 80, 125, 150

# VOID RATIO-PRESSURE CURVES

JOB NO. 72-11088

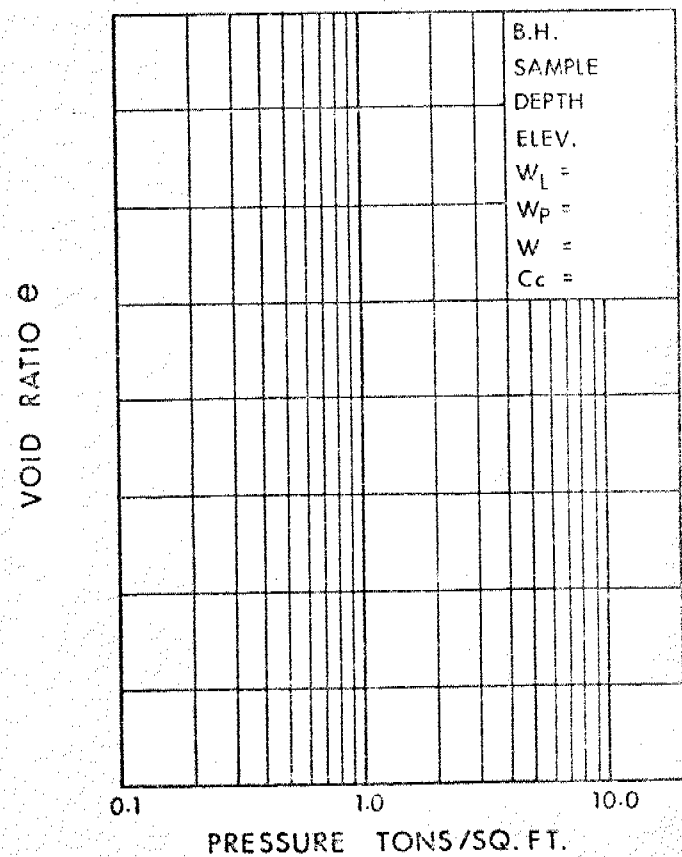
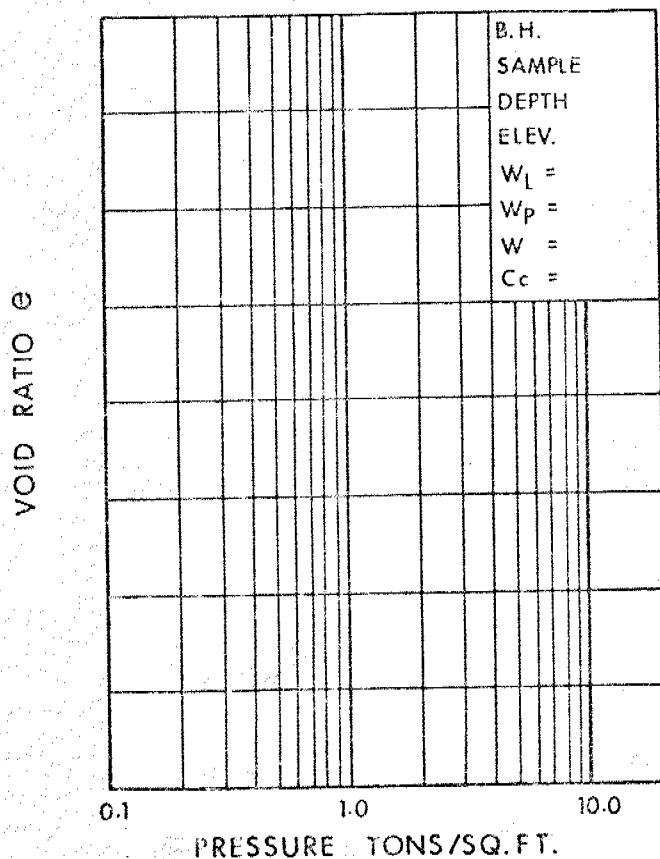
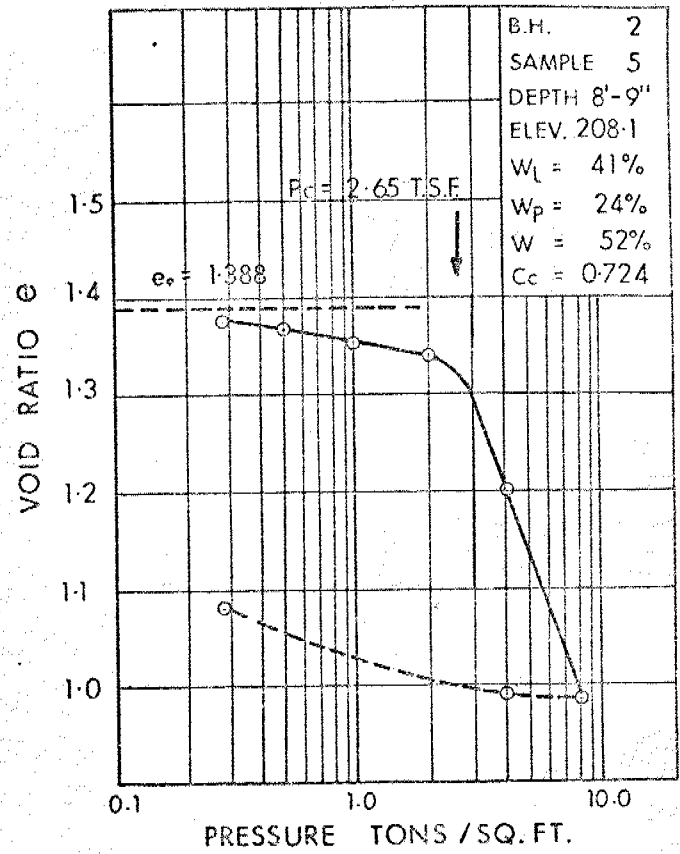
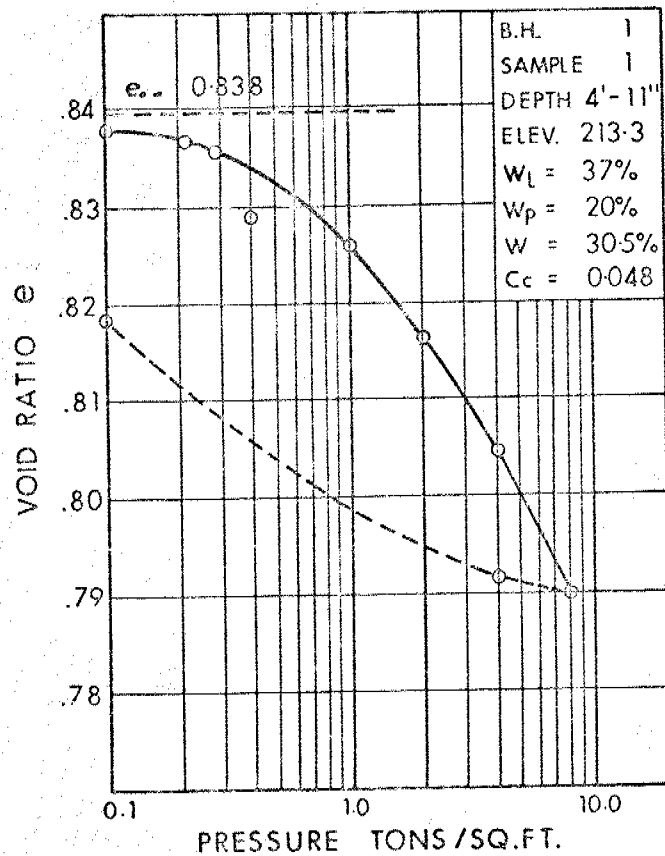


FIG. No. 4

## 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>c 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

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

### SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

# ABBREVIATIONS USED IN THIS REPORT

## SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	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
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

## GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF $\sigma$
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF $\sigma$ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

## STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

## EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	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
$\beta$	ANGLE OF SLOPE TO HORIZONTAL



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. M. Devata,  
Sup. Foundation Engineer.

FROM: Ken W. Ingham

ATTENTION:

DATE: January 2, 1973

OUR FILE REF.

IN REPLY TO

SUBJECT:

Foundation Investigation 72-11088;  
Highway 417 at Green Creek

The area is underlain by the Carlsbad formation, a dark grey shale somewhat calcareous with more or less fossil debris and thin vertical but irregular calcite veins throughout. Thin bedding is prominent; there are, however, medium bedded and also platy bedded sections. The shale parts readily parallel to the bedding planes imparting a general platy character to weathered or fractured zones.

Subordinate to the shale but nonetheless conspicuous are: layers of limey shale, shaley limestone and limestone. The limestone is for the most part silty, however, beds of pure light grey limestone are occasionally present. In general, the shaley beds range from 0.1 to 0.9 ft. in thickness and the bands of limestone from 0.1 to 0.5 ft.

A brief description of the rock encountered in borehole No. 2 is given below together with the appropriate bedrock elevation.

Hole No. 2

Bedrock at 170.8

46.0 - 51.5      Dark grey shale; medium bedded,  
occasional to frequent beds of  
limey shale, shaley limestone and  
silty limestone.

KWI:mv

K. W. Ingham,  
Geologist.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. T. C. Kingsland,  
Regional Structural Planning Eng.,  
Eastern Region,  
Kingston, Ontario.

FROM: Foundations Office,  
Design Services Branch,  
West Bldg., Downsview.

ATTENTION:

DATE: May 30, 1973.

OUR FILE REF.

IN REPLY TO

SUBJECT: Green Creek Diversion at Walkley Road Extension,  
Site #3-312, Twp. of Gloucester, Regional Municipality  
of Ottawa-Carleton, W.O. 72-11088 -- W.P. 10-69-13

A foundation investigation for the proposed structure at the crossing of the Walkley Road Extension and the Green Creek Diversion has been carried out. A detailed foundation report has been submitted (Report No. 72-11088, dated December 28, 1972).

During February 1973, two additional boreholes (B.H.'s #3 and #4) and one backhoe excavated test pit (T.P. #1) were put down at the open channel section of the Green Creek diversion. The results of this additional investigation were presented in an addendum submitted on February 21, 1973.

We are forwarding to you the Record of Borehole sheets (B.H.'s #3 and #4, and T.P. #1) and the revised Drawing No. 72-11088A, which should be included in our foundation report No. 72-11088.

Should you require further information regarding this project, please contact this Office.



M. Devata,  
SUPERVISING FOUNDATIONS ENGINEER.

MD/ao

Attch.

c.c. E. J. Orr  
B. R. Davis  
A. Rutka  
A. J. Percy  
J. E. Callaghan  
B. J. Giroux  
E. R. Saint  
G. A. Wrong  
B. A. Singh

Foundations Files  
Documents

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 3

JOB 72-11088

LOCATION Co-ords. 498,187 N; 232,023 E.

 ORIGINATED BY BTD

W.P. 10-69-13

BORING DATE Feb. 5, 1973

 COMPILED BY BTD

DATUM Geodetic

BOREHOLE TYPE Washboring, NX Casing

 CHECKED BY C/K

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$				BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000				WATER CONTENT %					
219.0	Ground Level															
0.0																
	Silty clay to clay.		1	SS	10	215										
	Very Stiff to Firm to Stiff		2	SS	7	210										
			3	TW	PM	205	+1.2	+2.4	x 5.3	+1.4						
			4	TW	PM	200	+1.4									
	seams of silt up to 1/2" thick					195	+0.4	+0.8								
194.0			5	TW	PM	190										
25.0	Silt with fine sand (with occasional thin seams of clayey silt)		6	SS	5											
187.0	Loose															
32.0	End of Borehole					185										

▼210.0

WL in open BH Feb.5/73

▼ 210.0  
WL in open  
BH Feb. 5/73

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 4

JOB 72-11088

LOCATION Co-ords. 497,939 N; 231,990 E.

 ORIGINATED BY BTD

W.P. 10-68-13

BORING DATE Feb. 5, 1973

 COMPILED BY BTD

DATUM Geodetic

BOREHOLE TYPE Wasnboring-NX Casing

 CHECKED BY MR.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$ $w_p$ ——— $w$ ——— $w_L$				BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.				WATER CONTENT %					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 400 800 1200 1600 2000									
216.7	Ground Level															
0.0	Silty clay to clay					215										
	Very Stiff to Firm		1	SS	9	210										
	Grey		2	SS	4	205										
			3	TW	PM	200										
	(seams of silt up to 1/2" thick)	4	TW	PM	195											
191.7	Silt with fine sand		5	TW	PM	190										
	(with occasional thin seams of clayey silt)															
184.7	Loose		6	SS	4	185										
32.0	End of Borehole															

202.0

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF TEST PIT NO 1

JOB 72-11088

LOCATION Co-ords. 498,013 N; 232,019 E.

ORIGINATED BY BTD

W.P. 10-69-13

BORING DATE February 2, 1973

COMPILED BY BTD

DATUM Geodetic

BOREHOLE TYPE Dug with Hy Hoe

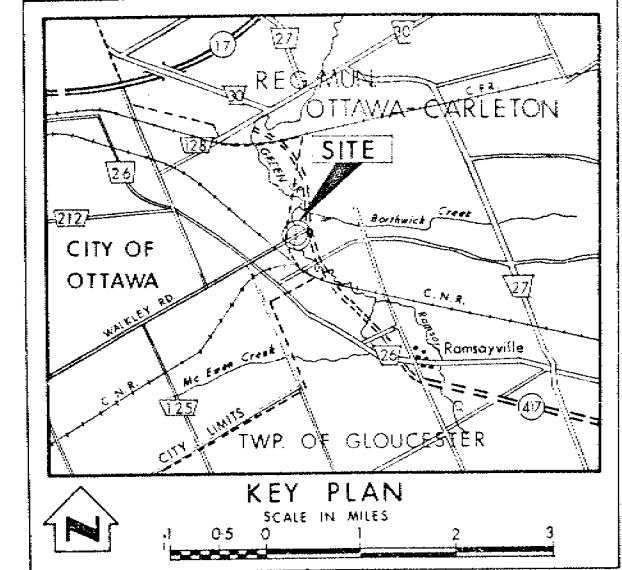
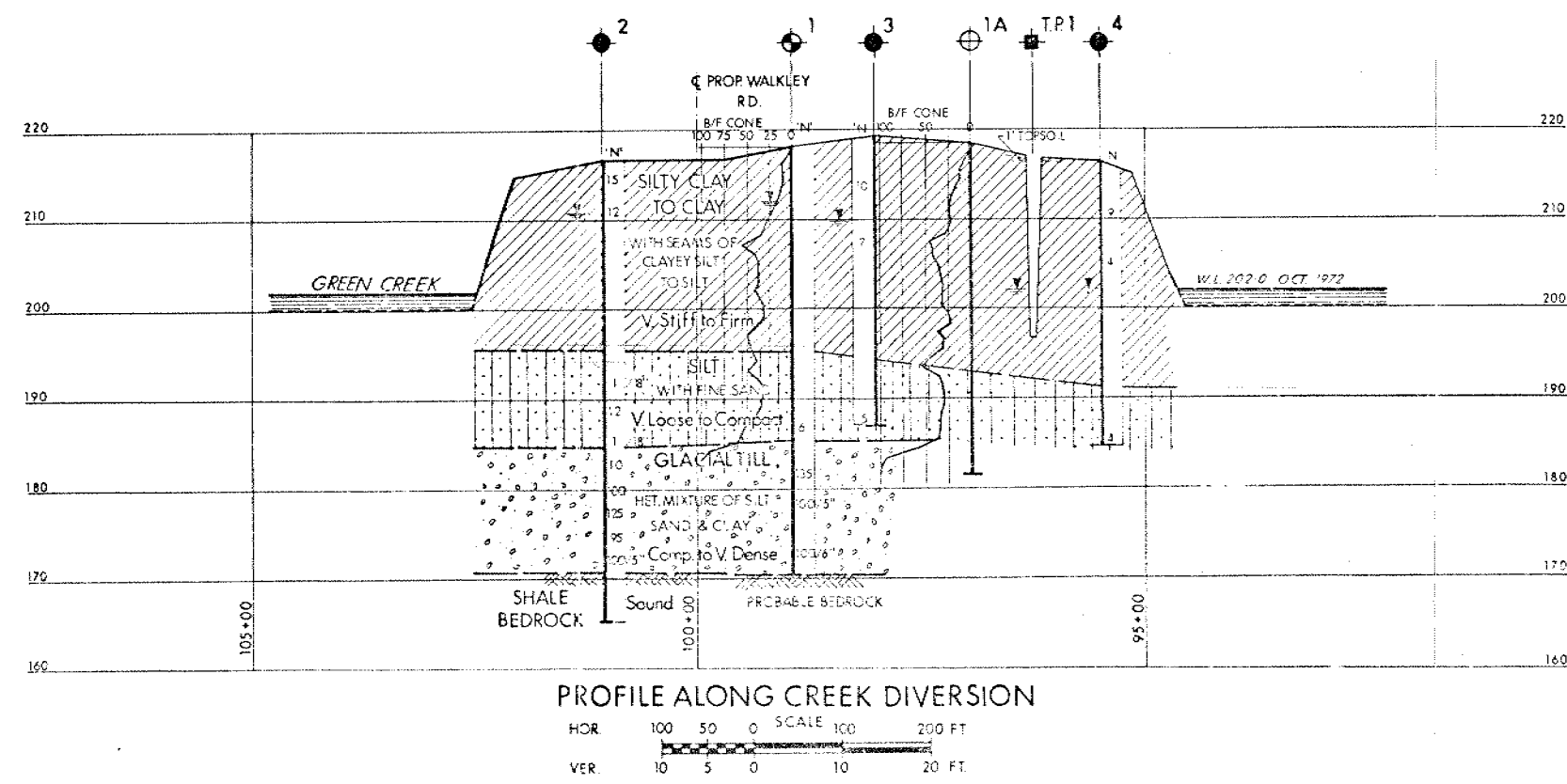
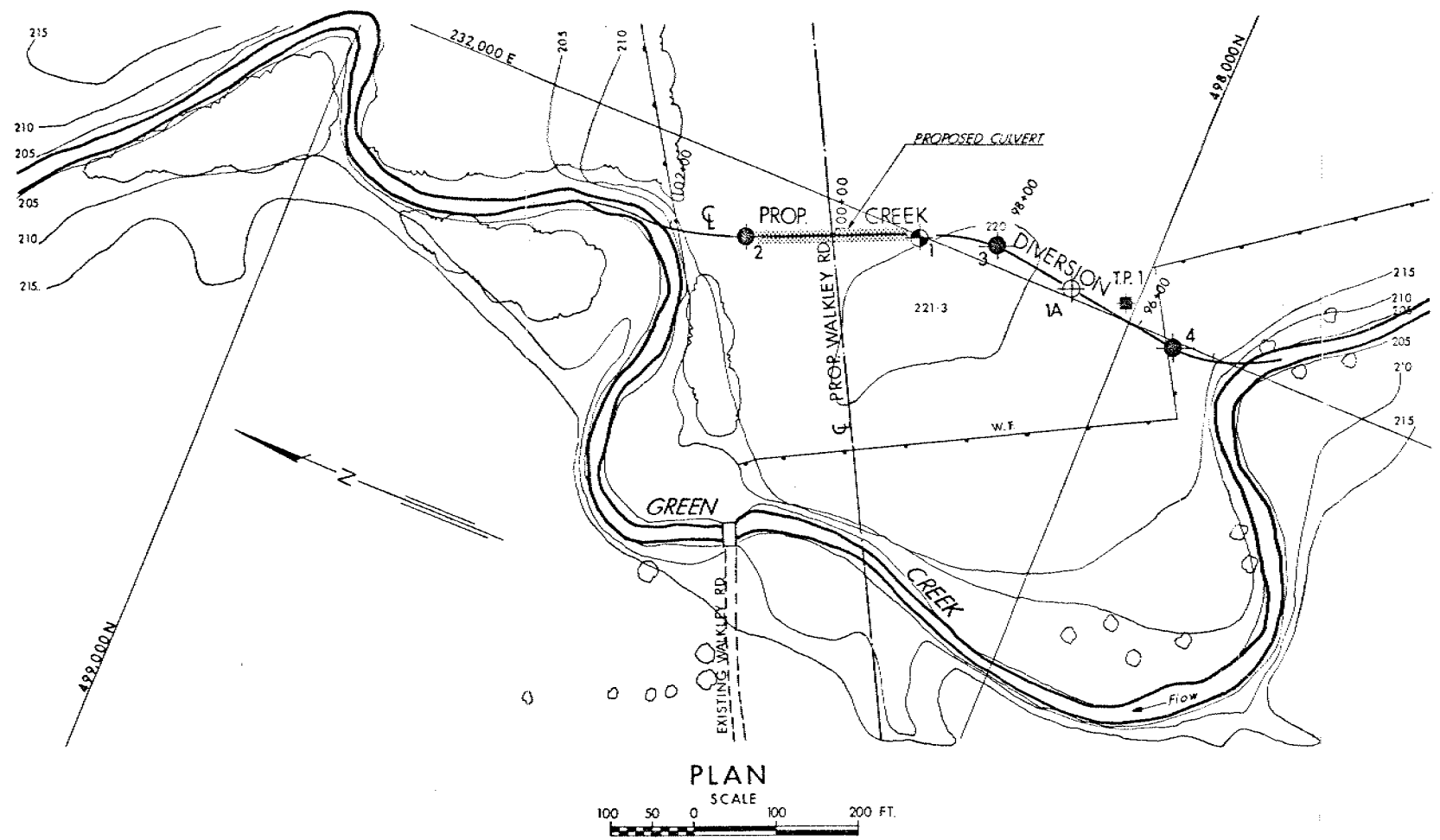
CHECKED BY SK

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$		BULK DENSITY $\gamma$ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT % $W_P$ $W$ $W_L$			
216.9	Ground Level											
0.0	Clayey Topsoil											
1.0	Clay to silty clay.  Very Stiff to Firm					215						
						210						
						205						
						200						
196.9												
20.0	End of Test Pit					195						

▼ 202.0

WL in Test  
Pit Feb. 2/73

OFFICE REPORT ON SOIL EXPLORATION



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation, OCT. 1972 & FEB. 1973		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	218.2	498,275	231,995
2	216.8	498,472	231,916
1A	218.8	498,080	232,010
3	219.0	498,187	232,023
4	216.7	497,939	231,990
T.P.1	216.9	498,013	232,019

— 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
1	10/24/73	S.O.	BORE HOLES 3, 4 & T.P.1 ADDED TO PLAN & PROFILE

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO  
DESIGN SERVICES BRANCH - FOUNDATIONS OFFICE

**GREEN CREEK DIVERSION**

HIGHWAY NO. WALKLEY ROAD DIST NO. 9  
CO. REGIONAL MUNICIPALITY OF OTTAWA - CARLETON  
TWP. GLoucester LOT A CON. 6

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBM'D C.P.	CHECKED <input checked="" type="checkbox"/>	W.P. NO. 10-67-13	DRAWING NO.
DRAWN F.L.	CHECKED <input checked="" type="checkbox"/>	W.C. NO. 72-11088	<b>72-11088A</b>
DATE	DEC 4, 1972	SITE NO.	BRIDGE DRAWING NO.
APPROVED		CONT. NO.	

PRINCIPAL ENGINEER



MEMORANDUM

TO: Mr. T. C. Kingsland, (2)  
Regional Structural Planning Eng.,  
Eastern Region,  
Kingston, Ontario.

FROM: Foundations Office,  
Design Services Branch,  
West Bldg., Downsview.

ATTENTION:

DATE: February 15, 1973.  
FEB 21 1973

OUR FILE REF. IN REPLY TO

SUBJECT:

ADDENDUM TO  
FOUNDATION INVESTIGATION REPORT  
Green Creek Diversion  
Test Pit (Station 96+25, o/s 20' Rt.)  
Twp. of Gloucester, Reg. Mun. of Ottawa-Carleton  
W.O. 72-11088 -- W.P. 10-69-13

1. INTRODUCTION:

A foundation investigation for the proposed structure at the crossing of the Walkley Rd. Extension and the Green Creek Diversion has been carried out. A detailed foundation report has been submitted (Report No. W.O. 72-11088, dated December 28, 1972).

The stratigraphical sequence across the site is composed of a 21 to 23 foot thick firm to very stiff silty clay stratum which is underlain by up to 11 feet of very loose to loose water bearing silt and fine sand. The granular deposit is underlain by glacial till followed by shale bedrock. It is understood that the invert of the structure and the open channel sections of the Green Creek Diversion are to be at about elevation 197 and 199, respectively. This would place the inverts near the base of the surficial clay stratum, anywhere from 2 to 4 feet above the surface of the water bearing silt and sand deposit.

As stated in the report the bottom of the structure and open channel excavations may heave due to the unbalanced hydrostatic water pressure head existing in the silt and sand

deposit. In order to investigate this possibility a test pit was dug in this area on Feb. 2, 1973, using a backhoe. This memo presents the factual information obtained from this test pit as well as our comments with regard to the potential construction problems.

## 2. TEST PIT OBSERVATIONS:

Location: Station 96+25, o/s 20' Rt.  
Dimensions: 12 feet by 15 feet by 20 feet deep  
Weather Conditions: Cloudy - Heavy Rain - Temp. 38° F

<u>Elev.</u>	<u>Stratigraphy - Soil</u>
217 - 216	Clayey Topsoil (brown)
216 - 209	Silty Clay (Desiccated Zone - brown)
209 - 197	Silty Clay (Grey)

End of Test Pit

### Groundwater Data

- Some groundwater seepage noticed at 15 feet depth (elevation 202)
- Groundwater accumulating in base of pit at 20 feet depth (elevation 197)
- Pit left open from 11:30 to 13:30 hrs. - 1 foot of water accumulated in base of pit

It should be noted that the base of the test pit did not appear to heave or boil from the time it was opened to the time it was backfilled (3 hrs. to excavate pit - left open for 2 hours).

## 3. COMMENTS PERTAINING TO CONSTRUCTION OPERATIONS:

### Structure - Green Creek Diversion and Walkley Rd. Extension:

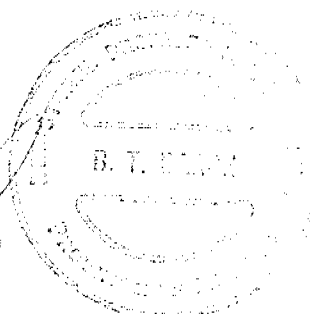
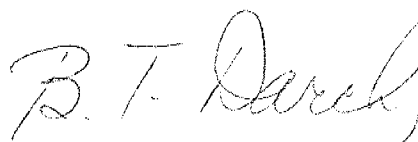
It is understood that twin 200 feet long multi-plate steel culverts, each 12 feet in diameter, will be placed at this site. Further, the base of the bedding for the culvert will be at about elevation 197. The test pit put down has indicated that groundwater seepage can be expected into an excavation extending to this depth. A dewatering scheme will, therefore, be required to facilitate construction in the dry.



February 15, 1973.

In order to minimize the possibility of the bottom of the excavation heaving due to the unbalanced hydrostatic water pressure head consideration should also be given to carrying out the structure installation in sections. For example, the open portion of the excavation should never be more than 30 feet long at any one time.

We believe that the aforementioned data will be sufficient for your immediate requirements. If we can be of any further assistance to you on this project, please contact this Office.



B. T. Darch,  
Senior Foundations Engineer,  
For: M. Devata,  
Supervising Foundations Engineer.

BTD/ao

cc: E. J. Orr  
B. R. Davis  
A. Rutka  
A. J. Percy  
J. E. Callaghan  
B. J. Giroux  
E. R. Saint  
G. A. Wrong  
B. A. Singh  
M. M. Dillon - Ottawa

Foundations Files ✓  
Documents

MINISTRY OF TRANSPORTATION & COMMUNICATIONS  
ONTARIO

GREEN CREEK CULVERTS

RECONSTRUCTED WALKLEY ROAD

SITE NO. 3-312

W.P. NO. 10-69-13

72-11-088

HIGHWAY 417 EASTBOUND

SITE NO. 3-313A

W.P. NO. 10-69-14

72-11-092

HIGHWAY 417 WESTBOUND

SITE NO. 3-313B

W.P. NO. 10-69-15

72-11-092

M. M. DILLON LIMITED  
CONSULTING ENGINEERS AND PLANNERS  
OTTAWA ONTARIO

MINISTRY OF TRANSPORTATION & COMMUNICATIONS  
ONTARIO

GREEN CREEK CULVERTS

TABLE OF CONTENTS

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4. SOILS CONDITIONS	3
5. CULVERT CROSS-SECTIONS	4
6. CULVERT PORTAL WALLS	5
7. OTHER DESIGN FACTORS	7
8. COST SUMMARY	8

EXHIBITS

SITE PLAN  
SINGLE CELL CULVERT  
TWIN CELL CULVERT  
TYPE I CIRCULAR CULVERT  
"SUPERSPAN" CULVERT  
45° PORTAL  
"HYPAR" PORTAL  
CURVED PORTAL  
PHOTOGRAPHS

MINISTRY OF TRANSPORTATION & COMMUNICATIONS  
ONTARIO

GREEN CREEK CULVERTS

1. RECOMMENDATIONS

The purpose of this report is to review design concepts and preliminary cost estimates for three major culverts on Green Creek associated with the construction of Highway 417 and ancillary roads.

The culvert locations are shown on the Site Plan included in the exhibits at the conclusion of this report. For all three sites, the following culvert details are recommended:

- a) Superspan steel cross-section (or similar) - for economic and ice control reasons.
- b) Curved portals - for economy consistent with aesthetics.

The total estimated costs, including engineering, based on the criteria outlined in this report are:

Walkley Road/Green Creek	\$ 118,000
EBL 417/Green Creek	160,000
WBL 417/Green Creek	<u>160,000</u>
TOTAL	<u>\$ 438,000</u>

## 2. HYDROLOGY

The report by M. M. Dillon Limited entitled "Hydrological Studies for Green Creek, Ottawa" dated February 1972 established culvert area and elevations for these structures, based on closed single-cell box culverts.

The cross-section types studied in this report are based on the areas and elevations in the aforementioned report, adjusted as required to suit section configuration and survey data.

## 3. ICE CONDITIONS

The Hydrology Report recommended clear span structures to avoid ice jam problems. Because the area in close proximity to the sites is rural and relatively sparsely populated, data on ice conditions from local residents is limited. Discussions held with three observers indicate that:

- some jamming does occur at existing bridges on the water-courses, but not as a yearly occurrence
- ice blocks range from 2 to 3 feet thick and 12 to 20 feet square
- since the creek is relatively shallow, the ice blocks rarely turn on edge

- as water level recedes, blocks of ice are frequently left beached  
on the stream banks

Inspection of foliage along the creek yields some minor evidence of ice damage. Some gouging of timber cribbing has occurred at two bridge locations - at the private lane to the Lancaster residence on Innes Road and at the abandoned structure on the extension of existing Walkley Road. However, this damage may have been caused by water-borne debris such as dead elm trees, etc., rather than ice.

#### 4. SOILS CONDITIONS

At the time of this report, detailed soils investigations have not been performed at the culvert sites. Soils profiles (for road design) and Foundation Investigation Reports for adjacent grade separation structures are available (Hwy 417/CNR Overhead Structures and Walkley Road Extension/Hwy 417 Grade Separation).

These reports generally indicate that below the thin topsoil layer, a stratum of firm to very stiff, sensitive clay extends to approximately elevation 197 (or slightly below invert levels of the culverts). Beneath the clay is a heterogeneous granular glacial till deposit to about elevation 183, followed by shale bedrock.

Piled foundations are recommended for the bridges noted above and consequently allowable bearing pressures for soil-supported structures are not contained therein. The portal walls for the culverts, which are described below, will impose toe pressures of 4 ksf. gross maximum at maximum height and would be founded at elevation 195 to 196. Cost estimates for these walls are based on footings supported on soil.

Anticipated long-term (5 years) settlements at the bridges are of the order of 4 to 5 inches for fills higher than will exist at the culverts. The short-term settlement (12 months) is estimated at about 2 inches. Settlements of these magnitudes will cause no structural problems for any of the culvert sections described below. However, it may be advisable to provide 6 inches extra freeboard if a rectangular culvert cross-section is selected.

## 5. CULVERT CROSS-SECTIONS

Exhibits at the conclusion of this report illustrate the four cross-sections studied for the Walkley Road/Green Creek site. The cross-sections for the Hwy 417/Green Creek structures are similar, except that the invert to soffit dimension is greater, as per the Hydrology Report. In addition, these culverts carry higher fills. Sufficient design calculations, and quantity and cost analyses have been done for the concrete alternatives to set estimated costs for the three sites.

Information received from representatives of Armco Canada Limited has permitted compilation of similar cost data for the "Superspan" steel alternative illustrated.

The estimated lineal foot costs which follow include excavation from and backfill to original grade, the supply and installation of concrete, and reinforcing steel or steel plate and concrete thrust blocks, allowances for contingencies (15%) and engineering (10%).

<u>Section Type</u>	<u>Walkley Road</u>	<u>Hwy 417</u>
Single Cell Box	\$1,065/LF	\$1,225/LF
Twin Cell Box	895/LF	1,040/LF
Type I Circular	1,250/LF	1,380/LF
"Superspan"	700/LF	780/LF

#### 6. CULVERT PORTAL WALLS

There are an infinite number of alternatives for the portal and retaining walls at culvert inlets and outlets. Three possibilities which satisfy aesthetic, hydraulic, structural, and maintenance factors to a high degree are illustrated in the attached exhibits. All are cast-in-situ concrete and can have a variety of surface textures or ornamentation.



#### 45° Portal

This type is an entrance/exit structure frequently used with culverts, is well suited to rectangular openings and is the least expensive of the three. Estimated cost, including excavation, backfill, concrete, reinforcing steel and engineering, etc., is \$8,000 per inlet/outlet or \$16,000 per culvert.

#### "Hypar" Portal

This type of inlet/outlet provides a smooth transition from trapezoidal open channel section to the closed culvert configuration. This type of transition is being used on the Balmoral Street Culvert presently under construction in Windsor, Ontario. It can be formed with straight timber. Estimated cost is \$20,000 per portal (\$40,000 per culvert). Photographs of the scale model of the Balmoral Street Transition are included with the exhibits.

#### Curved Portal

This type of portal is most suitable to curved culvert cross-sections (circular, oval, etc.) to provide a very pleasing appearance. Estimated cost is \$10,000 per portal or \$20,000 total per culvert.

## 7. OTHER DESIGN FACTORS

Use of twin circular steel pipe culverts was investigated with the assistance of Armco representatives but discarded as being more costly and less practical than the "Superspan" type.

The "Superspan" type of section is protected by patent rights and Armco Canada Limited is the only supplier of this type of section (employing concrete thrust beams).

To avoid patent infringements, Westeel-Rosco provide similar steel culvert cross-sections with heavier obvert plates in lieu of the concrete thrust beams. Competitive bidding for steel culverts of this size is possible by providing Contract Documents detailing both systems, and calling for alternative bids.

The Hwy 417 culverts (each 180 feet long) provide for three through lanes in each direction, plus speed change lanes and fill slopes of two horizontal to one vertical.

The Walkley Road culvert (140 feet long) provides for a divided four through lanes section, plus speed change lane and fill slopes of 2:1.

Use of flatter slopes would naturally increase the length of all alternatives and consequently the total cost.

The Innes Road Culverts referred to in the Hydrology Report, carry Green Creek under Hwy 417 on the portion of work being designed by De Leuw Cather & Company of Canada, Limited. At these sites, depth of cover is less and bedrock is higher than for the culverts studied in this report. It is understood that De Leuw Cather are presently evaluating rigid frame bridges versus "Superspan" steel culverts for these crossings.

#### 8. COST SUMMARY

##### WALKLEY ROAD/GREEN CREEK 140 FT. BETWEEN PORTALS

	<u>45° Portal</u>	<u>Hypar Portal</u>	<u>Curved Portal</u>
Single Cell	\$ 165,000	\$ 189,000	\$ 169,000
Twin Cell	141,000	165,000	145,000
Circular	191,000	215,000	195,000
"Superspan"	114,000	138,000	118,000

##### EBL HWY 417/GREEN CREEK 180 FT. BETWEEN PORTALS

	<u>45° Portal</u>	<u>Hypar Portal</u>	<u>Curved Portal</u>
Single Cell	\$ 237,000	\$ 261,000	\$ 241,000
Twin Cell	204,000	228,000	208,000
Circular	264,000	288,000	268,000
"Superspan"	156,000	180,000	160,000

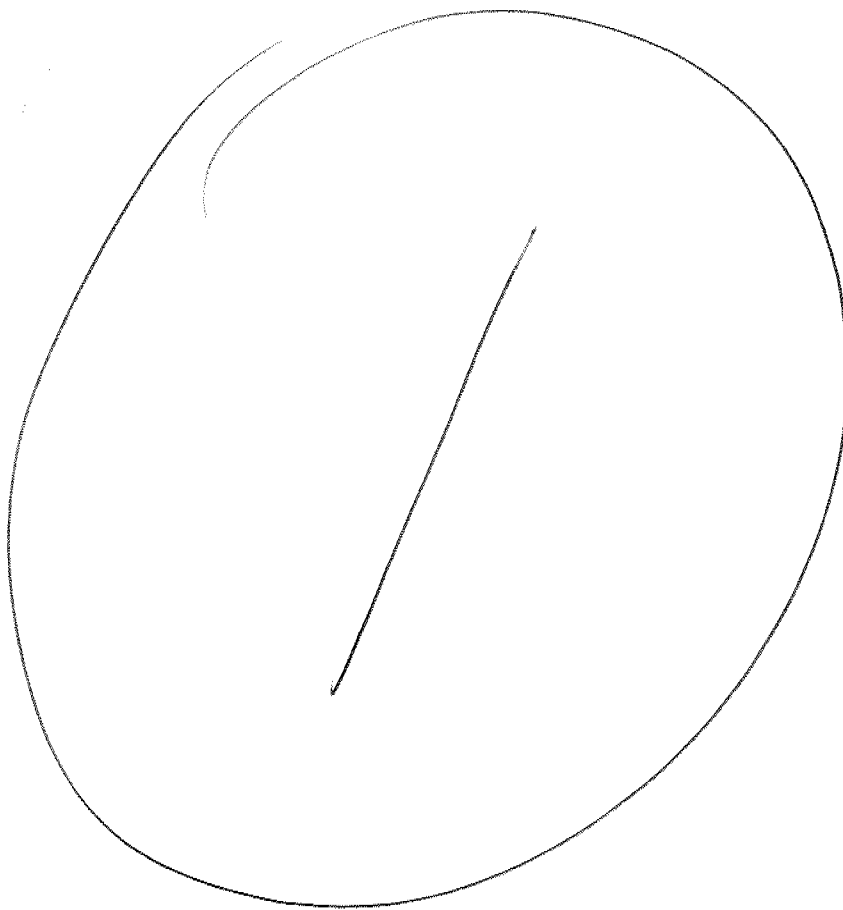
WBL HWY 417/GREEN CREEK  
180 FT. BETWEEN PORTALS

	<u>45° Portal</u>	<u>Hypar Portal</u>	<u>Curved Portal</u>
Single Cell	\$ 237,000	\$ 261,000	\$ 241,000
Twin Cell	204,000	228,000	208,000
Circular	264,000	288,000	268,000
"Superspan"	156,000	180,000	160,000

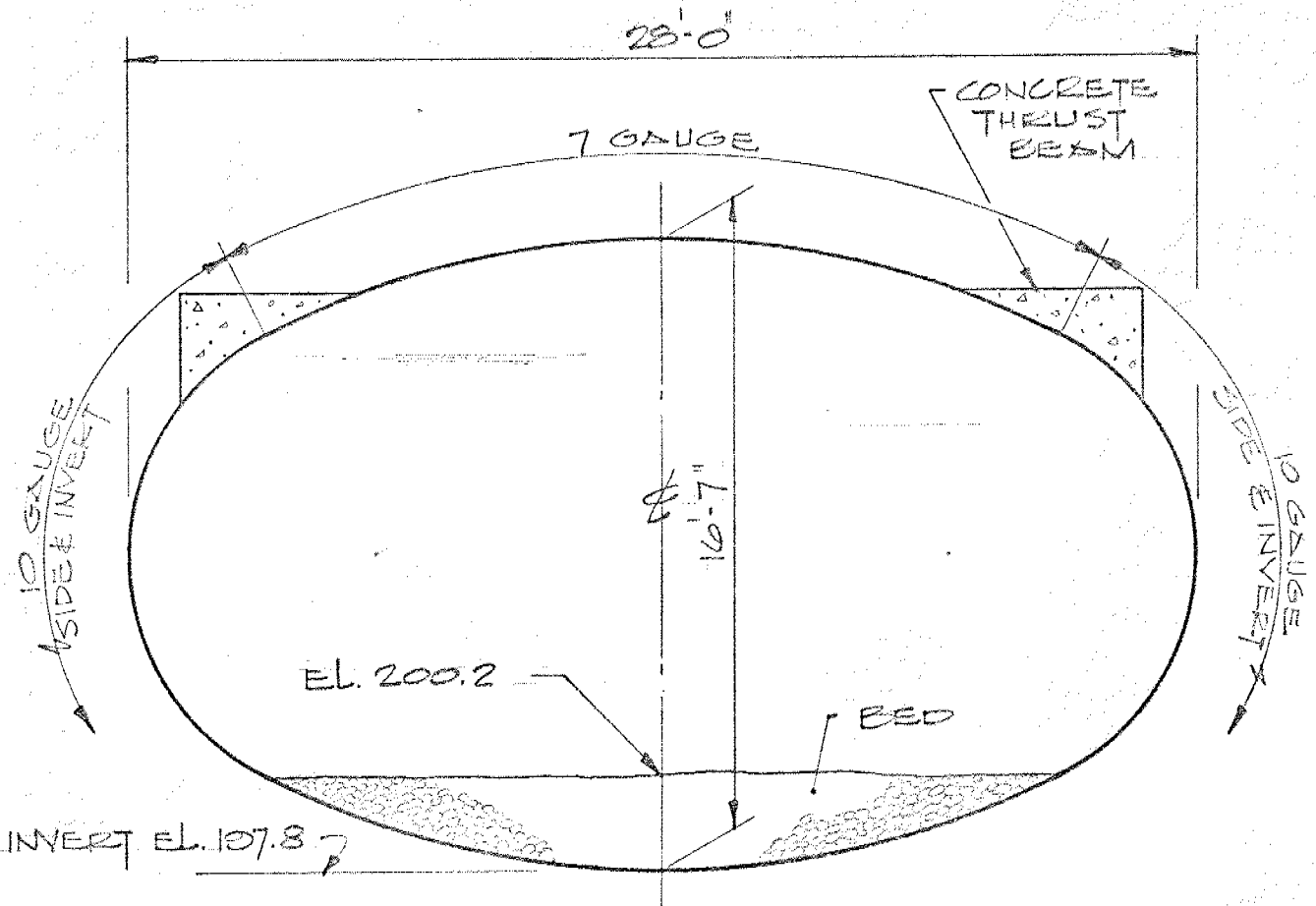
M. M. DILLON LIMITED  
CONSULTING ENGINEERS AND PLANNERS  
OTTAWA                      ONTARIO

35MM

DRAWING



FINISHED GRADE  
EL. 227.0'



SUPER SPAN

SCALE: 1" = 5'-0"



**M. M. DILLON LIMITED**  
CONSULTING ENGINEERS

TITLE **WALKLEY RD/GREEN CR.**

PROJECT

**HIGHWAY 417**

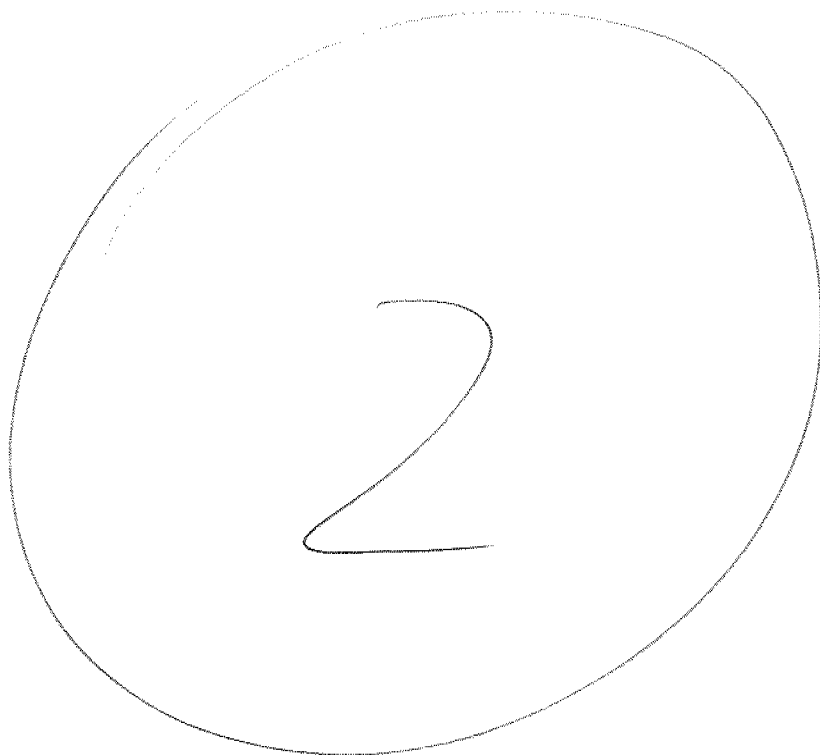
PROJECT NO.  
**6030-00**

DETAIL NO.

DATE **AUGUST 1972**

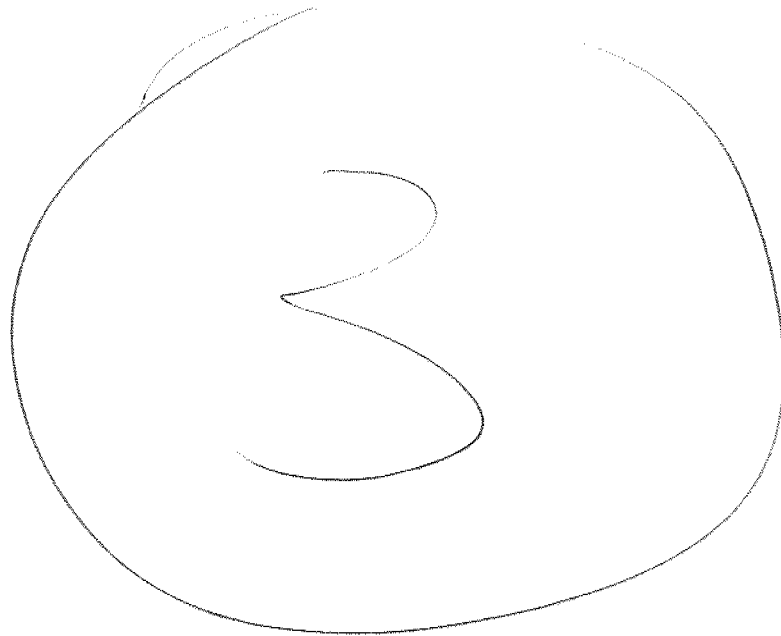
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DRAWING



35MM

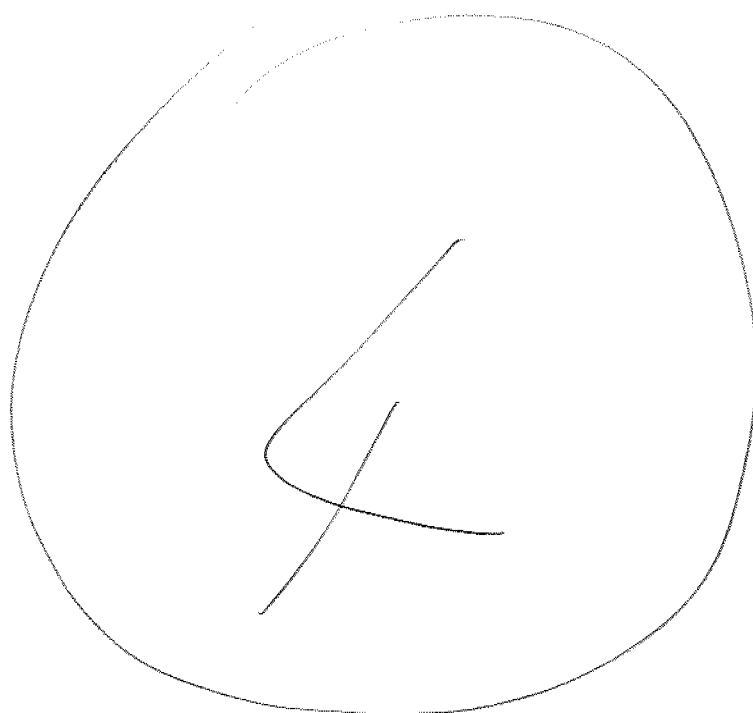
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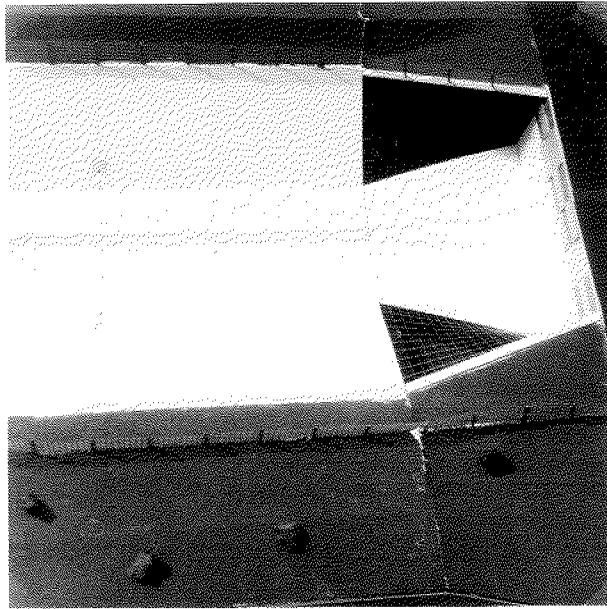




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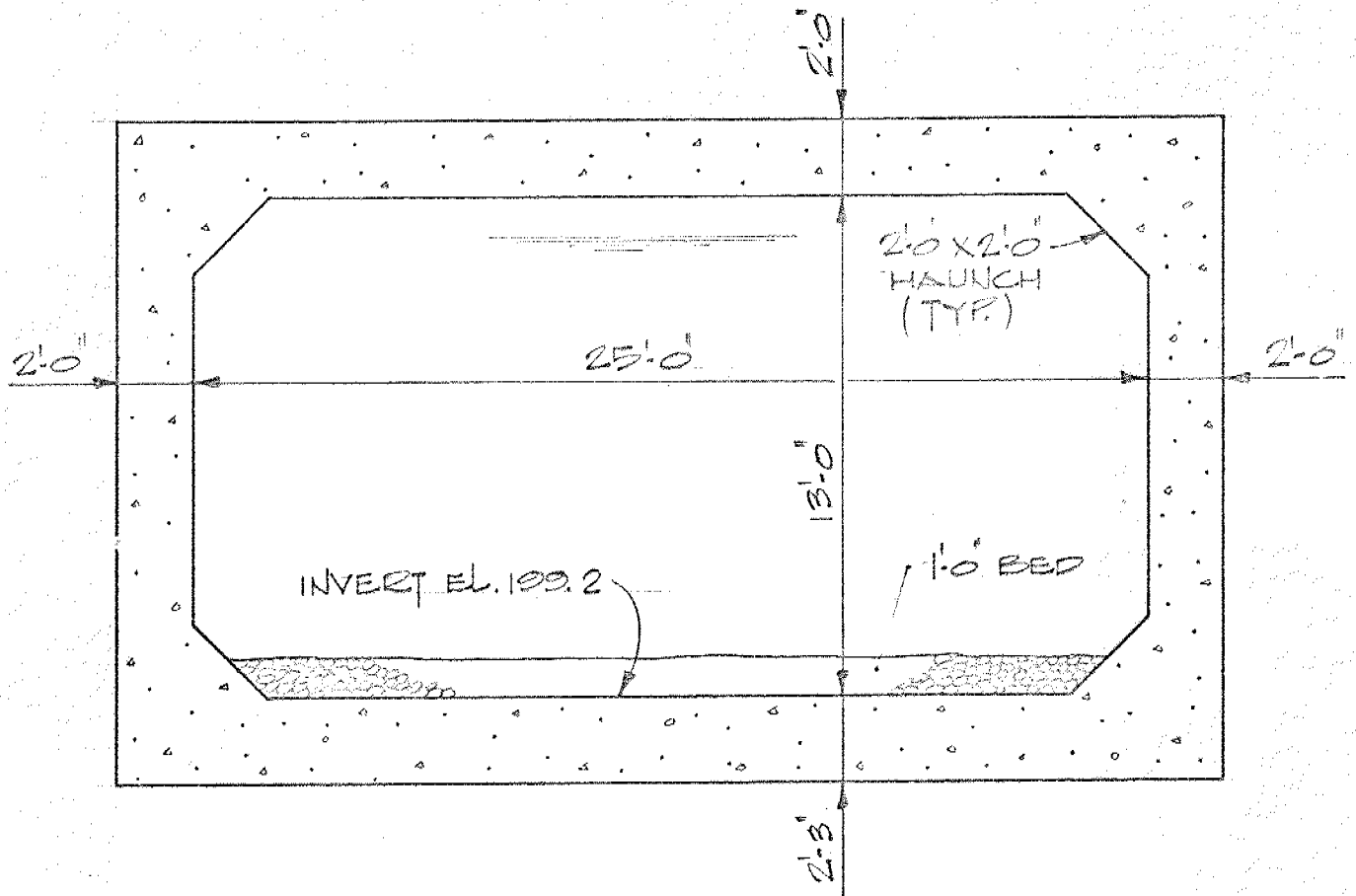
DRAWING





MODEL OF  
HYPAR TRANSITION SECTION  
BALMORAL STREET CULVERT - WINDSOR

FINISHED GRADE  
EL. 227.0±



SINGLE CELL BOX

SCALE: 1" = 5'-0"



M. M. DILLON LIMITED  
CONSULTING ENGINEERS

TITLE

WALKLEY RD./GREEN CR.

PROJECT NO.  
6830-00

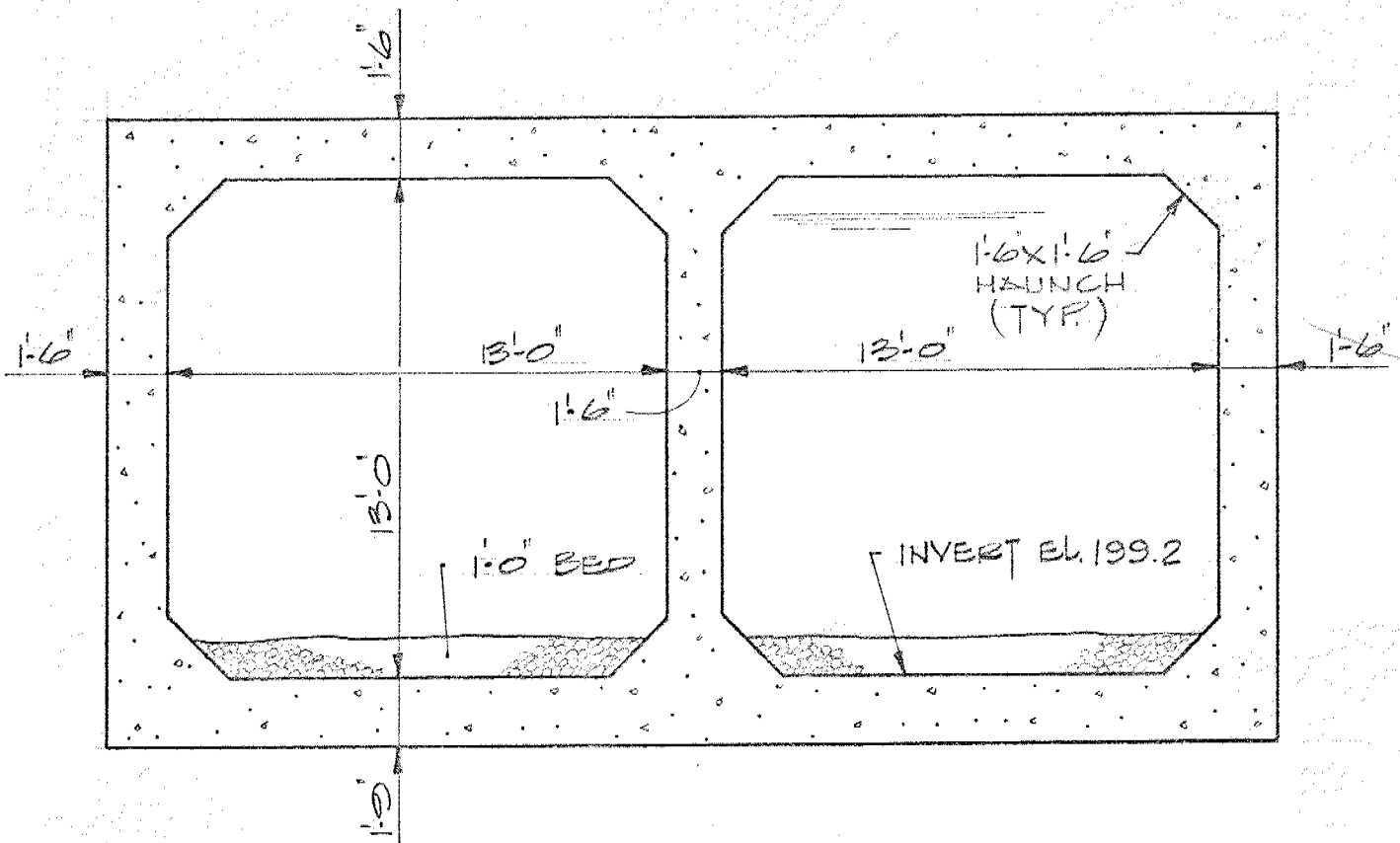
PROJECT

HIGHWAY 417

DETAIL NO.

DATE AUGUST 1972

FINISHED GRADE  
EL. 227.0±



TWIN CELL BOX

SCALE: 1" = 5'-0"



M. M. DILLON LIMITED  
CONSULTING ENGINEERS

DATE AUGUST 1972

TITLE

WALKLEY RD/GREEN CR.

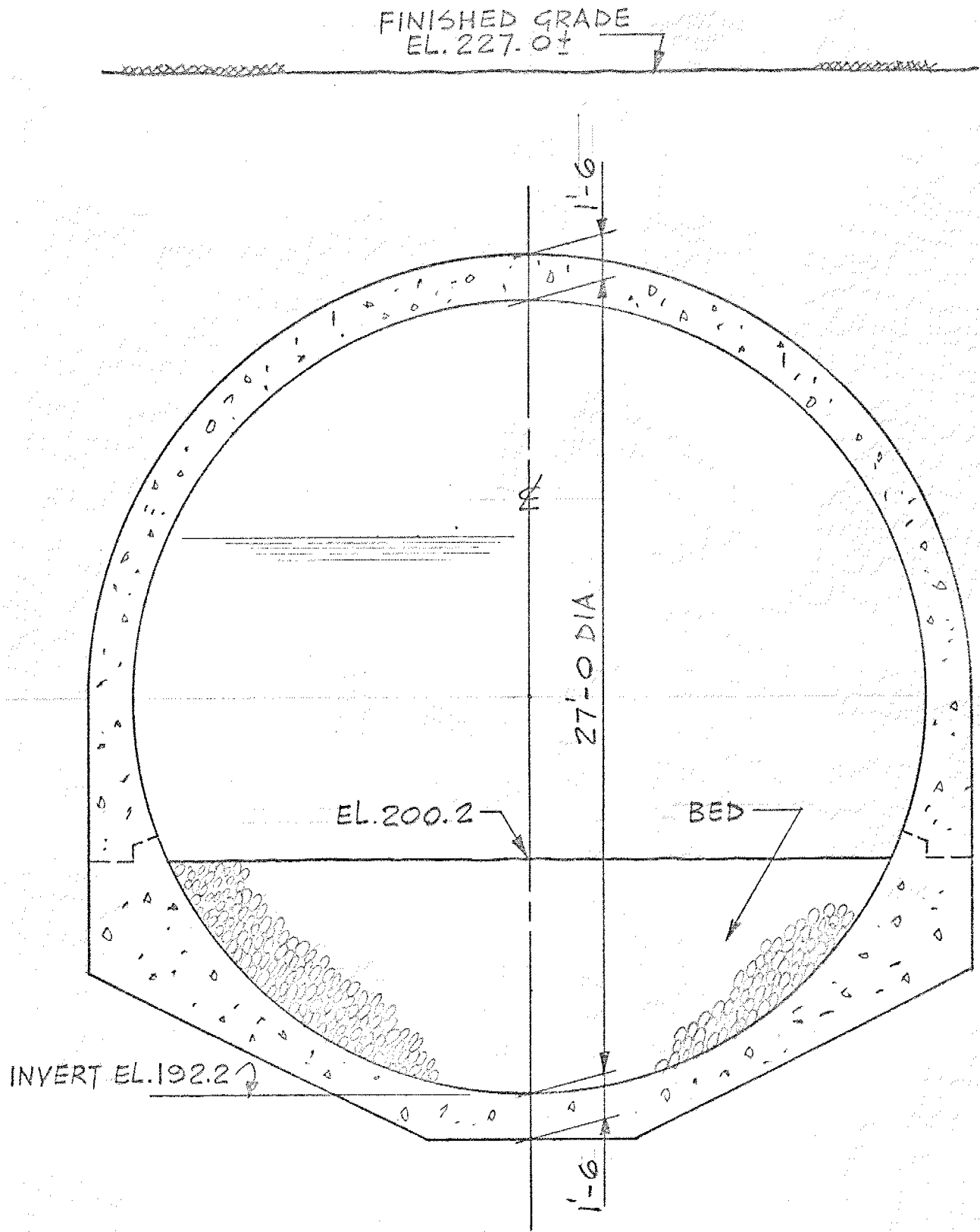
PROJECT

HIGHWAY 417

PROJECT NO.


6820-00

DETAIL NO.



# TYPE I CIRCULAR CULVERT

SCALE: 1" = 5'-0"

 <b>M. M. DILLON LIMITED</b> CONSULTING ENGINEERS	TITLE WALKLEY RD./GREEN CR.	PROJECT NO. 6830-00
DATE AUGUST 1972	PROJECT HIGHWAY 417	DETAIL NO.

72-11088

✓



FEB. 2/73

W.O 72-11088

GREEN CREEK DIVERSION SOUTH  
OF WAKELY RD. EXTENSION

PHOTO - ~~HY~~ HOE BACKHOE

USED TO DIG TEST PIT.

(20 FEET DEEP)

BTD





FEB. 2/73

W.O. 72-11088

GREEN CREEK DIVERSION

SHOT FROM <sup>SOUTH</sup>  
~~SOUTH~~ END OF FUTURE  
DIVERSION LOOKING NORTH.

B.T.D.

31



FEB. 2/73

W.O. 72-11082

GREEN CREEK DIVERSION SOUTH  
OF WAKELY RD. EXTENSION

SHOT " LOOKING SOUTH TOWARDS  
WHERE THE GREEN CREEK DIVER-  
SION WILL CONNECT WITH THE  
EXISTING CREEK

B.T.P.

4/



Feb. 2/73

W.O. 72-11088

TEST PIT STA. 96+25,  $\frac{1}{4}$  20' RT  
GREEN CREEK DIVERSION

---

PIT - 8' DEEP

CLAY - DRY

BTD



Feb. 2/73

W.O. 72-11088

TEST PIT STA 96+25,  $\frac{7}{8}$  20' RT  
GREEN CREEK DIVERSION

---

PIT - 15' DEEP.

CLAY - IN TACT AND

DRY

BTD.





Feb 2/73

W.O. 72-11088

TEST PIT STA. 96+25, 7s 20' RT

GREEN CREEK DIVERSION

---

TEST PIT 20' DEEP

1" OF WATER ENTERED INTO  
THE PIT IN 2 hrs.

BTD



Feb. 2/73

W.O. 72-11088

TEST PIT STA. 96+25, 7s 20' RT.  
GREEN CREEK DIVERSION

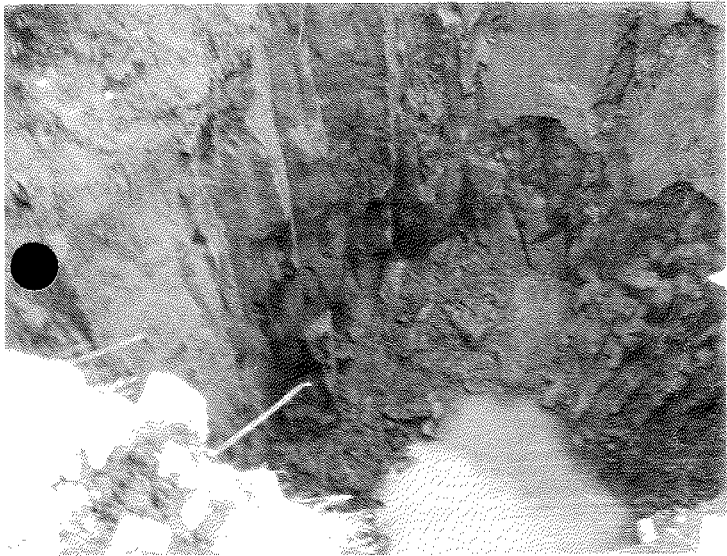
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— PIT 20' DEEP

— 1" OF WATER ENTERED INTO  
THE PIT IN 2 hrs.

BTD

8



Feb. 2/73

W.O. 72-11088

TEST PIT STA. 96+25, 18' 20' RT.

GREEN CREEK DIVERSION

---

- PIT 20' DEEP,

- 1' OF WATER ENTERED  
INTO THE PIT IN 2 HRS.

B.I.D.

9/



Feb. 2/73

W.O. 72-11088

TEST PIT STA. 96+25,  $\frac{7}{8}$  20' ET.  
GREEN CREEK DIVERSION

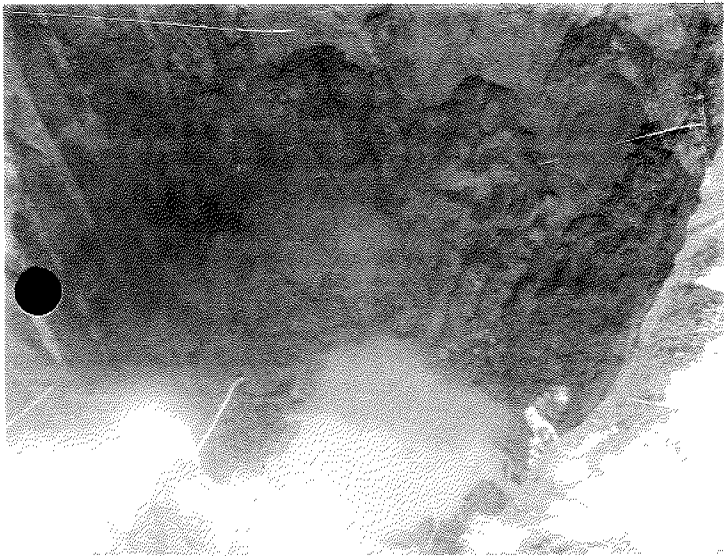
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— PIT 20' DEEP

— 1' OF WATER ENTERED  
INTO THE PIT IN 2 HRS

— NOTE BLOCKY STRUCTURE  
OF CLAY

BTD





Feb. 2/73

W.O. 72-11088

TEST PIT STA. 96+25, 7/8 20' R.  
GREEN CREEK DIVERSION.

— PIT 20' DEEP

— 1' OF WATER ENTERED  
THE PIT IN 2 HRS.

— B.T.D.



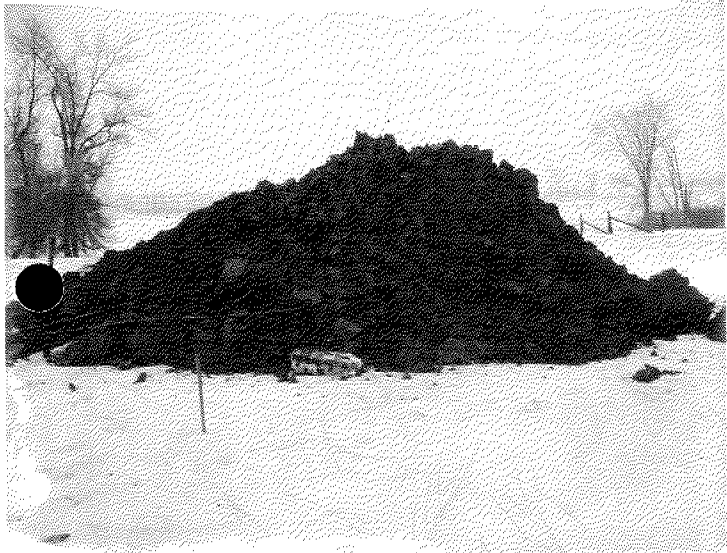
Feb. 2/73      W.O. 72-11088

TEST PIT STA. 96+25,  $\frac{7}{8}$  20' RT  
GREEN CREEK DIVERSION

---

- PIT 20' DEEP.
- 1' OF WATER ENTERED  
THE PIT IN 2 HRS.

3 TO  
CLAY SOIL EXCAVATED  
FROM PIT 12' x 15' by 20' DEEP



Feb. 2/73

W.O. 72-11088

TEST PIT STA. 96+25,  $\frac{3}{4}$  20' at  
GREEN CREEK DIVERSION.

- MATERIAL EXCAVATED  
FROM PIT, - MAINLY CLAY

S.T.D.

35MM

DRAWING

