Foundation Investigation Final Report
Martin Creek Culvert Replacement
Highway 522
East Mills Township
G.W.P. 476-98-00
GEOCRES No. 31E-261

Prepared for:

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Project No: SUGE00010242/C
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Part 1 Foundation Investigation

1.1 Introduction

This submission presents the results of a geotechnical investigation completed by Trow Associates Inc. (Trow) for the replacement of the Martin Creek Culvert (2500 mm diameter by 28.0 m long Corrugated Steel Pipe (CSP), located on Highway 522 at Station 27+608 within East Mills Township. The culvert replacement is to consist of a pre-cast concrete box culvert 3000 mm wide by 1800 mm high and approximately 28.0 m long. Photographs of the site are included in Appendix A.

The purpose of this geotechnical investigation was to determine the existing soil conditions within the proposed construction limits by field investigation and laboratory testing.

The MTO's explanation of terms, abbreviations and symbols are included in Appendix C.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The Martin Creek Culvert is located in the East Mills Township at Station 27+608 on Highway 522.

The site plan and cross section profile of the Martin Creek Culvert are as shown on Sheets No. 1 and 2 in Appendix B.

The overall terrain in the area consists of undifferentiated igneous and metamorphic rock, exposed at the surface or covered by a discontinuous layer of drift. The vegetation in the area consists mainly of coniferous trees, some deciduous trees and smaller low lying shrubs and grass. The drainage in the area generally consists of roadside ditches which drain into Martin Creek. A beaver dam and pond is located immediately upstream of the culvert inlet.

1.2.2 Geological Setting

According to the Ontario Geological Survey (OGS) Maps 2544 and 2556, the site is located in the Mesoproterozoic era within the central gneiss belt, which falls under the mafic rocks, amphibolite, gabbro, diorite and maffic gneisses. The topography in the area consists of undulating bedrock outcrops separated by intervening marshy zones and wooded areas. As such, the surface soils in the area consist of intervening shallow organic deposits (peat), with fluvial deposits consisting of gravel, sand, silt and clay.

1.3 Investigative Procedures

1.3.1 General

The fieldwork for this project was carried out on June 16th, June 17th and June 25th, 2006. The investigation consisted of a total of 3 boreholes (BH-1 to BH-3). Borehole BH-1 was drilled along the north side of the existing culvert embankment and borehole BH-3 was drilled along the south side of the existing culvert embankment to verify embankment fill materials and soil conditions below the existing culvert. Borehole BH-2 was drilled near the culvert outlet (northwest end of culvert), to verify soil conditions below the existing culvert. The original intent was to drill borehole BH-3 at the culvert inlet (northeast end of culvert). However, due to the topography of the land extensive reconfiguration would have been required to facilitate advancing a borehole near the culvert inlet. Therefore, subsurface conditions at the inlet location are unknown for design and construction. Foundation design for the new culvert inlet must be based on extrapolation of subsurface conditions at the other borehole locations.

All boreholes were advanced with a Mobile CME-55 track mounted drill rig equipped with continuous flight hollow stem augers and standard soil sampling equipment. All boreholes were advanced by Landcore Drilling.

From the drilling program, soil samples were obtained using a 51 mm (2 inch) outside diameter split spoon sampler in conjunction with Standard Penetration Tests (ASTM D 1586), at 0.75 m intervals for the upper 3.0 m and at 1.5 m intervals thereafter. The Standard Penetration Test "N" values were recorded and used to provide an assessment of the in-situ relative density of the overburden soils. All boreholes were backfilled with auger cuttings and sealed with bentonite pellets.

All fieldwork was supervised by a member of Trow's engineering staff who directed the drilling and sampling operations, logged the factual borehole data, and retrieved soil samples for subsequent laboratory testing and identification. All geodetic borehole elevations were determined in the field by Sutcliffe Rody Quesnel (SRQ). The locations of the boreholes and geodetic elevations are shown on Sheet 1, with a cross-section of the boreholes on Sheet 2 in Appendix B.

1.4 Laboratory

The soil samples obtained in the field were carefully transported to our Sudbury laboratory and examined for further verification and classification. A laboratory testing program for the selected soil consisted of Particle Size Analyses (LS 702).

The laboratory test results are summarized on the attached borehole logs in Appendix C, as well as in Appendix D.

1.5 Subsurface Conditions

1.5.1 General

The subsurface conditions encountered during the field investigation are summarized on the borehole logs located in Appendix C. The following is a description of the subsurface conditions encountered during the field investigation.

1.5.2 Stratigraphy, Highway Embankments

In general, the stratigraphy within boreholes BH-1 and BH-3 located along the north side and south side of the highway embankment, consisted of thin layer of asphalt, sand fill, sand, boulders, sand till and silty sand till overlying suspected boulders or bedrock.

A 130 (BH-1) to 150 mm (BH-3) thick layer of asphalt was encountered from ground surface. Underlying the asphalt was a 2.9 (BH-3) to 3.7 m (BH-1) thick layer of sand fill. The sand fill was brown to grey in colour, damp, well graded, fine to coarse grained and contained trace to some fine to coarse grained gravel and trace to some silt. Uncorrected SPT "N" values within the sand fill ranged from 4 to 50 blows per 300 mm indicating a very loose to dense material in relative density. Underlying the sand fill in borehole BH-1 was a 3.8 m thick layer of sand extending to a depth of 7.6 m. The sand material was brown to grey in colour, wet, well graded, fine to coarse grained and contained trace to some fine grained gravel and some silt. Recorded uncorrected SPT "N" values within the sand material were 15 blows per 300 mm above 6.1 m depth inferring a compact material in relative density and 4 blows per 300 mm below inferring a very loose material in relative density. Underlying the sand fill in borehole BH-3 was a 3.0 m thick layer of boulders. The boulders were cored from 3.1 to 6.1 m below grade. The boulders consisted mainly of granite and gneiss and were up to 0.23 m in diameter. Underlying the sand in borehole BH-1 and the boulders in BH-3 was a 3.1 (BH-1) to 3.3 m (BH-3) thick layer of sand till, which extended to a depth of 10.7 m in borehole BH-1 and 9.4 m in borehole BH-3. In borehole BH-3 the sand till overlaid suspected boulders or bedrock, where SPT refusal was encountered (i.e. >100 blows per 300 mm). The sand till was grey in colour, damp to wet, poorly graded, fine to coarse grained and contained trace fine grained gravel and some silt. Uncorrected SPT "N" values within the sand till ranged from 57 to 100 blows per 300 mm indicating a very dense material in relative density. Underlying the sand till in borehole BH-1 was silty sand till, which extended to the 11.1 m depth. The silty sand till overlaid suspected boulders or bedrock, where SPT refusal was encountered (i.e. >100 blows per 300 mm). The silty sand till was grey, wet, poorly graded and contained fine grained sand and trace to some fine to coarse grained gravel. The uncorrected SPT "N" value within the silty sand till was 100 blows per 300 mm indicating a very dense material in relative density.

1.5.3 Stratigraphy, Culvert Outlet

In general, the stratigraphy within borehole BH-2 at the culvert outlet, consisted of sand fill, sand and boulders.

Sand fill was encountered from ground surface to a depth of 3.1 m below grade. The sand fill was brown in colour, damp above 1.74 m depth and wet below, fine to coarse grained and contained trace to some fine to coarse grained gravel, trace to some silt and trace organics. Recorded uncorrected SPT "N" values within the sand fill material ranged from 0 to 5 blows per 300 mm inferring a very loose to loose material in relative density. Underlying the sand fill material was a 4.5 m thick layer of sand, which extended to a depth of 7.6 m. The sand was brown to grey in colour, wet, fine to coarse grained and contained trace fine grained gravel and some to with silt. Recorded uncorrected SPT "N" values within the sand ranged from 20 to 100 blows per 300 mm indicating a compact to very dense material in relative density. Underlying the sand was a 4.8 m thick layer of boulders. The boulders were cored from 7.6 to 12.4 m below grade. The boulders consisted mainly of granite and gneiss and were up to 0.1 m in diameter.

Borehole BH-2 was terminated at a depth of 12.4 m below grade.

1.6 Groundwater Conditions

The groundwater was encountered in boreholes BH-1 to BH-3 between Elevations 218.43 to 222.90 m. This infers a groundwater level near creek level at the time of the investigation. The lower water levels within the boreholes could be due to disturbance in the holes at the time of drilling and that the boreholes had not stabilized prior to backfilling. The higher groundwater level observed within borehole BH-2 at 222.90 m is likely due to trapped water within the existing fill. As such, for design purposes the groundwater level should be assumed to be equal to the creek water elevation, which was 222.73 m at the time of the investigation.

Seasonal variations in the water table should be anticipated, with higher levels occurring during wetter periods of the year (such as spring thaw and late fall) and lower levels during drier periods.

2.0 CLOSURE

This report has been prepared by D. Muldowney, B.Eng., and reviewed by T. Crilly M.Sc., P.Eng. and S. Gonsalves, M.Eng., P.Eng. Designated MTO Foundation Contact. The field investigation was conducted by Craig St Amant.

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

Yours truly,

Trow Associates Inc.

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Geotechnical Department

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Principal Engineer
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Encl.
Dist: Northland Engineering (1987) Limited (7)

Vesta/2006/MTO Projects//10242G-C Culverts/ Martin Creek Culvert/Martin Creek Foundation Investigation & Design Final Report - Sept. 26-06

Trow

APPENDIX A

Photographs

Photo #1 – Station 27+608, East Mills Township, Facing West
Photo taken on June 16th, 2006

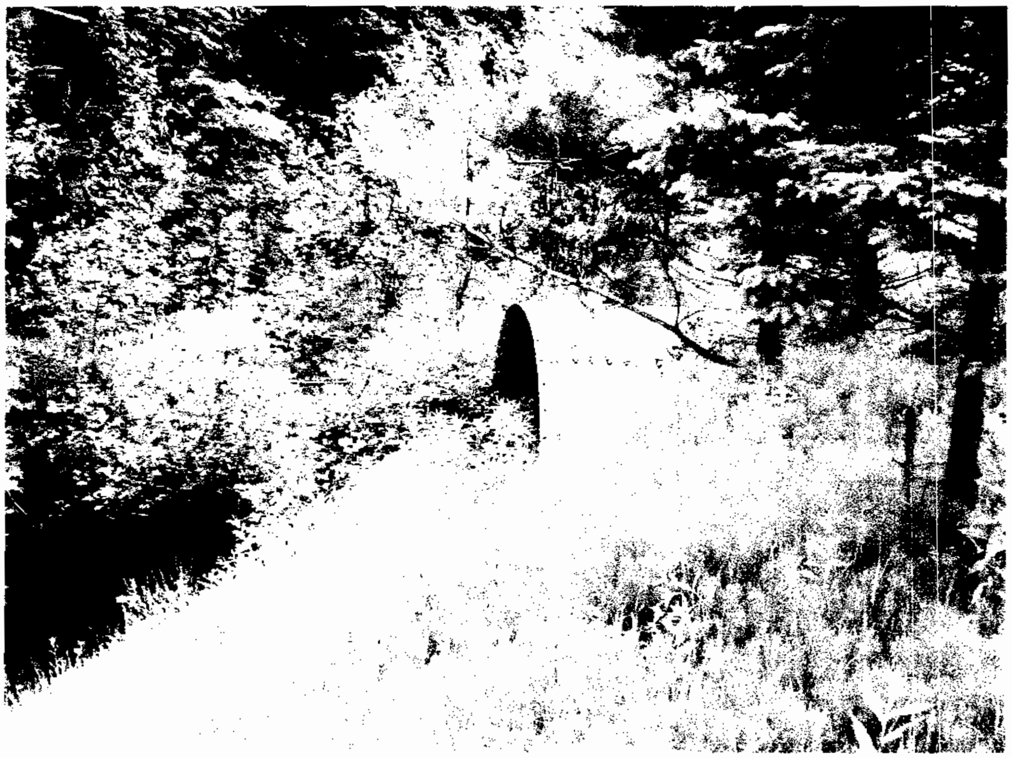


Photo #2 – Station 27+608, East Mills Township, Facing West
Photo taken on June 16th, 2006

APPENDIX B

Drawings

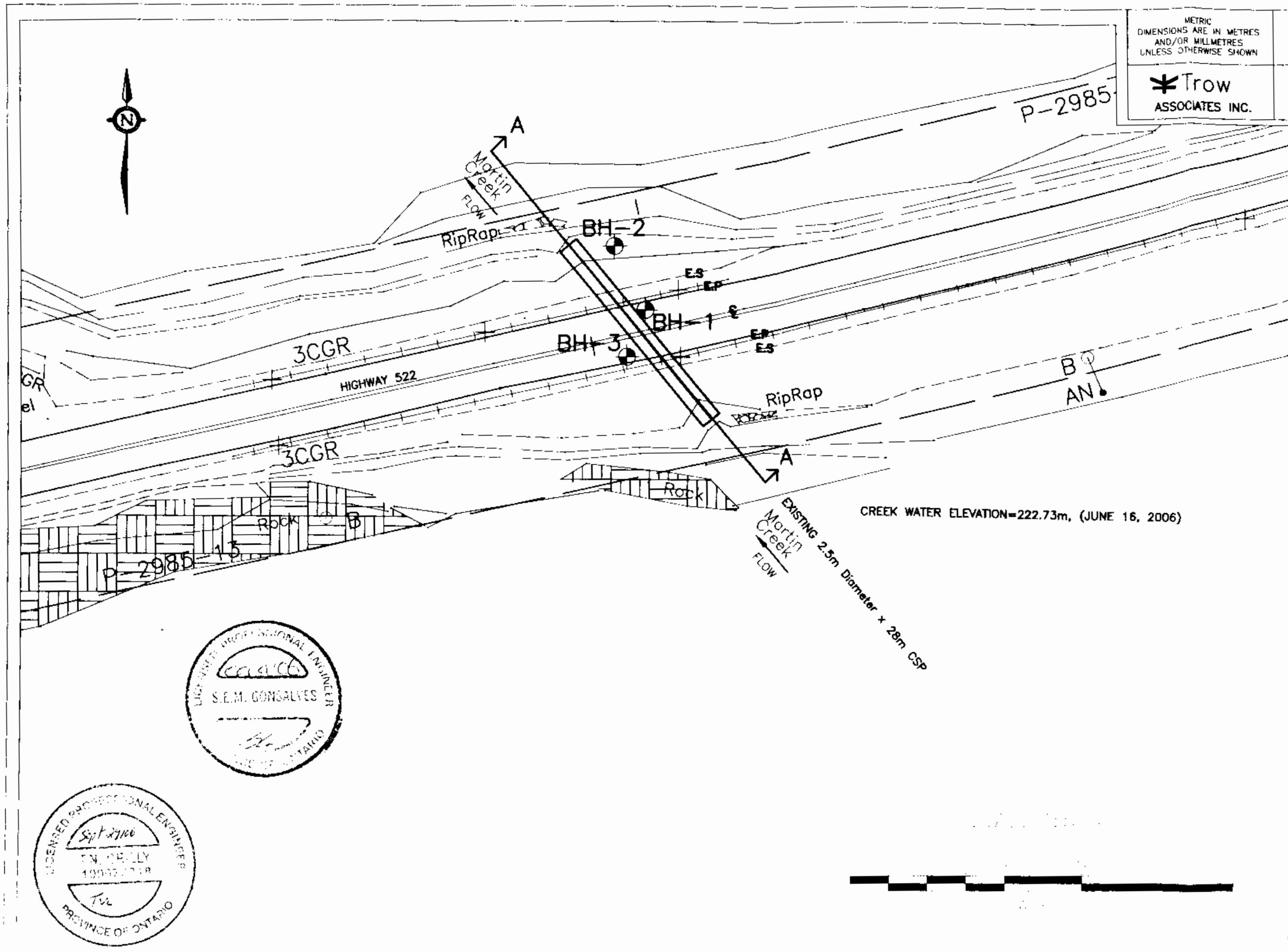
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

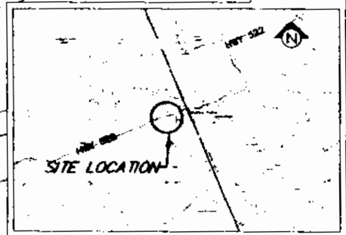
Trow ASSOCIATES INC.

GEOCRES No. 31E-261
GWP 476-98-00

MARTIN CREEK
CULVERT REPLACEMENT
BOREHOLE LOCATIONS

SHEET 1





KEYPLAN

LEGEND

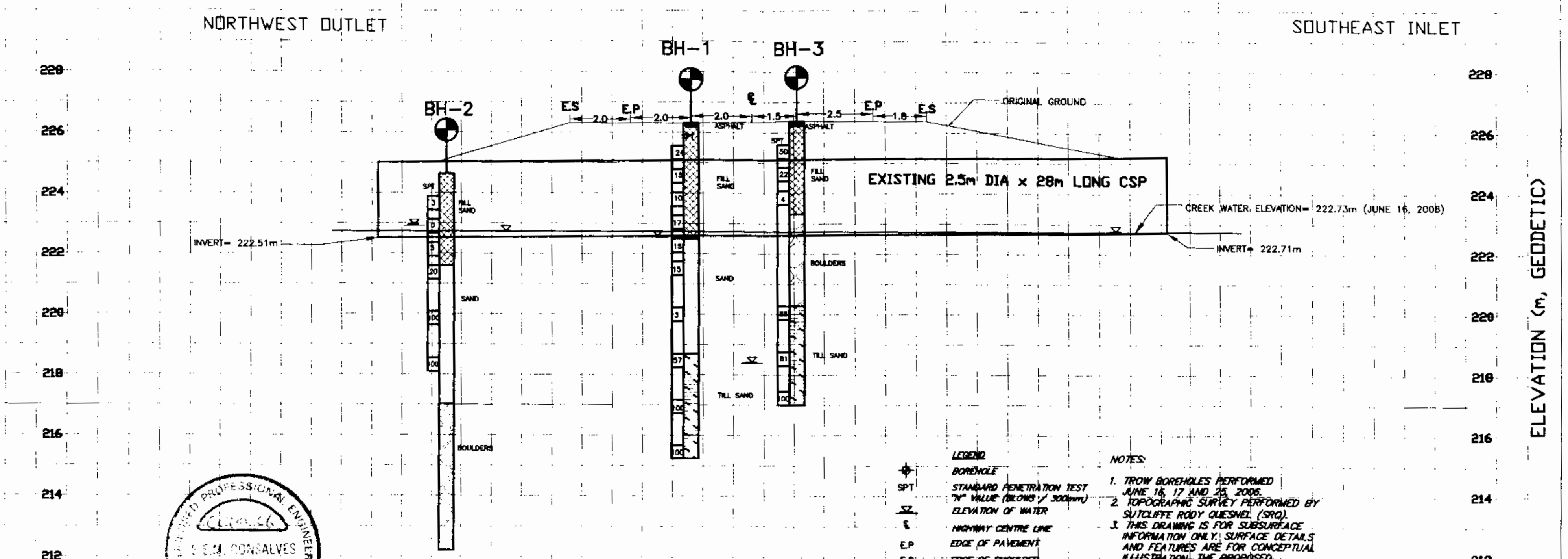
- BOREHOLE
- ℄ HIGHWAY CENTERLINE
- E.P EDGE OF PAVEMENT
- E.S EDGE OF SHOULDER

NOTES:

1. TROW BOREHOLES PERFORMED JUNE 16, 17 AND 25, 2006.
2. TOPOGRAPHIC SURVEY PERFORMED BY SUTCLIFFE RODY QUESNEL (SRQ).
3. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION. THE PROPOSED STRUCTURE LOCATION, DETOUR AND STAGING ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT BE CONSISTENT WITH THE FINAL DESIGN CONFIGURATION AS SHOWN ELSEWHERE IN THE CONTRACT DOCUMENT.
4. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.

NO.	ELEVATION	NORTHING	EASTING	OFFSET(m)
BH-1	226.32	5087247.12	281180.85	2.1 LT
BH-2	224.64	5087257.21	281179.01	11.7 LT
BH-3	226.40	5087240.65	281175.63	2.3 RT

METRIC DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN	GEOCRES No. 31E-261 GWP 476-98-00		
Trow ASSOCIATES INC.	MARTIN CREEK CULVERT REPLACEMENT BOREHOLE LOCATIONS PROFILE	SHEET 2	



LEGEND

- BOREHOLE
- SPT — STANDARD PENETRATION TEST "N" VALUE (BLOWS / 300mm)
- ELEVATION OF WATER
- ℄ — HIGHWAY CENTRE LINE
- E.P — EDGE OF PAVEMENT
- E.S — EDGE OF SHOULDER

NOTES:

1. TROW BOREHOLES PERFORMED JUNE 16, 17 AND 25, 2006.
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NO.	ELEVATION	NORTHING	EASTING	OFFSET(m)
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BH-2	224.64	5087257.21	281179.01	11.7 LT
BH-3	226.40	5087240.65	281175.83	2.3 RT

PROFESSIONAL ENGINEER — S.E.M. GONSALVES — PROVINCE OF ONTARIO

PROFESSIONAL ENGINEER — Sept 21/06 — T.N. [illegible]

SECTION A — A

MARTIN CREEK CULVERT PROFILE

SCALE 1:125

APPENDIX C

Borehole 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 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/0.3 m)	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 (R Q D), 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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Unified Soil Classification System (USCS) as outlined by the Ministry of Transportation. Different classification systems may be used by others; one such system is the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), as outlined in the Canadian Foundations Engineering Manual. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

UNIFIED SOIL CLASSIFICATION

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	200

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (75 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Notes On Soil Descriptions

4. The following table gives a description of the soil based on particle sizes. With the exception of those samples where grain size analyses have been performed, all samples are classified visually. The accuracy of visual examination is not sufficient to differentiate between this classification system or exact grain size.

Soil Classification		Terminology	Proportion
Clay and Silt	<0.075 mm		
Sand	0.075 to 4.75 mm	"trace" (e.g. Trace sand)	0% to 10%
Gravel	4.75 to 75 mm	"some" (e.g. Some sand)	10% to 20%
Cobbles	75 to 200 mm	with (e.g. with sand)	20% to 35%
Boulders	>200 mm	and (e.g. and sand)	35% to 50%

For a given material listed as an adjective (e.g. silty sand) means the predominant grain size is sand sized with 30 to 40% silt sized particles.

The compactness of Cohesionless soils and the consistency of the cohesive soils are defined by the following:

Cohesionless Soil		Cohesive Soil	
Compactness	**Standard Penetration Resistance "N" Blows/ 0.3 m**	**Consistency**	**Undrained Shear Strength (kPa)**
Very Loose	0 to 5	Very soft	<12
Loose	5 to 10	Soft	12 to 25
Compact	10 to 30	Firm	25 to 50
Dense	30 to 50	Stiff	50 to 100
Very Dense	Over 50	Very Stiff	100 to 200
		Hard	>200

5. **ROCK CORING**

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundless of the rock mass. It is obtained from the rock cores by summing the length of the core covered, counting only those pieces of sound core that are 100 mm or more length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD (%)
Very Poor Quality	<25
Poor Quality	25 to 50
Fair Quality	50 to 75
Good Quality	75 to 90
Excellent Quality	90 to 100

$$\text{Recovery Designation \% Recovery} = \frac{\text{Length of Core Per Run}}{\text{Total Length of Run}} \times 100$$

Trow Associates Inc.
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RECORD OF BOREHOLE No BH-1

SHEET 1 OF 1 **METRIC**

PROJECT NO. SO10242G/C **LOCATION** Martin Creek - Hwy 522 Sta 27+608, 2.1m LT of Centerline **ORIGINATED BY** CS

DIST Parry Sound **HWY** 522 **BOREHOLE TYPE** Hollow Stem Auger **COMPILED BY** TA

DATUM Geodetic **DATE** 6/16/2006 **CHECKED BY** TC

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	GR	SA	SI	CL
226.3										
	ASPHALT, 130mm thick.									
226.2	**FILL SAND**, brown to grey, damp, compact, well graded, fine to coarse grained, some fine to coarse grained gravel, some silt.	1	BAG			226				
		2	SS	24			18	66	16	
						225				
		3	SS	15						
		4	SS	10		224				
		5	SS	17		223				
222.5 / 3.8	**SAND**, brown to grey, wet, compact, well graded, fine to coarse grained, some fine grained gravel, some silt.	6	SS	15	▽		11	76	13	
						222				
		7	SS	15						
						221				
	very loose, trace fine grained gravel below ~ 6.10 m depth.	8	SS	3		220	1	86	13	
						219				
218.7 / 7.6	**TILL SAND**, grey, wet, very dense, poorly graded, fine grained, trace to some silt, trace fine grained gravel.	9	SS	57						
						218				
		10	SS	100		217				
						216				
215.7 / 10.7	**TILL SILTY SAND**, grey, wet, very dense, poorly graded, sand fine grained, trace to some fine to coarse grained gravel.	11	SS	100						
215.3 / 11.1	BOREHOLE TERMINATED AT ~ 11.07 m DEPTH DUE TO SPT REFUSAL ON SUSPECTED BOULDERS OR BEDROCK									

SPT TEST (N-Value) ● DYNAMIC CONE PENETRATION (20, 40, 60, 80, 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ⊗ QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100); PLASTIC LIMIT PL, NATURAL WATER CONTENT w, LIQUID LIMIT LL; WATER CONTENT (%) (10, 20, 30); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%)

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT 10242 - MARTIN CREEK.GPJ ON_MOT.GDT 06/09/25

Trow Associates Inc.
1595 Clark Boulevard Ltd.
Brampton, Ontario L6T 4V1

RECORD OF BOREHOLE No BH-2

SHEET 1 OF 1 **METRIC**

PROJECT NO. SO10242G/C **LOCATION** Martin Creek - Hwy 522 Sta 27+608, 11.7m LT of Centerline **ORIGINATED BY** CS

DIST Parry Sound **HWY** 522 **BOREHOLE TYPE** Hollow Stem Auger **COMPILED BY** TA

DATUM Geodetic **DATE** 6/16/2006 - 6/17/2006 **CHECKED BY** TC

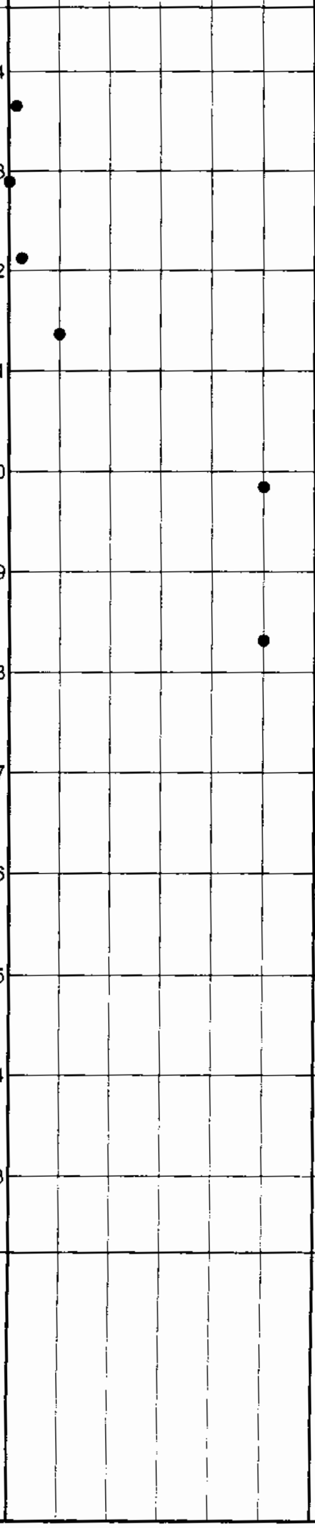
ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
224.6 / 0.0	**FILL SAND**, brown, dry, very loose, well graded, fine to coarse grained, some fine to coarse grained gravel, trace silt, trace organics. damp below ~ 0.76 m depth.	Fill	1	BAG						
			2	SS	3					
	wet below ~ 1.74 m depth.		3	SS	0	∇				
	trace fine grained gravel, some silt below ~ 2.29 m depth.		4	SS	6					
221.6 / 3.1	**SAND**, brown to grey, wet, compact, well graded, fine to coarse grained, trace fine grained gravel, some silt.		5	SS	20		5	77	18	
	with silt, very dense below ~ 4.57 m depth.		6	SS	100		3	66	31	
			7	SS	100					
217.0 / 7.6	**BOULDERS**, Granite, Gneiss up to 0.10 m in diameter.	Boulders								
212.3 / 12.4	BOREHOLE TERMINATED AT ~ 12.42 m DEPTH									

ELEVATION SCALE: 224, 223, 222, 221, 220, 219, 218, 217, 216, 215, 214, 213

SPT TEST (N-Value) ●
DYNAMIC CONE PENETRATION 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
⊗ QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT PL — NATURAL WATER CONTENT w — LIQUID LIMIT LL
WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³



+3, ×3 Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

ON_MOT 10242 - MARTIN CREEK.GPJ ON_MOT.GDT 06/09/22

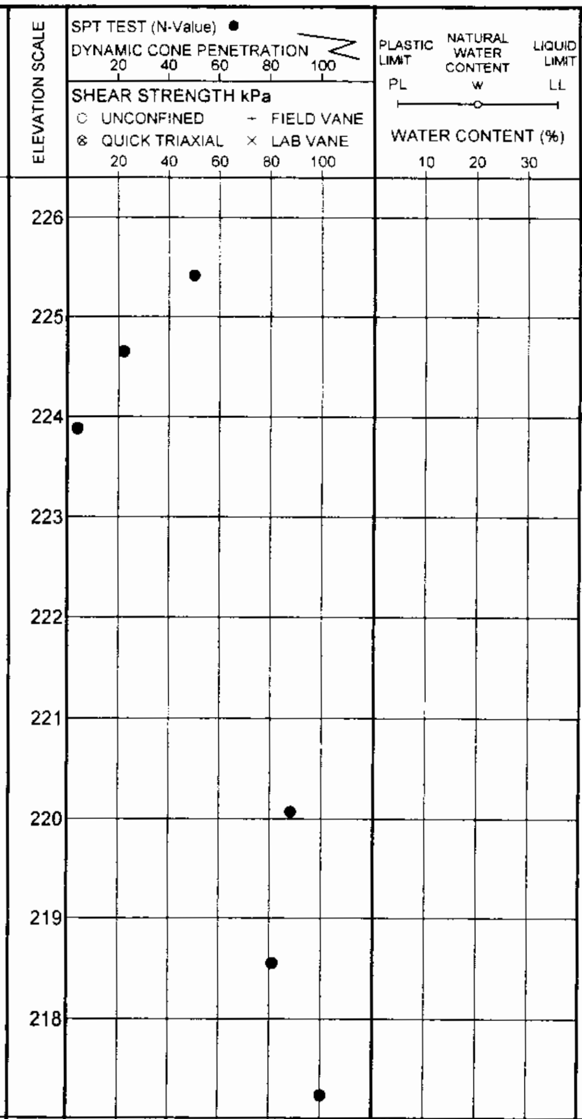
Trow Associates Inc.
1595 Clark Boulevard Ltd.
Brampton, Ontario L6T 4V1

RECORD OF BOREHOLE No BH-3

SHEET 1 OF 1 **METRIC**

PROJECT NO. SO10242G/C
LOCATION Martin Creek - Hwy 522 Sta 27+608, 2.3m RT of Centerline
ORIGINATED BY CS
DIST Parry Sound HWY 522
BOREHOLE TYPE Hollow Stem Auger
COMPILED BY TA
DATUM Geodetic
DATE 6/25/2006
CHECKED BY TC

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
226.4									
	ASPHALT, 150 mm depth.								
226.3	**FILL SAND**, brown, damp, dense, well graded, fine to coarse grained, trace to some fine to coarse grained gravel, trace silt. trace asphalt below ~ 0.76 m depth. some silt, trace fine grained gravel, compact below ~ 1.52 m depth. very loose below ~ 2.29 m depth.	1	BAG						
		2	SS	50					
		3	SS	22		4	77	19	
		4	SS	4					
223.4 / 3.1	**BOULDERS**, Granite, Gneiss - up to 0.23 m in diameter.								
220.3 / 6.1	**TILL SAND**, grey, damp, very dense, poorly graded, fine to coarse grained, trace fine grained gravel, with silt.	5	SS	88		7	71	23	
	wet below ~ 7.97 m depth.	6	SS	81	▽				
		7	SS	100					
217.0 / 9.4	BOREHOLE TERMINATED AT ~ 9.37 m DEPTH DUE TO SPT REFUSAL ON SUSPECTED BOULDERS OR BEDROCK								



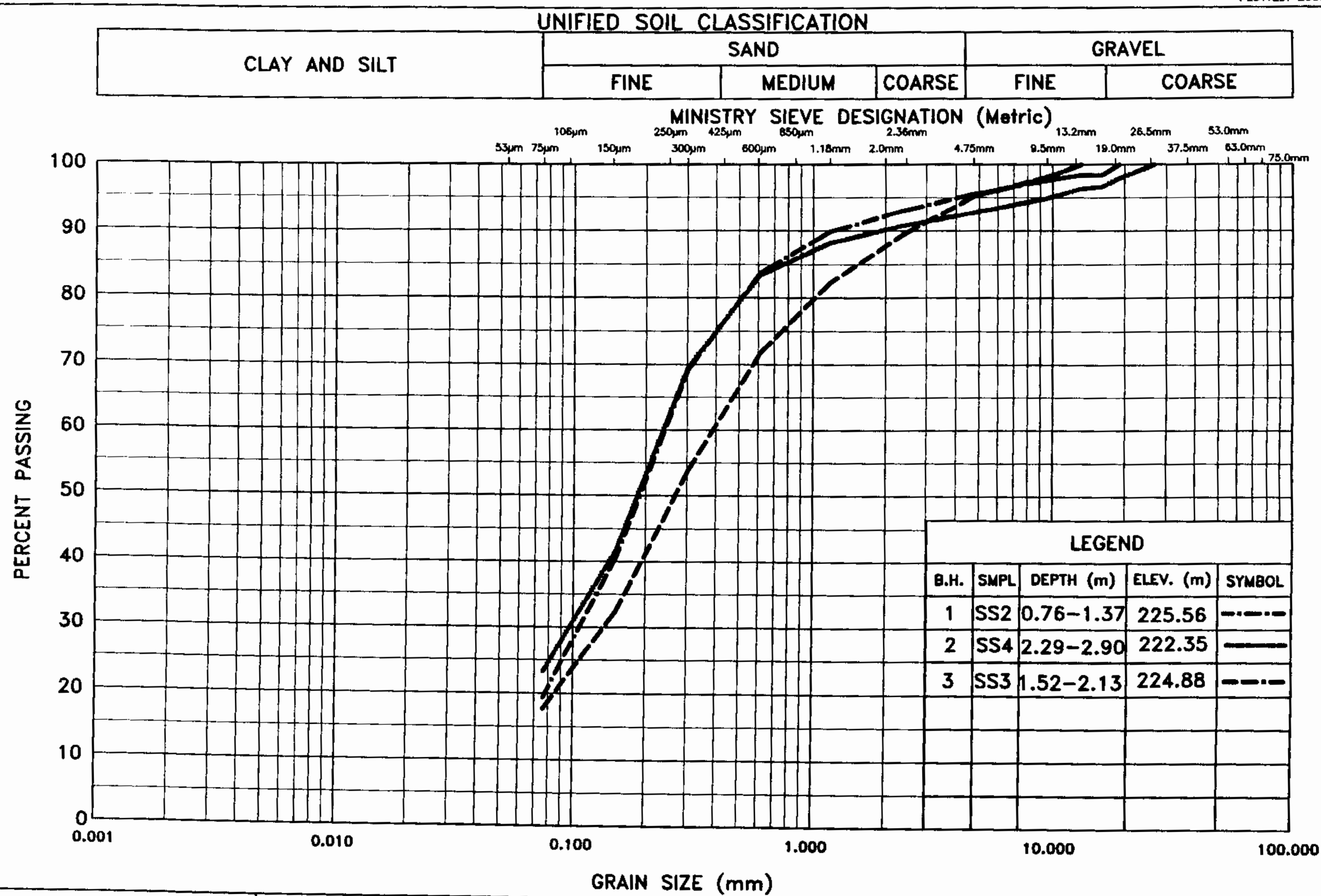
3 × 3 Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT 10242 - MARTIN CREEK.GPJ ON_MOT.GDT 06/09/22

APPENDIX D

Laboratory Data

PLOTTED: 2006/08/01



LEGEND

B.H.	SMPL	DEPTH (m)	ELEV. (m)	SYMBOL
1	SS2	0.76–1.37	225.56	–·–·–
2	SS4	2.29–2.90	222.35	——
3	SS3	1.52–2.13	224.88	– – · –

Ontario
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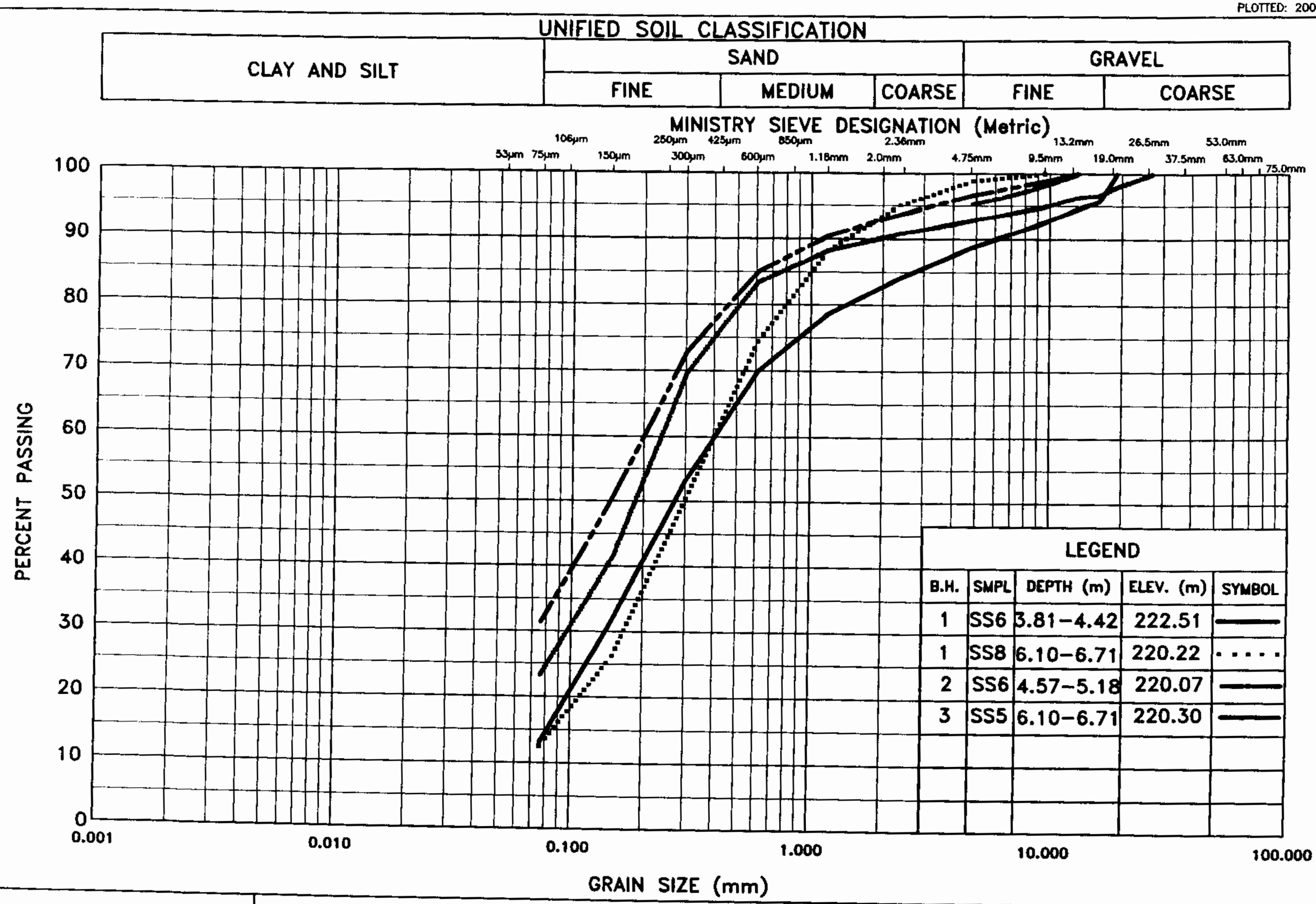
METRIC

GRAIN SIZE DISTRIBUTION
SAND FILL

FIGURE No. 6
G.W.P. 478–98–00
MARTIN CREEK CULVERT
REF. S010242G/C

PLOTTED: 2006/08/01



LEGEND

B.H.	SMPL	DEPTH (m)	ELEV. (m)	SYMBOL
1	SS6	3.81–4.42	222.51	———
1	SS8	6.10–6.71	220.22	• • • •
2	SS6	4.57–5.18	220.07	— — —
3	SS5	6.10–6.71	220.30	———

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METRIC

GRAIN SIZE DISTRIBUTION

SAND/SAND TILL

FIGURE No. 7

G.W.P. 478–98–00

MARTIN CREEK CULVERT

REF. S010242G/C