

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40J16-50

DIST. 1 REGION

W.P. No. 41-71-02

CONT. No. 83-35

W. O. No.

STR. SITE No. 14-221

HWY. No. 21

LOCATION Black Creek Bridge #1

No. of PAGES -

=====
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

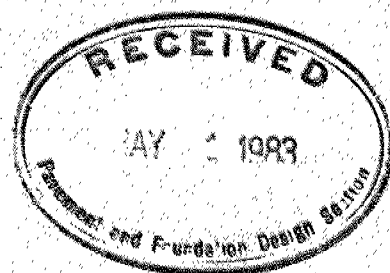
REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 83 - 35



Ministry of
Transportation and
Communications



I N D E X

<u>Page</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3	Soil Classification System
4 - 17	Foundation Investigation Report
	W.P. 41-71-02, Site: 14-195-221
	Black Creek Bridge, Village of Oil Springs

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

EXPLANATION OF TERMS USED IN REPORT

2

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

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 OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ 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	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

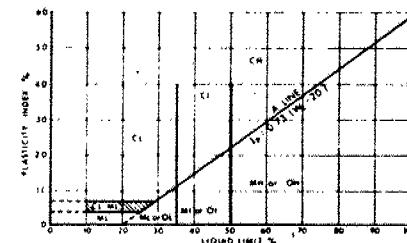
PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75 mm AND BASING FRACTIONS ON ESTIMATED MASS)					GROUP SYMBOL	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN 75 μm SMALLEST PARTICLE VISIBLE TO THE NAKED EYE	GRAVELS	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE			GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES	GIVE TYPE, NAME, IF NECESSARY, INDICATE APPROX. % OF SAND & GRAVEL, MAX. SIZE, ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS; LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION; & SYMBOL IN PARENTHESES. FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS	DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE. DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μm) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS: LESS THAN 5% GW, GP, SW, SP MORE THAN 12% GW, GC, SM, SC 5% TO 12% BORDERLINE CASES REQ. USE OF DUAL SYMBOLS
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES		
			NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)			GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES		
	SANDS	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES			SW	WELL GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES		
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING			SP	POORLY GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES		
			NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)			SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES		
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 μm SMALLEST PARTICLE VISIBLE TO THE NAKED EYE	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 μm								
	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)			GIVE TYPE, NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR IN WET CONDITION, ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESES. FOR UNDISTURBED SOILS ADD INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, MOISTURE & DRAINAGE CONDITIONS	
			NONE	QUICK	NONE	ML	INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR		
			MEDIUM TO HIGH	NONE TO VERY SLOW	MEDIUM	CL	CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS		
		LIQUID LIMIT BETWEEN 35% AND 50%	SLIGHT TO MEDIUM	SLOW	SLIGHT	OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS		
			NONE TO SLIGHT	SLOW TO QUICK	SLIGHT	MI	INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS		
			HIGH	NONE	MEDIUM TO HIGH	CI	SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY		
		LIQUID LIMIT GREATER THAN 50%	SLIGHT TO MEDIUM	VERY SLOW	SLIGHT	DI	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY		
			SLIGHT TO MEDIUM	SLOW TO NONE	MEDIUM	MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS		
			HIGH TO VERY HIGH	NONE	HIGH	CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS		
			MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
	HIGHLY ORGANIC SOILS						PE	PEAT & OTHER HIGHLY ORGANIC SOILS	

USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

BOUNDARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GW-GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

FOUNDATION INVESTIGATION REPORT
FOR

W.P. 41-71-02, Site: 14-195-221
Black Creek Bridge, Village of Oil Springs
Hwy. 21, District 1, Chatham

INTRODUCTION

This report summarizes the results of the foundation investigation required for the proposed structure at this site.

DESCRIPTION OF SITE AND GEOLOGY

The bridge site is on Hwy. 21 in a depression caused by Black Creek. The floor of the depression or valley is some 4.8 m lower than the surrounding area and some 304.8 m wide. This site is located just north of the Village of Oil Springs. The land on either side is used as pasture. There are a number of abandoned oil wells in the vicinity. The structure was widened to its present width in 1931.

Geologically, the site is in the physiographic region known as the St. Clair Clay Plain. The region is one of little relief with a deep deposit of clay. Most of Lambton County is essentially till plains smoothed by shallow deposits of lacustrine clay which settled in the depressions while the knolls were being lowered by wave action.

FIELD WORK AND LABORATORY INVESTIGATIONS

The field work consisted of 2 sampled boreholes and 3 dynamic cone tests, 2 of the cone tests being adjacent to the boreholes. The drilling was done by a muskeg vehicle mounted C.M.E. 55 equipped with standard augers. Disturbed samples were obtained by driving a split spoon sampler into the subsoil. Undisturbed samples were taken using a 50.8 mm I.D. thin-walled Shelby Tubes, pushed into the soil hydraulically.

Soil samples were identified in the field and again upon arrival in the laboratory. Tests to determine moisture content, grain size and Atterberg Limits were carried out on representative samples. Soil samples obtained from the Shelby Tubes were subjected to unconfined compression, quick triaxial and laboratory vane tests. All field and laboratory test results are recorded in the accompanying borelog sheets.

The groundwater levels across the site were determined by recording the water level in the open boreholes over the period of the investigation.

The locations and elevations of the boreholes were determined in the field from a benchmark located in the structure. A stratigraphical profile is plotted on Drawing No. 2 of the contract package.

SUBSOIL CONDITIONS

General

The subsoil at this site generally consists of some 18.3 m of cohesive soil overlying limestone and shale bedrock. The layer from the surface downward is, in B.H. #2, silty clay traces of sand, gravel and organics, and in B.H. #4 sand with clay, silt and gravel. Following these top layers is a deposit of silty clay with seams of sand and silt found in both holes, then silty clay to clayey silt some sand, (till) and below this a heterogeneous mixture of sand, gravel, silt and clay (till), and then bedrock which consists of limestone and shale.

Sand with Clay, Silt and Gravel, traces of Organics

Borehole #4 was placed in the creek where there was 0.2 m of water followed by 1.8 m of sand with clay, silt and gravel. The organic content measure in one sample was 5.1%. The 'N' value within this layer was 5 blows/305 mm corresponding to a loose relative density. The natural moisture content was calculated to be 30%.

Silty Clay traces of Sand, Gravel and Organics

This material was found in B.H. #2 which was placed on the bank of the creek. The silty clay traces of sand, gravel and organics extends down to 2.1 m below the surface to elev. 190.5 m. The 'N' values within this layer were 7 to 10 blows per 305 mm. The organic content was measured to be 3.5%. The plastic limit was calculated to be 29%, natural moisture content 38% and liquid limit 53%. The consistency of this material can be described as firm to stiff.

Silty Clay, seams of Silt and Sand

This layer was encountered between elev. 189.6 m and elev. 187.4 m in B.H. #4 and elev. 190.5 m and elev. 187.4 m in B.H. #2. In B.H. #4 the silty clay was 2.1 m in thickness and in B.H. #2, 3.0 m in thickness. The 'N' values within this layer varied from 7 to 13 blows per 305 mm. A localized sandy area with 33% sand was encountered in B.H. #4 sample #3. The properties of this layer are given below.

Natural Moisture Content (%) :	27-32
Liquid Limited (%) :	46-49
Plastic Limited (%) :	21-25
Bulk Density γ :	(kN/m ³) : (18.54-19.62)

Undrained Shear Strength

Laboratory Vane	(kPa) : 104.1 - 137.2
Unconfined Compression Test	(kPa) : 64.6 - 103.2
Triaxial Compression Test	(kPa) : 78.3

Laboratory grain size analysis produced the following distribution:

Gravel (%)	0
Sand (%)	0
Silt (%)	45-56
Clay (%)	44-55

Typical grain size distribution envelope and plasticity chart appears in the Appendix as Figures 1 and 2 respectively.

Silty Clay to Clayey Silt some Sand (Till)

In both Boreholes this layer was found at about elev. 187.4 m and extends for a distance of 9.4 to 9.1 m.

While augering Borehole #2, two layers of cobbles 0.3 to 0.6 m thick were encountered. The 'N' values measured within this material varied from 14 to 37 blows per 305 mm. Grain size analysis produced the following results:

Gravel (%)	0
Sand (%)	12-24
Silt (%)	52-61
Clay (%)	24-33

Natural moisture content and Atterberg Limits are as follows:

Natural Moisture Content (%)	18-28
Liquid Limit (%)	36-38
Plastic Limit (%)	20

A plasticity chart and grain size distribution envelope are included in the Appendix as Figures 3 and 4 respectively.

Heterogeneous Mixture of Silt, Sand, Gravel and Clay (Till)

This was the final layer sampled above the bedrock. It was found in B.H. #4, 14.2 m below the surface and in B.H. #2, 13.5 m below the surface. The average thickness is about 4.0 m. In both Boreholes, cobbles were encountered within the layer. The 'N' values measured within this layer varied from 73 to more than 100 blows per 305 mm, corresponding to a relative density of very dense. The natural moisture content of this layer was about 8%. Laboratory grain size analysis produced the following distribution:

Gravel (%)	: 24-25%
Sand (%)	: 25-49%
Silt (%)	: 22-32%
Clay (%)	: 4-19%

A typical grain size curve envelope is included in the Appendix as Figure 5.

Bedrock

The bedrock cored in B.H.#4 was identified by Geologist B. Glassford as follows:

el. 174.3 - 174.1 m	Limestone, grey, hard med. grain;
el. 174.1 - 173.9 m	Limestone, grey, hard med.to coarse grain with thin seams of shale;
el. 173.9 - 173.8 m	Limestone, grey, hard, med. to coarse grain;
el. 173.8 - 172.9 m	Shale, grey, soft with 3 up to 25.4 mm shaly limestone sections.

The bedrock is described as sound.

Groundwater

The groundwater levels were measured within the open boreholes over the duration of the field work.

B.H. #2 - Dry hole, probable water level 191.5 m;

B.H. #3 - El. 191.5 m - (Creek water elevation);

B.H. #4 - El. 191.5 m - (Creek water elevation).

During the investigation of Borehole #2, no groundwater was encountered because of the impervious nature of the subsoil. When bedrock was encountered, natural oil rose to elevation 185.3 m.

Miscellaneous

The field work was carried out from Jan. 7 to 10, 1974, and was supervised by Mr. P. Korgemagi, Project Foundations Engineer, M.T.C.

The equipment used was owned and operated by Master Soils Investigation, Rexdale, Ontario.

This report was written by Mr. P. Korgemagi and reviewed by Mr. K. G. Selby, Supervising Foundations Engineer.



:gm

D. H. Dundas
D. H. Dundas, P.Eng.,
Project Foundations Engineer.

K. G. Selby
K. G. Selby, P.Eng.,
Senior Foundations Engineer.

RECORD OF BOREHOLE No 2

METRIC 10.

W P 41-71-02 LOCATION Sta. 13 + 116.7 10.7 m Lt. of Hwy. 21 ORIGINATED BY PK
DIST 1 HWY 21 BOREHOLE TYPE Auger & Cone Test COMPILED BY SO
DATUM Geodetic DATE 74 01 09 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	15 30 45					
192.6	Ground Level													
0.0	Topsoil						192							
	Silty Clay, Traces of Sand, Gravel & Organics		1	SS	7									
190.5	Firm to Stiff		2	SS	10									
2.1	Silty Clay, Seams of Silt, Grey, Stiff		2A	TW	PH		190						19.3	Org. Cont. 3.56
			3	SS	12								18.5	0 0 45 55
			3A	TW	PH								19.5	
			4	TW	PH									
187.4			5	SS	13		188							0 0 56 44
5.2			6	SS	14		186							0 24 52 24
	Cobbles		7	SS	19		184							0 15 61 24
	Silty Clay to Clayey Silt (Till)		8	SS	22		182							
	Cobbles		9	SS	20		180							
	Grey Stiff to Hard		10	SS	34		178							
178.4							176							
14.2							174							
	Cobbles													
	Het. Mixture of Sand, Gravel & Clay (Till) V. Dense,													25 49 22 4
	Cobbles													
173.8			12	SS	50/0 cm									
18.8	End of Borehole Probable Bedrock													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

11

W P 41-71-02 LOCATION Sta. 13 + 127.2 11.3 m Rt. of Hwy. 21 ORIGINATED BY PK
 DIST 1 HWY 21 BOREHOLE TYPE Cone Test COMPILED BY SO
 DATUM Geodetic DATE 74 01 08 CHECKED BY LS

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									
191.5	Water Level													
0.0	Water													
0.3	Probable Sand													
	Probable Silty Clay													
186.0	End of Cone Test													

SERIES REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

METRIC

12

W P 41-71-02 LOCATION Sta. 13 + 103.2 7.8 m Rt. of Hwy. 21 ORIGINATED BY PK
DIST 1 HWY 21 BOREHOLE TYPE Auger & Cone Test COMPILED BY SO
DATUM Geodetic DATE 74 01 07 & 08 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
191.5	Water Level													
0.0	Water													
0.2	Sand with Silt, Clay & Gravel, Traces of Organics Loose		1	SS	5		190							Org. Cont. 5.11
189.5			2	SS	7									
2.0	Silty Clay, Seams of Silt & Sand Firm to Stiff		3	SS	10		188							0 33 42 25
187.4			4	SS	9									
4.1			5	SS	22		186							
			6	SS	23									0 15 49 36
			7	SS	25		184							
	Silty Clay to Clayey Silt Some Sand Grey Stiff to Hard		8	SS	34		182							0 15 52 33
			9	SS	37		180							0 12 57 31
			10	SS	14									
178.0							178							
13.5	Cobbles													
	Net. Mixture of Silt, Sand, Gravel & Clay (Till) Very Dense		11	SS	73		176							24 25 32 19
174.5			12	SS	100/2 cm									
17.0	Limestone & Shale Bedrock Sound		13	BXL RC	95%		174							
172.9														
18.6	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

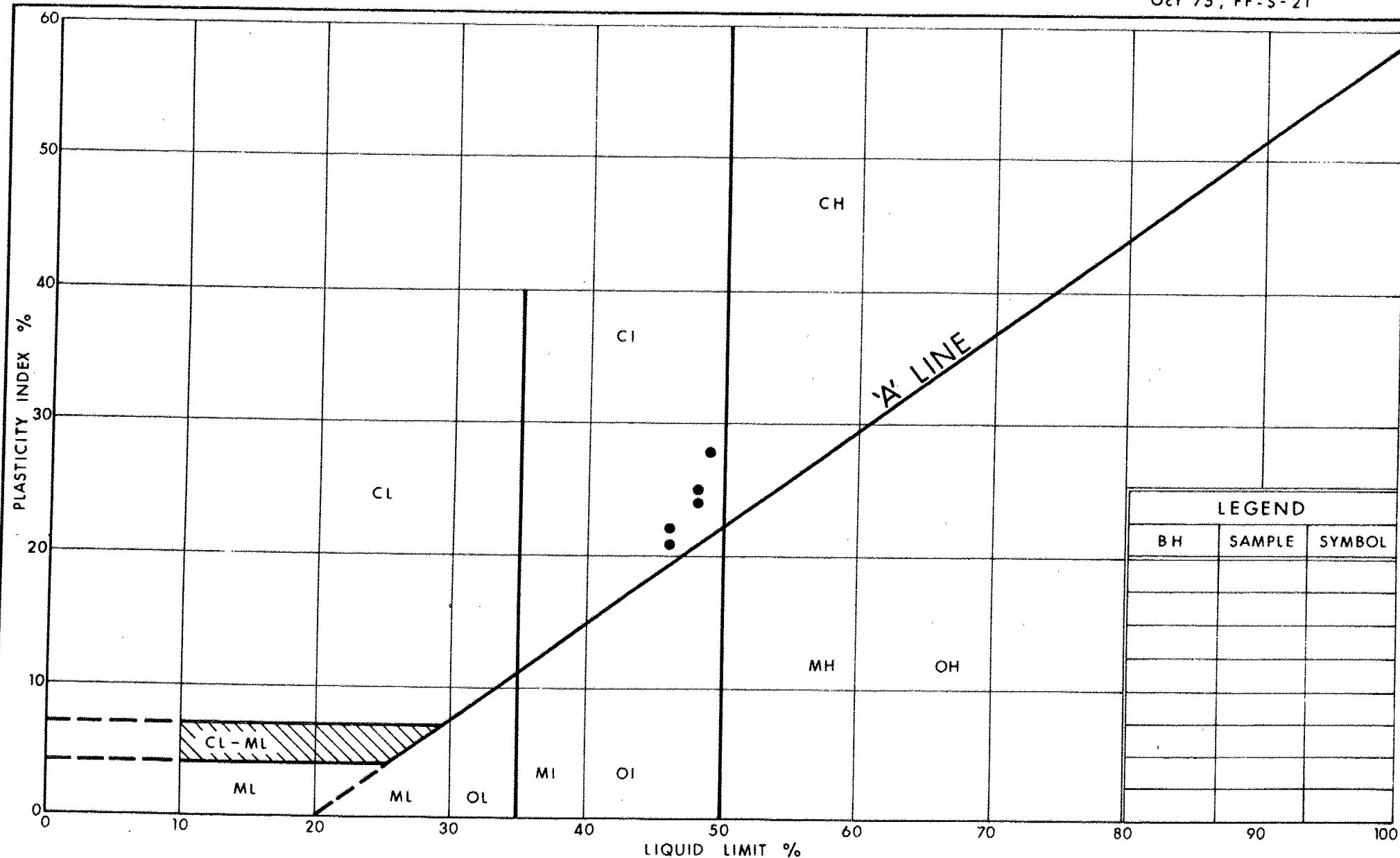
20
15 5 (%) STRAIN AT FAILURE
10

Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION SILTY CLAY

FIG No 1

W P 41-71-02

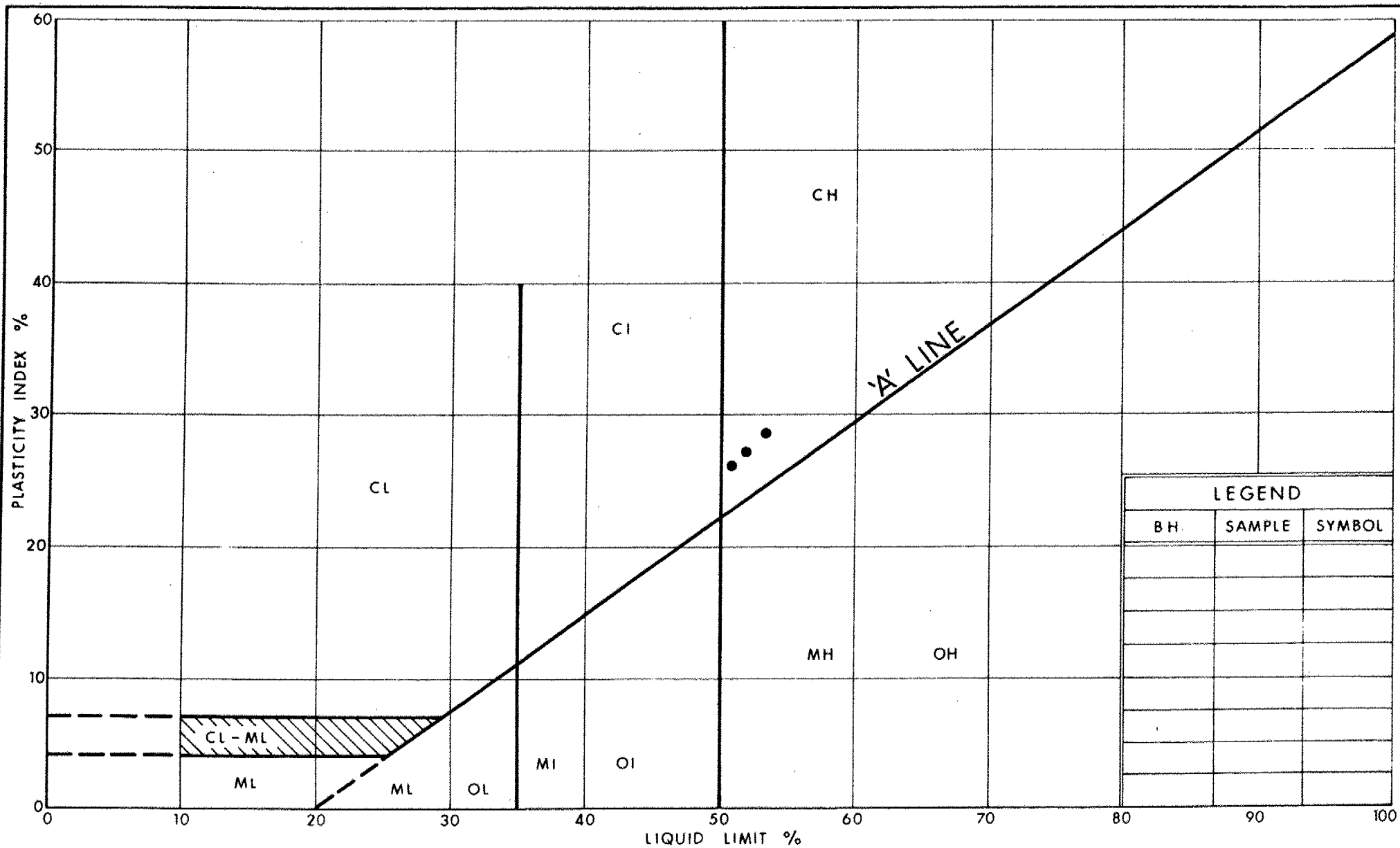


Ministry of
Transportation and
Communications

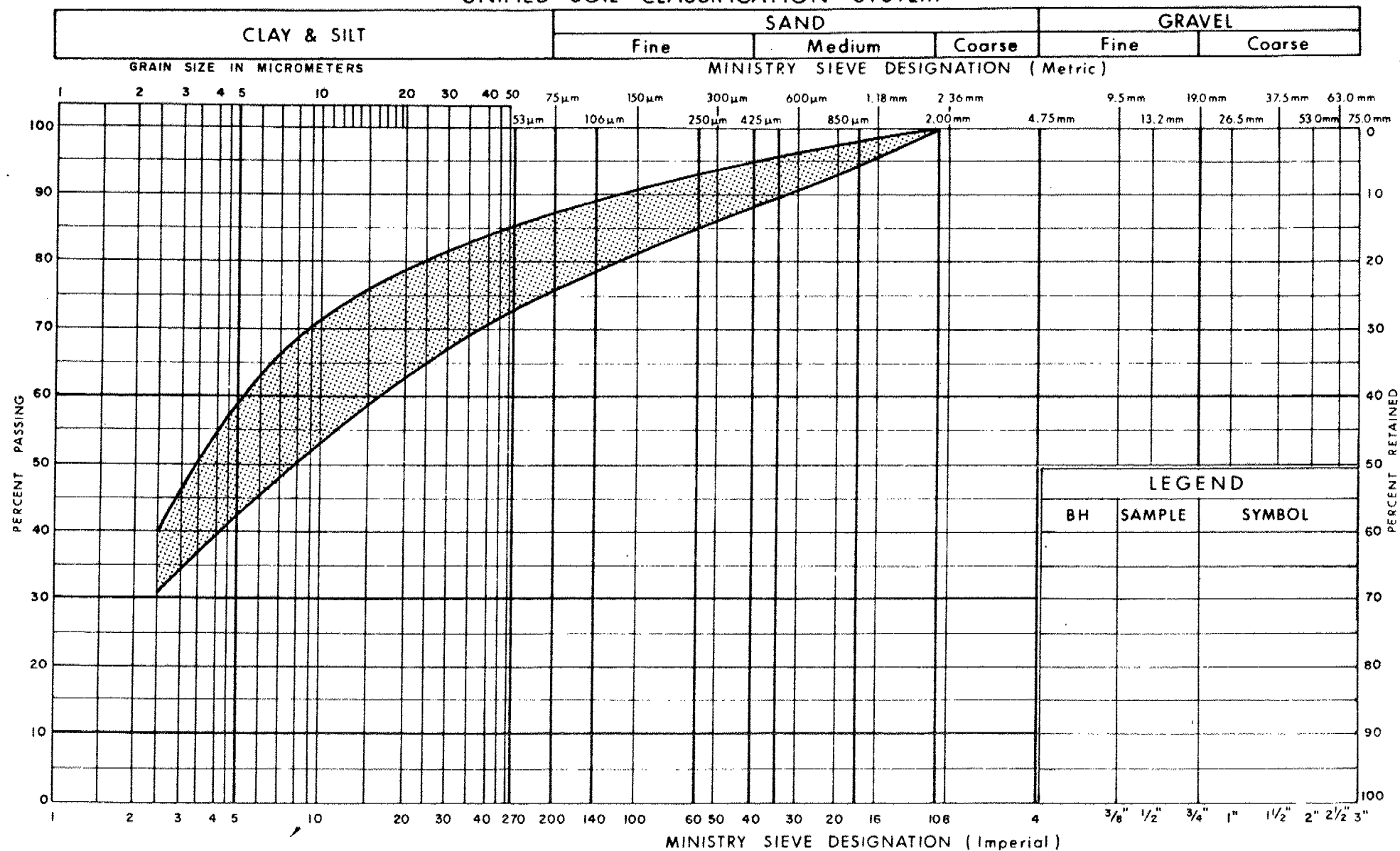
PLASTICITY CHART SILTY CLAY

FIG No 2

W P 41-71-02



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAYEY SILT
(Till) SOME SAND

FIG No 4

W P 41-71-02



**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION

HET MIXTURE OF SAND, SILT, GRAVEL & CLAY (Till)

FIG No 5

W P 41-71-02

14-221

40 J-160

GEOCRES No.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. A.P. Watt, (2)
Regional Structural Planning Eng.,
Southwestern Region,
LONDON, Ontario.

FROM: Soil Mechanics Section,
Geotechnical Office,
West Bldg., Downsview.

ATTENTION:

DATE: February 11th, 1974.

OUR FILE REF.

IN REPLY TO

FEB 14 1974

SUBJECT:

CONT 83-35
FOUNDATION INVESTIGATION REPORT

40316-50

GEOCRES No.

For
Black Creek Bridge No. 1
Village of Oil Springs
Bridge Site 14-221, Hwy. 21
District 1, Chatham

W.O. 73-11104

W.P. 41-71-02

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.

K. G. Selby

K.G. Selby,
SUPERVISING FOUNDATIONS ENGINEER.

KGS/mj
attach.

c.c. E.J. Orr
B.R. Davis
A. Rutka
A. Wittenberg
L.E. Walker
B.J. Giroux
J.R. Roy
G.A. Wrong
B.A. Singh

Files
Documents

14-195-221

TABLE OF CONTENTS

1. INTRODUCTION
 2. DESCRIPTION OF SITE AND GEOLOGY
 3. FIELD WORK AND LABORATORY INVESTIGATIONS
 4. SUBSOIL CONDITIONS
 - 4.1) General
 - 4.2) Sand with Clay, Silt, and Gravel, traces of Organics
 - 4.3) Silty Clay traces of Sand, Gravel, and Organics
 - 4.4) Silty Clay, seams of Silt and Sand
 - 4.5) Silty Clay to Clayey Silt some Sand (Till)
 - 4.6) Heterogeneous Mixture of Silt, Sand, Gravel, and Clay (Till)
 - 4.7) Bedrock
 5. GROUNDWATER
 6. DISCUSSION AND RECOMMENDATIONS
 - 6.1) General
 - 6.2) Foundations
 7. MISCELLANEOUS
-

*Foundation Investigation Report
For*

Black Creek Bridge No. 1

Village of Oil Springs

Bridge Site 14-221, Hwy. 21

District 1, Chatham

W.O. 73-11104

W.P. 41-71-01

1. INTRODUCTION:

A foundation investigation has been carried out at this site to determine the existing subsoil and groundwater conditions. A request for this investigation was received in a memorandum from Mr. S. Jants, Structural Planning Supervisor for the Southwestern Region, dated December 17, 1973. This report contains the results of the field and laboratory investigations together with recommendations concerning the structure foundations.

2. DESCRIPTION OF SITE AND GEOLOGY:

The bridge site is on Hwy. 21 in a depression caused by Black Creek. The floor of the depression or valley is some 15 ft. (4.8 m) lower than the surrounding area and some 1000 ft. (304.8 m) wide. This site is located just north of the Village of Oil Springs. The land on either side is used as pasture. There are a number of abandoned oil wells in the vicinity. The structure was widened to its present width in 1931.

Geologically, the site is in the physiographic region known as the St. Clair Clay Plain. The region is one of little relief with a deep deposit of clay. Most of Lambton County is essentially till plains smoothed by shallow deposits of lacustrine clay which settled in the depressions while the knolls were being lowered by wave action.

3. FIELD WORK AND LABORATORY INVESTIGATIONS:

The field work consisted of 2 sampled boreholes and 3 dynamic cone tests, 2 of the cone tests being adjacent to the boreholes. The drilling was done by a muskeg vehicle mounted C.M.E. 55 equipped with standard augers. Disturbed samples were obtained by driving a split spoon sampler into the subsoil. Undisturbed samples were taken using a 2 inch (50.8 mm) I.D. thin-walled Shelby Tubes, pushed into the soil hydraulically.

Soil samples were identified in the field and again upon arrival in the laboratory. Tests to determine moisture content, grain size and Atterberg Limits were carried out on representative samples. Soil samples obtained from the Shelby Tubes were subjected to unconfined compression, quick triaxial and laboratory vane tests. All field and laboratory test results are recorded in the accompanying borelog sheets.

The groundwater levels across the site were determined by recording the water level in the open boreholes over the period of the investigation.

The locations and elevations of the boreholes were determined in the field from a benchmark located in the structure. A stratigraphical profile is plotted on Drawing 73-11104A attached to the end of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The subsoil at this site generally consists of some 60 ft (18.3 m) of cohesive soil overlying limestone and shale bedrock. The layer from the surface downward is, in B.H. #2, silty clay traces of sand, gravel and organics, and in B.H. #4 sand with clay, silt, and gravel. Following these top layers is a deposit of silty clay with seams of sand and silt found in both holes then silty clay to clayey silt some

sand, (till) and below this a heterogeneous mixture of sand gravel silt and clay, (till), and then bedrock which consists of limestone and shale.

4.2) Sand with Clay, Silt, and Gravel, traces of Organics:

Borehole #4 was placed in the creek where there was 0.6 ft. (0.2 m) of water followed by 5.9 ft. (1.8 m) of sand with clay, silt, and gravel. The organic content measure in one sample was 5.1%. The 'N' value within this layer was 5 blows/foot corresponding to a loose relative density. The natural moisture content was calculated to be 30%.

4.3) Silty Clay traces of Sand, Gravel, and Organics:

This material was found in B.H. #2 which was placed on the bank of the creek. The silty clay traces of sand, gravel, and organics extends down to 7 ft. (2.1 m) below the surface to elev. 624.9 ft. (190.5 m). The 'N' values within this layer were 7 to 10 blows per foot. The organic content was measured to be 3.6%. The plastic limit was calculated to be 29%, natural moisture content 38% and liquid limit 53%. The consistence of this material can be described as firm to stiff.

4.4) Silty Clay, seams of Silt and Sand:

This layer was encountered between elev. 622 ft. (189.6 m) and elev. 615 ft. (187.4 m) in B.H. #4 and elev. 625 ft. (190.5 m) and elev. 615 ft. (187.4 m) in B.H. #2. In B.H. #4 the silty clay was 6.8 ft. (2.1 m) in thickness and in B.H. #2, 10 ft. (3.0 m) in thickness. The "N" values within this layer varied from 7 to 13 blows per foot. A localized sandy area with 33% sand was encountered in B.H. #4 sample #3. The properties of this layer are given below:

Natural Moisture Content (%) : 27-32
Liquid Limit (%) : 46-49
Plastic Limit (%) : 21-25
Bulk Density (pcf): 118-124.5
(T/m³): (1.89-2.0)

Undrained Shear Strength

Laboratory Vane (psf): 2175 - 2865
(kN/m²): 104.1 - 137.2

Unconfined Compression

Test (psf): 1350 - 2155
(kN/m²): 64.6 - 103.2

Triaxial Compression (psf): 1635
Test (kN/m²): 78.3

Laboratory grain size analysis produced the following distribution:

Gravel (%)	0
Sand (%)	0
Silt (%)	45-56
Clay (%)	44-55

Typical grain size distribution envelope and plasticity chart appear in the Appendix as Figures 1 and 2 respectively.

4.5) Silty Clay to Clayey Silt some Sand (Till):

In both Boreholes this layer was found at about elev. 615 ft. (187.4 m) and extends for a distance of 30 to 31 ft. (9.4 to 9.1 m).

While augering Borehole #2 two layers of cables,
COBBLES

.....5

1 to 2 feet (0.3 to 0.6 m) thick were encountered. The "N" values measured within this material varied from 14 to 37 blows per foot. Grain size analysis produced the following results:

Gravel (%)	0
Sand (%)	12-24
Silt (%)	52-61
Clay (%)	24-33

Natural moisture content and Atterberg Limits are as follows:

Natural Moisture Content (%)	: 18-28
Liquid Limit (%)	: 36-38
Plastic Limit (%)	: 20

A plasticity chart and grain size distribution envelope are included in the Appendix as Figures 3 and 4 respectively.

4.6) Heterogeneous Mixture of Silt, Sand, Gravel, And Clay (Till):

This was the final layer sampled above the bedrock. It was found in B.H. #4, 46.5 ft. (14.2 m) below the surface and in B.H. #2, 44.5 ft. (13.5 m) below the surface. The average thickness is about 13.2 ft. (4.0 m). In both boreholes cobbles were encountered within the layer. The 'N' values measured within this layer varied from 73 to more than 100 blows per foot, corresponding to a relative density of very dense. The natural moisture content of this layer was about 8%. Laboratory grain size analyse produced the following distribution:

Gravel (%)	: 24-25%
Sand (%)	: 25-49%

Silt (%) : 22-32%

Clay (%) : 4-19%

A typical grain size curve envelope is included in the Appendix as Figure 5.

4.7) Bedrock:

The bedrock cored in B.H. #4 was identified by Geologist B. Glassford as follows:

el. 571.9 - 571.3 ft. - Limestone, grey, hard
(174.3 - 174.1 m) med. grain.

el. 571.3 - 570.6 ft. - Limestone, grey, hard med. to coarse
(174.1 - 173.9 m) grain with thin seams of shale.

el. 570.6 - 570.1 ft. - Limestone, grey, hard, med. to
(173.9 - 173.8 m) coarse grain.

el. 570.1 - 567.4 ft. - Shale, grey, soft with 3 up to 1"
(173.8 - 172.9 m) shaly limestone sections.

The bedrock is described as sound.

5.) GROUNDWATER:

The groundwater levels were measured within the open boreholes over the duration of the field work.

B.H. #2 - Dry hole, probable water level -
628.4 ft. (191.5 m)

B.H. #3 - el. 628.4 ft. (191.5 m) - (Creek water
elevation)

B.H. #4 - el. 628.4 ft. (191.5 m) - (Creek water
elevation)

During the investigation of Borehole #2 no groundwater was encountered because of the impervious nature of the

subsoil. When bedrock was encountered natural oil rose to elevation 607.9 ft. (185.3 m).

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to replace the existing bridge on Hwy. 21 over Black Creek. The proposals are for a bridge with a 53 foot (16.2 m) span and a bridge, 20° skewed, with a 56 foot (17.1 m) span. The grade of Hwy. 21 has not been changed for this reconstruction.

Subsoil at the bridge site consists of sand with clay, silt, and gravel, traces of organics, silty clay traces of sand, gravel, and organics, silty clay, seams of silt and sand, silty clay to clayey silt some sand, till, a heterogeneous mixture of silt, sand, gravel, and clay, till, and finally bedrock.

6.2) Foundations:

The proposed structure may be supported on spread footings placed on or within the firm to stiff silty clay layer. The footings may be founded at or below elev. 622 ft. (189.6 m) depending on the depth of the existing footings. On removal of the old structure any soft areas below the proposed footing elevation should be excavated and replaced with mass concrete. A safe net pressure of 1.5 Tons/ft² (143.6 kN/m²) may be assumed for design purposes.

Alternatively, the structure may be supported on end bearing steel H-piles driven to bedrock. The maximum allowable load for the particular steel section may be assumed for design purposes.

A dewatering scheme may be required because of the existance of a granular material in the creek bottom, which was sampled to an elevation of 622 ft. (189.6 m) in bore-hole #4.

A lean concrete working slab may be required

in the bottom of the footing excavation in order to prevent softening of the base of the excavation.

All foundations should be protected against frost action by at least 4 feet of earth cover.

7. MISCELLANEOUS:

The field work was carried out from Jan. 7 to 10, 1974, and was supervised by Mr. P. Korgemagi, Project Foundations Engineer.

The equipment used was owned and operated by Master Soils Investigation, Rexdale, Ontario.

This report was written by Mr. P. Korgemagi and reviewed by Mr. K.G. Selby, Supervising Foundations Engineer.



P. Korgemagi, P. Eng.



K.G. Selby, P. Eng.

PK/sh

February 6, 1974.

APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 2

JOB 73-11104

LOCATION Sta. 202 + 24, 35' 10" (10.7 m) *B+116.7* *L12 Hwy 21*

ORIGINATED BY PK

W.P. 41-71-01

BORING DATE January 9, 1974

COMPILED BY PK

DATUM Geodetic

BOREHOLE TYPE Auger and Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT	BLOWS / FOOT (0.3 m)	25	50	75	100	125	W _p	W _L		
m	ft.						SHEAR STRENGTH P.S.F. (kN/m ²)					WATER CONTENT %			
							○ UNCONFINED + FIELD VANE					W _p — W — W _L			
							● QUICK TRIAXIAL × LAB VANE					15 30 45			
							1000 2000								
192.6	631.9	Ground Level													
0.0	0.0	Top Soil													
0.2	0.6	Brown Silty Clay traces of sand, gravel and Firm to Stiff organics	1	SS	7	630									
190.5	624.9		2	SS	10	192.0									
2.1	7.0	Silty Clay Seams of Silt Grey	2A	TW	PH										
			3	SS	12										
			3A	TW	PH	620									
			4	TW	PH	189.0									
187.4	614.9	Stiff	5	SS	13										
5.2	17.0	Silty Clay to Clayey Silt some Sand (Till)	6	SS	14	610									
		Cobbles	7	SS	19	185.9									
		Grey Cobbles	8	SS	22	600									
		Stiff to Hard	9	SS	20	182.9									
			10	SS	34	590									
178.4	585.4					179.8									
14.2	46.5	Cobbles	11	SS	100/15	580									
		Heterogeneous Mixture of Sand, Gravel, Silt, and Clay (Till) Cobbles very dense				176.8									
173.8	570.3	Probable Bedrock	12	SS	50/0										
18.8	61.6	End of Borehole													

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 3

JOB 73-11104

LOCATION Sta. 202 + 58, 37' ~~22~~ (11.3 m) *RT 81 Hwy 21*

ORIGINATED BY PK

W.P. 41-71-01

BORING DATE January 8, 1974

COMPILED BY PK

DATUM Geodetic

BOREHOLE TYPE Cone Test

CHECKED BY *ED*

SOIL PROFILE			SAMPLES			ELEV. SCALE ft. / m	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (0.3 m)					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			BULK DENSITY γ	REMARKS
ELEV. DEPTH ft.	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT (0.3m)		25	50	75	100	125	W_P	W	W_L		
191.5	Water Level															
191.2	Water															
0.3	River Bottom															
	Probable sand															
	Probable Silty Clay					620 189.0										
186.0	End of Cone Test															
5.5																
18.0																

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 4

13+103.2 7.8 m RT HWY 21

JOB 73-11104

LOCATION Sta. 201 + 79' 23" RT (7.0 m)

ORIGINATED BY PK

W.P. 41-71-01

BORING DATE January 7 to 8, 1974

COMPILED BY PK

DATUM Geodetic

BOREHOLE TYPE Auger and Cone Test

CHECKED BY OF

SOIL PROFILE			SAMPLES			ELEV. SCALE ft./m	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (0.3 m)				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F. GR. SA. SI. CL. T/m ³	REMARKS
ELEV. DEPTH ft.	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT 0.3m		25	50	75	100	125	w_p	w	w_L	
191.5	Water Level														
191.5	627.8														
0.2	0.6		1	SS	5										
189.6	621.9		2	SS	7	620									
2.0	6.5		3	SS	10	189.0									
187.4	615.1		4	SS	9										
4.1	13.3		5	SS	22										
			6	SS	23	610									
			7	SS	25	185.9									
			8	SS	34	600									
			9	SS	37	182.9									
			10	SS	14	590									
178.0	583.9					179.8									
13.5	44.5														
			11	SS	73	580									
						176.3									
174.5	572.6		12	SS	100	1/2" 2 cm									
17.0	55.8		13	RC	BYL	570									
172.9	567.4					173.7									
18.6	61.0														

OFFICE REPORT SOIL EXPLORATION

GRAIN SIZE DISTRIBUTION

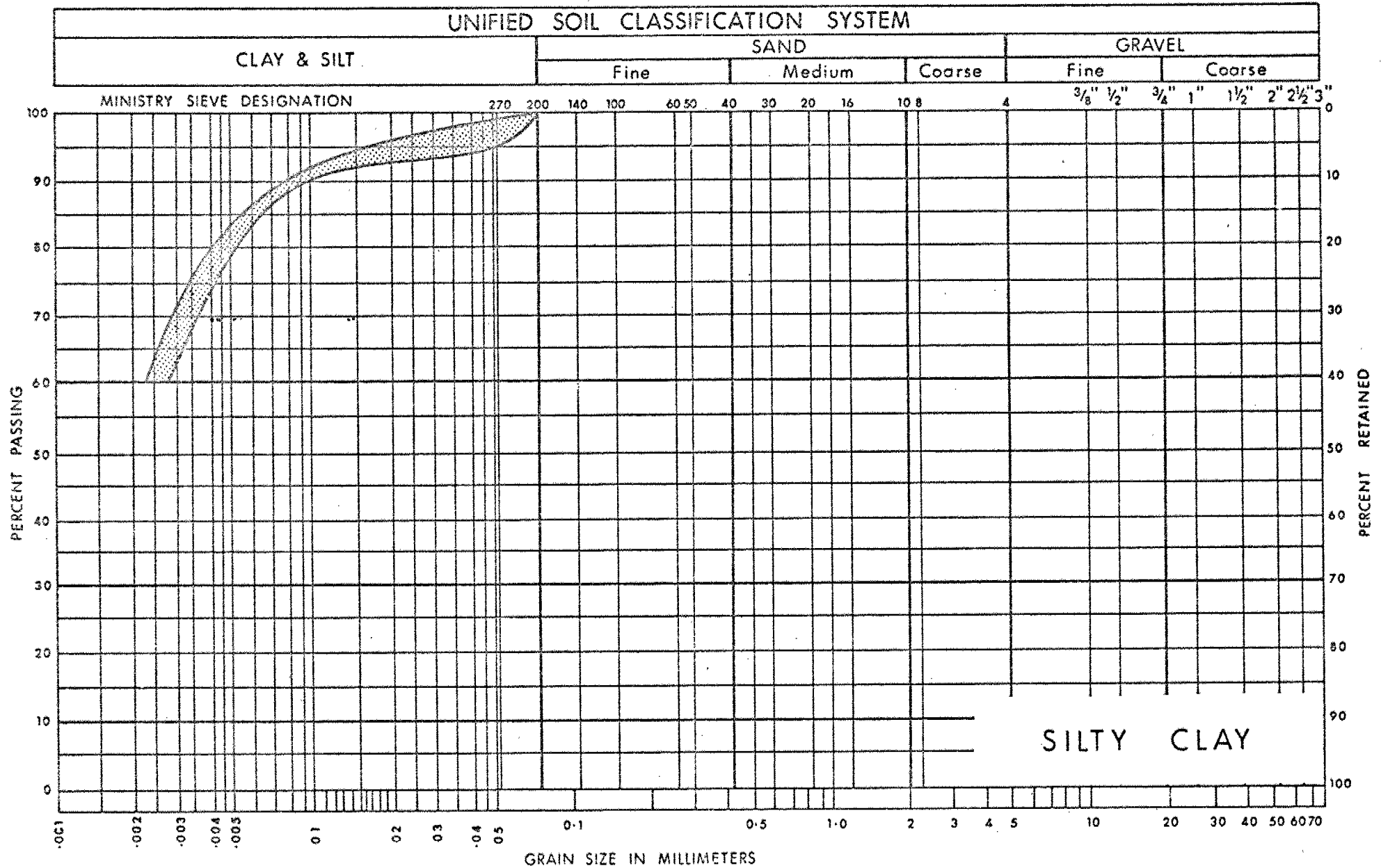


FIG. 1

W.O. 73-11104

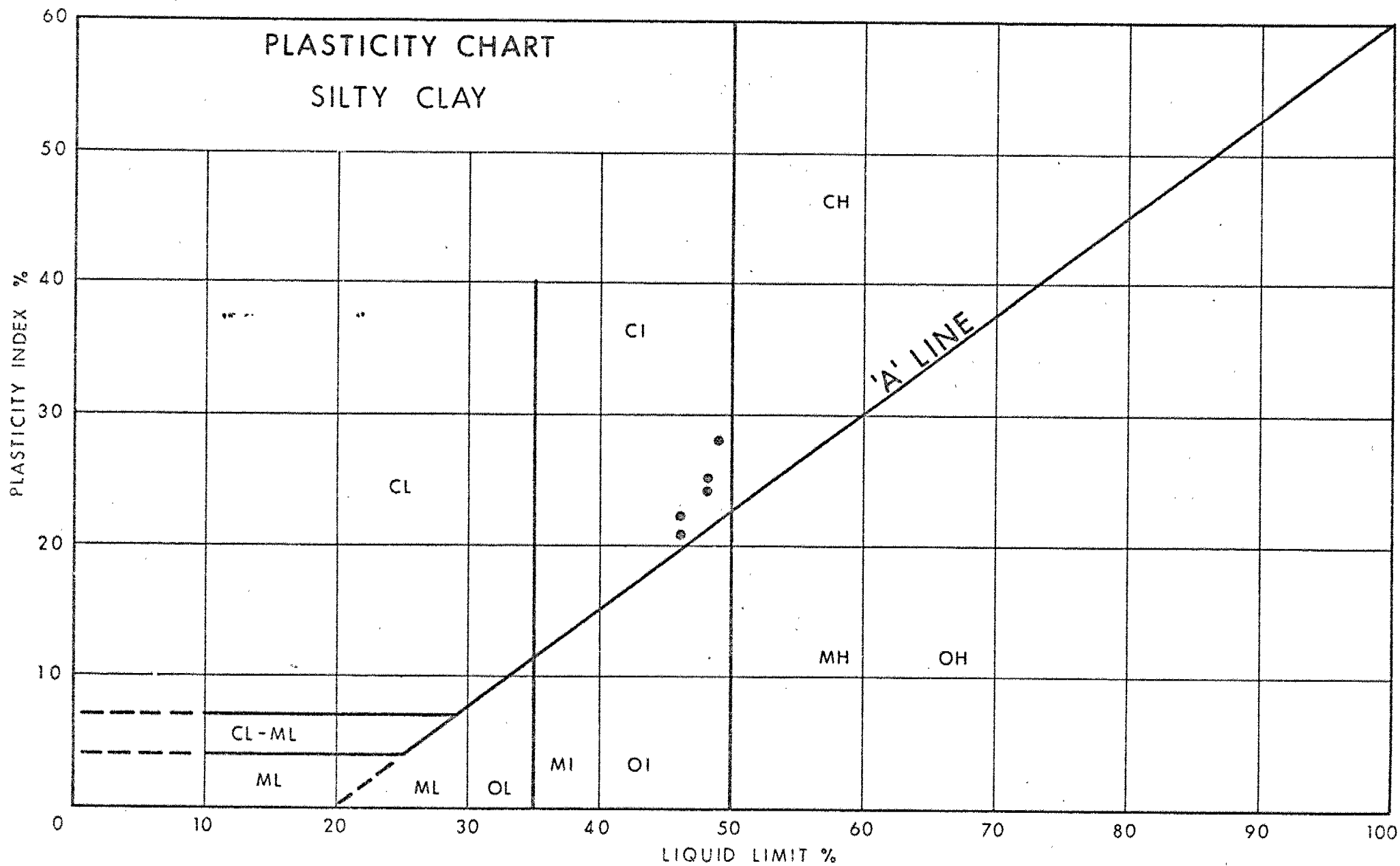


FIG. 2

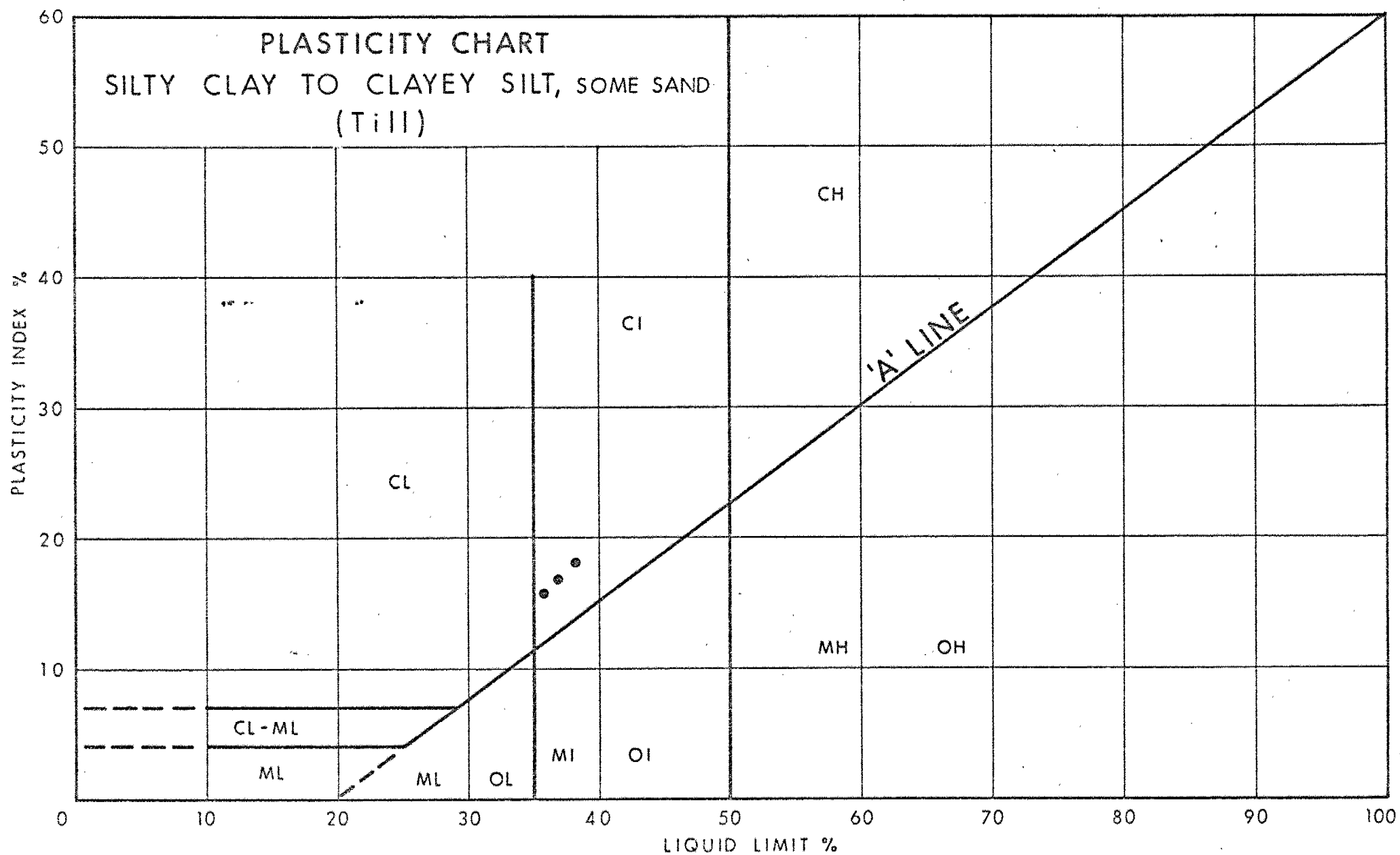


FIG. 3

GRAIN SIZE DISTRIBUTION

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

Coarse

Fine

Coarse

MINISTRY SIEVE DESIGNATION

270 200 140 100 60 50 40 30 20 16 10 8 4 3/8" 1/2" 3/4" 1" 1 1/2" 2" 2 1/2" 3"

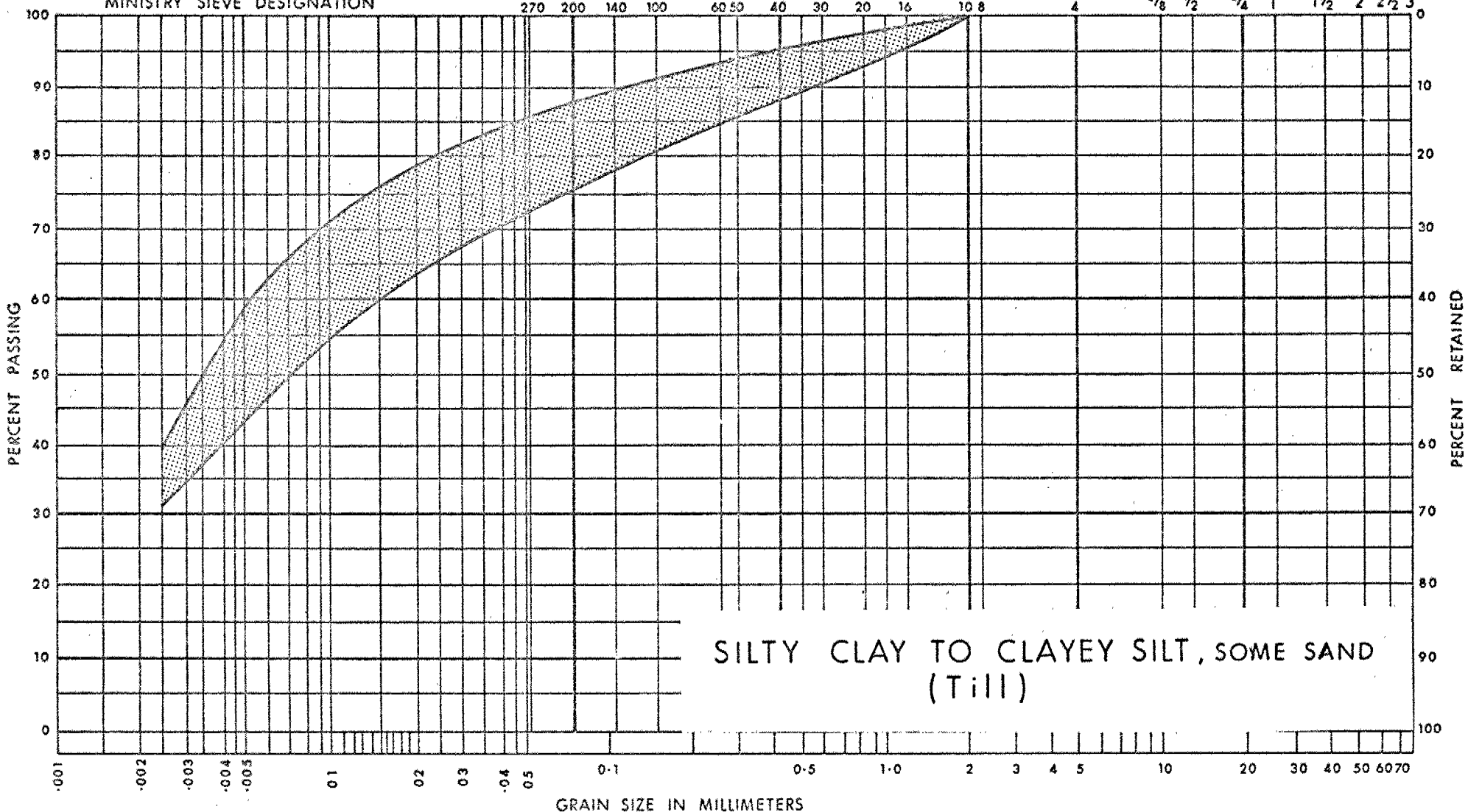


FIG. 4

W.O. 73-11104

GRAIN SIZE DISTRIBUTION

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

Coarse

Fine

Coarse

MINISTRY SIEVE DESIGNATION

270 200 140 100 60 50 40 30 20 16 10 8 4 3/8" 1/2" 3/4" 1" 1 1/2" 2" 2 1/2" 3"

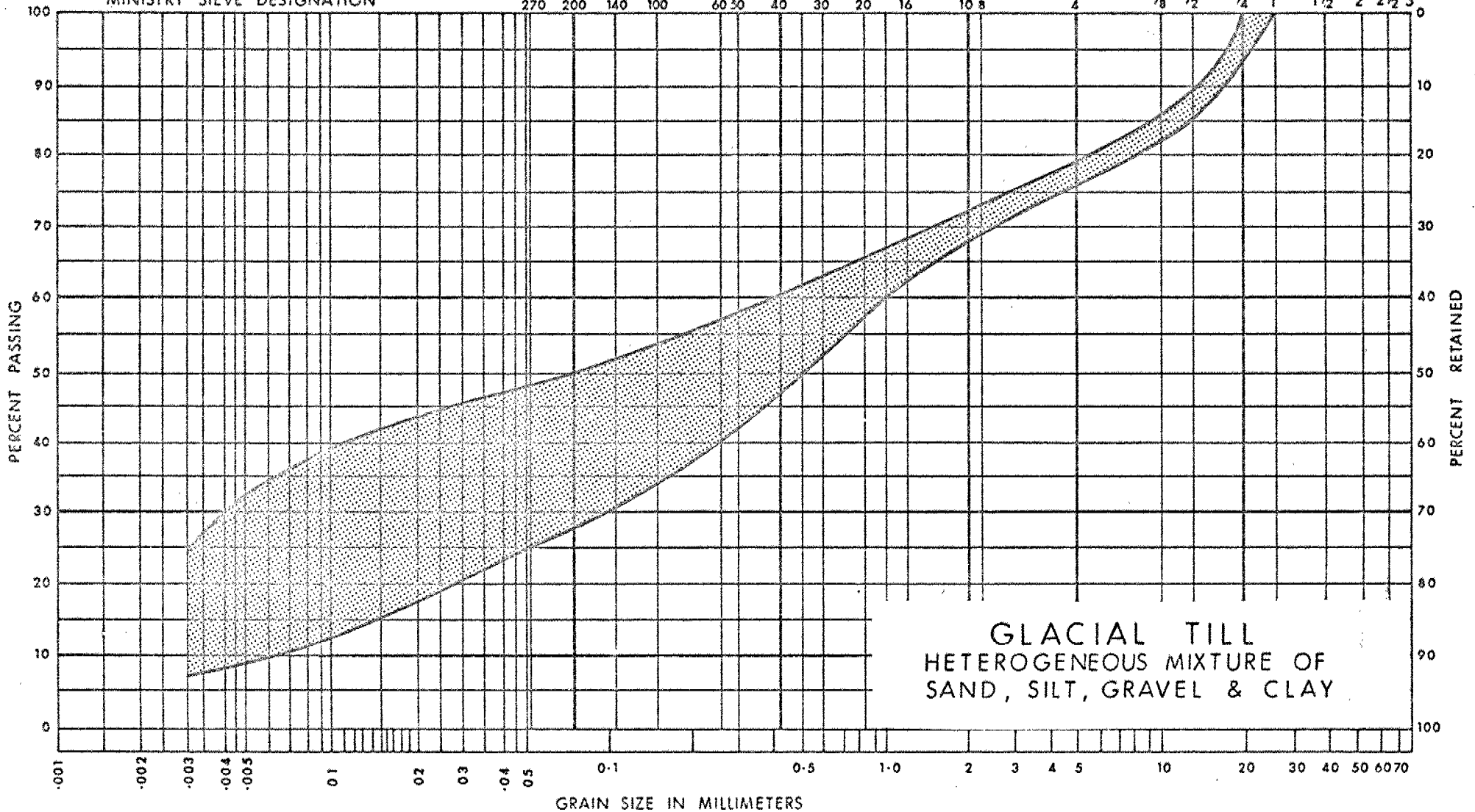


FIG. 5

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTPENETRATION RESISTANCE

'N' STANDARD PENETRATION RESISTANCE : - 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>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS 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
w_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
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a 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
σ	NORMAL STRESS
σ'	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

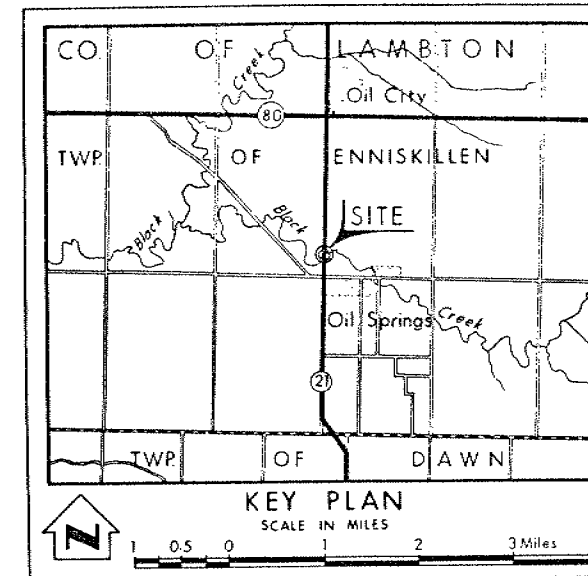
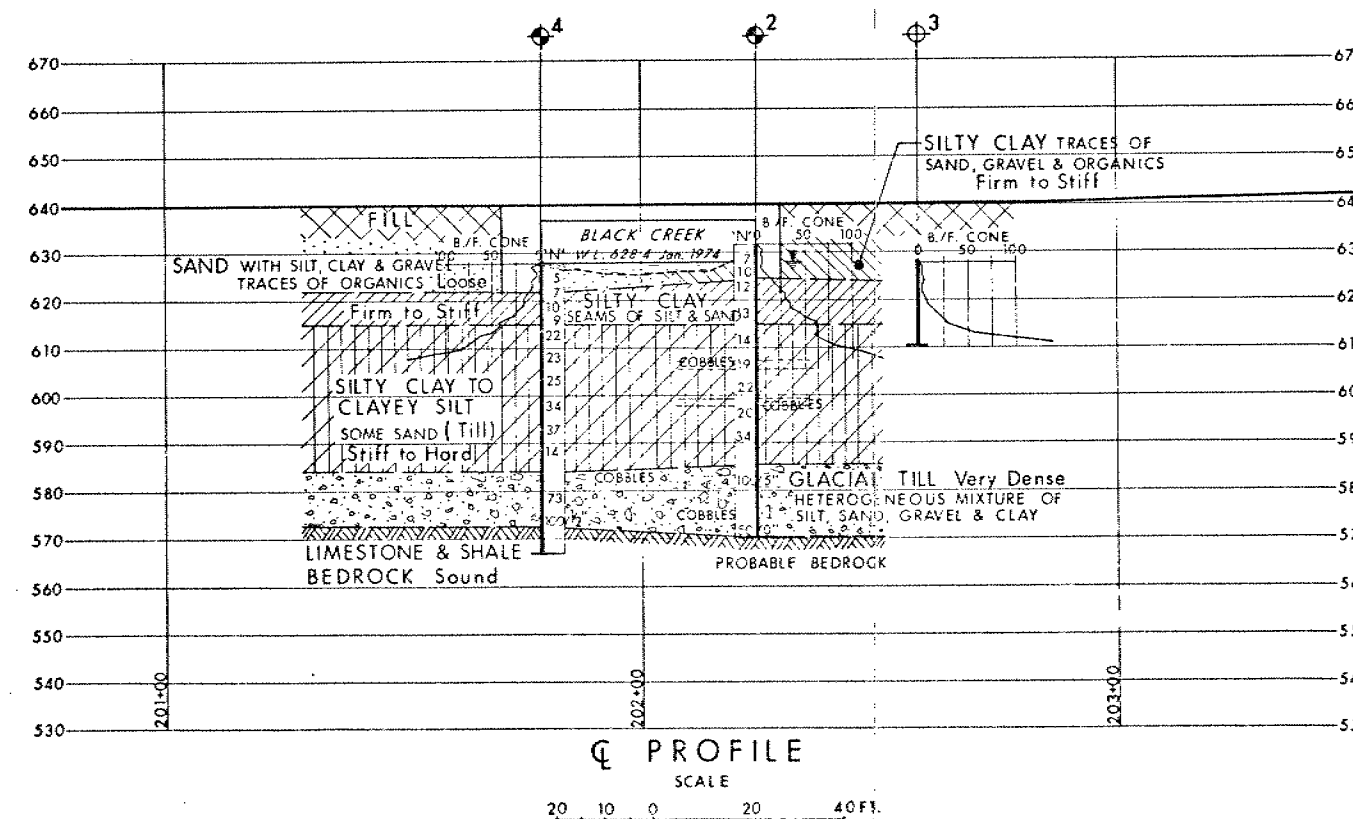
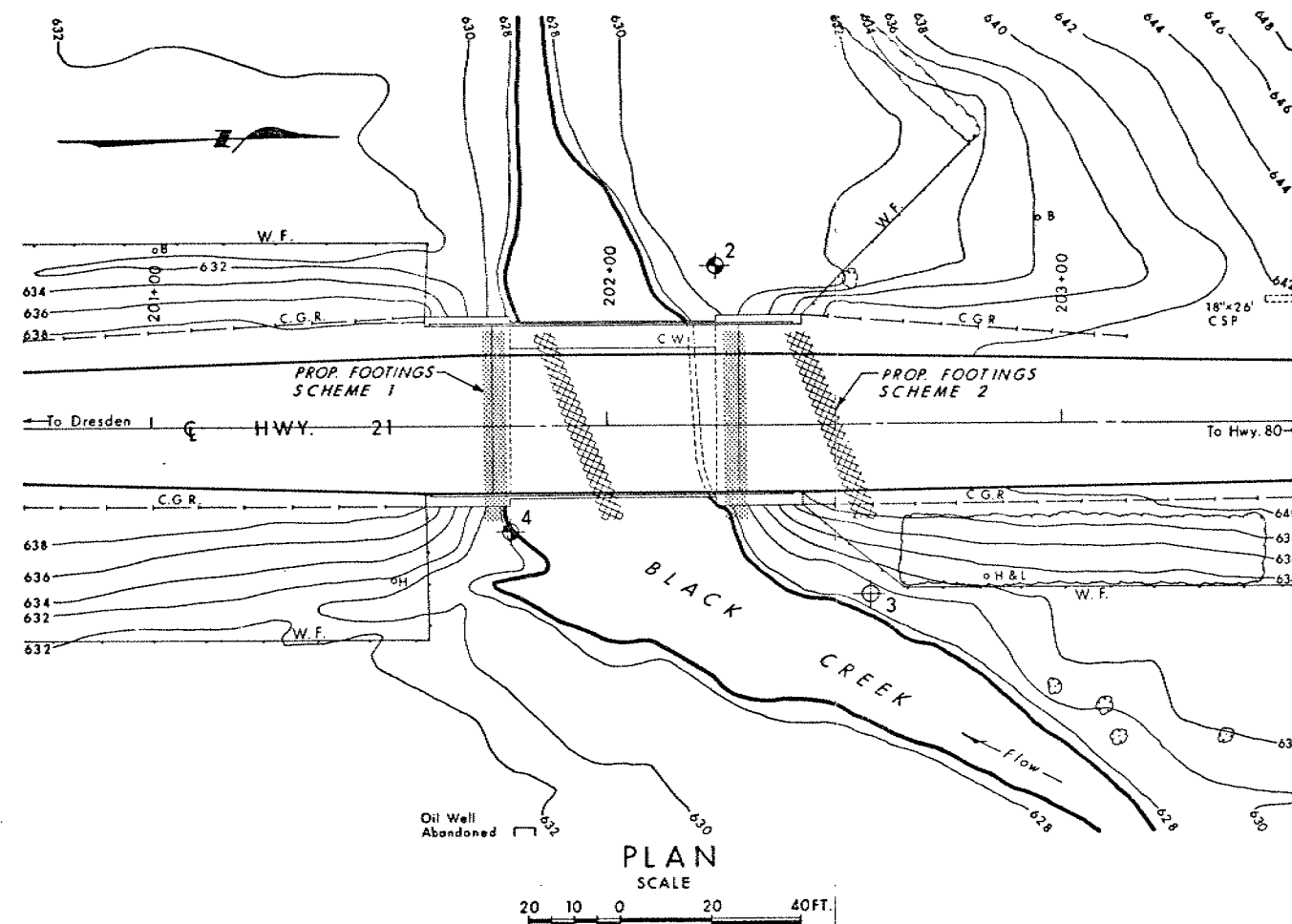
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

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



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation, Jan. 1974		
NO.	ELEVATION	STATION	OFFSET
2	631.9	202+24	35' LT.
3	628.4	202+58	37' RT.
4	628.4	201+79	23' RT.

NOTE: FOR CONTRACT DOCUMENT
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the CHATHAM District Office.

— 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

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
ENGINEERING SERVICES BRANCH—GEOTECHNICAL OFFICE

BLACK CREEK

HIGHWAY NO. 21 DIST. NO. 1
CO. LAMBTON RP 21 LOTS 27 & 28
TWP. ENNISKILLEN LOT 16 CON. TIT

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD P. K.	CHECKED	WP NO. 41-71-01	DRAWING NO.
DRAWN	CHECKED	WO NO. 73-11104	73-11104A
DATE Feb. 6, 1974	SITE NO.	BRIDGE DRAWING NO.	
APPROVED	CONT. NO.		

REF. NO. E-5346-1

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE NOTED.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST No 1
CONT No
WP No 41-71-02

BLACK CREEK BRIDGE
330-N. OF VILLAGE OF OIL SPRINGS
FOOTINGS

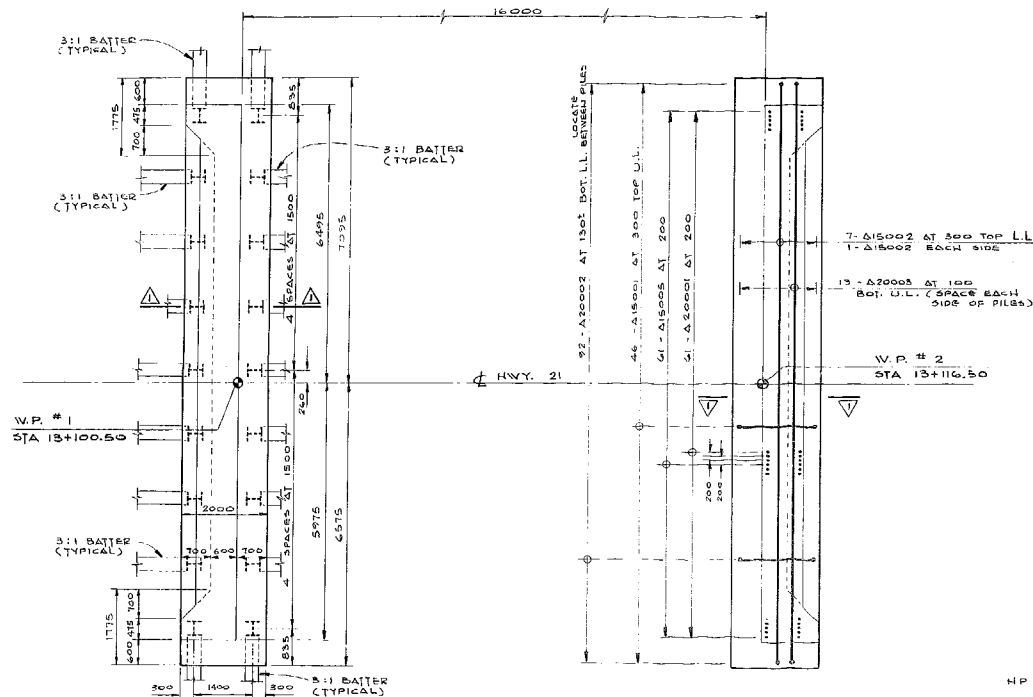
SHEET
2

TODDGHAM AND CASE
ASSOCIATES INCORPORATED

PILE DESIGN DATA

PILE TYPE	FACTORED CAPACITY AT U.L.B.	DESIGN LOAD AT S.L.S. II
HP 310x79	1150 kN	850 kN

- NUMBER OF PILES 34
- TYPE HP 310x79
- TOTAL LENGTH 588.6 m
- ASSUMED TIP ELEVATION 176.1
- PILE TIPS TO BE REINFORCED TO STANDARD PD-3301
- PILES TO BE DRIVEN TO BEDROCK
- LL DENOTES LOWER LAYER
- U.L. DENOTES UPPER LAYER

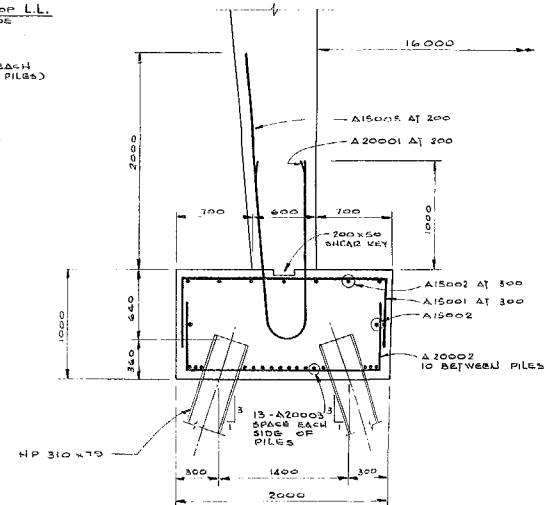


SHOWING DIMENSIONS
AND PILE LOCATIONS

SHOWING REINFORCING

FOOTING LAYOUT

SCALE - 1:50



SCALE - 1:20

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISION	DATE	BY	DESCRIPTION
DESIGN	DES	CHECK	LOADING CHOC-87 DATE
DRAWING	WA	CHECK (105)	SITE 14-195-211 DWG 2

COUNTY OF LAMBTON
TOWNSHIP OF ENNISKILLEN

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE NOTED.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES & METRES.

DIST No 1
CONT No
WP No 41-71-02



BLACK CREEK BRIDGE
390m U. of village of oil springs
GENERAL LAYOUT

SHEET 1

TODDHAM AND CASE
ASSOCIATES INCORPORATED

NOTES

CLASS OF CONCRETE

- Pile cap, approach slabs, 20 M Pa
- ALL OTHERS 30 M Pa

REINFORCING STEEL

- Pile caps 100T30
- Abutments & back face 60T20
- Wing walls front face 60T20
- Top of deck, curbs, sidewalks, barrier walls 10T20
- Bottom of deck 30T10

REINFORCING STEEL GRADE

- 400 M Pa. Bars marked with 36 epoxy coated

CONSTRUCTION NOTES

- Callwork supporting wing walls to remain in place until concrete in deck slab has reached 10 M Pa compressive strength.

- Place backfill simultaneously raising both abutments keeping heights of backfill within 600mm differential behind both abutments.

- Remove falsework supporting deck after backfill raised behind abutments to elev. 194.25

- Cast barrier walls after backfill behind abutments is completed.

- Concrete quantities are listed below for appropriate concrete lump sum tender items.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

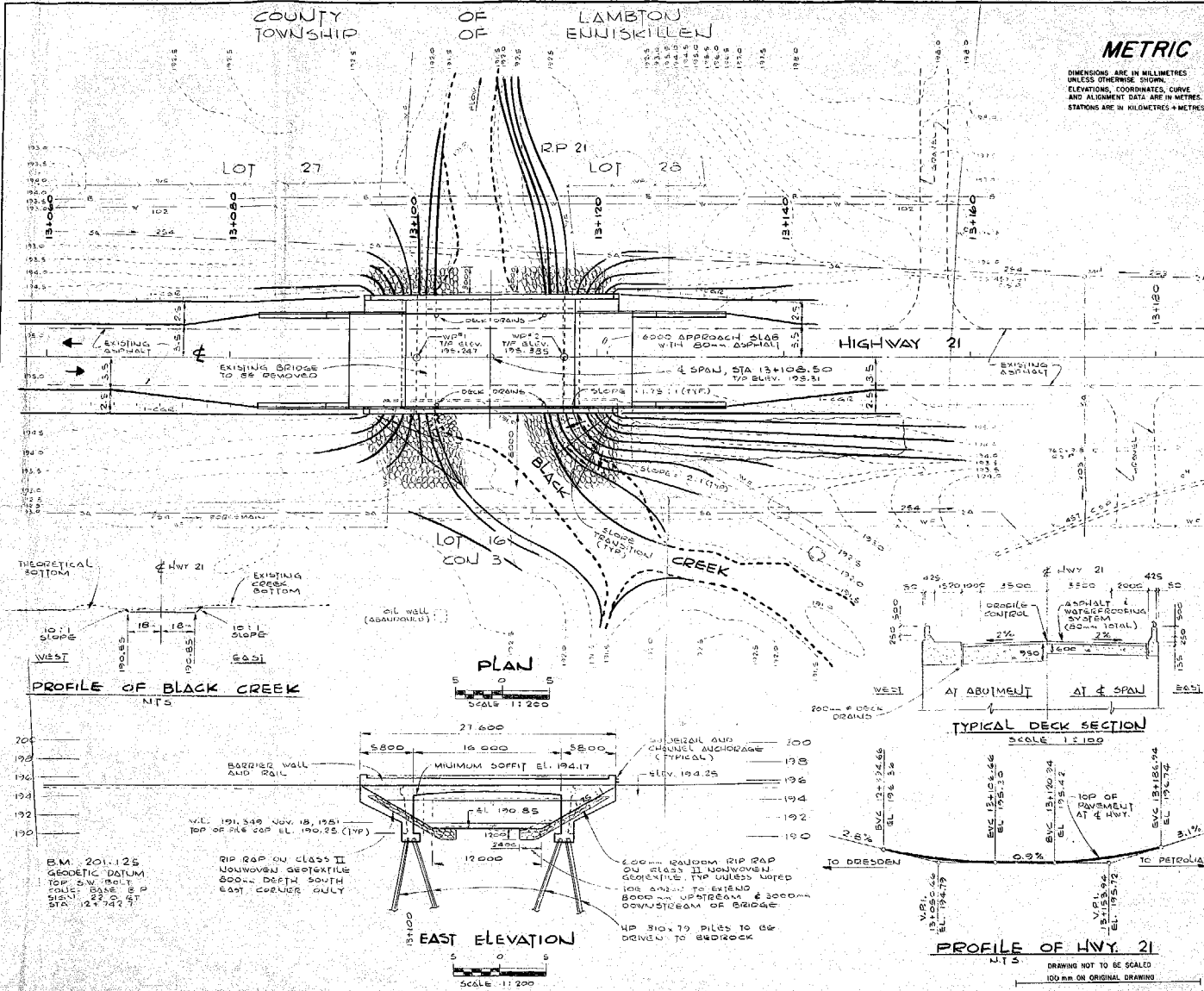
- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2

- CONCRETE QUANTITIES ARE LISTED BELOW FOR APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS.

- 1 CONC IN BRIDGE FOUNDATIONS 55.3
- 2 CONCRETE IN ABUTMENTS 285.1
- 3 CONC IN BARRIER WALLS 13.9
- 4 CONC IN APPROACH SLABS 37.2



LIST OF DRAWINGS

1. GENERAL LAYOUT
2. PILE CAPS
3. ABUTMENT
4. WING WALLS
5. BARRIER WALL WITH RAILING
6. RAILING FOR BARRIER WALL
7. STANDARD DETAILS
8. BRIDGE DATA & SITE NUMBER DATA
9. 3D CONSTRUCTION ELEV. & DIM.
10. PLAN QUANTITIES

DATE	BY	DESCRIPTION
DESIGN	DESIGN	DESIGN
CHECK	CHECK	CHECK
APPROVE	APPROVE	APPROVE