



**FOUNDATION INVESTIGATION REPORT  
KEEMLE LAKE CULVERT  
HIGHWAY 11  
UNSURVEYED TERRITORY, THUNDER BAY DISTRICT  
AGREEMENT NO.: 6013-E-0021  
ASSIGNMENT NO.: 5  
SITE NO.: 48C-183/C  
GEOCRES NO. 52H-27  
GWP NO. 6315-14-00**

**MARCH 17, 2015  
GS-TB-019794**

**PREPARED FOR:**  
Ministry of Transportation  
Geotechnical Section  
Northwestern Region Office  
615 South James Street  
Thunder Bay, ON P7E 6P6

2 Copies - Ministry of Transportation, Thunder Bay, ON  
1 Copies - Ministry of Transportation, Downsview, ON  
1 Copy - DST Consulting Engineers

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**FOUNDATION INVESTIGATION REPORT  
KEEMLE LAKE CULVERT REPLACEMENT  
HIGHWAY 11  
THUNDER BAY DISTRICT  
AGREEMENT NO.: 6013-E-0021  
ASSIGNMENT #5  
SITE NO.: 48C-183/C**

**PART 1: FACTUAL INFORMATION**

**1. INTRODUCTION**

DST Consulting Engineers Inc. (DST) has been retained by the Ministry of Transportation (MTO), Geotechnical Section, Northwestern Region to conduct a foundation investigation for the proposed culvert replacement on Highway 11. This work was carried out under Agreement No.: 6013-E-0021, Geotechnical Retainer, Assignment No. 5.

This report addresses the field investigation, laboratory test program, factual report on soils conditions at the culvert location.

## **2. SITE DESCRIPTION**

The site is located on Highway 11, approximately 34.3 km North of Highway 17 (latitude 49.2662, longitude -88.108), Station 16+588, in unsurveyed territory, in the District of Thunder Bay.

It is understood that the existing 25.0 m long centerline culvert is a cast-in-place concrete box culvert approximately 3.05 m wide and 1.83 m in height. The existing culvert (Figure 2.3 and 2.4) was originally built in 1899 and inspection by others indicates there is an extensive deterioration of concrete and cracks on walls. The fill thickness above the culvert is approximately 4.0 m and the side slope of the embankment is approximately 2H:1V. The surrounding area is moderately vegetated and wooded (Figure 2.1 and 2.2). Photographs were taken by others (Figures 2.1 to 2.4). The flow direction of water in the creek is from east to west.

Geological information is available from published *Ontario Geological Survey Map #52HSE* by the *Ontario Ministry of Natural Resources* for the area. The map indicates that the local area landform is identified as colluvial, Talus pile with primary material as rubble. The topography in the area is mainly high relief; sloping with dry drainage conditions.



Figure 2.1 Location of existing culvert at Highway 11 (Looking North)



Figure 2.2 Location of existing culvert at Highway 11 (Looking South)





Figure 2.3 Culvert inlet (Looking West)



Figure 2.4 Culvert outlet (Looking East)

### **3. INVESTIGATION PROCEDURES AND LABORATORY TESTING**

Site work was carried out between October 21, 2014 and October 26, 2014 utilizing a CME 750 drill rig equipped for geotechnical drilling and operated by DST. A total of four boreholes were advanced up to depths between 6.8 to 9.8 m. The minimum number and depth of the boreholes was specified by the Ministry of Transportation (MTO).

The borehole locations and stratigraphic sections are shown on the Drawings 1 to 3. Borehole 1 was advanced South of the existing culvert at station 16+582, 5.0 m right of centreline, and advanced to a depth of 6.8 m below existing surface. Borehole 2 was advanced South of the existing culvert at station 16+572, 5.0 m right of centreline, and advanced to a depth of 6.9 m below existing surface. Borehole 3 was advanced North of existing culvert at station 16+592, 5.0 m left of centreline, and advanced to a depth of 9.8 m below existing surface. Borehole 4 was advanced North of existing culvert at station 16+599, 4.4 m left of centreline, and advanced to a depth of 6.9 m below existing surface.

The borehole locations are referenced to the MTO station numbering system as indicated on the drawings provided by MTO. The ground surface elevations at the borehole locations were surveyed by DST personnel and referenced to the existing culvert at Station 16+588. The centreline of the road at station 16+588 was assigned as temporary benchmark with elevation of 100.0 m. Table 3.1 summarizes the detail of borehole locations and depths.

All boreholes were abandoned using suitable abandonment barrier as described in Ontario Regulation 903 and its amendments. Boreholes were decommissioned by backfilling to the bottom of the road base with cuttings and bentonite chips. From the bottom of the road base, granular materials were replaced to the bottom of the asphalt and the asphalt was sealed with a cold patch.

The fieldwork was supervised on a full-time basis by DST personnel who located the boreholes in the field, performed sampling, in-situ testing and logged the boreholes. Soil samples were obtained from the auger flights and from the split spoon sampler used for the standard penetration test (SPT). The SPT involves driving a 51 mm diameter thick-walled sampler into the soil under the energy of a 63.5 kg weight falling through 760 mm. The number of blows required to drive the sampler 305 mm is known as the standard penetration blow count (N) which provides an indication of the condition or consistency of the soil. The soil samples collected during drilling were identified in the field, placed in labelled containers and transported to DST's laboratory in Thunder

Bay for further analysis.

Classification and index tests were subsequently performed in the laboratory on samples collected from the boreholes to aid in the selection of engineering properties. Laboratory tests included moisture contents, particle size analyses and Atterberg limits including plastic limit and liquid limit. A total of forty eight (48) moisture contents, and Twenty Two (22) sieve analyses have been carried out for this assignment. Laboratory test results are presented in the Boreholes Logs and in graphical plots in Appendix D (Enclosures).

Table 3.1 Detail of borehole locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	16+582	99.9	6.8	5.0 Rt
BH2	16+572	99.9	6.9	5.0 Rt
BH3	16+592	99.8	9.8	5.0 Lt
BH4	16+599	99.8	6.9	4.4 Lt

#### 4. DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions are presented based on the information obtained during power auger drilling.

The generalized stratigraphy of the existing embankment, based on the conditions encountered in Boreholes 1 to 4, consists of granular sand or sand and crushed gravel fill with cobbles and boulders underlain by sand and gravel layer with cobbles and boulders.

Table 4.1 Summary of soil strata at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Fill- Granular	0.0 to 5.0	99.9 to 94.9	BH1
	0.0 to 4.0	99.9 to 95.9	BH2
	0.0 to 5.0	99.8 to 94.8	BH3
	0.0 to 5.0	99.8 to 94.8	BH4
Sand and Gravel	5.0 to 6.8	94.9 to 93.1	BH1
	4.0 to 6.9	95.9 to 93.0	BH2
	5.0 to 9.8	94.8 to 90.0	BH3
	5.0 to 6.9	94.8 to 92.9	BH4

##### 4.1 Fill – Granular

Granular sand or sand and crushed gravel fill with trace to some silt, with gravel to gravelly, and cobbles and boulders was encountered in Boreholes 1 to 4 at surface. The thickness of this stratum was found to vary from 4.0 m to 5.0 m at depths between 0.0 and 5.0 m (Elev. 99.9 to 94.9 m), 0.0 and 4.0 m (Elev. 99.9 to 95.9 m), 0.0 and 5.0 m (Elev. 99.8 to 94.8 m) and 0.0 and 5.0 m (Elev. 99.8 to 94.8 m) for Boreholes 1 to 4 respectively. Black organics or wood was encountered within this stratum in Borehole 1 and 4 at depth of 4.8 m.

SPT 'N' values for the samples range between 7 to more than 100 indicating very loose to very dense conditions. The moisture contents of samples tested range from 5 to 15%. The results of laboratory tests are summarized in Table 4.2.

Table 4.2 Summary of granular fill sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	16 to 42
Sand %	47 to 72
Fines %	8 to 19

## 4.2 Sand and Gravel

Sand and Gravel with some silt, cobbles and boulders, was encountered in Boreholes 1 to 4 at a depths from 4.0 to 5.0 m (Top Elev. 94.8 m to 95.9 m). The thickness of this stratum is not defined as borehole terminus was reached within this stratum due to auger refusal on possible cobbles or boulders.

SPT 'N' values for this samples range between 28 and more than 100 indicating compact to very dense conditions. The moisture contents of samples tested range from 4% to 26%. The laboratory test results are summarized in following Tables 4.3.

Table 4.3 Summary of sand and gravel particle size analyses

Laboratory Results – Particle Size Analysis	
Gravel %	31 to 62
Sand %	36 to 60
fines %	2 to 11

## 4.3 Auger Refusal

Auger Refusal on possible cobbles or boulders was encountered in Boreholes 1 to 4 depths of 6.8 to 9.8 m (Elev. 90.0 m to 93.1 m).

## 4.4 Groundwater

The groundwater table was identified below the ground surface based on the field observation and visual identification of the soil samples. The estimated groundwater level below the ground surface elevation is given in Table 4.4. The groundwater levels can be expected to vary with the season and precipitation events.

Table 4.4      Groundwater Depths

Borehole Number	Groundwater Depth (m)	Elevation (m)
BH1	5.0	94.9
BH2	5.3	94.6
BH3	5.1	94.7
BH4	5.0	94.8



## **5. MISCELLANEOUS**

Site work was carried out between October 21, 2014 and October 26, 2014 utilizing a CME 750 drill rig equipped for geotechnical drilling and operated by DST. Fieldwork was supervised on a full time basis by Peter Raynak who located the boreholes in the field, performed sampling, in-situ testing and logged the boreholes. Soil samples collected during drilling were identified in the field, placed in labelled containers and transported to DST's laboratory in Thunder Bay for further analysis. Interpretation of the data and preparation of the report was completed by Deep Bansal, P.Eng and reviewed by Prof. Myint Win Bo, P.Eng a designated principal contact for MTO projects.

## 6. LIMITATIONS OF REPORT

A description of limitations which are inherent in carrying out site investigation studies is given in Appendix 'A', and this forms an integral part of this report.

For DST CONSULTING ENGINEERS INC.

Prepared by:

Reviewed by:



Deep Bansal, P. Eng  
Geotechnical Engineer

A handwritten signature in blue ink, appearing to read "Bernardo Villegas".

Bernardo Villegas, M.Sc  
Manager

Reviewed By:



Dr. M W Bo, PhD., P. Eng, P. Geo, Int PE,  
C. Geol, C. Eng, Eur Geol, Eur Eng  
Senior Vice President / Senior Principal



# APPENDIX 'A'

## LIMITATIONS OF REPORT

## LIMITATIONS OF REPORT

## GEOTECHNICAL STUDIES

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1. 2023 年 1 月 1 日起，所有在北京市注册的企业，其企业所得税税率由 25% 调整为 20%。

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**Appendix B**

**DESCRIPTION OF TERMS**

## EXPLANATION OF TERMS USED IN REPORT

**SPT 'N' VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE OF THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51 mm O.D. SPLIT BARREL SAMPLES TO PENETRATE 0.3 m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76 m. FOR PENETRATION OF LESS THAN 0.3 m 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 (DCPT):** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51 mm 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 0.3 m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

### ***SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS***

#### **TEXTURAL CLASSIFICATION OF SOILS**

BOULDERS	COBBLES	GRAVEL	SAND	SILT	CLAY
GREATER THAN 200 mm	75 TO 200 mm	4.75 TO 75 mm	0.075 TO 4.75 mm	0.002 TO 0.075 mm	LESS THAN 0.002 mm

#### **COARSE GRAIN SOIL DESCRIPTION (50% GREATER THAN 0.075 mm)**

TERMINOLOGY	TRACE OR OCCASIONAL	SOME	WITH	ADJECTIVE (e.g. SILTY OR SANDY)	AND (e.g. SAND AND SILT)
	LESS THAN 10%	10 TO 20%	20 TO 30%	30 TO 40%	40 TO 60%

#### **CONSISTENCY\*: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $C_u$ ) AND SPT 'N' VALUES AS FOLLOWS**

$C_u$ (kPa)	0 – 12	12 – 25	25 – 50	50 - 100	100 - 200	> 200
N (BLOWS / 0.3 m)	<2	2 - 4	4 - 8	8 - 15	15 - 30	>30
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

#### **DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS ON 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, 100 mm+ IN LENGTH EXPRESSED AS A PERCENTAGE OF THE LENGTH OF THE CORING RUN.

THE **ROCK QUALITY DESIGNATION (R.Q.D)** FOR MODIFIED RECOVERY IS:

R.Q.D (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

#### **LEGEND OF RECORDS FOR BOREHOLES: SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE**

SS	SPLIT SPOON SAMPLE	WS	WASH SAMPLE
TW	THIN WALL SHELBY TUBE SAMPLE	AS	AUGER (GRAB) SAMPLE
PH	SAMPLER ADVANCED BY HYDRAULIC PRESSURE	TP	THIN WALL PISTON SAMPLE
WH	SAMPLER ADVANCED BY SELF STATIC WEIGHT	PM	SAMPLER ADVANCED BY MANUAL PRESSURE
SC	SOIL CORE	RC	ROCK CORE
	WATER LEVEL	$SENSITIVITY = \frac{UNDISTURBED\ SHEAR\ STRENGTH}{REMOLDED\ SHEAR\ STRENGTH}$	

\*HIERARCHY OF SOIL STRENGTH PREDICTION: **1)** LABORATORY TRIAXIAL TESTING. **2)** FIELD INSITU VANE TESTING. **3)** LABORATORY VANE TESTING. **4)** SPT VALUES. **5)** POCKET PENETROMETER.

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
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# **Appendix C**

## **DRAWINGS**

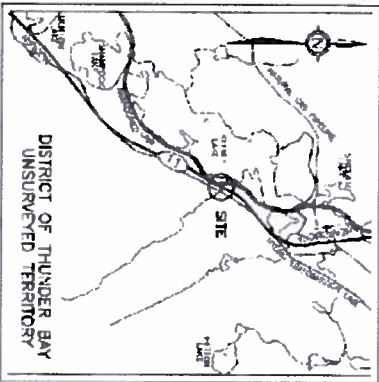
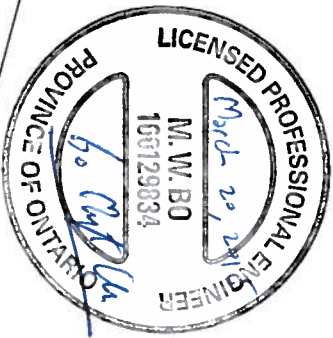
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETERS + METERS

CONT No  
GWP No 6315-14-00  
SITE No 48C-183/C  
GEOCRES No 52H-27



CULVERT REPLACEMENT  
KEEMLE LAKE CULVERT  
STA 16+572 TO STA 16+592  
Survey \_\_\_\_\_ Revised \_\_\_\_\_

SHEET



KEY PLAN  
1:10,000  
1:10,000

LEGEND

- Borehole
- Borehole with CPT
- Asphalt Core
- Rock Probe
- Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Water level at time of investigation.

- Fill
- Organics
- Topsoil
- Till
- Bedrock
- Sand
- Silt
- Clay
- Sand & Gravel
- Boulders

No.	Elevation	Nothing	Existing	Station	Offset
BH1	99.9	*	*	16+582	5.0 m RT
BH2	99.9	*	*	16+572	5.0 m RT
BH3	99.9	*	*	16+582	5.0 m LT
BH4	99.9	*	*	16+599	4.4 m LT

NOTE:  
The boundaries between soil areas have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

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DRAWING 1

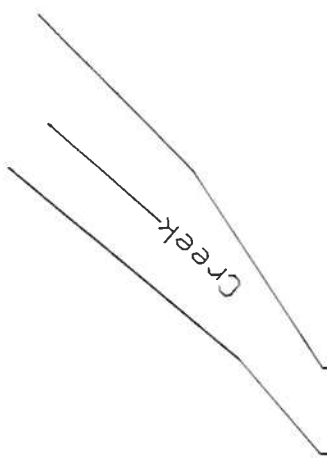
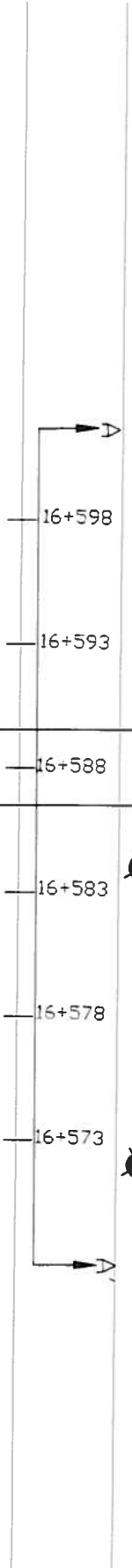
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CULVERT REPLACEMENT KEEMLE LAKE CULVERT	SHEET
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STA 16+572 TO STA 16+592  
Survey \_\_\_\_\_ Revised \_\_\_\_\_

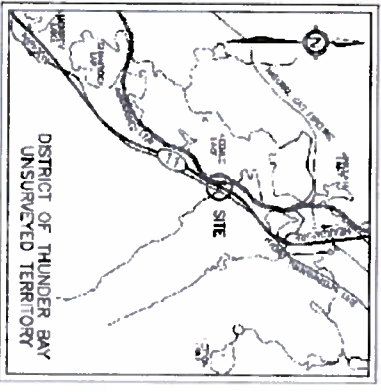
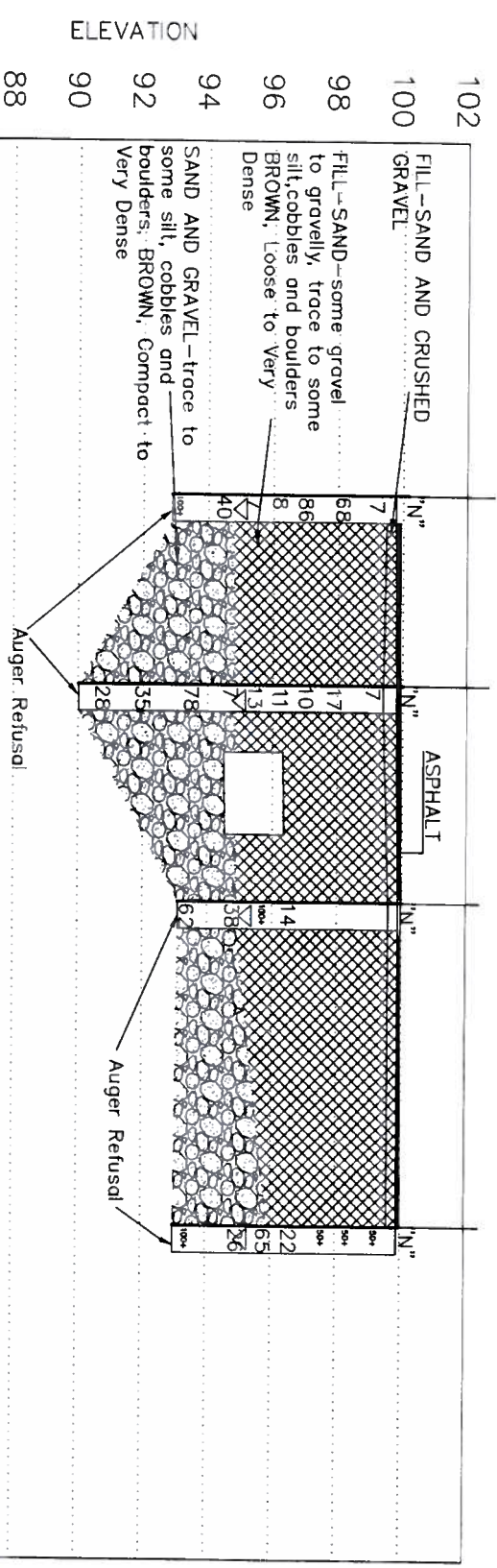
Highway 11



PROFILE ALONG SECTION A-A'



BH4 BH3 BH1 BH2



KEY PLAN

LEGEND

	Borehole		Sand
	Borehole with CPT		Silt
	Asphalt Core		Clay
	Rock Probe		Sand & Gravel
	Blows 0.3m (Std. Pen Test, 475 J/blow)		Boulders
	Water level at time of investigation.		
	Fill		
	Organics		
	Topsoil		
	Bedrock		

No.	Elevation	Nothing	Easting	Station	Offset
BH1	93.9	.	.	16+582	5.0 m RT
BH2	93.9	.	.	16+572	5.0 m RT
BH3	93.8	.	.	16+592	5.0 m LT
BH4	93.5	.	.	16+599	4.4 m LT

NOTE:  
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METRIC  
DIMENSIONS ARE IN METERS  
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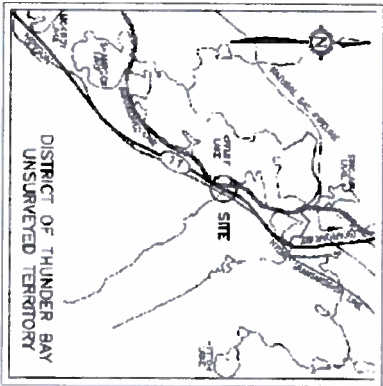
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SITE No 48C-183/C  
GEOCRES No 52H-27



CULVERT REPLACEMENT  
KEEMLE LAKE CULVERT  
STA 16+572 TO STA 16+592

SHEET

Survey \_\_\_\_\_ Revised \_\_\_\_\_



KEY PLAN  
1:2 km 1:0 km

LEGEND

- Borehole
- Borehole with CPT
- Asphalt Core
- Rock Probe
- Blow/0.3m (Std. Pen Test, 475 J/blow)
- Water level at time of investigation.
- Fill
- Organics
- Topsoil
- Till
- Bedrock
- Sand
- Silt
- Clay
- Sand & Gravel
- Boulders

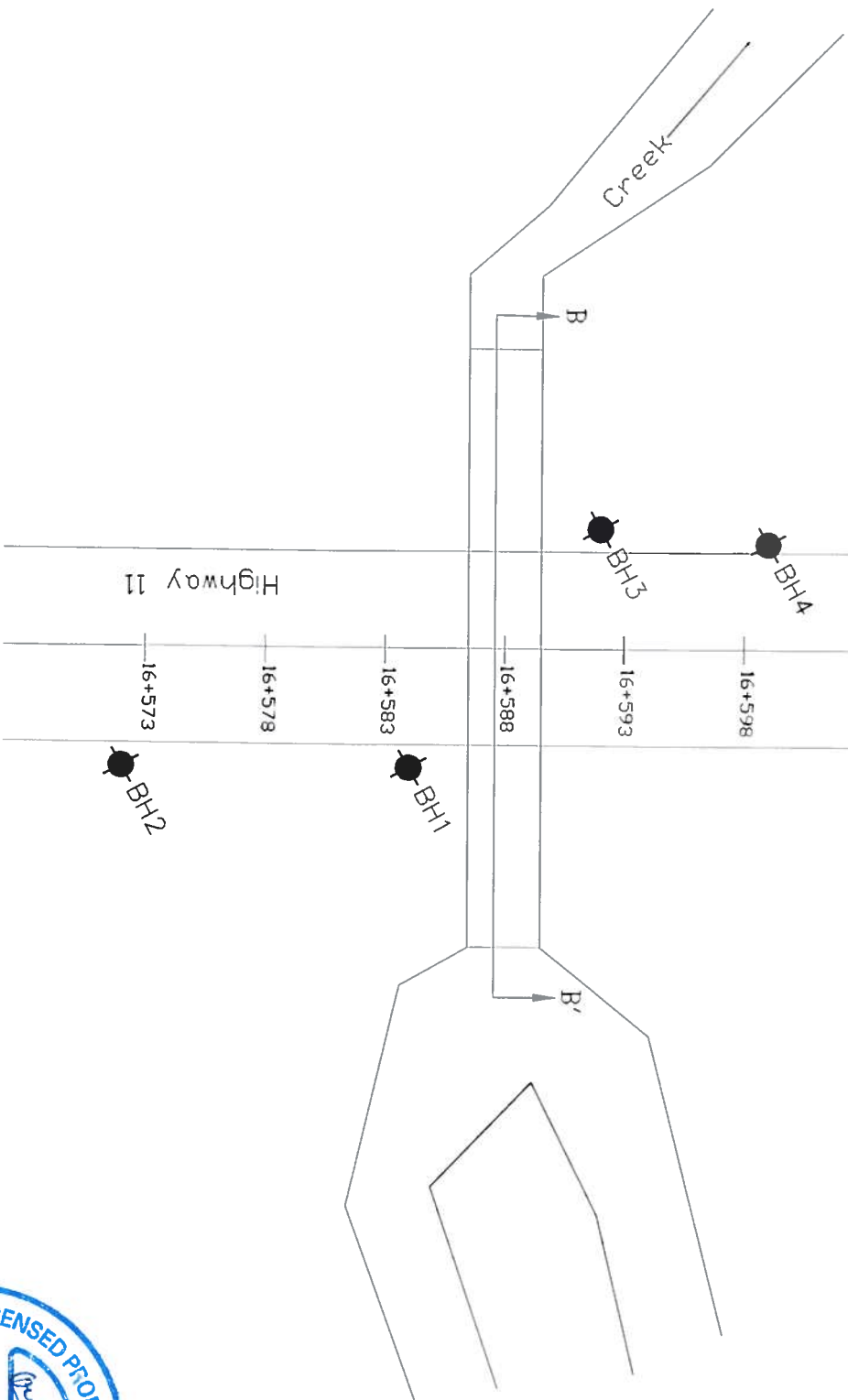
No.	Elevation	Northing	Eastng	Station	Offset
-----	-----------	----------	--------	---------	--------

BH1	99.9	.....	.....	16+582	5.0 m RT
BH2	99.9	.....	.....	16+572	5.0 m RT
BH3	99.8	.....	.....	16+582	5.0 m LT
BH4	99.8	.....	.....	16+599	4.4 m LT

NOTE:  
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

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605 Hewlison Street  
Thunder Bay, ON P7B 5V5  
Ph: (807) 623-2929  
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Email: thunderbay@dstgroup.com

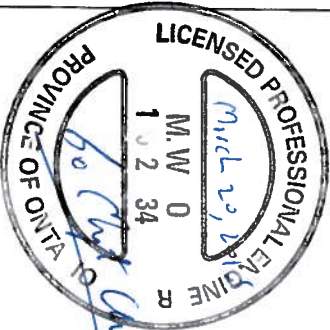
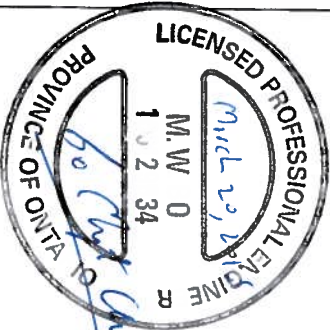
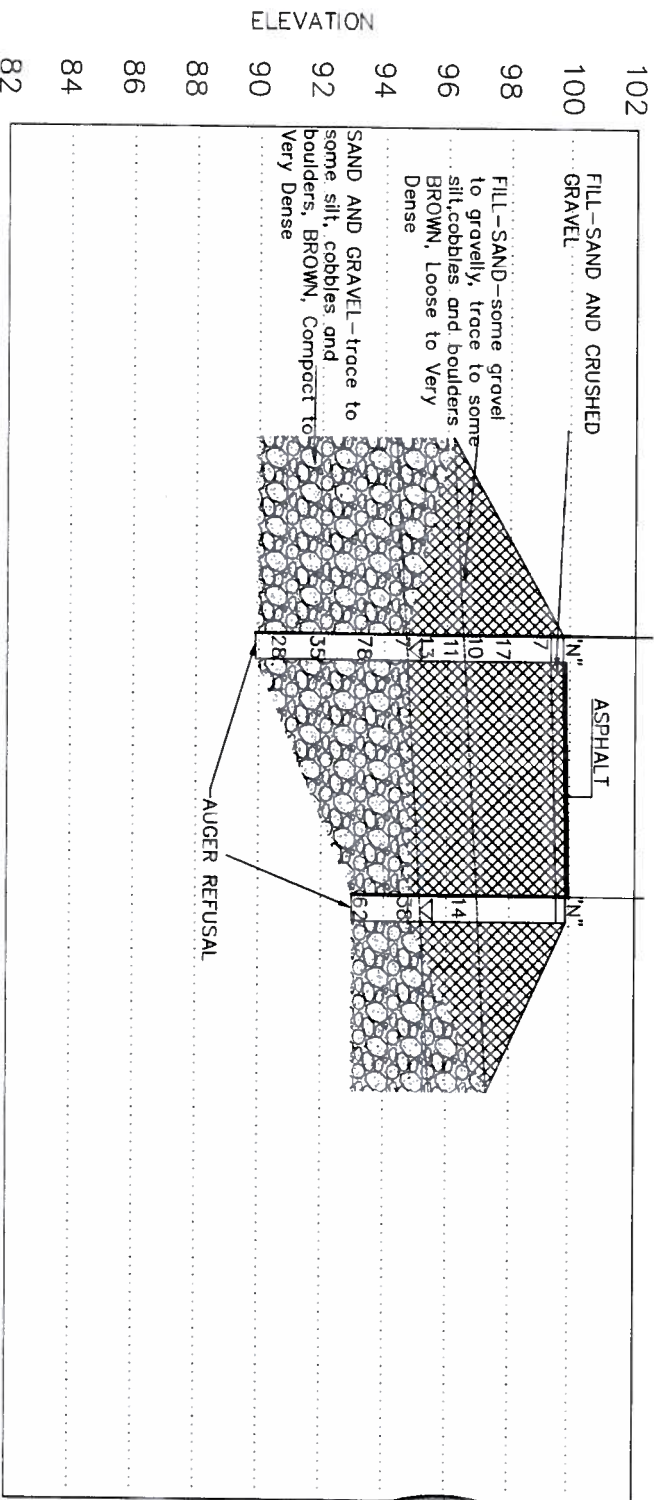
DRAWING 3



PROFILE ALONG SECTION B-B'

BH3 BH1

25 M 0.0 M 25 M



**Appendix D**  
**ENCLOSURES**

# RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Keemle Lake STA 16+582, 5.0 RT ORIGINATED BY PR  
DIST Thunder Bay HWY 11 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB  
DATUM Local DATE 2014 10 21 CHECKED BY DM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20	40	60	80	100								
99.9	GROUND SURFACE																			
99.6	FILL-SAND AND CRUSHED GRAVEL		AS1	AS																
0.3	FILL-SAND-with gravel to gravelly, some silt, cobbles and boulders, BROWN, Compact to Very Dense		AS2	AS																
			AS3	AS																
			AS4	AS																
	-cobbles		SS5	SS	14															
			SS6	SS	100+															
	-wood		SS7	SS	38															
94.9	SAND AND GRAVEL-some silt, cobbles and boulders, BROWN, Very Dense																			
5.0																				
			SS8	SS	62															
93.1	END OF BOREHOLE Auger Refusal on Possible Cobbles/boulders																			
6.8																				

NR = NO RECOVERY + <sup>3</sup>, X <sup>3</sup>: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ENCLOSURE 1

# RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Keemle Lake STA 16+572, 5.0 RT ORIGINATED BY PR  
DIST Thunder Bay HWY 11 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB  
DATUM Local DATE 2014 10 21 CHECKED BY DM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100					20	40	60	80				
99.9	GROUND SURFACE																							
99.6 0.3	FILL-SAND AND CRUSHED GRAVEL  FILL-SAND-with gravel to gravelly, some silt, cobbles and boulders, BROWN, Compact to Very Dense		AS1	AS														29	57 (14)					
			SS2	SS	50+																			
			SS3	SS	50+																			
			SS4	SS	50+																			
			SS5	SS	22																			
95.9 4.0	SAND AND GRAVEL- trace to some silt, cobbles and boulders, GREY, Compact to Very Dense		SS6	SS	65													62	36 (2)					
			SS7	SS	26																			
			SS8	SS	100+																			
93.0 6.9	END OF BOREHOLE Auger Refusal on Possible Cobbles/boulders																							

ONL MOT GS-TB-019796 KEEMLE LAKE.GPJ DST\_MIN.GDT 2/23/15

NR = NO RECOVERY +<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ENCLOSURE 2

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Keemle Lake STA 16+592, 5.0 LT ORIGINATED BY PR  
DIST Thunder Bay HWY 11 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB  
DATUM Local DATE 2014 10 21 CHECKED BY DM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)			
								20	40	60	80	100						GR	SA	SI	CL
99.8	GROUND SURFACE																				
99.4	FILL-SAND AND CRUSHED GRAVEL		AS1	AS			99												34	58	(8)
0.4	SAND-gravelly, trace to some silt, cobbles and boulders, BROWN, Loose to Compact		SS2	SS	7																
			SS3	SS	17		98												36	50	(14)
			SS4	SS	10		97														
			SS5	SS	11		96														
			SS6	SS	13		95														
			SS7	SS	7		94														
94.8	SAND AND GRAVEL-trace to some silt, cobbles and boulders, BROWN, Compact to Very Dense																				
5.0			SS8	SS	78		94												50	40	(10)
							93														
			SS9	SS	35		92														
							91														
90.0	END OF BOREHOLE Auger Refusal on Possible Cobbles/boulders		SS10	SS	28		90												31	60	(9)
9.8																					

ONL MOT GS-TB-019796 KEEMLE LAKE.GPJ DST\_MIN.GDT 2/23/15

NR = NO RECOVERY +<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ENCLOSURE 3

# RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. 6013-E-0021 LOCATION Keemle Lake STA 16+599, 4.4 LT ORIGINATED BY PR  
DIST Thunder Bay HWY 11 BOREHOLE TYPE Hollow Stem Auger 80 mm COMPILED BY DB  
DATUM Local DATE 2014 10 21 CHECKED BY DM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20	40	60	80	100						20	40	60
99.8	GROUND SURFACE																			
99.5	FILL-SAND AND CRUSHED GRAVEL		AS1	AS		99										16 72 (12)				
0.3	SAND-some gravel,some silt, cobbles and boulders, BROWN, Loose to Very Dense		SS2	SS	7															
			SS3	SS	68															
			SS4	SS	86															
			SS5	SS	8															
			SS6	SS	7															
94.8			-organics	SS7	SS		40	95										18 6 (19)		
5.0	SAND AND GRAVEL-some silt, cobbles and boulders, BROWN, Very Dense																			
		SS8	SS	100+	94															
92.9	END OF BOREHOLE Auger Refusal on Possible Cobbles/boulders																			
6.9																				

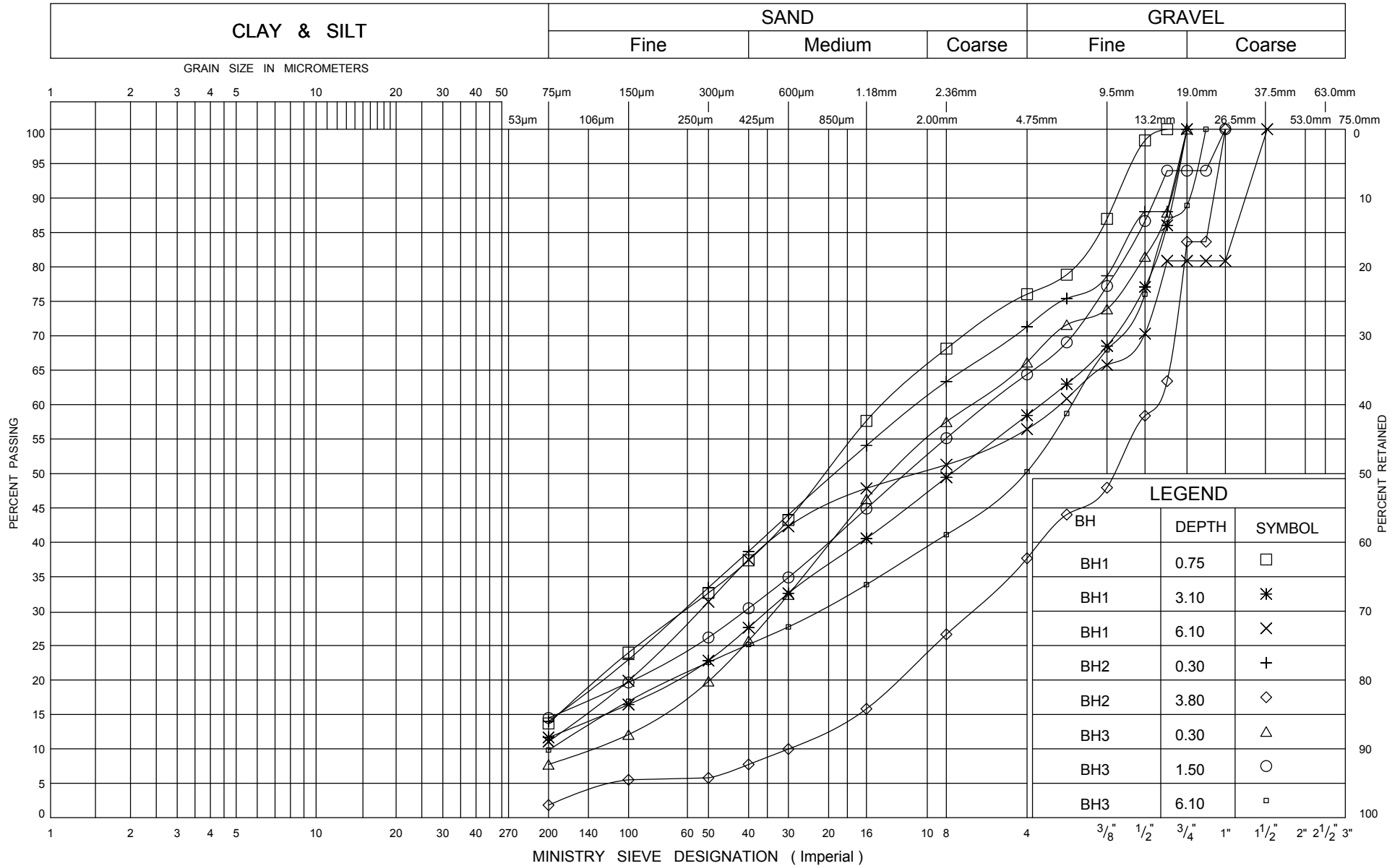
NR = NO RECOVERY

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

○ 3% STRAIN AT FAILURE

ENCLOSURE 4

# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation  
Ontario

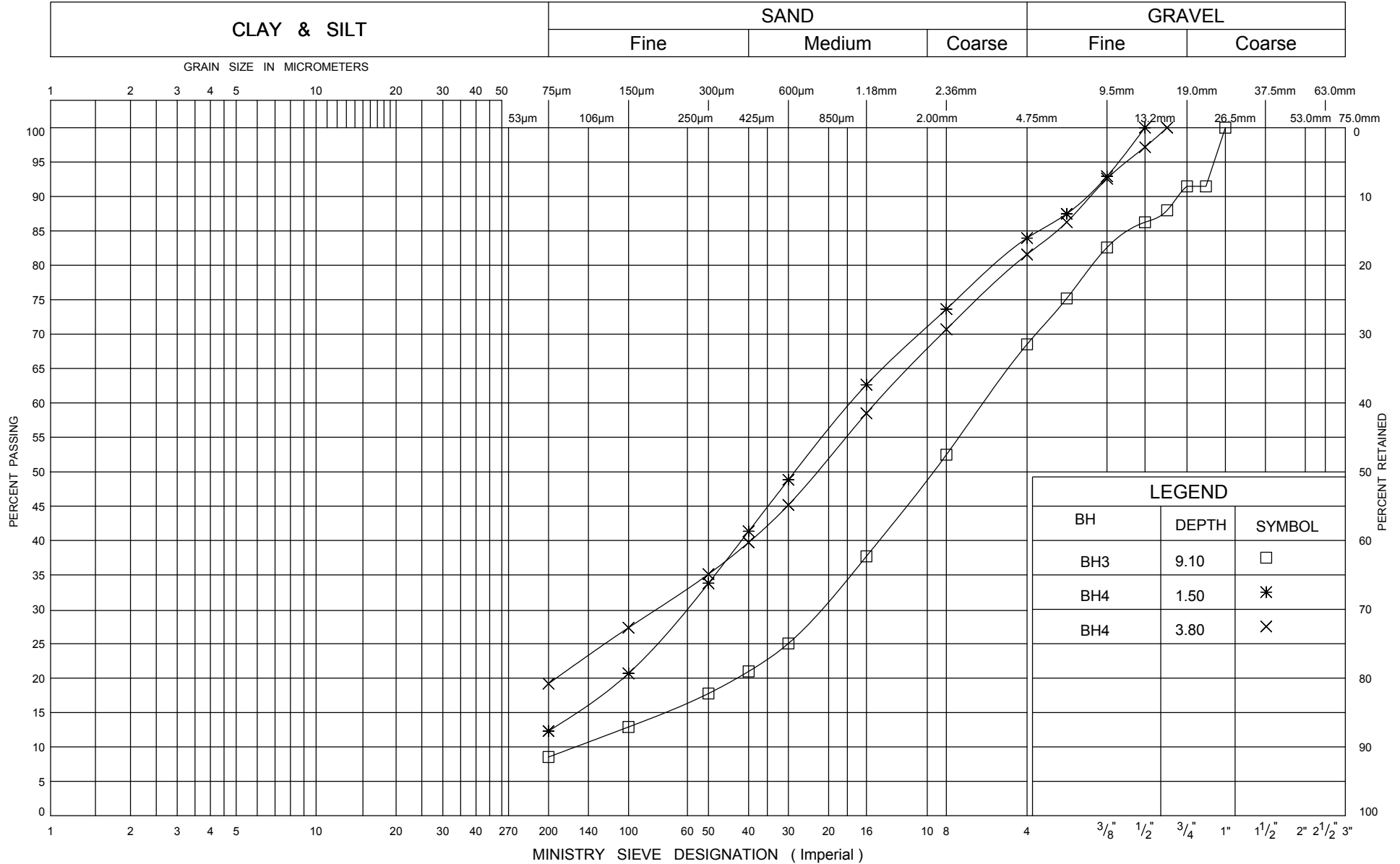
GRAIN SIZE DISTRIBUTION  
SAND

ENCLOSURE 5

W P 6013-E-0021

HWY 11

# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation  
Ontario

## GRAIN SIZE DISTRIBUTION SAND

ENCLOSURE 6

W P 6013-E-0021

HWY 11