

**Foundation Investigation Report
Highway Platform Widening and Culvert Repair
Highway 11
Station 19+500 to Station 19+600
Township of Chamberlain
W.P. 109-98-00
MTO District 53, New Liskeard**

Prepared for:

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PREFACE

This assignment encompasses the detailed design for the proposed highway embankment/platform widening and culvert repair for an existing 4880 mm x 1830 mm concrete box culvert.

The limits of the site are from Station 19+500 to Station 19+600, Chamberlain Township. The existing culvert is located at approximately Station 19+560, about 11.6 km north of the Town of Englehart on Highway 11, within the MTO District No. 53 (New Liskeard).

This foundation report has been prepared for the detailed design assignment associated with the proposed widening and repairs at this culvert site.

Part 1 - Foundation Investigation

1.0 INTRODUCTION

This report addresses the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (“Trow”) for a proposed culvert repair/wing wall construction, resulting from a highway platform widening. The embankment is to be widened on the west side in order to improve the existing shoulders and roundings to meet current design standards. The western five (5) m of the culvert have been identified as needing replacement, as a result of deterioration of the concrete. Due to localized sloughing/erosion of the embankment at the northeast end of the existing culvert, the Ministry of Transportation of Ontario (“MTO”) structural section has suggested that the addition of wing walls at the eastern end of the culvert be investigated.

With the above-mentioned improvements in mind, the following investigation was undertaken.

1.1 SITE DESCRIPTION

The site is located in the Township of Chamberlain on Highway 11, approximately 11.6 km north of the Town of Englehart in the District of Timiskaming. The approximate stationing of the site is from Station 19+500 to 19+600, Chamberlain Township, with the centre of a small creek valley located at about Station 19+560, as indicated on the Site Plan, Drawing 1 in Appendix B. Also included in Appendix B are six (6) photographs of the site.

In general, the existing embankment appears to have been constructed of earth fill (i.e. sands and gravels) over blast rock fill and/or bedrock. The existing embankment has a maximum height of approximately 10 m between Station 19+500 and Station 19+600. The side slopes range from 1.5H:1V to 2H:1V.

The stream continuously flows from the west to the east of the site and was about 150 mm to 200 mm deep at the time of the investigation. The culvert is a 4880 mm x 1830 mm concrete box culvert, which has experienced some deterioration over the years.

The overall terrain in the vicinity of the site is moderately undulating. Within the right of way, the site is relatively clear of brush and trees. However, there are mature trees (both deciduous and coniferous) with heavy underbrush beyond the right of way.

1.2 GEOLOGICAL SETTING

According to OGS Maps 2543 and 2555, the bedrock beneath the site is composed of Mafic and related intrusive rocks of the Presissac swarm within the Paleoproterozoic group. Bedrock outcrops are visible along the southern edge of the creek on the eastern side of the culvert. The overburden soils have been mapped as comprising glaciolacustrine deposits. These deposits are basin and quiet water deposits comprised of silt and clay, with minor sands.

1.3 INVESTIGATIVE PROCEDURES

1.3.1 General

The following section of this report describes the investigative procedures adopted for the geotechnical assessment of the above-mentioned proposed highway embankment/platform widening and culvert repairs. Properties of the overburden soils were obtained by in-situ and laboratory testing methods. The procedures employed during the investigation are described below.

1.3.2 Field Investigation

The current field investigation for the proposed culvert extension was carried out on July 23 and 24, 2001. The investigation consisted of three (3) boreholes advanced through the existing fills at the top of the existing embankment, two (2) testpits at the west toe, and two (2) testpits at the east toe of the existing embankment (near the culvert inlet and outlet).

Boreholes BH-60, BH-61, and BH-62 were advanced utilizing a truck mounted CME-55 drill rig, equipped with solid and hollow stem augers, supplied by an MTO approved soils drilling contractor, Colbar Resources. Testpits TP-1 and TP-2 were excavated with a track mounted excavator, while Testpits TP-3 and TP-4 were excavated using hand shovels since these locations were not accessible by the excavator. A member of Trow Sudbury's geotechnical engineering staff was on site during the advancement of the boreholes and supervised the excavation of the testpits.

Soil samples were obtained in Boreholes BH-60, BH-61 and BH-62 by using a 51 mm OD split-spoon sampler, in conjunction with Standard Penetration Tests (SPT), at approximately 750 mm and 1.5 m intervals. The Standard Penetration Test 'N' values were recorded and used to provide an assessment of the relative density of the overburden fills.

All of the recovered soil samples were logged, then sealed in the field to prevent moisture loss, and transported to Trow's Sudbury laboratory for detailed visual examination, routine moisture content determination, and classification. Following completion of the boreholes and testpits, water level measurements were obtained and the boreholes and test pits were then backfilled as per MTO requirements. Details of the soil and groundwater conditions encountered in the boreholes and testpits are included on the logs in Appendix C. The additional standard data sheet, included with the logs, provides further details on soil descriptions for classification purposes. The locations of the boreholes and testpits are presented on Drawings 1 and 2, located in Appendix B. The locations and surface elevations of the boreholes and testpits were established by interpolation from drawings provided by D.F. Elliott Consulting Engineers Ltd. ("D.F. Elliott").

1.3.3 Laboratory Program

The laboratory testing program for the selected soil samples consisted of the following:

- Natural moisture content determinations (LS 701);
- Grain size distribution analyses (LS 702);
- Atterberg limits (LS 703 and LS 704).

The grain size distribution curves for selected soil samples are presented on Figures 1 to 4 and the results of the Atterberg Limit test are plotted on the Plasticity Chart on Figure 5, both included in Appendix D.

1.4 SUBSURFACE CONDITIONS

The borehole locations are shown on the site plan, Drawing 1, in Appendix B. Included in Appendix C are the borehole and testpit logs. A longitudinal soil section is plotted on Drawing 1. Drawing 2 contains cross sections of the highway embankment at Stations 19+500, 60 m south of the centreline of the valley, and 19+600, approximately 40 m north of the centreline of the valley.

In general, the following different soil layers were encountered with increasing depth:

- Fill (Sand and Angular Gravel);
- Fill (Sand and Rounded Gravel);
- Fill (Sand);
- Fill (Silt and Sand);
- Fill (Clayey Silt);
- Fill (Blast Rock);
- Bedrock/Boulders.

A summary of the above soil strata encountered in the boreholes and testpits is presented below.

1.4.1 Fill (Sand & Angular Gravel)

From the surface of the embankment (at approximately elevation 256.7 m) to 500 mm depth, the embankment fill material is composed of a mixture of brown sand and angular gravel with a trace of silt. The fill was moist, having a moisture content ranging from 1.3% to 3.2%, and it was in a loose condition. This unit was encountered in Boreholes BH-60, BH-61 and BH-62, which were advanced from on top of the existing embankment, within the shoulders of the roadway.

1.4.2 Fill (Sand & Rounded Gravel)

Beneath the surficial sand and angular gravel fill, a loose sand and rounded gravel fill, containing occasional cobbles, was intercepted in all three boreholes. This fill was brown in colour and in a moist condition. This layer extended from beneath the surficial sand and angular gravel fill at a depth of 500 mm to a depth of about 1.5 m (about elevation 255.2 m).

1.4.3 Fill (Sand)

A layer of brown, fine to medium grained sand fill was encountered at all three borehole locations at a depth of 1.5 m below existing grade (about elevation 255.2 m). This fill was described as containing a trace of silt and was in a very loose to loose state, based on the standard penetration test “N” values, which ranged from 2 to 10 blows per 300 mm. The fill became silty and occasional organic inclusions were noted with depth in all three of the borehole locations. The fill was described as moist, based on the moisture content values ranging from 5.1% to 17.8%. However, the fill was described as wet at a depth of 6.1 m at the location of Borehole BH-62. This fill layer extended to depths varying from 7.6 m to 7.9 m below grade (approximately elevation 249.0 m).

1.4.4 Fill (Silt and Sand)

A silt and fine grained sand fill, extending from a depth of 7.6 m (elevation 249.0 m) to a depth of 8.5 m (elevation 248.1 m) below the existing grade, was noted beneath the sand fill layer in Borehole BH-60. The layer was grey and was described as loose, having an SPT “N” value of 5 blows per 300 mm. The moisture content was 20.7%.

1.4.5 Fill (Clayey Silt)

Beneath the silt and sand fill (in Borehole BH-60) and the sand fill (in Boreholes BH-61 and BH-62), a grey, moist to saturated, clayey silt fill was encountered at depths between 7.7 m and 8.3 m (elevations varying from 248.1 m to 249.0 m). This fill layer contained sand and occasional organic inclusions.

The moisture contents were generally in the range of about 17.6% to 21.8%. Atterberg limits were as follows: Liquid Limit, 26.9%; Plastic Limit, 15.4%; Plasticity Index, 11.5%. These results indicate that, in general, this fill material can be described as an inorganic clay of medium plasticity (CL).

A standard penetration test “N” value of 17 blows for 300 mm was measured in the clayey silt fill, indicating a compact condition.

1.4.6 Fill (Blast Rock)

A surficial layer of “blast rock” fill was encountered at the location of Testpits TP-1, TP-2 and TP-3. This fill layer comprised boulder and cobble sized rock pieces combined with gravel and sand, along with alluvium stream deposited material. The thickness of this layer varied from 600 mm to 900 mm.

1.4.7 Bedrock/Boulders

Testpits TP-1 and TP-2 were terminated at depths varying from 600 mm to 900 mm below existing grade on exposed bedrock. Testpit TP-3 was located directly on exposed bedrock.

Boreholes BH-60, BH-61 and BH-62 were terminated upon auger refusal. Based on the blast rock fill observed at the testpit locations, it is likely that auger refusal occurred on similar blast rock fill at these three locations.

1.5 GROUNDWATER CONDITIONS

Water was not noted in any of the boreholes or testpits during the field investigation. The groundwater table is expected to be consistent with the water level observed in the creek (i.e. virtually at grade in the vicinity of the testpits) and, hence, may vary seasonally.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact us.

Yours truly,

Trow Consulting Engineers Ltd.

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APPENDIX A

LIMITATIONS

LIMITATIONS

The recommendations presented in this report are in accordance with our present understanding of the project and are provided solely for the use of D. F. Elliott Consulting Engineers Ltd., the MTO and their design team for the design of the highway embankment platform widening and culvert repair at Station 19+500 to 19+600, Chamberlain Township. We request that we be retained to review the design and our recommendations as the design proceeds, to ensure that the final design is in general agreement with our recommendations and that our recommendations have been interpreted as intended.

A subsurface investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to allow reassessment of our recommendations. It may then be necessary to carry out additional field work and analyses.

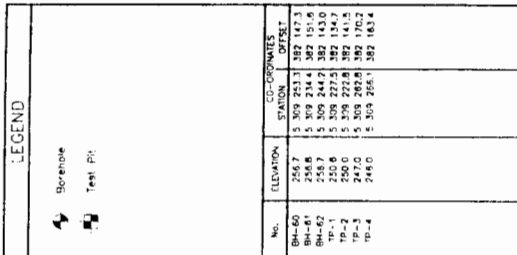
Contractors bidding on or undertaking the works should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information presented in this report is based upon an investigation designed to provide information to support an overall assessment of the current geotechnical conditions as the site of the proposed highway embankment platform widening, and culvert repair Station 19+500 to 19+600, Township of Chamberlain, District of Temiskaming. The conclusions presented in this report reflect the site conditions existing at the time of the investigation. It is noted that the soil boundaries indicated on the logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

APPENDIX B

DRAWINGS AND PHOTOGRAPHS

	PROPOSED	EXISTING
260		
255		



NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Damages, information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2-2.1 of OAS Gen. Con.

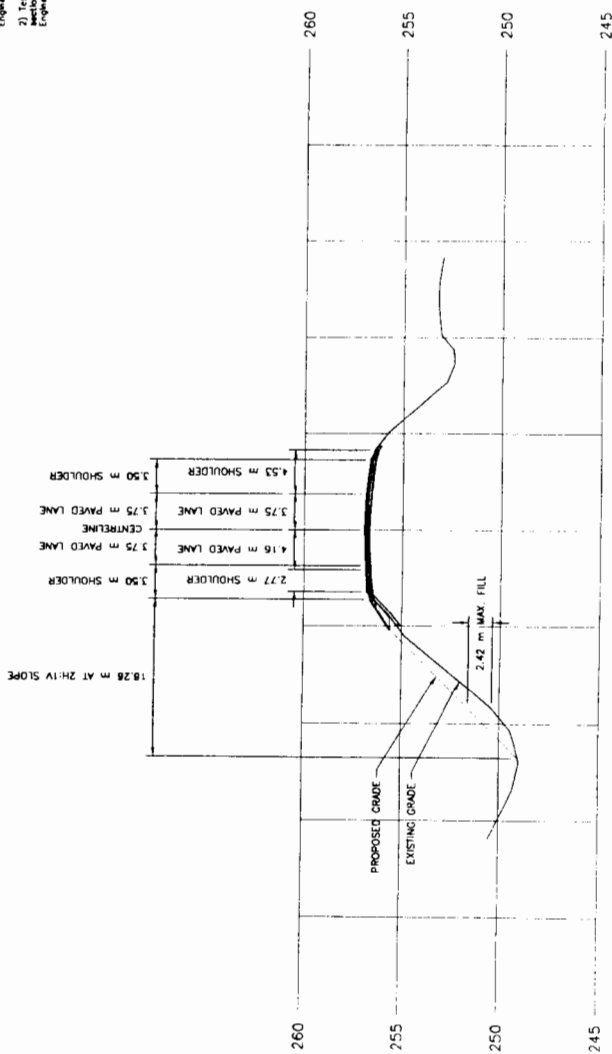
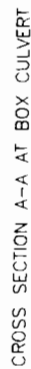
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DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

NOTES

1) Plan provided by D.F. Elliott Consulting Engineers Ltd.

2) Test hole elevations interpolated from cross section data provided by D.F. Elliott Consulting Engineers Ltd.



TYPICAL CROSS SECTION B-B AT STATION 19+540

METRIC

1) Plan provided by D.F. Ebert Consulting Engineers Ltd.
2) Test hole locations indicated from cross section provided by D.F. Ebert Consulting Engineers Ltd.

DIST 53

WP No 109-98-00

SITE No.

SITE PLAN AND CENTRELINE PROFILE

HIGHWAY PLANNING WORKING

STATION 19+500 TO 19+550

CONTRACT NO. 109-98-00

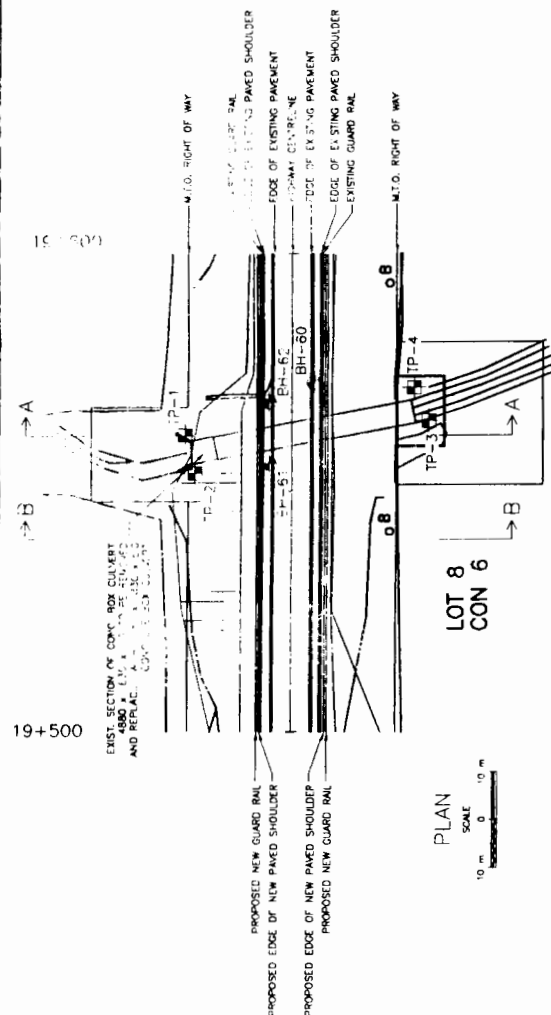
SHEET

1 OF 2

TROW CONSULTING ENGINEERS LTD.

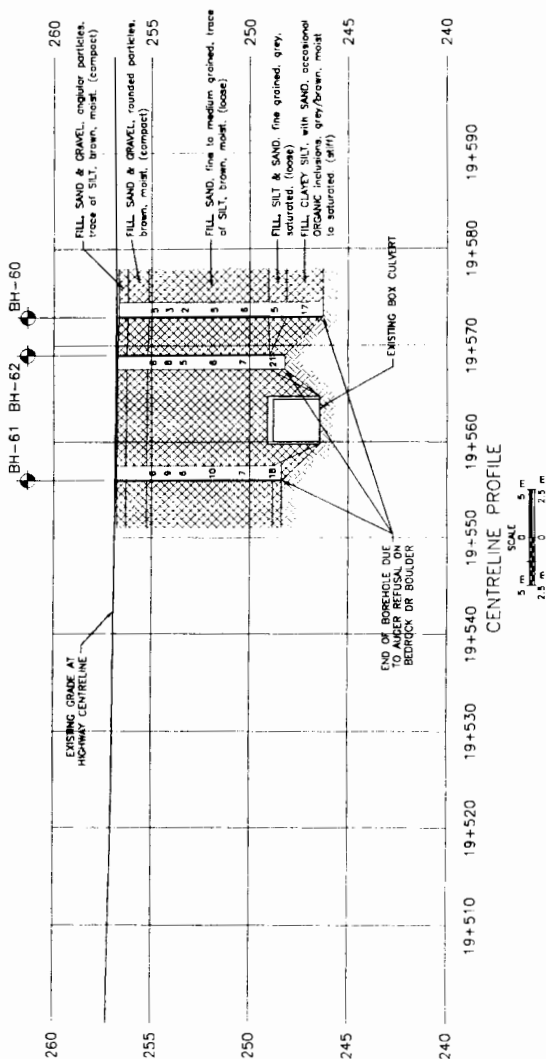
SUDBURY, ONTARIO

TROW PROJ. No. 581316/3 DWG. No. 1



PLAN
SCALE
10 m 0 10 m

LOT 8
CON 6



CENTRELINE PROFILE

SCALE
5 m 0 5 m
2.5 m 0 2.5 m

LEGEND	
	Borehole
	Test Pit

ELEVATION	
No.	Station
BH-60	256.7
BH-61	256.8
BH-62	256.7
TP-3	256.8
TP-4	256.7
TP-5	256.8
TP-6	256.7
TP-7	256.8
TP-8	256.7
TP-9	256.8
TP-10	256.7
TP-11	256.8
TP-12	256.7
TP-13	256.8
TP-14	256.7
TP-15	256.8
TP-16	256.7
TP-17	256.8
TP-18	256.7
TP-19	256.8
TP-20	256.7
TP-21	256.8
TP-22	256.7
TP-23	256.8
TP-24	256.7
TP-25	256.8
TP-26	256.7
TP-27	256.8
TP-28	256.7
TP-29	256.8
TP-30	256.7
TP-31	256.8
TP-32	256.7
TP-33	256.8
TP-34	256.7
TP-35	256.8
TP-36	256.7
TP-37	256.8
TP-38	256.7
TP-39	256.8
TP-40	256.7
TP-41	256.8
TP-42	256.7
TP-43	256.8
TP-44	256.7
TP-45	256.8
TP-46	256.7
TP-47	256.8
TP-48	256.7
TP-49	256.8
TP-50	256.7
TP-51	256.8
TP-52	256.7
TP-53	256.8
TP-54	256.7
TP-55	256.8
TP-56	256.7
TP-57	256.8
TP-58	256.7
TP-59	256.8
TP-60	256.7
TP-61	256.8
TP-62	256.7
TP-63	256.8
TP-64	256.7
TP-65	256.8
TP-66	256.7
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TP-72	256.7
TP-73	256.8
TP-74	256.7
TP-75	256.8
TP-76	256.7
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TP-87	256.8
TP-88	256.7
TP-89	256.8
TP-90	256.7
TP-91	256.8
TP-92	256.7
TP-93	256.8
TP-94	256.7
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TP-96	256.7
TP-97	256.8
TP-98	256.7
TP-99	256.8
TP-100	256.7

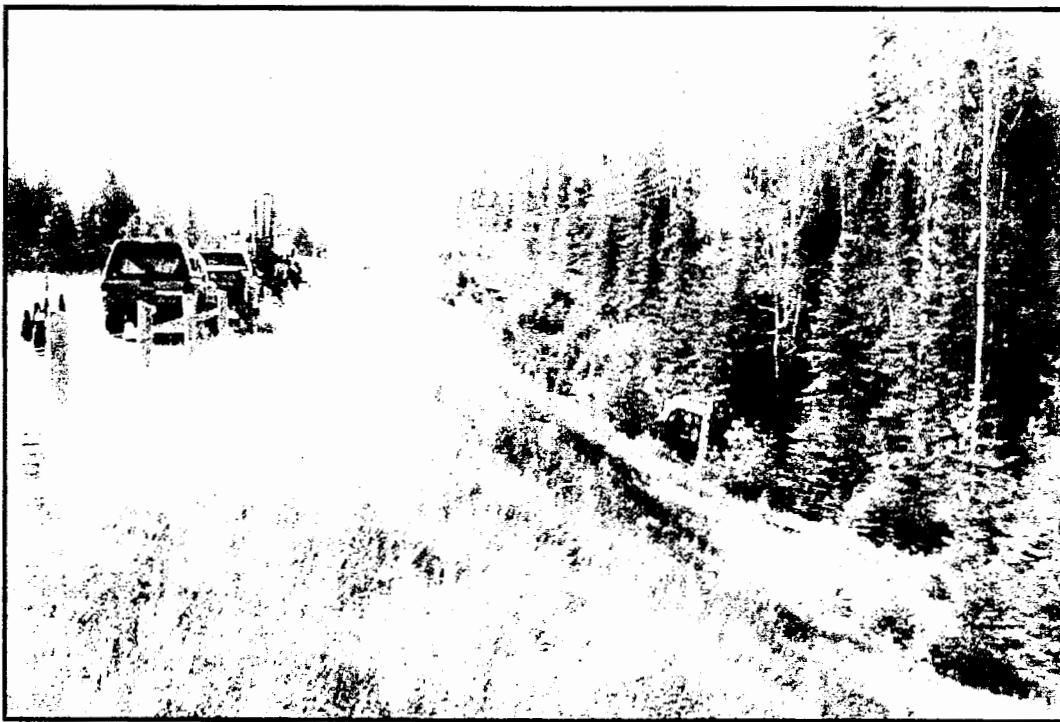
NOTE: The boundaries between well areas have been established only at bore hole locations. Between bore holes the boundaries are shown from geological evidence.

NOTE: The complete investigation and design report for this project and other related documents may be reviewed at the Engineering Services Office. Otherwise, information contained in this report is for informational purposes only and should not be used in conjunction with the conditions of Section 26.2.1 of OAS 2000.

DRAWING NOT TO BE SCALED
1:50 mm ON ORIGINAL DRAWING



PHOTOGRAPH 1: Photograph taken from approximately Station 19+550 towards the north, from the top of the existing embankment.



PHOTOGRAPH 2: Photograph taken from the west (top) of the embankment towards the south. (Note: excavator is excavating test pit TP-2 at the toe of the slope).



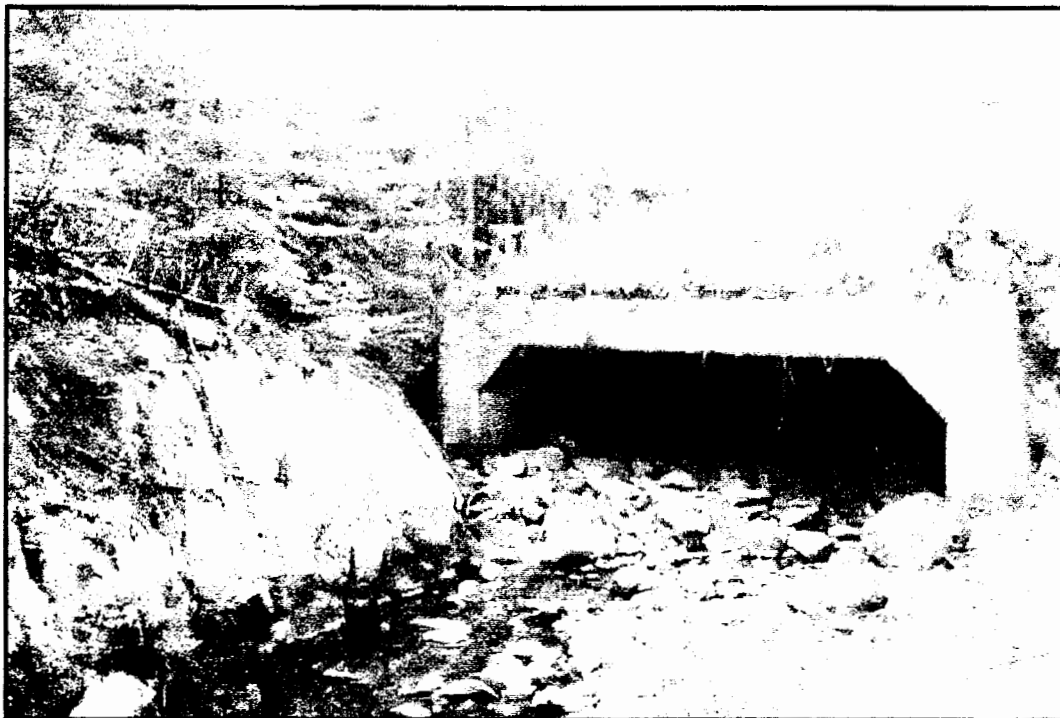
PHOTOGRAPH 3: Photograph taken from the west side of the embankment, towards the north at the excavation of test pit TP-1.



PHOTOGRAPH 4: Photograph taken from the west of the embankment, towards the northwest at the excavation of test pit TP-2



PHOTOGRAPH 5: Test pit TP-2 being excavated.



PHOTOGRAPH 6: Photograph taken of the east end of the culvert (outlet). (Note: Bedrock is outcropping at the south edge of the culvert).

APPENDIX C

BOREHOLE AND TEST PIT LOGS

EXPLANATION OF TERMS USED IN REPORT

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 62.5kg, 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	kg/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE BH-60

1 OF 1

METRIC

W.P. 109-98-00 LOCATION 5 309 253.3 N, 382 147.3 E ORIGINATED BY L.B.
 DIST 53 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE July 23, 2001 CHECKED BY A.S.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION							
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	SHEAR STRENGTH: Cu, KPa						WATER CONTENT (%)						
							UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR												
256.7	GROUND SURFACE																			
0.0	FILL, SAND & GRAVEL, angular particles, trace of SILT, brown, moist.		1	AS																
256.2																				
0.5	(compact)																			
255.2	FILL, SAND & GRAVEL, rounded particles, brown, moist.																			
1.5	(compact)																			
	FILL, SAND, fine to medium grained, trace of SILT, brown, moist.		2	SS	5															
	(loose)																			
	Very loose at ~2.3 m depth.		3	SS	3															
	SILTY at ~3.0 m depth.		4	SS	2															
	Loose at ~4.6 m depth.		5	SS	5															
	Becoming grey at ~6.1 m depth. Occasional ORGANIC inclusions at ~6.1 m depth.		6	SS	6															
249.1																				
7.6	FILL, SILT & SAND, fine grained, grey, saturated.		7	SS	5															
	(loose)																			
248.2																				
8.5	FILL, CLAYEY SILT, with SAND, occasional ORGANIC inclusions, grey/brown, moist to saturated.		8	SS	17															
	(stiff)																			
246.3																				
10.4	END OF BOREHOLE DUE TO AUGER REFUSAL ON PROBABLE BOULDER OR POSSIBLE BEDROCK																			
	Notes: 1) This borehole forms part of the Foundation Evaluation for the Culvert at Station 19+560, Highway 11, Township of Chamberlain. 2) Borehole drilled at station 19+573, offset ~4.5 m right of centreline of Highway 11. 3) No free water noted on completion. 4) Ground surface elevation interpolated from road cross sections provided by D.F. Elliott Consulting Engineers Ltd.																			



RECORD OF BOREHOLE BH-61

1 OF 1

METRIC

W.P. 109-98-00 LOCATION 5 309 234.4 N, 382 151.6 E ORIGINATED BY L.B.
 DIST 53 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE July 24, 2001 CHECKED BY A.S.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60	80	wp	w	wl		
256.8	GROUND SURFACE															
0.0	FILL, SAND & GRAVEL, angular particles, trace of SILT, brown, moist.		1	AS												
256.3																
0.5	(compact)															
255.3	FILL, SAND & GRAVEL, rounded particles, occasional cobbles, brown, moist.															
1.5	(compact)		2	SS	6											
	FILL, SAND, fine to medium grained, trace of SILT, brown, moist. (loose)		3	SS	9											
			4	SS	6											
	SILTY at ~4.6 m depth.		5	SS	10											
	Occasional ORGANIC inclusions at ~6.1 m depth.		6	SS	7											
248.9			7	SS	18											
7.9	FILL, CLAYEY SILT, with SAND, occasional ORGANIC inclusions, grey, moist to saturated. (stiff)															
248.4																
8.4	END OF BOREHOLE DUE TO AUGER REFUSAL ON PROBABLE BOULDER OR POSSIBLE BEDROCK															
	Notes: 1) This borehole forms part of the Foundation Evaluation for the Culvert at Station 19+560, Highway 11, Township of Chamberlain. 2) Borehole drilled at station 19+556, offset ~4.8 m left of centreline of Highway 11. 3) No free water noted on completion. 4) Ground surface elevation interpolated from road cross sections provided by D.F. Elliott Consulting Engineers Ltd.															



RECORD OF BOREHOLE BH-62

1 OF 1

METRIC

W.P. 109-98-00

LOCATION 5 309 244.2 N, 382 143.0 E

ORIGINATED BY L.B.

DIST 53 HWY 11

BOREHOLE TYPE Hollow Stem Augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 24, 2001

CHECKED BY A.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) × CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20	40	60	80					
256.7	GROUND SURFACE															
0.0	FILL, SAND & GRAVEL, angular particles, trace of SILT, brown, moist.		1	AS			256									
256.2	(loose)															
0.5	FILL, SAND & GRAVEL, rounded particles, occasional COBBLES, brown, moist.															
255.2	(loose)						255									
1.5	FILL, SAND, fine to medium grained, trace of SILT, brown, moist. (loose)		2	SS	6											
			3	SS	8		254									
			4	SS	5		253									
	SILTY at ~4.6 m depth. Occasional ORGANIC inclusions at ~4.6 m depth.		5	SS	6		252									
							251									
	Becoming wet at ~6.1 m depth.		6	SS	7		250									
248.9	FILL, CLAYEY SILT, occasional ORGANIC inclusions, grey, moist to saturated		7	SS	21		249									
7.8	(stiff)															
248.2	END OF BOREHOLE DUE TO AUGER REFUSAL ON PROBABLE BOULDER OR POSSIBLE BEDROCK															
8.5	Notes: 1) This borehole forms part of the Foundation Evaluation for the Culvert at Station 19+560, Highway 11, Township of Chamberlain. 2) Borehole drilled at station 19+569, offset ~4.8 m left of centreline of Highway 11. 3) No free water noted on completion. 4) Ground surface elevation interpolated from road cross sections provided by D.F. Elliott Consulting Engineers Ltd.															



TEST PIT LOGS

Test Pit No.	Location and Elevation	Depth (m)	Description
TP-1	~ Sta. 19+562 ~ 22 m left of centreline ~ El. 248.7	0 – 0.6 to 0.9 0.6 to 0.9	Fill – Blast Rock (boulder and cobble sized) with gravel and sand and alluvium Bedrock
TP-2	~ Sta. 19+554 ~ 20 m left of centreline ~ El. 248.1	0.6 to 0.9 0.6 to 0.9	Fill – Blast Rock (boulder and cobble sized) with gravel and sand and alluvium Bedrock
TP-3	~ Sta. 19+565 ~ 28 m right of centreline ~ El. 247.0	0.0	Bedrock <i>Notes: Bedrock is approximately at the same elevation as the top of the culvert. Bedrock rises towards the south.</i>
TP-4	~ Sta. 19+572 ~ 25 m right of centreline ~ El. 246.0	0.0	Fill – Blast Rock (boulder and cobble sized) with gravel and sand and alluvium

APPENDIX D

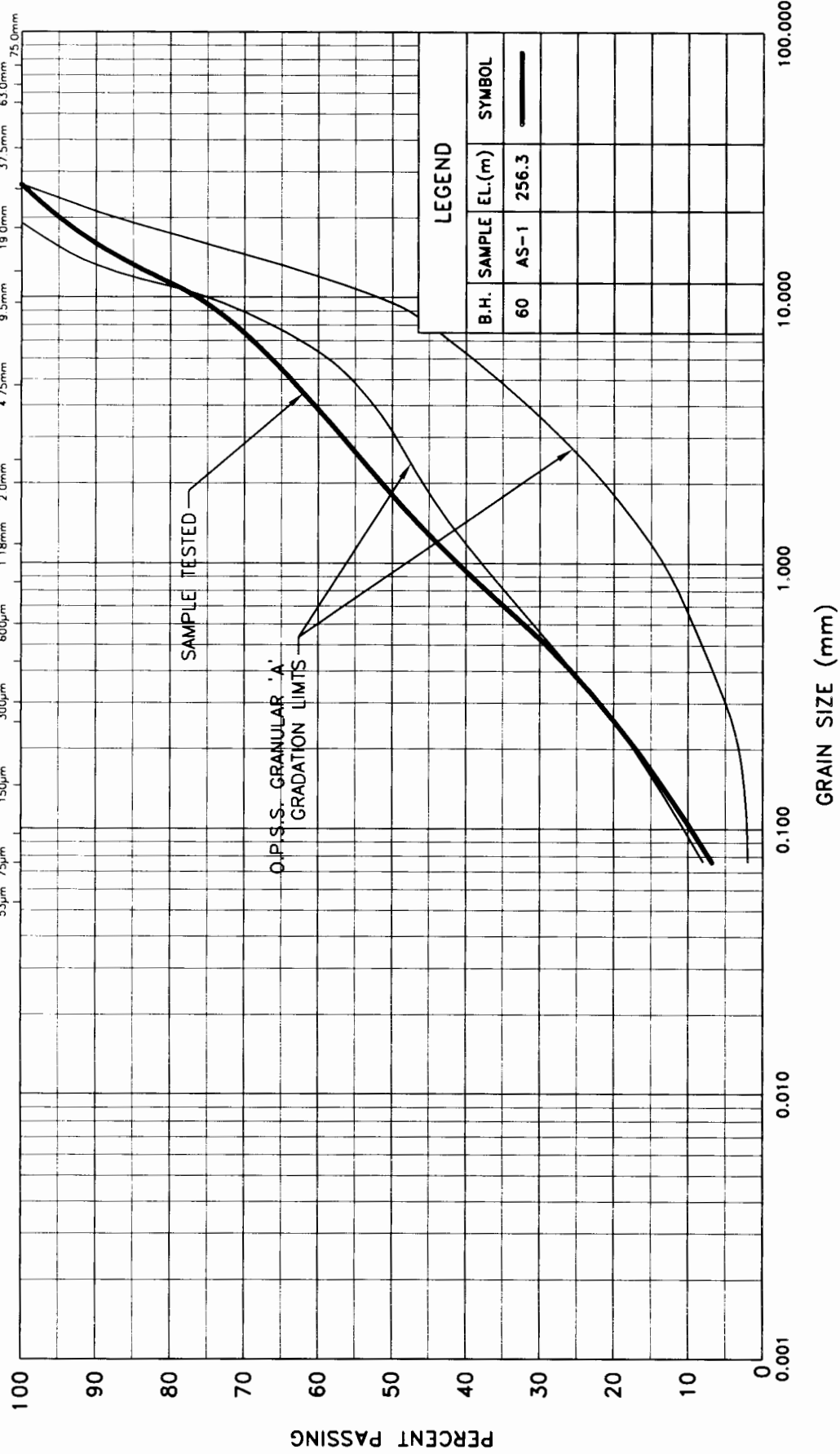
LABORATORY TEST RESULTS

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT		SAND			GRAVEL		
		FINE	MEDIUM	COARSE	FINE	COARSE	COARSE

MINISTRY SIEVE DESIGNATION (Metric)

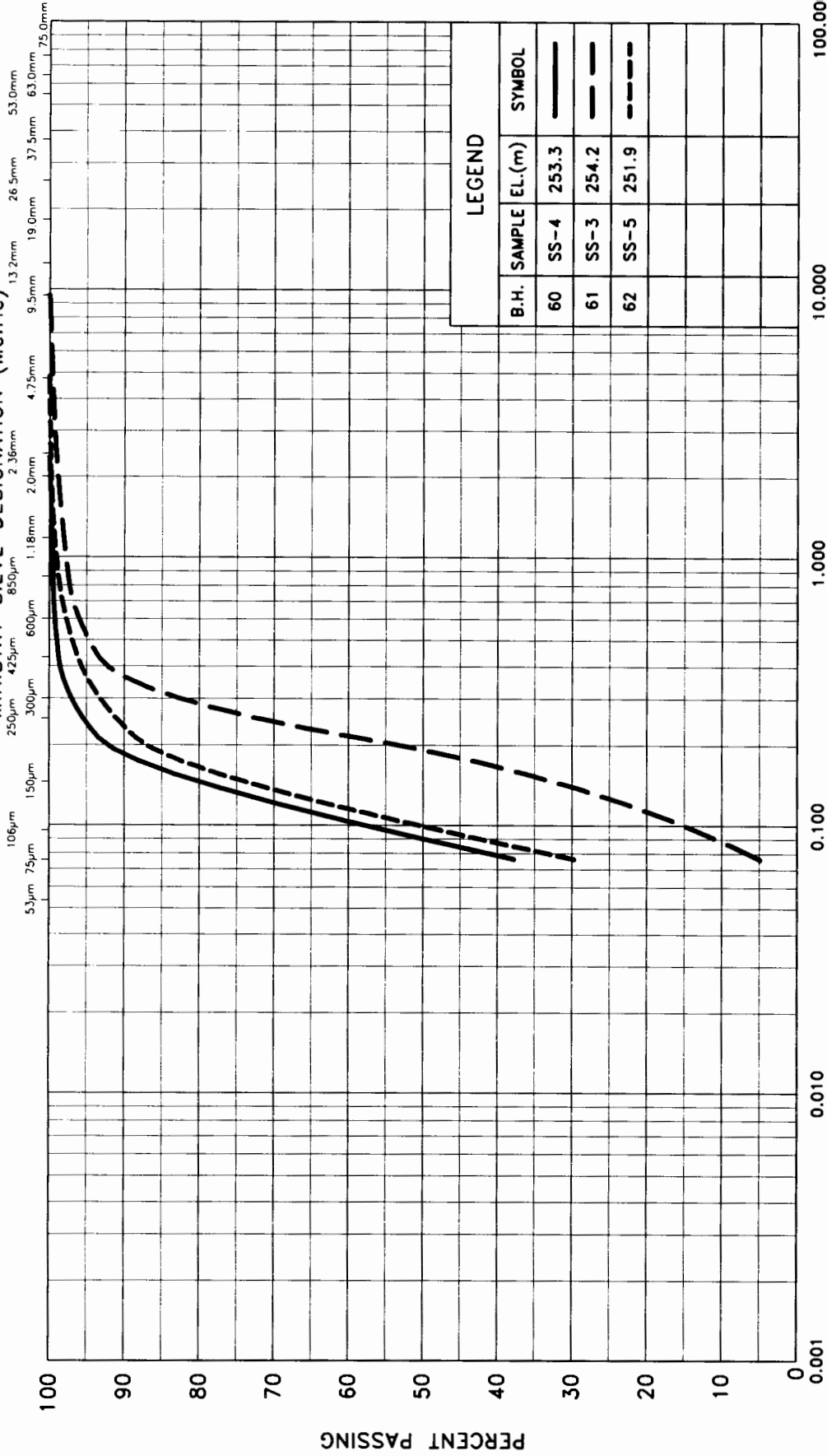
53µm 75µm 106µm 150µm 250µm 300µm 425µm 600µm 850µm 1.18mm 2.0mm 2.36mm 4.75mm 9.5mm 13.2mm 19.0mm 26.5mm 37.5mm 53.0mm 63.0mm 75.0mm



UNIFIED SOIL CLASSIFICATION

CLAY AND SILT		SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

B.H.	SAMPLE	EL.(m)	SYMBOL
60	SS-4	253.3	—
61	SS-3	254.2	- - -
62	SS-5	251.9	- · - ·

GRAIN SIZE (mm)

Ministry of
Transportation



METRIC

GRAIN SIZE DISTRIBUTION SAND FILL

FIGURE No. 2

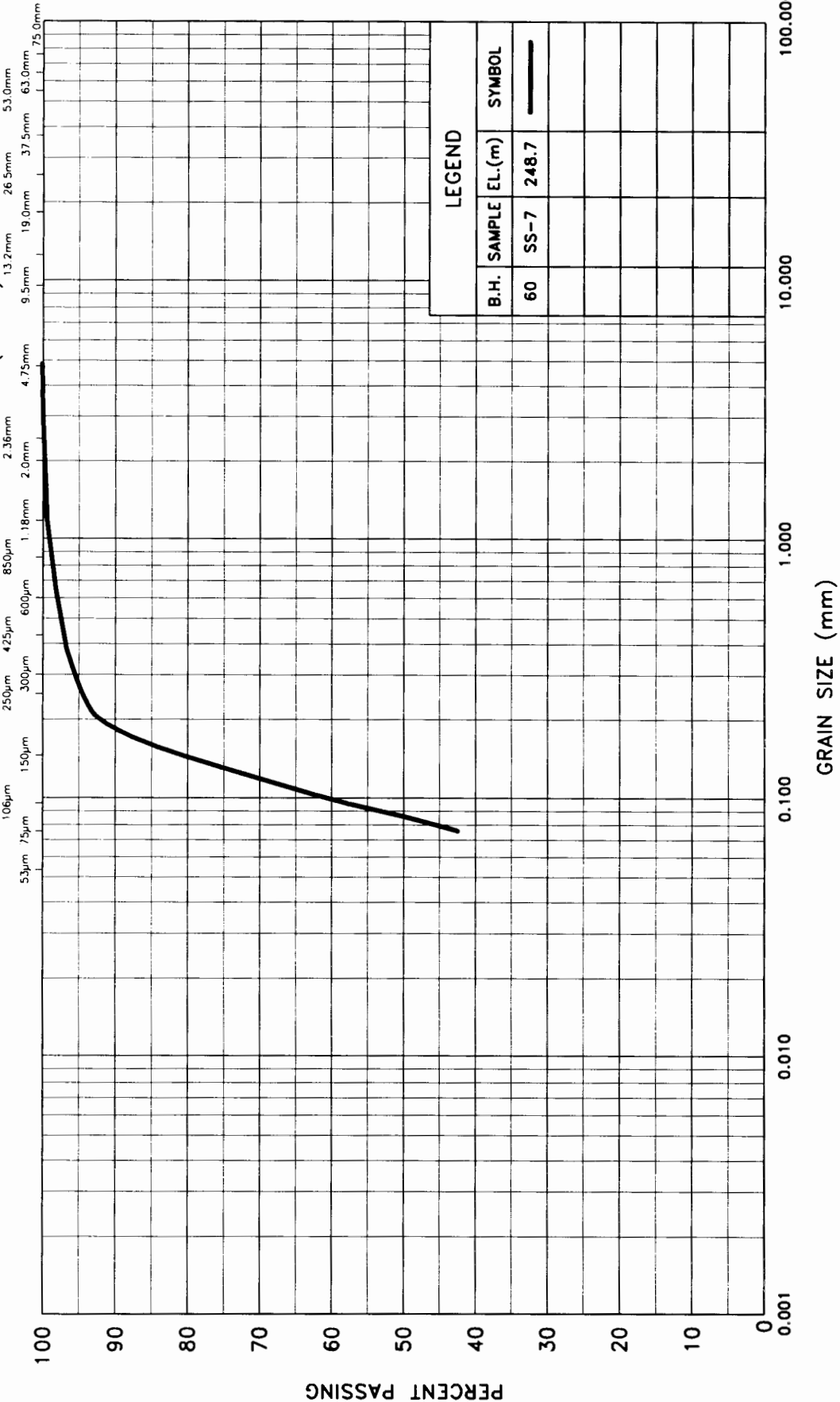
W.P. 109-98-00

REF. S08131G/Q

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT		SAND			GRAVEL		
		FINE	MEDIUM	COARSE	FINE	COARSE	

MINISTRY SIEVE DESIGNATION (Metric)





Ministry of
Transportation

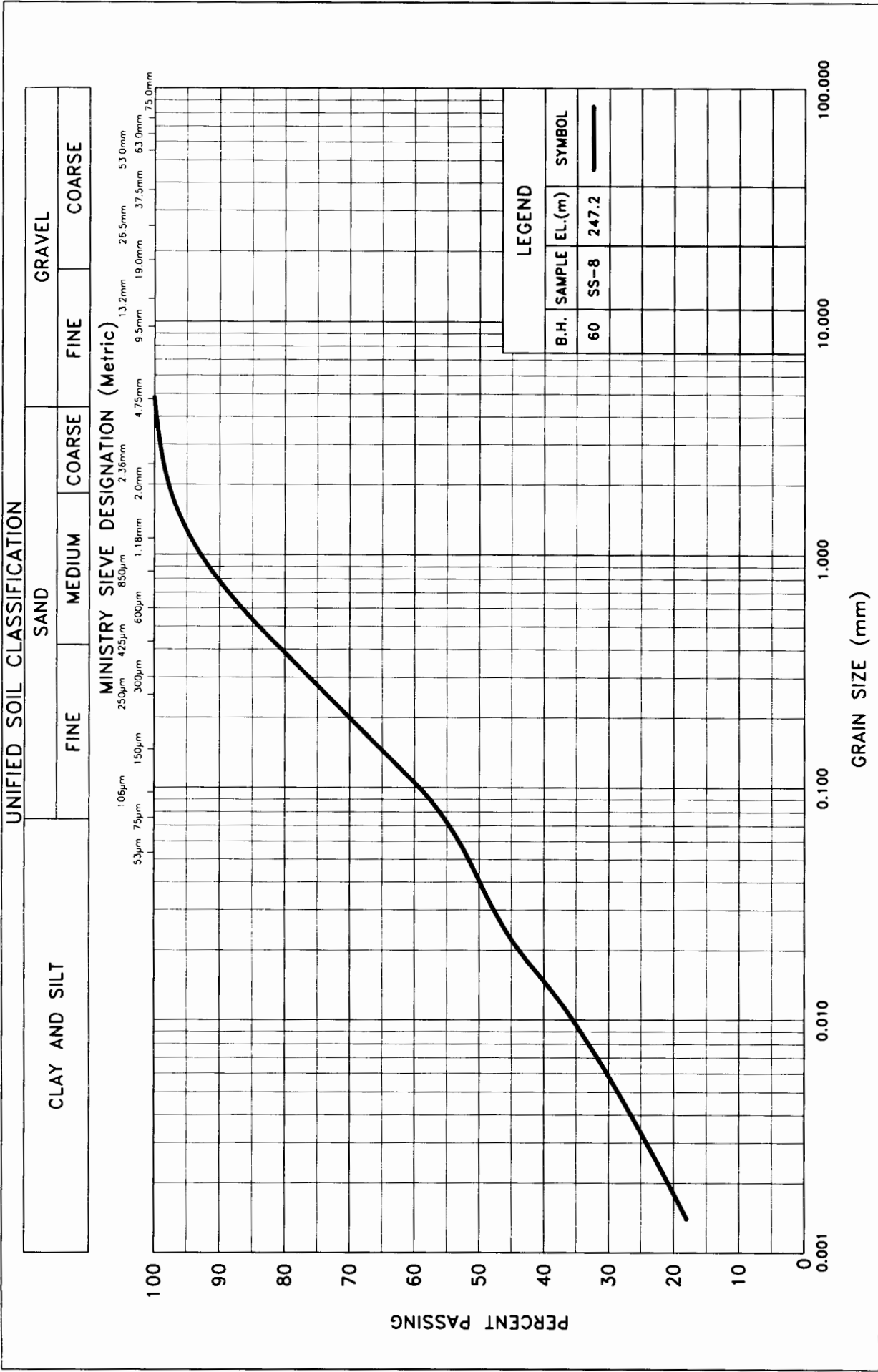
FIGURE No. 3


GRAIN SIZE DISTRIBUTION
SILT & SAND FILL

W.P. 109-98-00

REF. S08131G/Q

METRIC





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METRIC

GRAIN SIZE DISTRIBUTION

CLAYEY SILT FILL

FIGURE No. 4

W.P. 109-98-00

REF. S08131G/Q

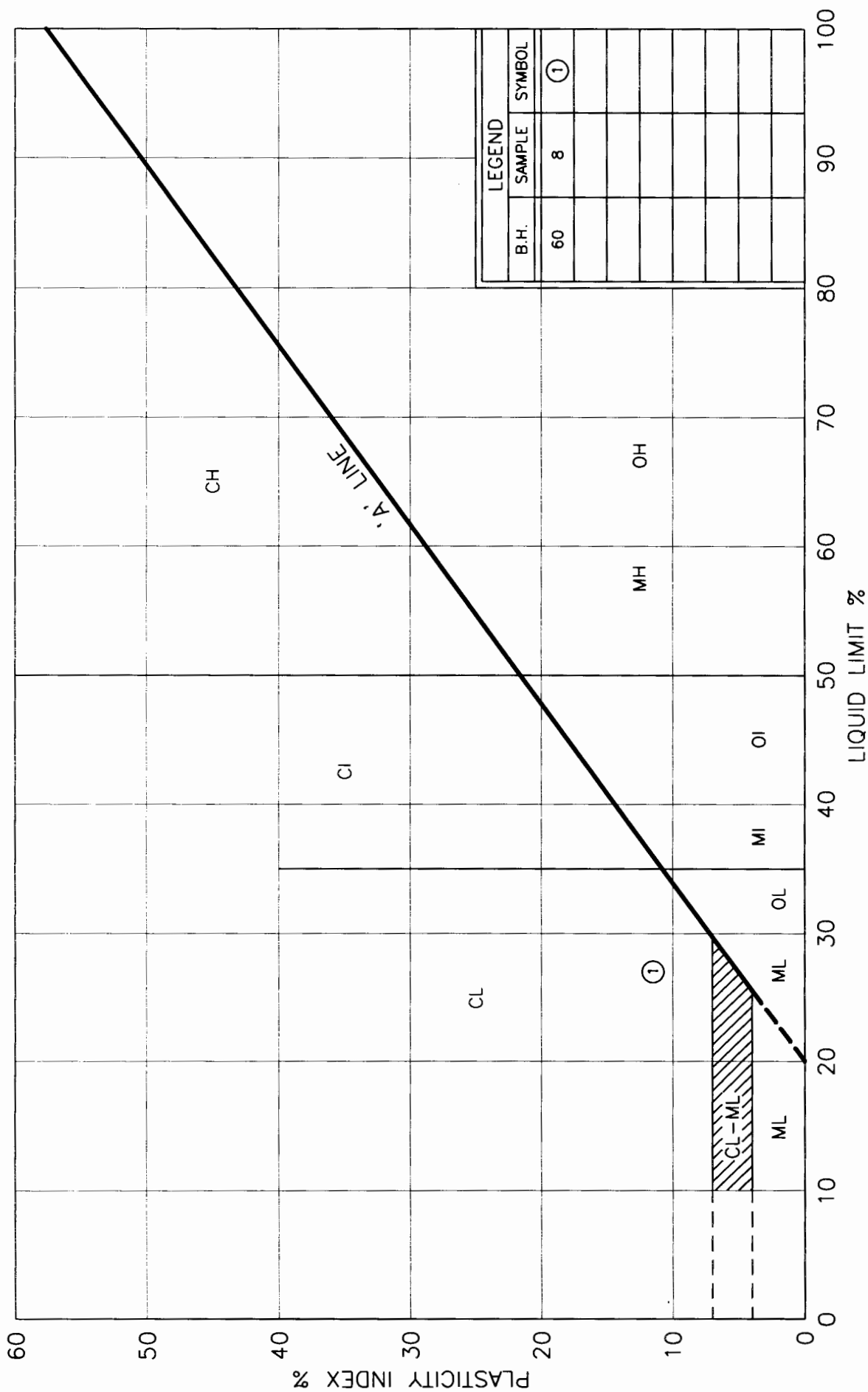


FIGURE No. 5

PLASTICITY CHART FILL, SILTY CLAY

W.P. 109-98-00

REF. S08131G/Q

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METRIC