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**Foundation Investigation Final Report  
Unknown Creek Culverts Replacement  
Highway 522  
East Mills Township  
G.W.P. 476-98-00  
GEOCRES No. 31E-262**

**Prepared for:**

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Project No: SUGE00010242/C  
September 26, 2006

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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 Unknown Creek culverts (twin 1830 mm diameter by approximately 26.0 m long Corrugated Steel Pipe (CSP)), located on Highway 522 at Stations 21+516 and 21+518 within East Mills Township. The culvert replacement is to consist of a single pre-cast concrete box culvert 2000 mm wide by 1500 mm high and approximately 26.0 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 Unknown Creek culverts are located in the East Mills Township at Stations 21+516 and 21+518 on Highway 522.

The site plan and cross section profiles of the Unknown Creek culverts 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 deciduous trees, some coniferous trees and smaller low lying shrubs and grass. The drainage in the area generally consists of roadside ditches, which drain into Unknown Creek.

#### **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 mafic 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 23<sup>rd</sup> and June 24<sup>th</sup>, 2006. The investigation consisted of a total of 4 boreholes (BH-1 to BH-4). Borehole BH-1 was drilled along the north side of the highway embankment and boreholes BH-3 and BH-4 were drilled along the south side of the highway embankment to verify embankment fill materials and soil conditions below the existing culvert. Borehole BH-2 was drilled near the culvert outlet (north end of culvert), to verify soil conditions below the existing culverts. 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. The original intent was to drill borehole BH-4 at the culvert inlet (south 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 locations 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.

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 the 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 borehole logs located 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

Borehole BH-1 was drilled along the north side of the highway embankment, borehole BH-2 was drilled near the culvert outlet (north end of culvert), and boreholes BH-3 and BH-4 were drilled along the south side of the highway embankment.

In general, the stratigraphy within boreholes BH-1 to BH-4 consisted of a thin layer of asphalt overlying sand fill, silt and sand, and boulders overlying suspected bedrock.

The asphalt ranged in thickness from approximately 40 (BH-1) to 50 mm (BH-3 and BH-4) thick. Asphalt was not encountered in borehole BH-2. Underlying the asphalt in boreholes BH-1, BH-3 and BH-4 and the from ground surface in borehole BH-2, was a 2.5 (BH-1) to 3.7 m (BH-1) thick layer of sand fill. The sand fill was brown in colour, damp to wet, well graded, fine to coarse grained and contained trace to with fine to coarse grained gravel and trace to with silt. Recorded uncorrected Standard Penetration Test (SPT) "N" values within the sand fill ranged from 3 to 58 blows per 300 mm inferring a very loose to very dense material in relative density. Underlying the sand fill in borehole BH-1 was a 1.4 m thick layer of boulders, which was cored from 3.7 to 5.1 m below grade. The boulders mainly consisted of granite and gneiss and were up to 0.28 m in diameter. Underlying the sand fill in borehole BH-3 was a 1.4 m thick layer of silt and sand, which extended to 4.5 m below grade. The silt and sand was brown to grey in colour, wet, poorly graded, fine to coarse grained (sand), and contained trace fine grained gravel. The recorded uncorrected SPT "N" value within the silt and sand was 8 blows per 300 mm inferring a loose material in relative density. Standard Penetration Test (SPT) refusal (i.e. >100 blows per 300 mm) was encountered in boreholes BH-2 to BH-4 between 2.54m (BH-2) and 4.47 m (BH-3) below grade.

Bedrock was encountered in borehole BH-1 underlying the boulder material at approximately 5.1 m below existing grade. A 2.8 m core was taken from the bedrock. The bedrock consisted of granite and gneiss. The bedrock was fresh, intact, light grey to pink in colour, fine to medium grained and very strong. The Rock Quality Designation (RQD) was between 82% and 97%, indicating a good to excellent quality of rock. The RQD is also included in the attached borehole logs in Appendix C.

## 1.6 Groundwater Conditions

Groundwater elevations observed within boreholes BH-1 to BH-3 were between 232.75 and 233.69 m. This infers a groundwater level slightly below 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. As such, for design purposes the groundwater level should be assumed to be equal to the creek water elevation, which was 233.87 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

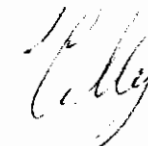
This report has been prepared by D. Muldowney, B.Eng., and reviewed by T. Crilly M.Sc., P.Eng. and S. Gonsalves, M.Eng., P.Eng. Designated MTO Foundation Contact. The field investigation was conducted by Craig St Amant.

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

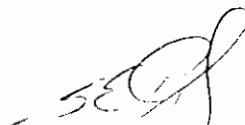
Yours truly,

**Trow Associates Inc.**

  
David Muldowney, B.Eng.  
Geotechnical Department

  
Tom Crilly, M. Sc., P.Eng.  
Branch Manager/Sr. Geotechnical  
Engineer



  
S.E. Gonsalves, M.Eng., P.Eng.  
Principal Engineer  
Designated MTO Foundation Contact



Encl.

Dist: Northland Engineering (1987) Limited (7)

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## **APPENDIX A**

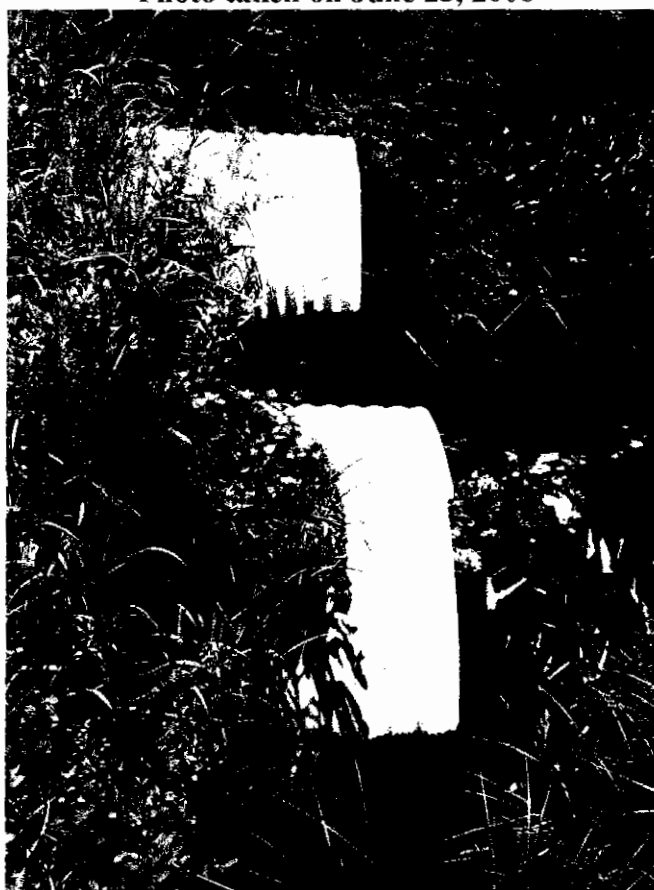
### **Photographs**

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**Photo #1 – Stations 21+516 and 21+518, East Mills Township, Facing North**  
**Photo taken on June 23, 2006**



**Photo #2 – Stations 21+516 and 21+518, East Mills Township, Facing East**  
**Photo taken on June 23, 2006**

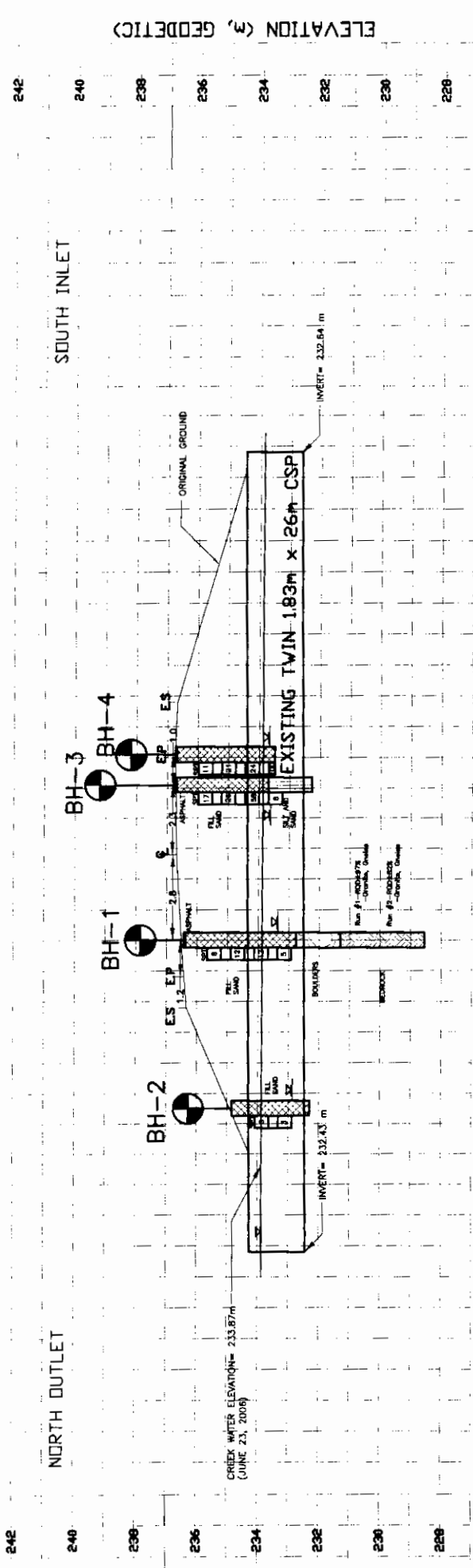
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## **APPENDIX B**

### **Drawings**





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NOTES:

1. TROW BORINGS PERFORMED ON JUNE 23 AND 24, 2008.
2. TOPOGRAPHIC SURVEY PERFORMED BY SUTCLIFFE BODY QUENSEL (SQD).
3. THIS DRAWING IS FOR SURFACE DETAILS INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL DESIGN PURPOSES ONLY. THE EXACT STRUCTURE, LOCATION, DETAIL AND STAGING ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT BE CONSISTENT WITH THE FINAL DESIGN CONFIGURATION AS SHOWN ELSEWHERE IN THE CONTRACT DOCUMENTS.
4. THE BOUNDARIES BETWEEN SUB STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS BETWEEN BOREHOLE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.

LOGO	STANDARD PENETRATION TEST 75° VALUE (BLOMS / 300mm) ELEVATION OF WATER	HIGHWAY CENTRE LINE EDGE OF PAVEMENT EDGE OF SHOULDER	NO.	ELEVATION	NORTHING	EASTING	OFFSET(m)
	SPT		BH-1	238.42	5085469.30	275404.71	2.6 LT
	W		BH-2	234.85	5085463.81	275400.37	0.6 LT
	C		BH-3	238.74	5085463.77	275400.81	2.5 HT
	E.P		BH-4	238.72	5085454.35	275405.83	2.3 RT

SECTION A - A  
UNKNOWN CREEK CULVERT PROFILE

VAL 175



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## **APPENDIX C**

### **Borehole Logs**

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## 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 31mm O.D. SPLIT BARREL SAMPLE 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 (31mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON A 1" 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 - 500mm	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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$u$	l	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
$E$	kPa	MODULUS OF LINEAR DEFORMATION
$G$	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	l	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

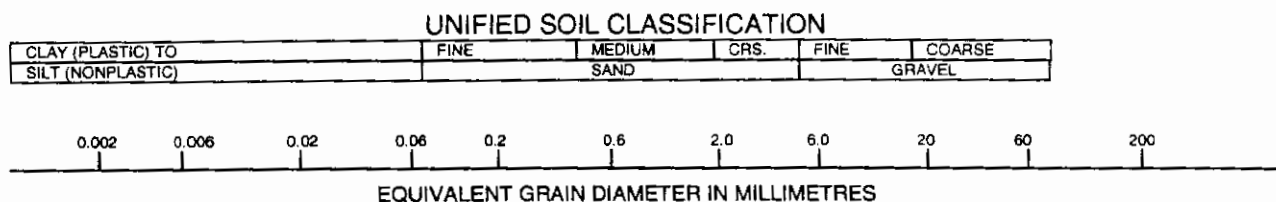
$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	l	COMPRESSION INDEX
$C_s$	l	SWELLING INDEX
$C_\alpha$	l	RATE OF SECONDARY CONSOLIDATION
$C_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
$m$	m	DRAINAGE PATH
$T_v$	l	TIME FACTOR
$U$	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_f$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	l	SENSITIVITY = $\frac{c_u}{\tau_f}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	$e$	l, %	VOID RATIO	$e_{min}$	l, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	$n$	l, %	POROSITY	$I_D$	l	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	$w$	l, %	WATER CONTENT	$D$	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	l	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	$h$	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	$q$	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	$v$	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	l	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	$i$	l	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	l	CONSISTENCY INDEX = $\frac{w - w_p}{I_p}$	$k$	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	l, %	VOID RATIO IN LOOSEST STATE	$j$	kN/m <sup>2</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

## 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.



**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 soundness 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.  
1595 Clark Boulevard Ltd.  
Brampton, Ontario L6T 4V1

# RECORD OF BOREHOLE No BH-1

SHEET 1 OF 1

METRIC

PROJECT NO. SO10242C LOCATION Unknown Creek - Hwy 522 Sta 21+517, 2.8m LT of Centerline ORIGINATED BY CS  
DIST Parry Sound HWY 522 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TA  
DATUM Geodetic DATE 6/23/2006 CHECKED BY TC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	SPT TEST (N-Value) • DYNAMIC CONE PENETRATION		PLASTIC LIMIT PL	NATURAL WATER CONTENT W	LIQUID LIMIT LL	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
236.4								20 40 60 80 100						
0.0	ASPHALT 40mm depth. FILL SAND, brown, damp, loose to compact, well graded, fine to coarse grained sand, some fine to coarse grained gravel, trace silt. trace fine grained gravel, some silt below ~ 0.76 m depth.		1	BAG			236							6 81 13
			2	SS	8		235							
			3	SS	12									
			4	SS	12		234							
	wet and loose below ~ 3.05 m depth.		5	SS	5		233							
232.8							232							
3.7	BOULDERS: granite, gneiss up to 0.28 m in size.													
231.3														
5.1	BEDROCK: granite, gneiss Run #1 At ~ 5.11-6.48 m depth Rec=97% RQD=Excellent +/-97% High water return (75%), light grey  Run #2 At ~ 6.48-7.87 m depth Rec=82% RQD=Good +/-82% High water return (75%), light grey													
228.6														
7.9	BOREHOLE TERMINATED AT ~ 7.87 m DEPTH													

ON LOT 1, 242 - EAST WILLS GPJ ON MOT GDT 06/09/22



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

# RECORD OF BOREHOLE No BH-2

SHEET 1 OF 1

METRIC

PROJECT NO. SO10242C LOCATION Unknown Creek - Hwy 522 Sta 21+517, 8.6m LT of Centerline ORIGINATED BY CS  
DIST Parry Sound HWY 522 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TA  
DATUM Geodetic DATE 6/23/2006 CHECKED BY TC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	SPT TEST (N-Value) •		PLASTIC LIMIT PL	NATURAL WATER CONTENT w	LIQUID LIMIT LL	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		DYNAMIC CONE PENETRATION	SHEAR STRENGTH kPa					
234.9 0.0	FILL SAND, brown, damp, loose, well graded, fine to coarse grained, some fine to coarse grained gravel, trace silt, trace organics. some asphalt below ~ 0.76 m depth.  very loose, trace fine grained gravel, with silt below ~ 1.52 m depth. wet below ~ 2.10 m depth.		1	BAG									5 70 25
			2	SS	8	234							
			3	SS	3	233							
232.3 2.5	SPT REFUSAL AT ~ 2.54 m DEPTH ON SUSPECTED BOULDERS OR BEDROCK												

Dr. JT 10242 - EAST MILLS GPJ ON MOT GDT 06/09/22

3 x 3

Numbers refer to  
Sensitivity

3% STRAIN AT FAILURE



Trow Associates Inc.  
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Brampton, Ontario L6T 4V1

# RECORD OF BOREHOLE No BH-3

SHEET 1 OF 1

METRIC

PROJECT NO. SO10242C LOCATION Unknown Creek - Hwy 522 Sta 21+517, 2.5m RT of Centerline ORIGINATED BY CS  
DIST Parry Sound HWY 522 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TA  
DATUM Geodetic DATE 6/24/2006 CHECKED BY TC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	SPT TEST (N-Value) ●	PLASTIC LIMIT PL	NATURAL WATER CONTENT w	LIQUID LIMIT LL	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES					
							20 40 60 80 100					
236.7	ASPHALT 50mm depth.		1	BAG								
236.7	FILL SAND, brown, damp, compact, well graded, fine to coarse grained, with fine to coarse grained gravel, trace silt, trace fine grained gravel below ~ 0.30 m depth.		2	SS	17							
			3	SS	26							
	very dense below ~ 2.29 m depth.		4	SS	58							
233.7												
3.1	SILT AND SAND, brown to grey, wet, loose, poorly graded, sand fine to coarse grained, trace fine grained gravel.		5	SS	8							3 44 53
232.3	SPT REFUSAL AT ~ 4.47 m DEPTH ON SUSPECTED BOULDERS OR BEDROCK											
4.5												

ON MOT 42- EAST GILLS GPJ ON MO: SGT 06/09/25



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1595 Clark Boulevard Ltd.  
Brampton, Ontario L6T 4V1

# RECORD OF BOREHOLE No BH-4

SHEET 1 OF 1

METRIC

PROJECT NO. SO10242C LOCATION Unknown Creek - Hwy 522 Sta 21+517, 2.3m RT of Centerline ORIGINATED BY CS  
DIST Parry Sound HWY 522 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TA  
DATUM Geodetic DATE 6/24/2006 CHECKED BY TC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	SPT TEST (N-Value) •		PLASTIC LIMIT PL	NATURAL WATER CONTENT w	LIQUID LIMIT LL	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		DYNAMIC CONE PENETRATION	20 40 60 80 100					
236.7	ASPHALT 50mm depth.												
0.1	FILL SAND, brown, damp, compact, well graded, fine to coarse grained, with fine to coarse grained gravel, trace silt. trace fine grained gravel below ~ 0.25 m depth.		1	BAG									
			2	SS	11								
			3	SS	21								
	some silt below ~ 2.29 m depth.		4	SS	24								
233.5	wet, trace fine grained gravel, with silt below ~ 3.05 m depth. SPT REFUSAL AT ~ 3.25 m DEPTH ON SUSPECTED BOULDERS OR BEDROCK		5	SS	100								17 58 25
3.3													

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## **APPENDIX D**

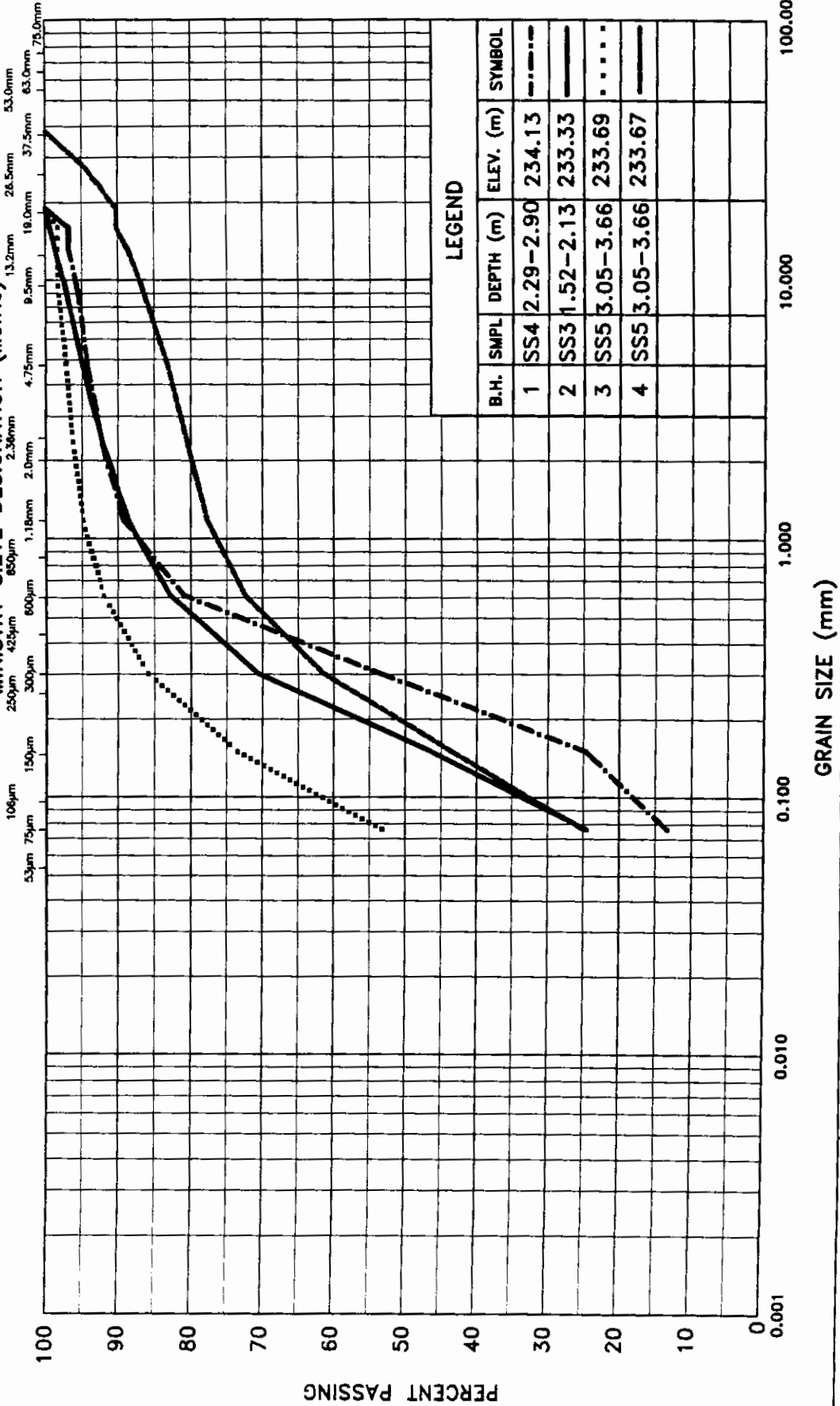
### **Laboratory Data**

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# UNIFIED SOIL CLASSIFICATION

CLAY AND SILT		SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE

## MINISTRY SIEVE DESIGNATION (Metric)



## GRAIN SIZE DISTRIBUTION

Ministry of  
Transportation



METRIC

FIGURE No. D1

G.W.P. 478-98-00

UNKNOWN CREEK CULVERT

REF. S010242G/C