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**Preliminary  
Foundation Investigation and Design Report  
Highway 11/17 Culverts  
Station 40+300 Township of MacGregor  
Station 42+130 Township of MacGregor**

**GWP 125-90-00**

**Geocres Nos.: XXX-XX and XXX-XX**

**Prepared for  
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#### **Appendices Series – 1**

Appendix A-1, Borehole Logs

Appendix B-1, Laboratory Test Data

Appendix C-1, Borehole Locations, Drawings and Sections

### **Culvert at Station 42+130 Township of MacGregor (Site 3)**

#### **Appendices Series – 2**

Appendix A-2, Borehole Logs

Appendix B-2, Laboratory Test Data

Appendix C-2, Borehole Locations, Drawings and Sections

## **Part A - FOUNDATION INVESTIGATION REPORT**

### **1 Introduction**

TBT Engineering Limited (TBTE) has been retained by Engineering Northwest Limited a division of Hatch Mott MacDonald (ENL) to provide preliminary foundation investigation and design services for the proposed culvert replacements on Highway 11/17 located at Sta. 40+300 and 42+130 in the Township of MacGregor. These sites are a part of the Highway 11/17, four-laning project from 5.0 km west of Highway 587 easterly 6.5 km. The foundation investigations were conducted to provide preliminary subsurface data for the development of a new eastbound and westbound lane for Hwy 11/17.

These sites are two of several foundation sites being investigated as a part of the Hwy. 11/17 four laning project. The remaining foundation sites (Embankments on Hwy.11/17 and 587 and Culvert on Hwy 587) are addressed under separate covers. The Hwy. 11/17 culverts have been designated as foundation Site 1(Station 40+300) and 3 (Station 42+130) for the project.

This investigation consisted of two boreholes drilled adjacent to each existing culvert, and two boreholes drilled along the proposed new embankment location, laboratory testing and geotechnical analysis of the data. This report (Part A) describes the subsurface conditions encountered during the investigation. The test holes are labeled from 1-1 to 1-4 for Site 1 and Boreholes 3-11, 3-12, 3-15 and 3-16.

The foundation section has assigned GEOCREs Nos. XXX-XX and XXX-XX to these sites.

## **2 Site Description**

The foundation investigations were carried out to investigate subsurface conditions at the culvert located at Sta. 40+300 and the culvert located at Sta. 42+130 along Hwy 11/17 in the Township of MacGregor.

### **2.1 Site 1 – Station 40+300 Township of MacGregor**

The culvert system located at this site consists of a culvert which crosses Hwy 11/17 and a second culvert which crosses Nelson Road. Both culverts are 1200 mm CSP with approximate lengths of 32 and 22 m respectively, and are both in good condition. The culverts at Site 1 (Station 40+300) do not have a direct water course associated with them and are part of the highway drainage system. There was approximately 200 mm of water flow in the culverts at the time of the investigation. A bedrock outcrop was observed westerly of the site on the left side of the highway. The water flow in the culvert was approximately 0.2 m above the invert at the time of the investigation (Elevation 235.5)



Site Photo 1 - Culverts at Site 1

The new westbound and eastbound highway embankment will be constructed approximately 19 m and 63 m to the right of current embankment (from the current

embankments left shoulder) respectively . The new westbound and eastbound embankments are approximately 0.5 m higher than existing highway embankment, respectively.

## **2.2 Site 3 – Station 42+130 Township of MacGregor**

The culvert located at this site is a 1830 mm CSP approximately 39 m long and is perched at both the inlet and outlet. The inlet is protected with rock fill and the outlet is protected with gabions. The culvert at Site 3 (Station 42+130) services an unnamed watercourse which flows north to south. The water flow in the culvert was approximately 0.2 m above the invert at the time of the investigation (Elevation 240.7)



Site Photo 2 - Culverts at Site 3

The new eastbound embankment will have a maximum fill thickness of 8 m, with an estimated 7 m thickness at the culvert location. The new westbound embankment will have a maximum thickness of 5.5 m with an estimated 0.5 m thickness over the existing highway embankment.

### **2.3 Surficial Geology For Sites 1 and 3**

Based on review of surface geology mapping, the sites are located in an area of organic terrain overlying sand and glacial outwash plain. The area also includes bedrock knob terrain with subordinate land forms consisting of till ground moraine.



### 3 Investigation Procedures

A geotechnical site investigation was undertaken during the following dates:

**Table 1: Investigation Dates**

Site Number	Dates	Test Hole Investigated
1	April 11 to 15, 2013	1-2 to 1-4
1	April 25, 2013	1-1
3	April 4 to 8, 2013	3-11, 3-12, 3-15, 3-16

The borehole locations are illustrated on the Borehole Location Plan found in Appendix A-1 (Site 1) and Appendix A-2 (Site 3). The borehole locations were determined and advanced prior to the completion of preliminary design of the proposed culverts.

The borehole locations were identified in the field by TBTE personnel and service clearances were completed prior to mobilizing the drill rig to site. The boreholes were advanced using an all terrain mounted drill rig equipped with hollow stem augers and a cat head used to carry out standard penetration testing (SPT). Soil samples were obtained at the boreholes from the auger flights and using a split spoon sampler as a part of the Standard Penetration Testing (SPT). The test pit was advanced using a CAT 315 CL excavator.

Surveys were conducted using North American Datum 1983, MTM CSRS Zone 15. Control was established from existing published Horizontal Control Monuments and a Geodetic Benchmark based on the Canadian Geodetic Vertical Datum 1928. The horizontal control point used is identified as HCM 00819710510, and vertical control point is identified as GBM 0011993U171 with a Geodetic Elevation of 244.800. The survey was completed using a Trimble R8 Series 3 RTK GPS.

All boreholes were backfilled with a bentonite mixture following drilling. Temporary standpipes have been removed and decommissioned.

### 4 Laboratory Testing

Samples which were obtained during the field investigation were subjected to routine laboratory testing. The routine testing included moisture content, Atterberg limits and



grain size analysis (where appropriate). The results of this testing are shown on the Borehole Logs (Appendix A-1 and A-2) and on the laboratory data reports (Appendix B-1 and B-2).

## **5 Sub-Surface Conditions**

### **5.1 Culvert at 40+300 Township of MacGregor (Site 1)**

Details of the subsurface conditions are provided on the test hole logs (Appendix A-1) and on the Soil Strata Drawings (Appendix C-1).

The subsurface soils at this site typically consist of organics which overlie various mixtures of sand and silt. All boreholes extended to shallow practical refusal on boulders or bedrock; the test pit extended until excavator could no longer advance.

#### **5.1.1 Topsoil**

Topsoil was encountered at ground surface at Borehole 1-4. The topsoil is approximately 100 mm thick. Deeper zones may exist between and/or outside of the test hole locations.

#### **5.1.2 Organics**

Organic material was encountered at the ground surface of Boreholes 1-2, 1-3 and Test Pit 1-1. The material ranges in thickness from 0.2 to 1.2 m. Based on six samples the natural moisture content of this material ranges from 130 to 382 %. Test Pit 1-1 terminated within this material. Numerous cobbles and boulders were noted in Test Pit 1-1.

#### **5.1.3 Sand**

Silty sand with trace gravel was encountered beneath the organics at Test Pit 1-1, Borehole 1-2, and gravelly sand with some silt was encountered beneath the topsoil at Borehole 1-4. The sand was encountered at elevations of 233.8 and 235.9 with thicknesses of 2.4 and 2.3 m respectively. Three samples were selected for grain size distribution testing. The test results indicate a grain size distribution of 4 to 34 % gravel, 53 to 74% sand, and 13 to 21 % silt/clay sized particles. The sand has a very loose to compact density as indicated by "N" values ranging from 1 to 21 blows/0.3 m. It should be noted that Borehole 1-2 terminated at this level. Cobles and boulders were noted in Test Pit 1-1.

#### **5.1.4 Silt**

Sandy silt to sand and silt with some gravel was encountered beneath the organics at Borehole 1-3, and silt with trace sand and gravel was encountered beneath the gravelly sand at Borehole 1-4. The silt was encountered at elevations of 234.4 and 233.6 with thicknesses of 3.1 and 4.0 m respectively. Four samples were selected for grain size distribution testing. The test results indicated a grain size distribution of 0 to 16 % gravel, 6 to 40 % sand, and 45 to 94 % silt/clay sized particles. The silt is loose to dense as indicated by “N” values ranging from 6 to 40 blows/0.3 m.

#### **5.1.5 Refusal**

Auger refusal and “N” values of 100+ blows/0.3 m was encountered at all borehole locations and the excavator was not able to advance further at Test Pit 1-1. The following table indicates the recorded refusal depths at each test hole. Auger refusals may be on cobbles, boulders, or bedrock. The refusal material at the test pit was on a boulder. Refusal material was not sampled.

**Table 2: Borehole Refusal**

Test hole Number	Refusal Depth (m)	Refusal Elevation (m)
1-1	1.2	232.5
1-2	3.3	231.4
1-3	4.3	231.3
1-4	6.9	229.6

#### **5.1.6 Ground Water**

The ground water level was measured on May 22, 2013 at Boreholes 1-2 and 1-4. The ground water was present at a depth of 0.2 m from ground surface (Elev. 234.5) at Borehole 1-2 and at ground surface of Borehole 1-4 (Elev. 236.5). Ground water levels will vary from season to season and from the effects of heavy precipitation events.

The water level at the outlet of the existing culvert (crossing Hwy 11/17) was at an elevation of approximately 235.4 at the time the ground water levels were measured. A historic creek water level downstream of the Nelson Road culvert of 233.2 was recorded in October of 2010. It should be noted that the historic water level was taken near the location of Test Pit 1-1 which has a ground surface elevation of 233.7 m.

## **5.2 Culvert at 42+130 Township of MacGregor (Site 3)**

Details of the subsurface conditions are provided on the test hole logs (Appendix A-2) and on the Soil Strata Drawings (Appendix C-2).

The subsurface soils at this site typically consist of organics which overlie various mixtures of sand and silt. A discontinuous fill (organic and sand strata) is encountered above the organics at Borehole 3-16. All boreholes extended to shallow practical refusal on boulders or bedrock.

### **5.2.1 Fill**

Fill consisting of organic material over sand fill was encountered from the ground surface at Borehole 3-16. The organic fill was 0.2 m thick. The sand with some silt and some gravel fill has a thickness of 1.6 m and extends to an elevation of 240.9. The results of a single grain size test result indicates a grain size distribution of 13 % gravel, 69 % sand, and 18 % silt/clay sized particles. The sand fill is very loose to loose as indicated by “N” values of 3 and 6 blows/0.3 m.

### **5.2.2 Organics**

Organic material was encountered at the ground surface of Boreholes 3-11, 3-12 and 3-15 and below the fill at Borehole 3-16. The material ranges in thickness from 0.2 to 2.2 m and extends to an elevation ranging from 237.8 to 242.5. Based on seven samples the natural moisture content of this material ranges from 88 to 255 %.

### **5.2.3 Sand**

Sand with some silt and trace gravel to silty sand with some gravel was encountered beneath the organics at Borehole 3-15. The sand was encountered at an elevation of 241.4 with a thickness of 4.6 m. A single grain size test indicates a distribution of 9 % gravel, 78% sand, and 13 % silt/clay sized particles. The sand is loose to very dense as indicated by “N” values of 9 to 100+ blows/0.3 m. Occasional cobbles and boulders were noted within this material

### **5.2.4 Sand and Silt**

Sand and silt with some gravel was encountered beneath the organics at Borehole 3-11, 3-12, and 3-16 and beneath the sand at Borehole 3-15. Silt with trace sand and gravel was encountered beneath the gravelly sand at Borehole 1-4. The silt was encountered

at elevations ranging from 236.8 to 239.7 with thicknesses ranging from 2.0 to 7.3 m. Five samples were selected for grain size distribution testing. The test results indicate a grain size distribution of 12 to 17 % gravel, 37 to 42 % sand, and 42 to 47 % silt/clay sized particles. The silt is loose to very dense as indicated by “N” values ranging from 6 to 100+ blows/0.3 m.

#### **5.2.5 Refusal**

Auger refusal and “N” values of 100+ blows/0.3 m was encountered at all borehole locations. The following table indicates the recorded refusal depths at each borehole. Refusals may be on cobbles, boulders, or bedrock. Refusal material was not sampled.

**Table 3: Borehole Refusal**

Test hole Number	Refusal Depth (m)	Refusal Elevation (m)
3-11	4.3	235.7
3-12	9.5	230.5
3-15	7.0	234.6
3-16	5.0	237.7

#### **5.2.6 Ground Water**

The ground water level was measured on May 23, 2013 at Borehole 3-16 at depth of 0.3 m from ground surface (Elev. 242.4). The area around Borehole 3-12 (Elev. 240.0) was flooded at this time. Ground water levels will vary from season to season and from the effects of heavy precipitation events.

The water level at the outlet of the existing culvert was at an elevation of approximately 240.5 at the time the ground water levels were measured. A historic creek water level of 239.9 was recorded in October of 2010.

## **6 Miscellaneous**

Laboratory testing was carried out at the TBT Engineering laboratory in Thunder Bay. The drill equipment for this investigation was operated by TBT Engineering Limited, with the excavator provided by Don Nichols Contracting. The field operations were supervised by David Binch. Laboratory testing was supervised by T. Fummerton C.E.T. This report was prepared by Steven Seller, P.Eng, and reviewed by W. Hurley, P.Eng (TBTE designated principal contact identified for MTO Foundation Engineering projects).

## **Part B - FOUNDATION DESIGN RECOMMENDATIONS**

### **7 Introduction**

TBT Engineering Limited (TBTE) has been retained by Engineering Northwest Limited a division of Hatch Mott MacDonald (ENL) to provide preliminary foundation investigation and design services for the proposed culvert replacements on Highway 11/17 located at Sta. 40+300 and 42+130 in the Township of MacGregor. These sites are a part of the Highway 11/17, four-laning project from 5.0 km west of Highway 587 easterly 6.5 km. The foundation investigations were conducted to provide preliminary subsurface the preliminary design of the culverts. The final design of the proposed culverts could include the use of closed bottom culverts and/or open footing culverts. .

The preliminary foundation investigations as described in Part A, were carried out to investigate subsurface conditions at these sites. The preliminary investigation at Site 1 (Culvert at Station 40+300) consisted of four test holes (TPH 1-1 and BH 1-2 to 1-4). The preliminary investigation at Site 3 (Culvert at Station 42+130) consisted of four boreholes (BH3-11, 3-12, 3-15 and 3-16).

The subsurface soils at this site typically consist of organic material over various mixtures of sand and silt. All test holes extended to shallow practical refusal on boulders or bedrock (100+ "N" values as determined from the Standard Penetration Test), or until the excavator could no longer advance.

The purpose of this section of the report (Part B) is to provide preliminary foundation recommendations for various foundation options. These are based on the conditions encountered at the test hole locations and TBTE's interpretation of the subsurface conditions at the sites.

### **8 Structure Foundations**

Multiple foundation systems have been considered for the proposed culvert replacement. The foundation systems considered are:

- Closed Bottom Culverts
- Spread Footings on Native Soil (where appropriate)
- Spread Footings on Rock Fill
- Driven Piles

Preliminary design parameters for the above foundation systems are presented below. Preliminary recommendations for the viable foundation systems are presented based on the subsurface conditions encountered on site and the preliminary vertical alignment increase.

Unless noted otherwise, foundation design parameters are given for static, vertically and concentrically loaded foundations in compression.

### **8.1 Closed Bottom Culverts**

Closed bottom culverts can be placed on compacted granular material either in an earth excavation, rock excavation or natural embankment. The culvert shall be placed on bedding grade fill material and backfilled in accordance with OPSD 802.010, 802.013 and/or 802.014.

### **8.2 Spread Footings**

Spread footings will likely be appropriate for open footing culverts. A resistance factor of 0.5 has been applied for the estimation of factored geotechnical resistance at ULS. Settlements for SLS have been estimated assuming a uniform pressure distribution over the entire base of the foundation, with an allowance for potential of some disturbance of the founding surface during construction.

Any divergence from the conditions described herein could result in the reduction of ULS values, presented in Tables 4 to 6. For example if the foundation is placed shallower (less depth of cover to the underside of footing) and/or the ground is sloping away from the foundation, a reduction in the ULS values may be realized.

Preliminary analyses for various spread footing sizes have been completed for spread footings constructed on native sand or rock fill over native soils (as appropriate).

#### **8.2.1 Spread Footings For Culvert at 40+300 (Site 1)**

##### **8.2.1.1 Spread Footings on Native Sand**

Footings may be placed directly on the loose native sand subgrade. Preliminary estimates of foundation bearing resistances/reactions of typical designs are provided on Table 4:



**Table 4: Preliminary Geotechnical Resistances and Reactions .**

Effective Footing Width (m)	Depth of Cover to Underside of Footing (m)	Factored Geotechnical Resistance, ULS (kPa)	Geotechnical Reaction, SLS (kPa) for 25 mm settlement
1.2	1	100	70
1.5	1	105	60
1.8	1	115	55
2.0	1	120	55

#### 8.2.1.2 Spread Footings on Rock Fill

Footings may also be founded on a rock fill pad. Typical designs include:

1. Foundation element is on a graded rock fill pad with a specific thickness.
2. The graded rock fill pad will be placed on native sand or sand and silt.

Typical geotechnical resistances at ULS and geotechnical reactions at SLS for footings founded on rock fill are provided in Table 5:

**Table 5: Preliminary Geotechnical Resistances and Reactions**

Effective Footing Width (m)	Depth of Fill Below Footing (m)	Depth of Cover to Underside of Footing (m)	Factored Geotechnical Resistance, ULS (kPa)	Geotechnical Reaction, SLS (kPa) for 25 mm settlement
1.2	0.5	1	215	85
1.5	0.5	1	215	75
1.8	0.5	1	215	65
2.0	0.5	1	220	65

The rock fill pad should consist of graded rock fill . The base of the pad should extend horizontally beyond the edge of the footings by a distance at least equal to the thickness of the rock fill pad provided.

### 8.2.2 **Spread Footings For Culvert at 42+130 (Site 3)**

#### 8.2.2.1 Spread Footings on Native Sand

Spread footings constructed on native sands or sand and silt is not recommended at this site. The general thickness of the overlying organics and fills would place the proposed footing well below the existing and historic creek water level. Construction of spread

footings below the creek level would prove difficult and problematic.

#### 8.2.2.2 Spread Footings on Rock Fill

Footings may also be founded on a rock fill pad. Typical designs include:

1. Foundation element is on a graded rock fill pad with a specific thickness.
2. The graded rock fill pad will be placed on native sand.

Typical geotechnical resistances at ULS and geotechnical reactions at SLS for footings founded on rock fill are provided in Table 6:

**Table 6: Preliminary Geotechnical Resistances and Reactions**

Effective Footing Width (m)	Depth of Fill Below Footing (m)	Depth of Cover to Underside of Footing (m)	Factored Geotechnical Resistance, ULS (kPa)	Geotechnical Reaction, SLS (kPa) for 25 mm settlement
1.2	0.5	1	275	85
1.5	0.5	1	275	75
1.8	0.5	1	280	65
2.0	0.5	1	285	60

The rock fill pad should consist of graded rock fill . The base of the pad should extend horizontally beyond the edge of the footings by a distance at least equal to the thickness of the rock fill pad provided.

### 8.3 Piles

Driven piles are not considered appropriate as culvert foundations at either of these sites due to the large variance in refusal depth and the frequent shallow refusal depths encountered.

Rock socket piles could be considered during detailed design once refusal material is confirmed. Rock socket piles can provide high geotechnical resistances and geotechnical reaction values.

## 9 Culvert Camber

Camber may have to be built into the culverts at these sites depending upon the final height of embankments and the proposed construction schedule. Foundation soils at both sites are granular and settlements under the weight of the new embankment fills

will occur rapidly, as the embankments are constructed. Culverts installed after embankment construction will not require camber. The amount of camber required should be determined during detail design.

### **10 Backfill and Bedding Material**

The existing site materials are not suitable for use as structural backfill. Any excavated existing fill or native materials shall be replaced by Granular "B" Type II. Granular "A" may be specified as structural backfill in specific zones.

### **11 Scour Protection**

Where appropriate, foundation elements should be provided with sufficient scour protection in the event of elevated river levels. Scour protection should be designed in accordance with Section 1.10.5 of the Canadian Highway Bridge Design Code

### **12 Estimated Frost Depth**

Based on the Ontario Provincial Standard Drawing 3090.1 "Foundation Frost Depth for Northern Ontario" the estimated frost depth penetration within the expected embankment fill is 2.6 m. The soils anticipated within the frost depth are considered to be of low frost susceptibility (MTO Pavement Design and Rehabilitation Manual).

### **13 Roadway Protection**

The overall embankment fill thicknesses will be in the order of 3.5 to 7 m (Site 1 and Site 3 respectively), and may require the use of roadway protection during construction, depending on final alignments and construction staging.

### **14 Dewatering, Excavations and Channel Diversion**

Excavations should be excavated and sloped in accordance with the requirements of the Occupational Health and Safety act. The soils below the ground water level are coarse grained and permeable. Flows in to open excavations below the ground water level will be rapid.

Channel diversion is not anticipated to be required during construction.

Improvements/revisions to the channel may be required following removal of the existing culvert. Foundation implications are expected to be minimal, providing the new culvert spans the full channel width.

## **15 Potential Construction Issues**

No major construction difficulties are foreseen at these sites. Issues which may require consideration include:

- Control of surface water during construction. Permanent positive drainage will be ensured during the design phase.
- Control of groundwater during excavation below the creek/groundwater level.
- Potential foundation design/construction constraints resulting from fishery considerations.

## **16 Scope of Detailed Investigation**

The detailed design of the proposed embankments and culverts will require additional geotechnical investigation to complete a detailed Foundations Investigation and Design report for both sites. The scope of work should address all issues normally included in such a report and should incorporate the following items:

- Review of any existing geological and geotechnical information in the area;
- Foundation field investigation to MTO standards, to determine subsurface conditions, including depth to competent stratum and water levels;
- Confirmation of the refusal material;
- Shear testing of foundation soils;
- Preparation of Foundation Reports (Parts A and B) documenting factual information and recommendations on geotechnical aspects of design and construction.
- Confirmation of potential camber requirements.
- Potential design for use of deep foundations if appropriate
- Subsurface investigations should address potential roadway protection requirements.

## **17 Limitations**

Conclusions and recommendations presented in this report are based on the information determined at the test hole locations. These preliminary recommendations are made on the basis that additional investigations, testing and analyses will be carried out during detail design and are not to be used for construction. Subsurface and groundwater conditions between and beyond these locations may differ from those encountered. Conditions may become apparent during detailed design investigations or construction that were not detected and could not be anticipated at the time of the preliminary site investigation.

The comments given in this report on potential construction problems and possible methods of construction are intended only for the guidance of the designer.

Groundwater levels indicated are based on the information described within the report. The presence of all conditions that could affect the type and scope of dewatering procedures which may be considered cannot readily be determined from boreholes. These include local and seasonal fluctuations of the groundwater level, changes in soil conditions between test locations, thin and/or discontinuous layers of highly permeable soils, etc.

The information contained within this report in no way reflects any environmental aspect of the site or soil.

### 18 Closure

We trust the above addresses your project requirements at this time. Should you have any questions or comments, please do not hesitate the contact us at your convenience.

Yours truly,

For TBT ENGINEERING



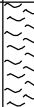

Steven Seller, P.Eng  
Project Engineer



Wayne Hurley, P.Eng.  
Senior Engineer  
Principal Contact for MTO Foundations

**APPENDIX A-1**  
**Culvert at Station 40+300**  
**Borehole Logs**



TBT Engineering Consulting Group			<b>RECORD OF TESTPIT No TP 1-1</b>				1 OF 1		<b>METRIC</b>			
W.P. <b>125-90-00</b>			PROJECT <b>Geotechnical Investigation</b>				SITE NO. <b>1</b>		ORIGINATED BY <b>D.B.</b>			
DIST <b>61</b> HWY <b>11/17</b>			LOCATION <b>MTM 15 393177, 5383311</b>				TBTE JOB# <b>11-214</b>		COMPILED BY <b>T.B.</b>			
DATE <b>2013 April 25</b>			EQUIPMENT <b>Excavator</b>				DATUM <b>Geodetic</b>		CHECKED BY <b>S.S.</b>			
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa <div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>UNCONFINED</span> <span>FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between;"> <span>SPT (N)</span> <span>LAB VANE</span> </div>				W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%)
233.7 0.0	ORGANICS - black		1	GS			233				381.7	
232.9 0.8	SAND & GRAVEL - trace silt with organics, numerous cobbles & boulders		2	GS							320.8	54 39 (7)
232.5 1.2	End of Testpit @ 1.2 m. No Further Progress. On Boulder.											Multiple attempt made with drill rig could not pass 0.5 m. Switched to excavator.

TBT Engineering Consulting Group			<b>RECORD OF Borehole No BH 1-2</b>			1 OF 1		<b>METRIC</b>	
W.P. <b>125-90-00</b>			PROJECT <b>Geotechnical Investigation</b>			SITE NO. <b>1</b>		ORIGINATED BY <b>D.B.</b>	
DIST <b>61</b> HWY <b>11/17</b>			LOCATION <b>MTM 15 393172, 5383333</b>			TBTE JOB# <b>11-214</b>		COMPILED BY <b>T.B.</b>	
DATE <b>2013 April 11</b>			BOREHOLE TYPE <b>Hollow Stem Auger</b>			DATUM <b>Geodetic</b>		CHECKED BY <b>S.S.</b>	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		ELEVATION SCALE	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				
234.7 0.0	ORGANICS - some sand, black		1	AS					
233.8 0.9	SAND - Silty, trace gravel, brown, very loose to compact		2	SS	3				
			3	SS	3				
			4	SS	12				
			5	SS	21				
			6	SS	100+				
231.4 3.3	End of Borehole @ 3.3 m. Auger Refusal.								

**DYNAMIC CONE PENETRATION RESISTANCE PLOT**

**SHEAR STRENGTH kPa**

○ UNCONFINED    ✕ FIELD VANE    ● NATURAL MOISTURE CONTENT    ▲ LIQUID LIMIT

■ SPT (N)    ★ LAB VANE    W<sub>p</sub>    W    W<sub>L</sub>

20 40 60 80 100    20 40 60    20 40 60

WATER CONTENT (%)

UNIT WEIGHT  $\gamma$  kN/m<sup>3</sup>

GR SA SI CL

Water level @ 0.2 m on May 22, 2013.

4 74 (22)

Temporary Standpipe installed to 2.8 m.

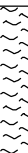
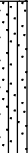
6 74 (21)

TBT Engineering Consulting Group **RECORD OF Borehole No BH 1-3** 1 OF 1 **METRIC**

W.P. **125-90-00** PROJECT **Geotechnical Investigation** SITE NO. **1** ORIGINATED BY **D.B.**

DIST **61** HWY **11/17** LOCATION **MTM 15 393179, 5383373** TBTE JOB# **11-214** COMPILED BY **T.B.**

DATE **2013 April 12** BOREHOLE TYPE **Hollow Stem Auger** DATUM **Geodetic** CHECKED BY **S.S.**

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 (%)		
								○ UNCONFINED	✕ FIELD VANE	■ SPT (N)						★ LAB VANE		
235.6	ORGANICS - black		1	AS														
0.0																		
234.4			2	SS	7													
1.2	SILT & SAND to Sandy, some gravel, brown, compact to dense																	
			3	SS														
			4	SS	24													
			5	SS	40													
231.3																		
4.3	End of Borehole @ 4.3 m. Auger Refusal.		6	SS	100+													

✕<sup>3</sup>, ★<sup>3</sup>: Numbers refer to Sensitivity  
NP Non Plastic  
○ 3% STRAIN AT FAILURE

W.P.	<u>125-90-00</u>	PROJECT	<u>Geotechnical Investigation</u>	SITE NO.	<u>1</u>	ORIGINATED BY	<u>D.B.</u>
DIST	<u>61</u> HWY <u>11/17</u>	LOCATION	<u>MTM 15 393169, 5383426</u>	TBTE JOB#	<u>11-214</u>	COMPILED BY	<u>T.B.</u>
DATE	<u>2013 April 15</u>	BOREHOLE TYPE	<u>Hollow Stem Auger</u>	DATUM	<u>Geodetic</u>	CHECKED BY	<u>S.S.</u>

ON MOT\_BH\_MTM 11-214-1.GPJ ON MOT.GDT 13/10/10

✕<sup>3</sup>, ★<sup>3</sup>: Numbers refer to Sensitivity  
 NP Non Plastic  
 ○<sup>3%</sup> STRAIN AT FAILURE

## 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/0.3m)	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 (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

**JOINTING AND BEDDING:**

	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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$\text{kPa}^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_a$	1	RATE OF SECONDARY CONSOLIDATION
$C_v$	$\text{m}^2/\text{s}$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	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
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_i$	1	SENSITIVITY = $\frac{C_u}{\tau_r}$

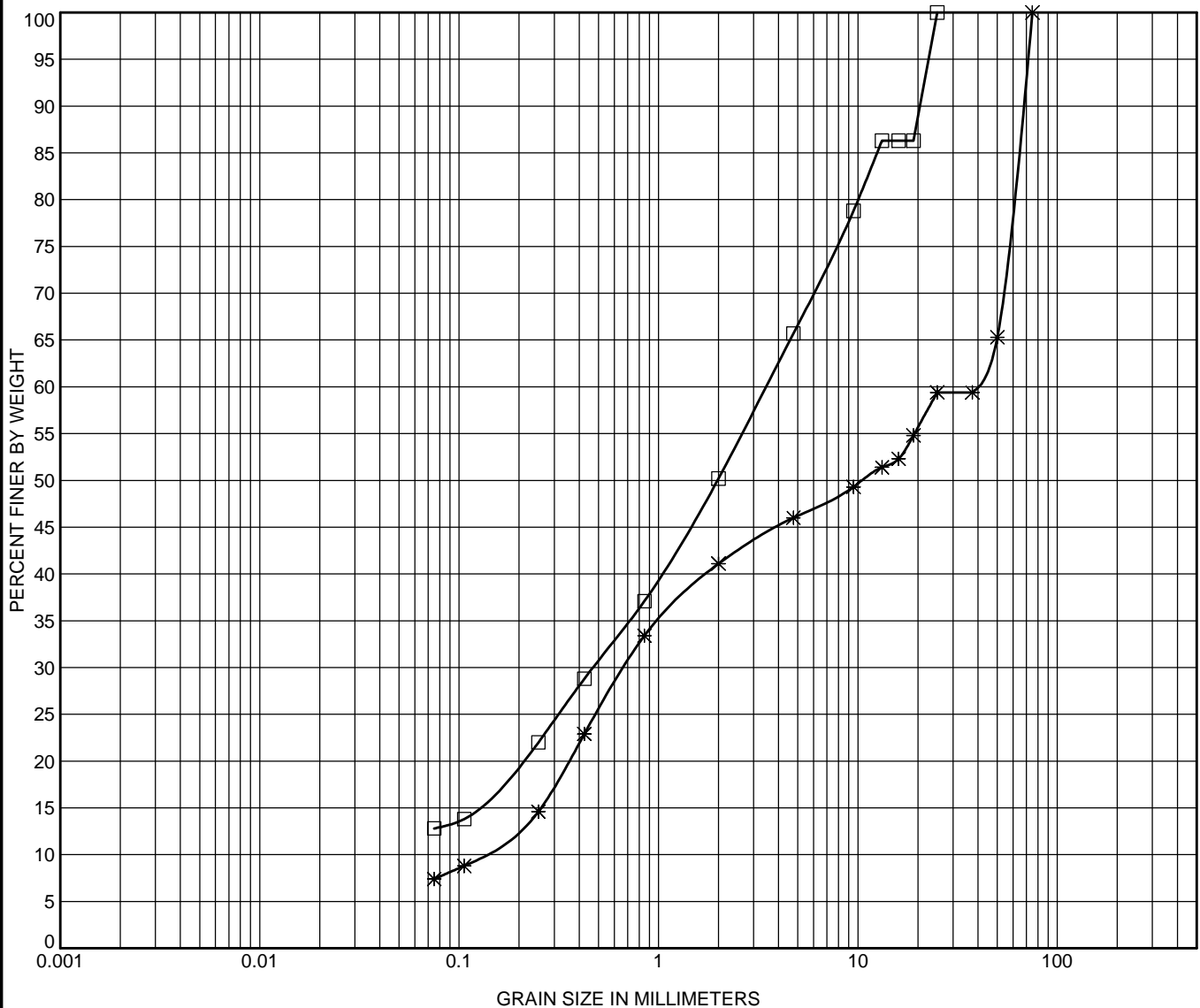
### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	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
$\mu$	1	COEFFICIENT OF FRICTION

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{\min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

**APPENDIX B-1**  
**Culvert at Station 40+300**  
**Laboratory Test Data**



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SANDS & GRAVELS - Gravelly SANDS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ BH 1-4	1.50	25	3.456	0.47		34.3	52.9	12.8	
* TP 1-1	0.90	75	38.613	0.679	0.127	54.0	38.6	7.4	



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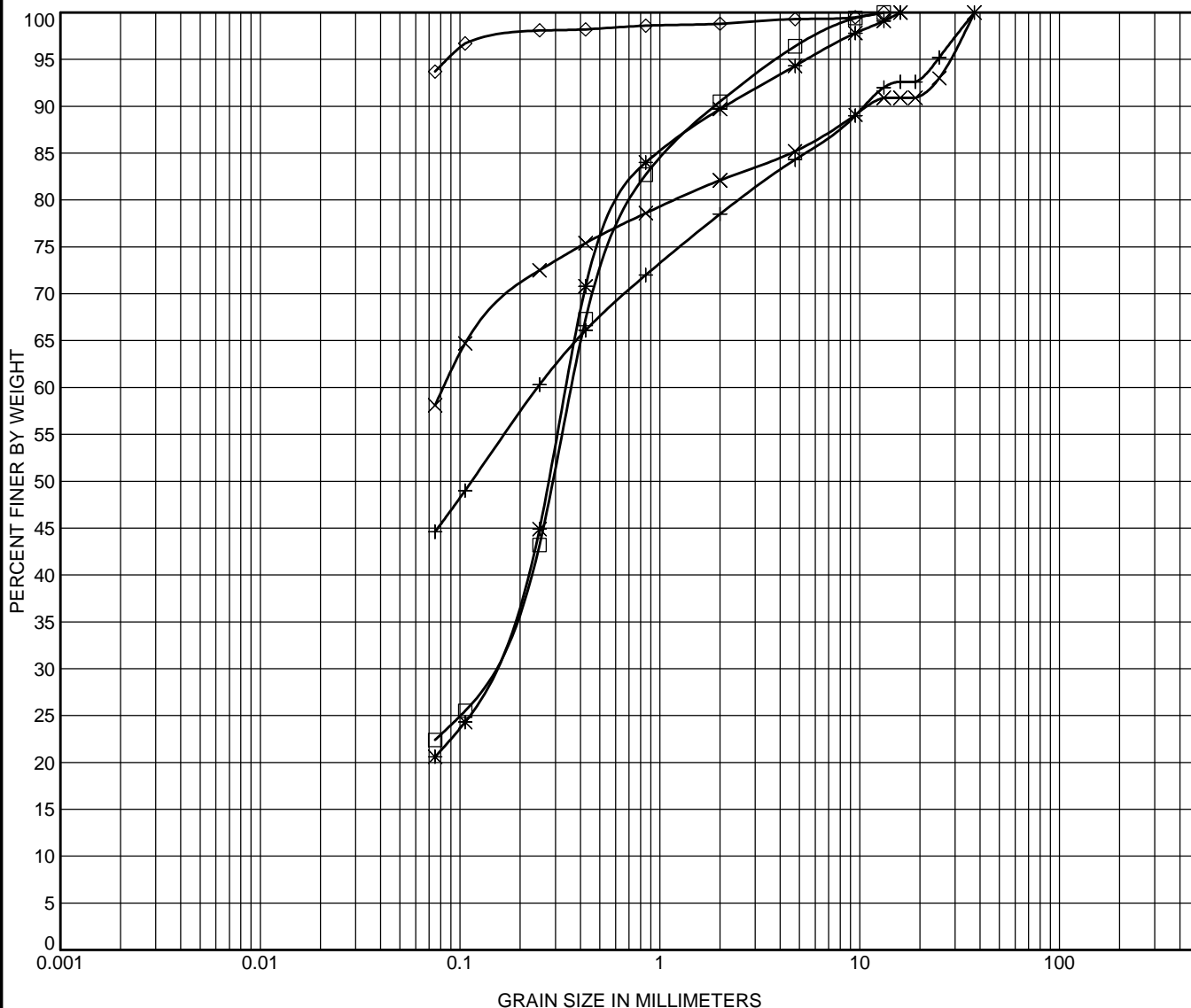
## GRAIN SIZE DISTRIBUTION

Project: Geotechnical Investigation

W P: 125-90-00

DIST: 61 HWY: 11/17





SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SANDS & SILTS - Silty SANDS - SILTS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ BH 1-2	1.50	13.2	0.362	0.132		3.6	74.0	22.4	
* BH 1-2	3.00	16	0.341	0.134		5.7	73.7	20.6	
× BH 1-3	2.20	37.5	0.083			14.8	27.1	58.1	
+ BH 1-3	3.00	37.5	0.244			15.7	39.7	44.6	
◇ BH 1-4	4.50	13.2				0.7	5.6	93.7	



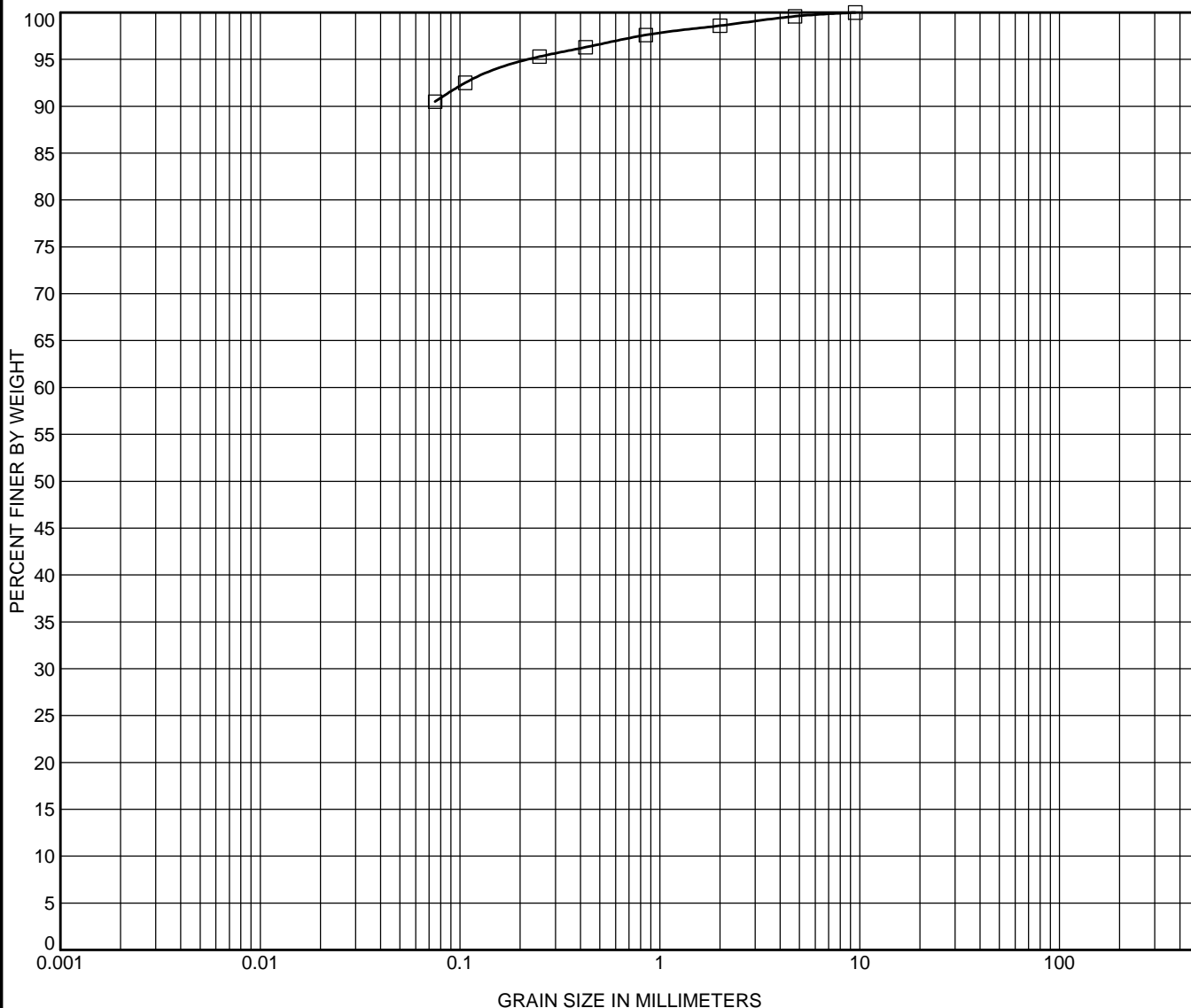
TBT Engineering Limited  
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Web: www.tbte.ca

## GRAIN SIZE DISTRIBUTION

Project: Geotechnical Investigation

W P: 125-90-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SANDS & SILTS - Silty SANDS - SILTS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
<input type="checkbox"/> BH 1-4	6.00	9.5				0.4	9.1	90.5	



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Web: [www.tbte.ca](http://www.tbte.ca)

## GRAIN SIZE DISTRIBUTION




Project: Geotechnical Investigation

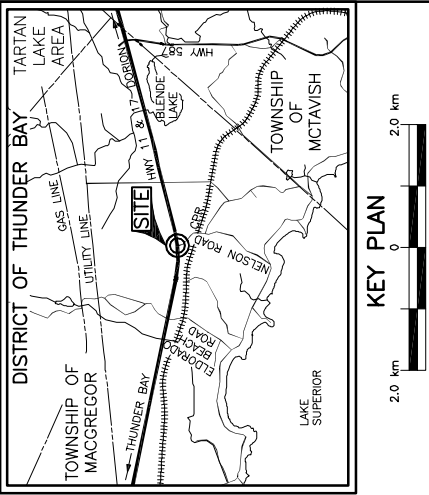
W P: 125-90-00





DIST: 61 HWY: 11/17




**APPENDIX C-1**  
**Culvert at Station 40+300**  
**Borehole Locations, Drawings and Sections**



DIST No. 61		SHEET
CONT No. 2011-xx		
WP No. 125-90-00		
40+300 AT HWY 11/17 CULVERT INVESTIGATION BOREHOLE LOCATIONS AND SOIL STRATA		Ministry of Transportation Northwestern Region Structural Section
		 <b>TBT ENGINEERING</b> CONSULTING GROUP



SOIL STRATA SYMBOLS	
	ORGANICS or TOPSOIL
	SAND
	SILT
	SAND & GRAVEL

LEGEND		
	Borehole	
	Testpit	
'N'	Std Pen Test (Blows/0.3m)	
	Water Level	
NFP	No Further Progress	
AR	Auger Refusal	
No	ELEVATION	CD-ORDINATES (MTM) NORTH EAST
1-1	233.7	15 5 383 311 393 177
1-2	234.7	15 5 383 333 393 172
1-3	236.6	15 5 383 373 393 178
1-4	236.5	15 5 383 426 393 169

—NOTE—

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS								
DD/MM/YY	BY	REVISION			DESCRIPTION			
DESIGN	XX	CHK	XX	CODE	XXXX-XX	LOAD XX-XXX	DATE	XXXXXX
DRAWN	XX	CHK	XX	SITE	XXX-XXX		DWG	2

**APPENDIX A-2**  
**Culvert at Station 42+130**  
**Borehole Logs**

## RECORD OF Borehole No 3-1

1 OF 1

METRIC

W.P. 125-90-00 PROJECT Hwy 11/17 - 4 Laning SITE NO. 3 ORIGINATED BY D.B.  
DIST 61 HWY 11/17 LOCATION MTM 15 394055, 5384626 TBTE JOB# 11-214 COMPILED BY T.B.  
DATE 2013 April 8 BOREHOLE TYPE Hollow Stem Auger DATUM Geodetic CHECKED BY S.S.

✕<sup>3</sup>, ★<sup>3</sup>: Numbers refer to Sensitivity  
 NP Non Plastic  
 ○<sup>3%</sup> STRAIN AT FAILURE

TBT Engineering Consulting Group		<b>LOG OF DCPT No 3-2</b>				1 OF 1		<b>METRIC</b>										
W.P. <b>125-90-00</b>		PROJECT <b>Hwy 11/17 - 4 Laning</b>				SITE NO. <b>3</b>		ORIGINATED BY <b>D.B.</b>										
DIST <b>61</b> HWY <b>11/17</b>		LOCATION <b>MTM 15 394082, 5384670</b>				TBTE JOB# <b>11-214</b>		COMPILED BY <b>T.B.</b>										
DATE <b>2013 April 2</b>		BOREHOLE TYPE <b>Dynamic Cone Penetration Test</b>				DATUM <b>Geodetic</b>		CHECKED BY <b>S.S.</b>										
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	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60	80	100	20
241.2 0.0	DCPT Testing Only						241											
							240											
							239											
							238											
237.2 4.0																		

✕<sup>3</sup>, ★<sup>3</sup>: Numbers refer to Sensitivity  
 NP Non Plastic  
 ○ 3% STRAIN AT FAILURE

ONL\_MOT\_DCPT 11-214-3.GPJ ONL\_MOT\_GDT 13/10/11



TBT Engineering Consulting Group **RECORD OF Borehole No 3-3** 1 OF 1 **METRIC**

W.P. **125-90-00** PROJECT **Hwy 11/17 - 4 Laning** SITE NO. **3** ORIGINATED BY **D.B.**

DIST **61** HWY **11/17** LOCATION **MTM 15 394092, 5384662** TBTE JOB# **11-214** COMPILED BY **T.B.**

DATE **2013 April 2** BOREHOLE TYPE **Hollow Stem Auger** DATUM **Geodetic** CHECKED BY **S.S.**

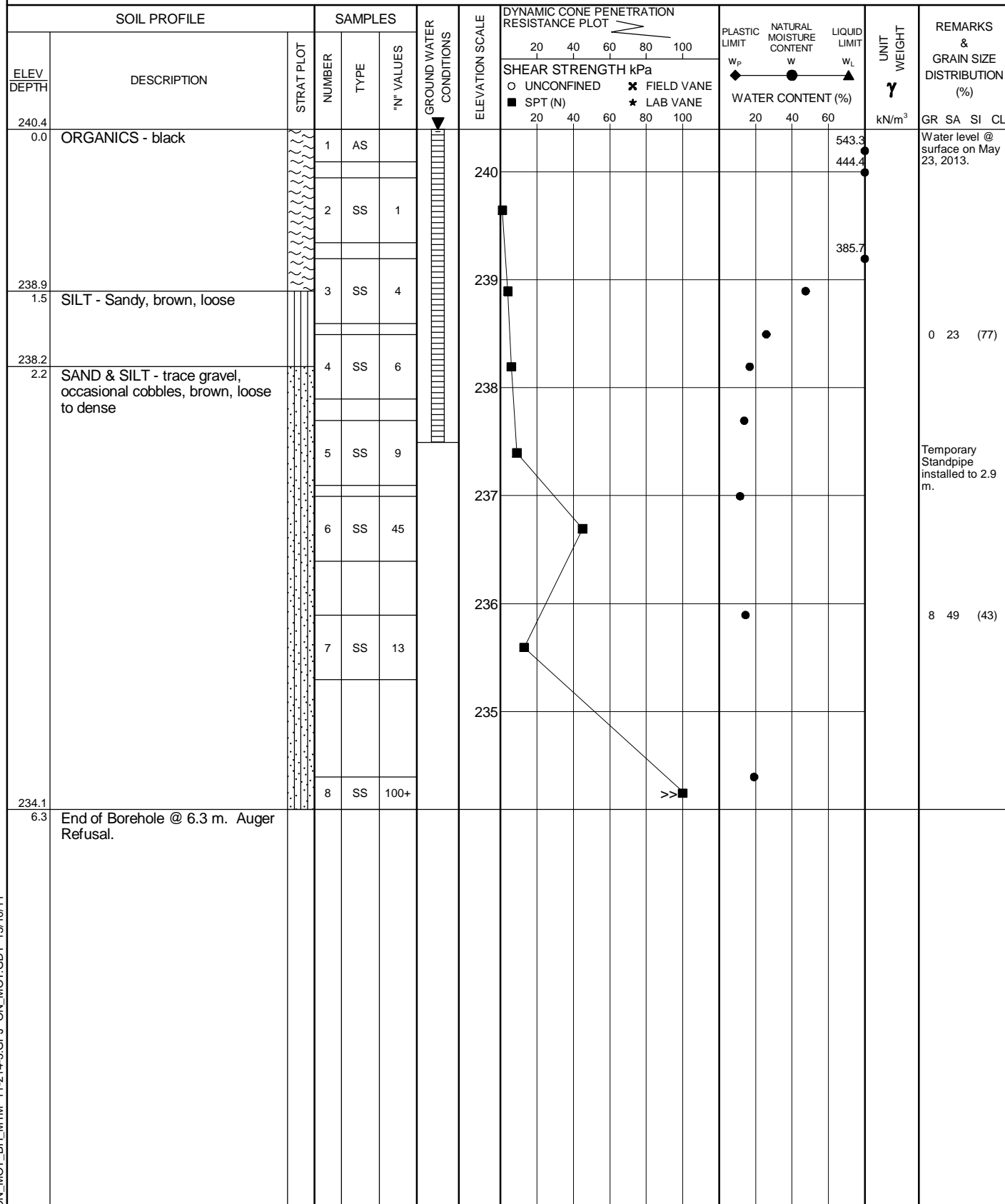
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
240.3 0.0	ORGANICS - 300 mm		1	AS			20 40 60 80 100	○ UNCONFINED	✕ FIELD VANE	20 40 60					
240.0 0.3	SAND - Silty, brown, compact		2	SS	17		20 40 60 80 100	■ SPT (N)	★ LAB VANE	20 40 60					
238.6 1.7	SILT - some sand, trace gravel, brown, loose		3	SS	8		20 40 60 80 100								
			4	SS	7		20 40 60 80 100								
237.2 3.1	SAND & SILT - some gravel, grey, loose to compact		5	SS	9		20 40 60 80 100								
			6	SS	22		20 40 60 80 100								
236.1 4.2	End of Borehole @ 4.2 m. No Further Progress. Boulders.		7	SS	100+		20 40 60 80 100								

TBT Engineering Consulting Group **RECORD OF Borehole No 3-4** 1 OF 1 **METRIC**

W.P. **125-90-00** PROJECT **Hwy 11/17 - 4 Laning** SITE NO. **3** ORIGINATED BY **D.B.**

DIST **61** HWY **11/17** LOCATION **MTM 15 394105, 5384707** TBTE JOB# **11-214** COMPILED BY **T.B.**

DATE **2013 April 2** BOREHOLE TYPE **Hollow Stem Auger** DATUM **Geodetic** CHECKED BY **S.S.**



ONL\_MOT\_BH\_MTM 11-214-3.GPJ ON\_MOT.GDT 13/10/11



TBT Engineering Consulting Group **RECORD OF Borehole No 3-6** 1 OF 1 **METRIC**

W.P. **125-90-00** PROJECT **Hwy 11/17 - 4 Laning** SITE NO. **3** ORIGINATED BY **D.B.**

DIST **61** HWY **11/17** LOCATION **MTM 15 39448, 5384741** TBTE JOB# **11-214** COMPILED BY **T.B.**

DATE **2013 April 3** BOREHOLE TYPE **Hollow Stem Auger** DATUM **Geodetic** CHECKED BY **S.S.**

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 ○ UNCONFINED      ✕ FIELD VANE ■ SPT (N)          ★ LAB VANE								WATER CONTENT (%)
240.1								20	40	60	80	100				
0.0	ORGANIC- black		1	AS			240							633.7		
							239							611.6		
238.0			2	SS	1											
2.1	SAND - some gravel, brown, loose		3	SS	9		238									
237.3																
2.8	SAND & SILT - trace to some gravel, occasional cobbles, brown, loose to compact		4	SS	13		237								3 49 (48)	
			5	SS	8		236								12 48 (40)	
			6	SS	9		235									
234.7			7	SS	100+											
5.4	End of Borehole @ 5.4 m. Auger Refusal.															

$\times^3, \star^3$ : Numbers refer to Sensitivity  
 NP Non Plastic  
 ○ 3% STRAIN AT FAILURE

ONL\_MOT\_BH\_MTM 11-214-3.GPJ ON\_MOT.GDT 13/10/11

TBT Engineering Consulting Group		<b>RECORD OF Borehole No 3-7</b>				1 OF 1		<b>METRIC</b>						
W.P. <b>125-90-00</b>		PROJECT <b>Hwy 11/17 - 4 Laning</b>				SITE NO. <b>3</b>		ORIGINATED BY <b>D.B.</b>						
DIST <b>61</b> HWY <b>11/17</b>		LOCATION <b>MTM 15 394165, 5384795</b>				TBTE JOB# <b>11-214</b>		COMPILED BY <b>T.B.</b>						
DATE <b>2013 April 3</b>		BOREHOLE TYPE <b>Hollow Stem Auger</b>				DATUM <b>Geodetic</b>		CHECKED BY <b>S.S.</b>						
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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
240.6 0.0	ORGANICS - some sand		1	AS										Water level @ surface on May 23, 2013.  1 90 (9)  1 17 (82)  Temporary Standpipe installed to 2.9 m.  11 51 (38)
238.9 1.7	SAND - trace silt, trace gravel, brown, very loose to compact		2	SS	1									
238.0 2.6	SILT - some sand, trace gravel, brown, compact		3	SS	12									
237.6 3.0	SAND & SILT - some gravel, brown, compact		5	SS	18									
			6	SS	23									
			7	SS	100+									
236.1 4.5	End of Borehole @ 4.5 m. Auger Refusal.													

✕<sup>3</sup>, ★<sup>3</sup>: Numbers refer to Sensitivity  
 NP Non Plastic  
 ○ 3% STRAIN AT FAILURE

ONL\_MOT\_BH\_MTM 11-214-3.GPJ ON\_MOT.GDT 13/10/11



TBT Engineering Consulting Group

# RECORD OF Borehole No 3-9

1 OF 1

METRIC

W.P. **125-90-00** PROJECT **Hwy 11/17 - 4 Laning** SITE NO. **3** ORIGINATED BY **D.B.**  
 DIST **61** HWY **11/17** LOCATION **MTM 15 394184, 5384830** TBTE JOB# **11-214** COMPILED BY **T.B.**  
 DATE **2013 April 4** BOREHOLE TYPE **Hollow Stem Auger** DATUM **Geodetic** CHECKED BY **S.S.**

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
241.2								20	40	60	80	100		
240.0	ORGANICS - 100 mm		1	AS			241	○ UNCONFINED	✕ FIELD VANE					
0.1	SAND - Silty, some gravel, trace organics, brown, loose to dense		2	SS	11		240	■ SPT (N)	★ LAB VANE					
			3	SS	8		239							
			4	SS	11		238							
	----- - occasional cobbles		5	SS	26		237							
			6	SS	31		236							
			7	SS	14		235							
235.9	SAND & SILT - trace gravel, occasional cobbles, brown, very dense		8	SS	75		234							
5.3			9	SS	55									
			10	SS	100+									
233.8	End of Borehole @ 7.4 m. Auger Refusal.													
7.4														

✕<sup>3</sup>, ★<sup>3</sup>: Numbers refer to Sensitivity  
 NP Non Plastic  
 ○ 3% STRAIN AT FAILURE

ONL\_MOT\_BH\_MTM 11-214-3.GPJ ON\_MOT.GDT 13/10/11

W.P. 125-90-00 PROJECT Hwy 11/17 - 4 Laning SITE NO. 3 ORIGINATED BY D.B.  
DIST 61 HWY 11/17 LOCATION MTM 15 394197, 5384820 TBTE JOB# 11-214 COMPILED BY T.B.  
DATE 2013 April 3 BOREHOLE TYPE Dynamic Cone Penetration Test DATUM Geodetic CHECKED BY S.S.

✕<sup>3</sup>, ★<sup>3</sup>: Numbers refer to Sensitivity  
 NP Non Plastic  
 ○<sup>3%</sup> STRAIN AT FAILURE



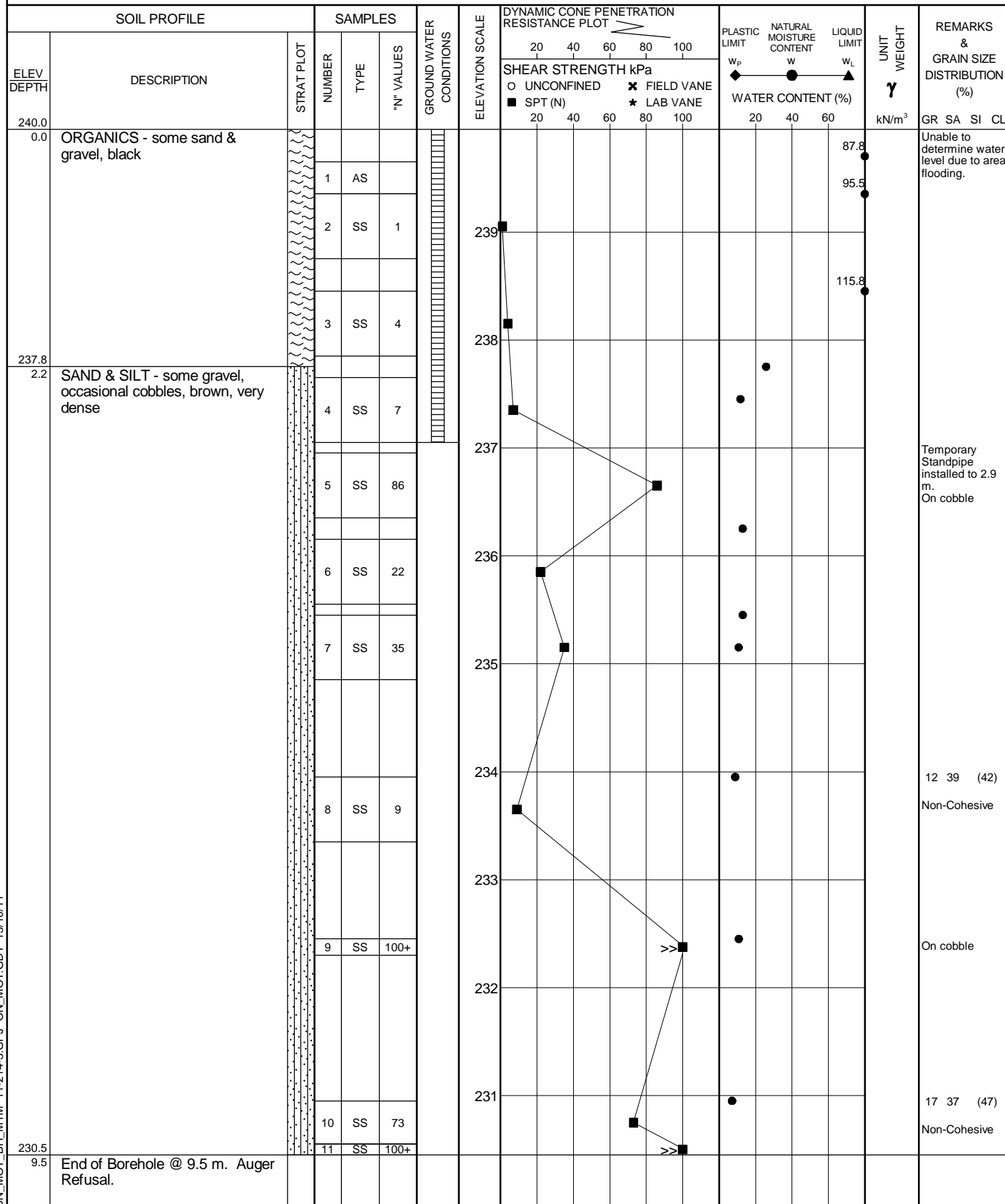
TBT Engineering Consulting Group			<b>RECORD OF Borehole No 3-11</b>			1 OF 1		<b>METRIC</b>	
W.P. <b>125-90-00</b>			PROJECT <b>Hwy 11/17 - 4 Laning</b>			SITE NO. <b>3</b>		ORIGINATED BY <b>D.B.</b>	
DIST <b>61</b> HWY <b>11/17</b>			LOCATION <b>MTM 15 394208, 5384856</b>			TBTE JOB# <b>11-214</b>		COMPILED BY <b>T.B.</b>	
DATE <b>2013 April 5</b>			BOREHOLE TYPE <b>Hollow Stem Auger</b>			DATUM <b>Geodetic</b>		CHECKED BY <b>S.S.</b>	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS		ELEVATION SCALE	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				
240.0 0.0	ORGANICS - some sand		1	AS					
			2	SS	1				
238.5 1.5	SAND & SILT - some gravel, brown, loose to very dense		3		9				
			4	SS	6				
	----- - occasional cobbles		5	SS	40				
			6	SS	24				
235.7 4.3	End of Borehole @ 4.3 m. Auger Refusal.		7	SS	100+				
						DYNAMIC CONE PENETRATION RESISTANCE PLOT			
						 SHEAR STRENGTH kPa ○ UNCONFINED    ✕ FIELD VANE ■ SPT (N)        ★ LAB VANE 20 40 60 80 100			
						PLASTIC LIMIT    NATURAL MOISTURE CONTENT    LIQUID LIMIT W <sub>p</sub> W                      W <sub>L</sub> WATER CONTENT (%) 20 40 60			
						UNIT WEIGHT γ kN/m <sup>3</sup>			
						REMARKS & GRAIN SIZE DISTRIBUTION (%)			
								GR SA SI CL	

TBT Engineering Consulting Group **RECORD OF Borehole No 3-12** 1 OF 1 **METRIC**

W.P. **125-90-00** PROJECT **Hwy 11/17 - 4 Laning** SITE NO. **3** ORIGINATED BY **D.B.**

DIST **61** HWY **11/17** LOCATION **MTM 15 394222, 5384858** TBTE JOB# **11-214** COMPILED BY **T.B.**

DATE **2013 April 4** BOREHOLE TYPE **Hollow Stem Auger** DATUM **Geodetic** CHECKED BY **S.S.**



ONL\_MOT\_BH\_MTM 11-214-3.GPJ ON\_MOT.GDT 13/10/11

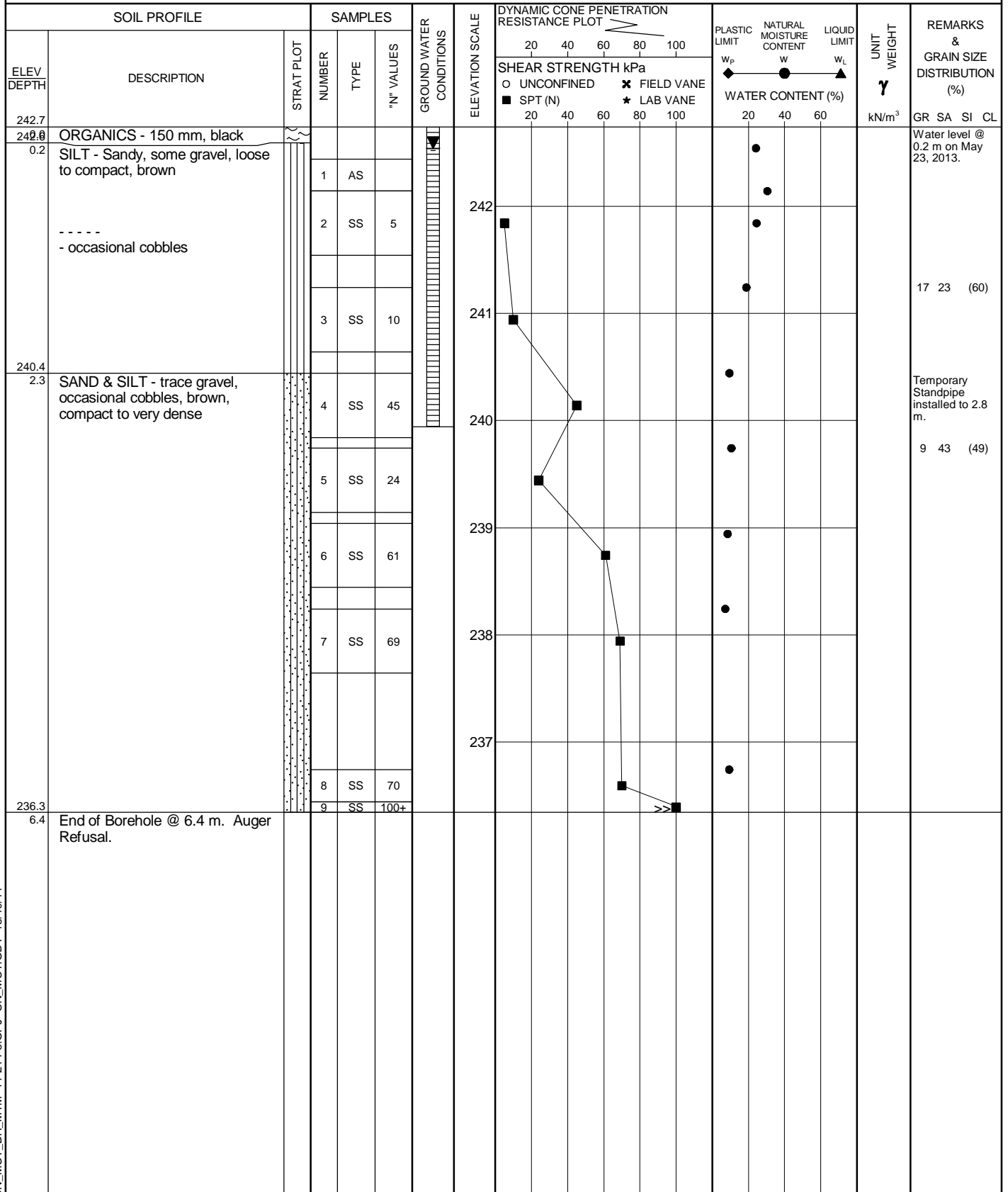
TBT Engineering Consulting Group		<b>RECORD OF Borehole No 3-13</b>				1 OF 1		<b>METRIC</b>						
W.P. <b>125-90-00</b>		PROJECT <b>Hwy 11/17 - 4 Laning</b>				SITE NO. <b>3</b>		ORIGINATED BY <b>D.B.</b>						
DIST <b>61</b>		HWY <b>11/17</b>		LOCATION <b>MTM 15 394249, 5384907</b>		TBTE JOB# <b>11-214</b>		COMPILED BY <b>T.B.</b>						
DATE <b>2013 April 5</b>		BOREHOLE TYPE <b>Hollow Stem Auger</b>				DATUM <b>Geodetic</b>		CHECKED BY <b>S.S.</b>						
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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
240.3								20 40 60 80 100						
0.0	ORGANICS - 300 mm, black		1	AS			240							
			2	SS	61									On cobble
239.2	- SAND - trace gravel, occasional cobbles, brown, very dense													
1.1	End of Borehole @ 1.1 m. Auger Refusal.		3	SS	100+									

TBT Engineering Consulting Group **RECORD OF Borehole No 3-14** 1 OF 1 **METRIC**

W.P. **125-90-00** PROJECT **Hwy 11/17 - 4 Lining** SITE NO. **3** ORIGINATED BY **D.B.**

DIST **61** HWY **11/17** LOCATION **MTM 15 394260, 5384949** TBTE JOB# **11-214** COMPILED BY **T.B.**

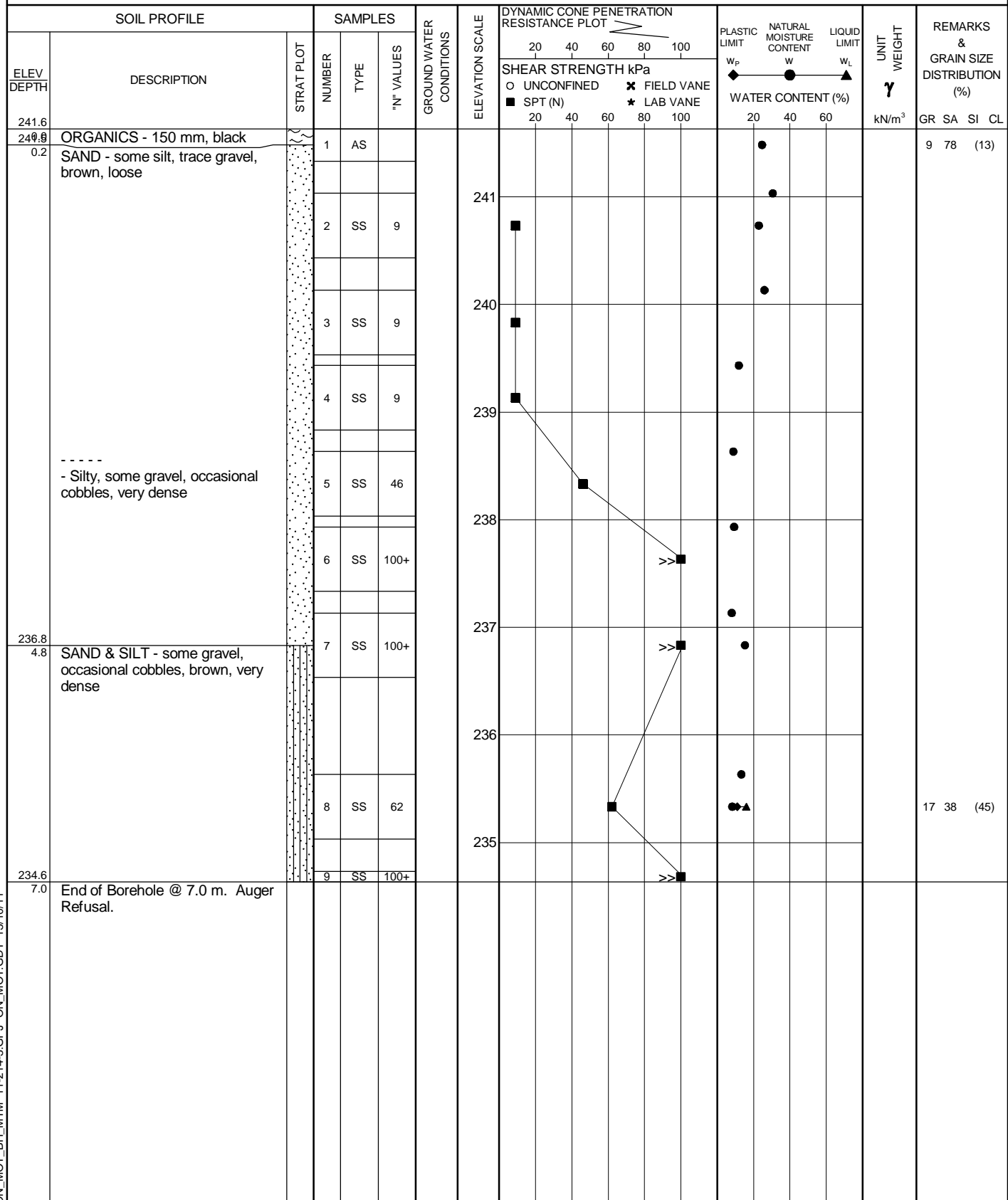
DATE **2013 April 5** BOREHOLE TYPE **Hollow Stem Auger** DATUM **Geodetic** CHECKED BY **S.S.**



✕, ★: Numbers refer to Sensitivity  
NP Non Plastic  
○ 3% STRAIN AT FAILURE

ONL\_MOT\_BH\_MTM 11-214-3.GPJ ON\_MOT.GDT 13/10/11

TBT Engineering Consulting Group		<b>RECORD OF Borehole No 3-15</b>		1 OF 1	<b>METRIC</b>
W.P. <b>125-90-00</b>	PROJECT <b>Hwy 11/17 - 4 Laning</b>	SITE NO. <b>3</b>	ORIGINATED BY <b>D.B.</b>		
DIST <b>61</b>	HWY <b>11/17</b>	LOCATION <b>MTM 15 394223, 5384934</b>	TBTE JOB# <b>11-214</b>	COMPILED BY <b>T.B.</b>	
DATE <b>2013 April 8</b>	BOREHOLE TYPE <b>Hollow Stem Auger</b>	DATUM <b>Geodetic</b>	CHECKED BY <b>S.S.</b>		



$\times^3, \star^3$ : Numbers refer to Sensitivity  
 NP Non Plastic  
 O 3% STRAIN AT FAILURE

ONL\_MOT\_BH\_MTM 11-214-3.GPJ ON\_MOT.GDT 13/10/11

TBT Engineering Consulting Group		<b>RECORD OF Borehole No 3-16</b>		1 OF 1 <b>METRIC</b>	
W.P. <b>125-90-00</b>		PROJECT <b>Hwy 11/17 - 4 Laning</b>		SITE NO. <b>3</b>	
DIST <b>61</b> HWY <b>11/17</b>		LOCATION <b>MTM 15 394162, 5384933</b>		TBTE JOB# <b>11-214</b>	
DATE <b>2013 April 8</b>		BOREHOLE TYPE <b>Hollow Stem Auger</b>		DATUM <b>Geodetic</b>	
				ORIGINATED BY <b>D.B.</b>	
				COMPILED BY <b>T.B.</b>	
				CHECKED BY <b>S.S.</b>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	W <sub>p</sub>	W	W <sub>L</sub>			
242.7														
242.9	FILL - ORGANICS - black													
0.2	FILL - SAND - some silt, some gravel, brown, very loose to loose		1	AS										Water level @ 0.3 m on May 23, 2013.
			2	SS	6									13 69 (18)
			3	SS	3									
240.9	SAND & ORGANICS - black, very loose to loose		4	SS	6									
1.8			5	SS	1									
			6	SS	32									Temporary Standpipe installed to 2.8 m.
239.7	SAND & SILT - some gravel, occasional cobbles, brown, compact to very dense		7	SS	60									14 42 (44) Non-Cohesive
3.0			8	SS	100+									
237.7	End of Borehole @ 5.0 m. Auger Refusal.													
5.0														

x<sup>3</sup>, \*<sup>3</sup>: Numbers refer to Sensitivity  
 NP Non Plastic  
 O 3% STRAIN AT FAILURE

ONL\_MOT\_BH\_MTM 11-214-3.GPJ ON\_MOT.GDT 13/10/11

## 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/0.3m)	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 (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

**JOINTING AND BEDDING:**

	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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$\text{kPa}^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_a$	1	RATE OF SECONDARY CONSOLIDATION
$C_v$	$\text{m}^2/\text{s}$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	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
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{C_u}{\tau_r}$

### STRESS AND STRAIN

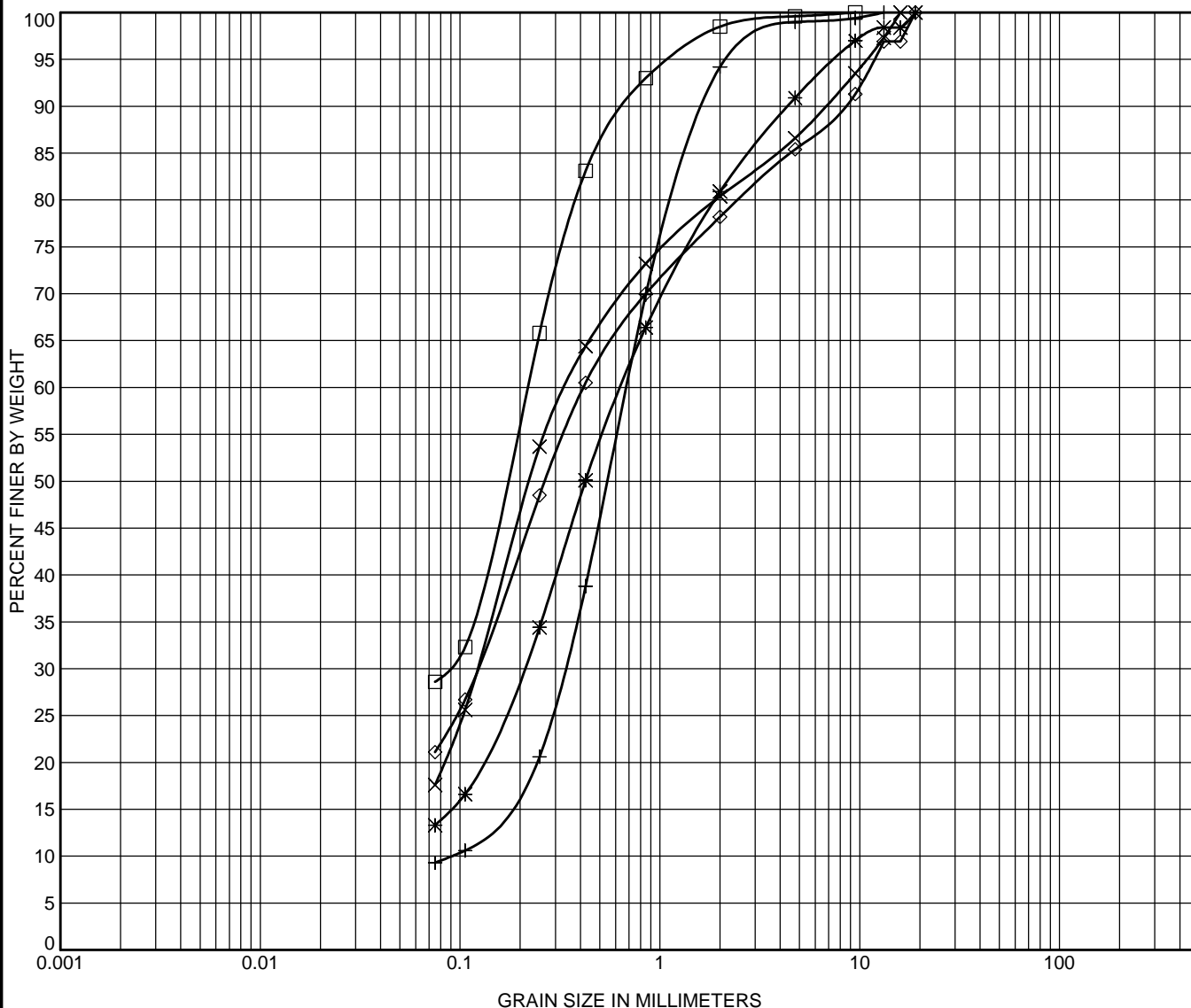
$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS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

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{\min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

**APPENDIX B-2**  
**Culvert at Station 42+130**  
**Laboratory Test Data**





SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SANDS - Silty SANDS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 3-1	0.60	9.5	0.215	0.085		0.4	71.0	28.6	
* 3-15	0.15	19	0.647	0.202		9.1	77.6	13.3	
× 3-16	0.60	16	0.342	0.121		13.4	69.0	17.6	
+ 3-7	2.20	13.2	0.682	0.329	0.09	1.0	89.7	9.3	
◇ 3-9	0.60	19	0.416	0.121		14.6	64.3	21.1	



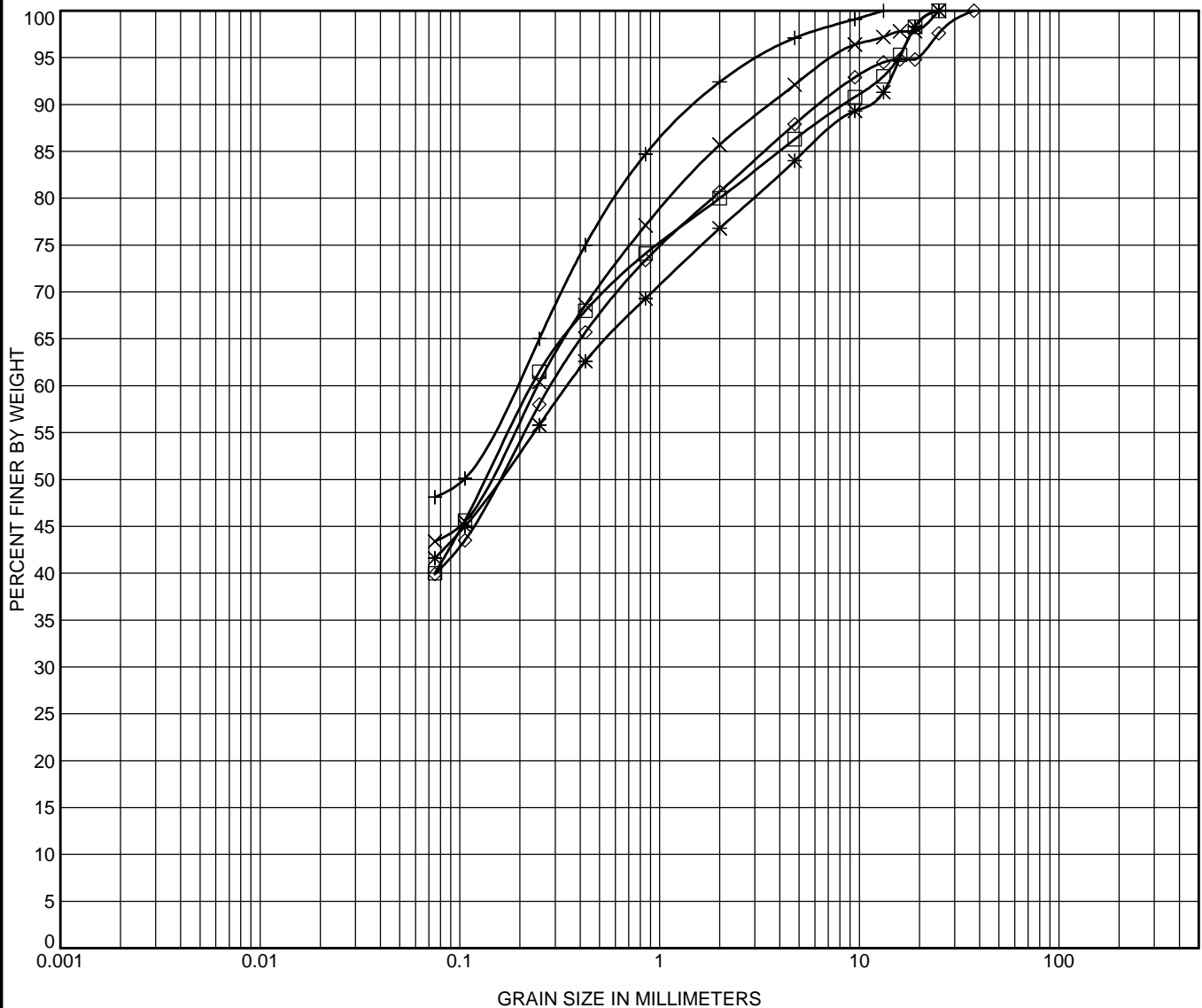
TBT Engineering Limited  
1918 Yonge Street  
Thunder Bay, Ontario P7C 6T9  
PH: 807-624-5160  
FX: 807-264-5161  
Email: tbte@tbte.ca  
Web: www.tbte.ca

## GRAIN SIZE DISTRIBUTION

Project: Hwy 11/17 - 4 Laning

W P: 125-90-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SANDS & SILTS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 3-1	2.20	25	0.231			13.7	46.3	40.0	
* 3-3	3.60	25	0.347			16.0	42.4	41.6	
× 3-4	4.50	25	0.244			7.9	48.7	43.4	
+ 3-6	3.00	13.2	0.187			2.9	49.0	48.1	
◇ 3-6	3.70	37.5	0.287			12.1	48.0	39.9	



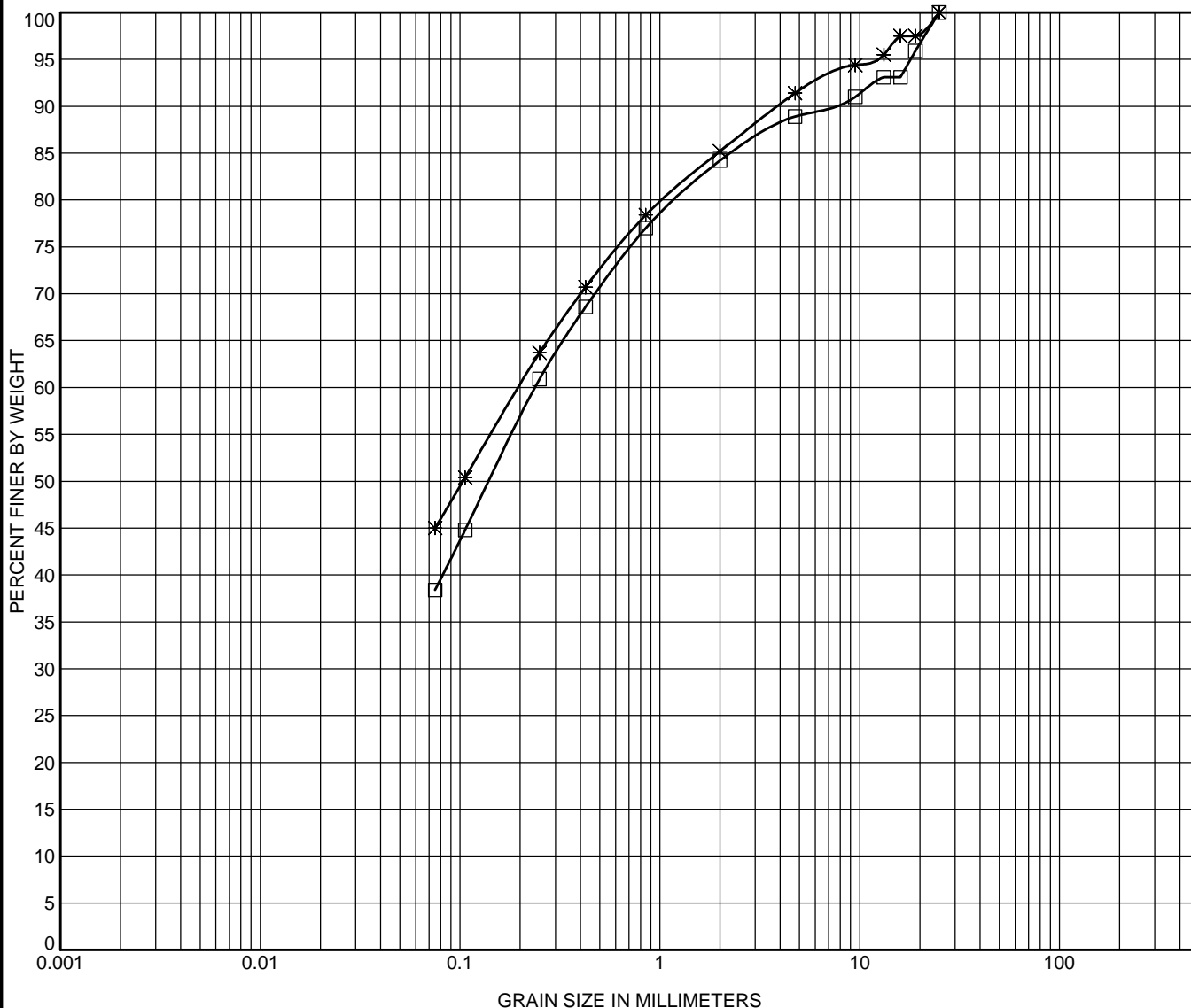
TBT Engineering Limited  
1918 Yonge Street  
Thunder Bay, Ontario P7C 6T9  
PH: 807-624-5160  
FX: 807-264-5161  
Email: tbte@tbte.ca  
Web: www.tbte.ca

## GRAIN SIZE DISTRIBUTION

Project: Hwy 11/17 - 4 Laning

W P: 125-90-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SANDS & SILTS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 3-7	3.70	25	0.238			11.1	50.5	38.4	
* 3-9	6.70	25	0.197			8.6	46.4	45.0	



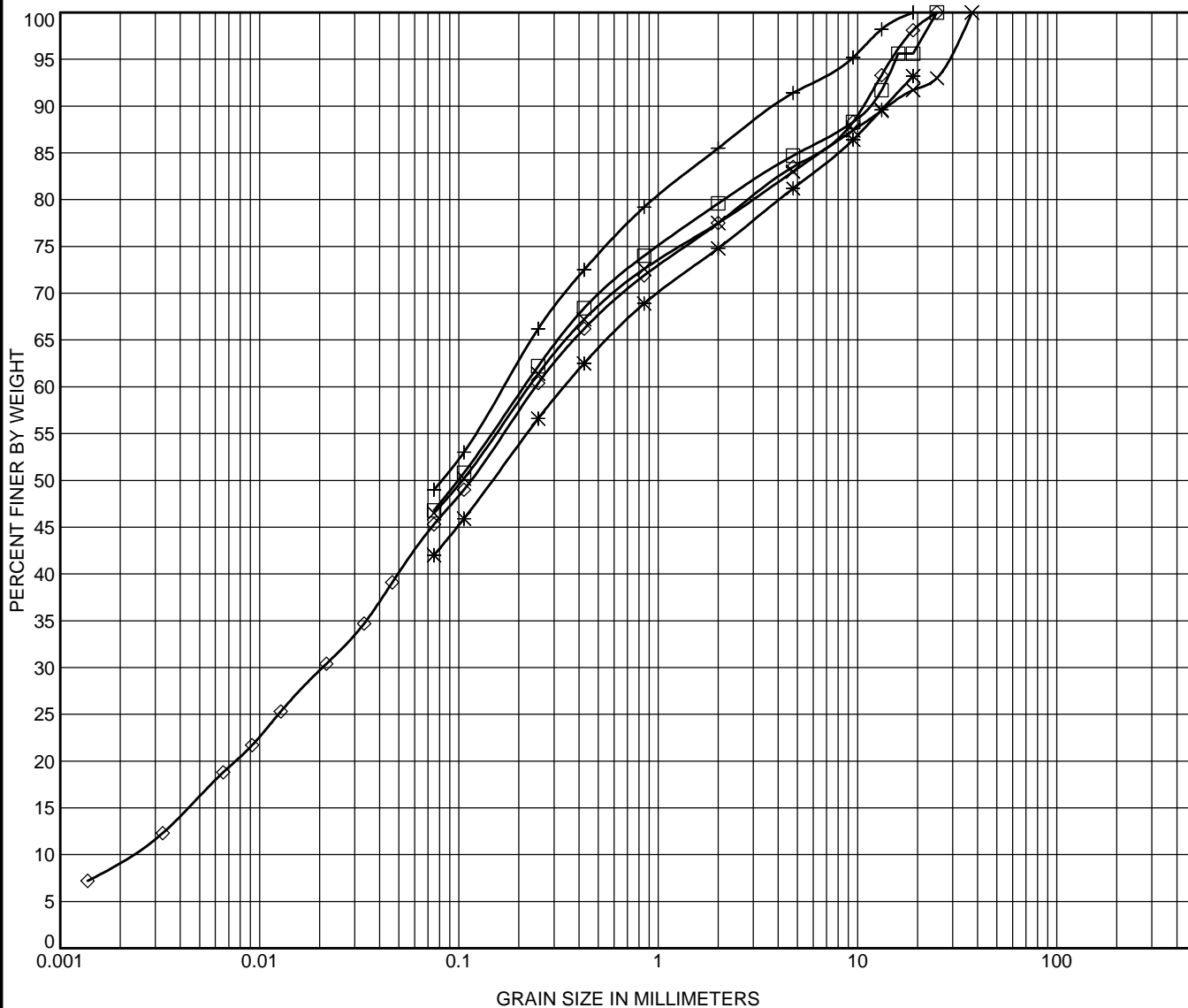
TBT Engineering Limited  
1918 Yonge Street  
Thunder Bay, Ontario P7C 6T9  
PH: 807-624-5160  
FX: 807-264-5161  
Email: [tbte@tbte.ca](mailto:tbte@tbte.ca)  
Web: [www.tbte.ca](http://www.tbte.ca)

## GRAIN SIZE DISTRIBUTION

Project: Hwy 11/17 - 4 Laning

W P: 125-90-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SANDS & SILTS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
3-11	3.70	25	0.212			15.3	37.9	46.8	
3-12	6.00	19	0.339			12.0	39.2	42.0	
3-12	9.00	37.5	0.225			17.0	36.5	46.5	
3-14	3.00	19	0.167			8.6	42.4	49.0	
3-15	6.30	25	0.243	0.021	0.002	16.5	38.2	45.3	



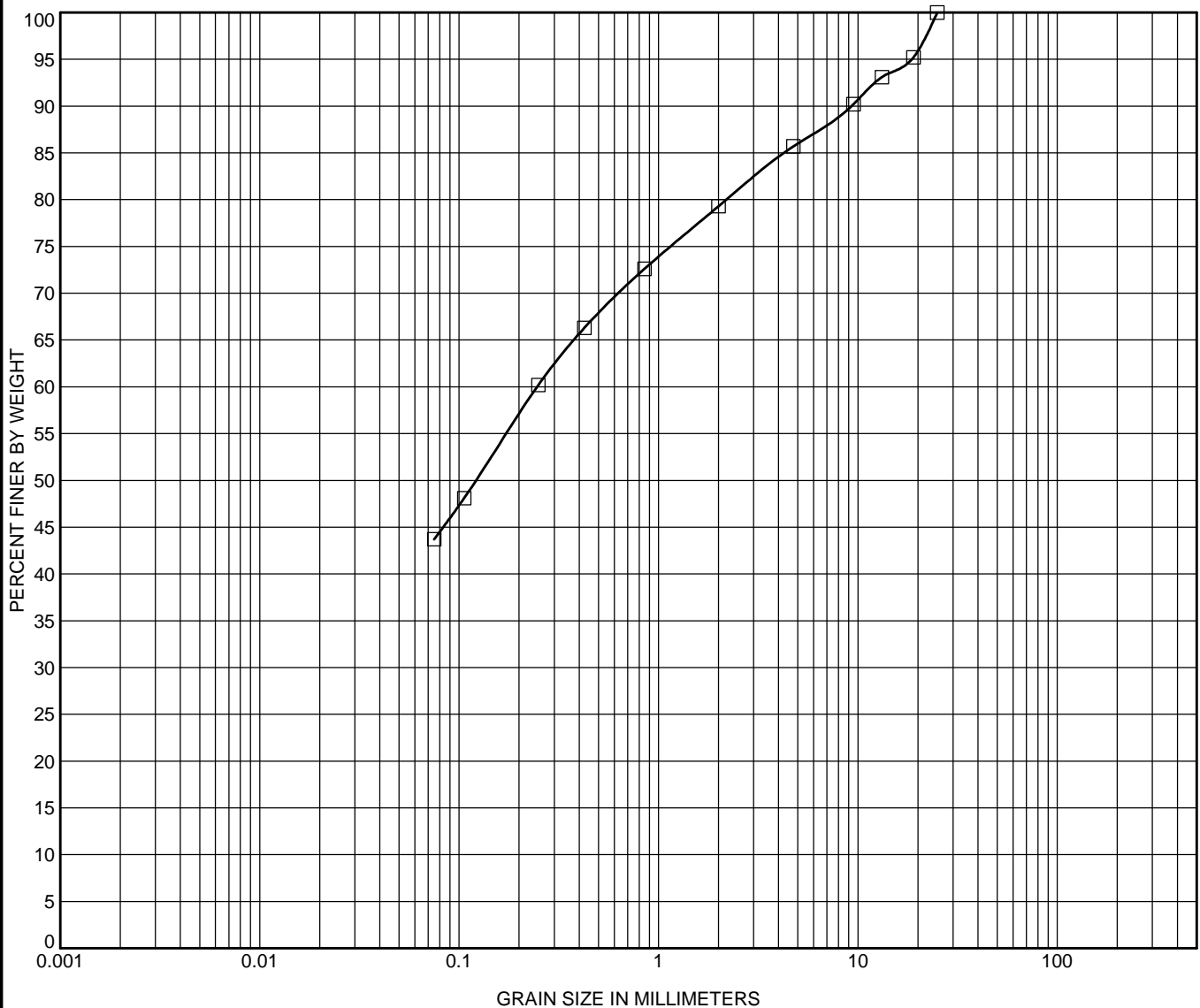
TBT Engineering Limited  
1918 Yonge Street  
Thunder Bay, Ontario P7C 6T9  
PH: 807-624-5160  
FX: 807-264-5161  
Email: [tbte@tbte.ca](mailto:tbte@tbte.ca)  
Web: [www.tbte.ca](http://www.tbte.ca)

## GRAIN SIZE DISTRIBUTION

Project: Hwy 11/17 - 4 Laning

W P: 125-90-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SANDS & SILTS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
<input checked="" type="checkbox"/> 3-16	3.70	25	0.246			14.3	42.0	43.7	



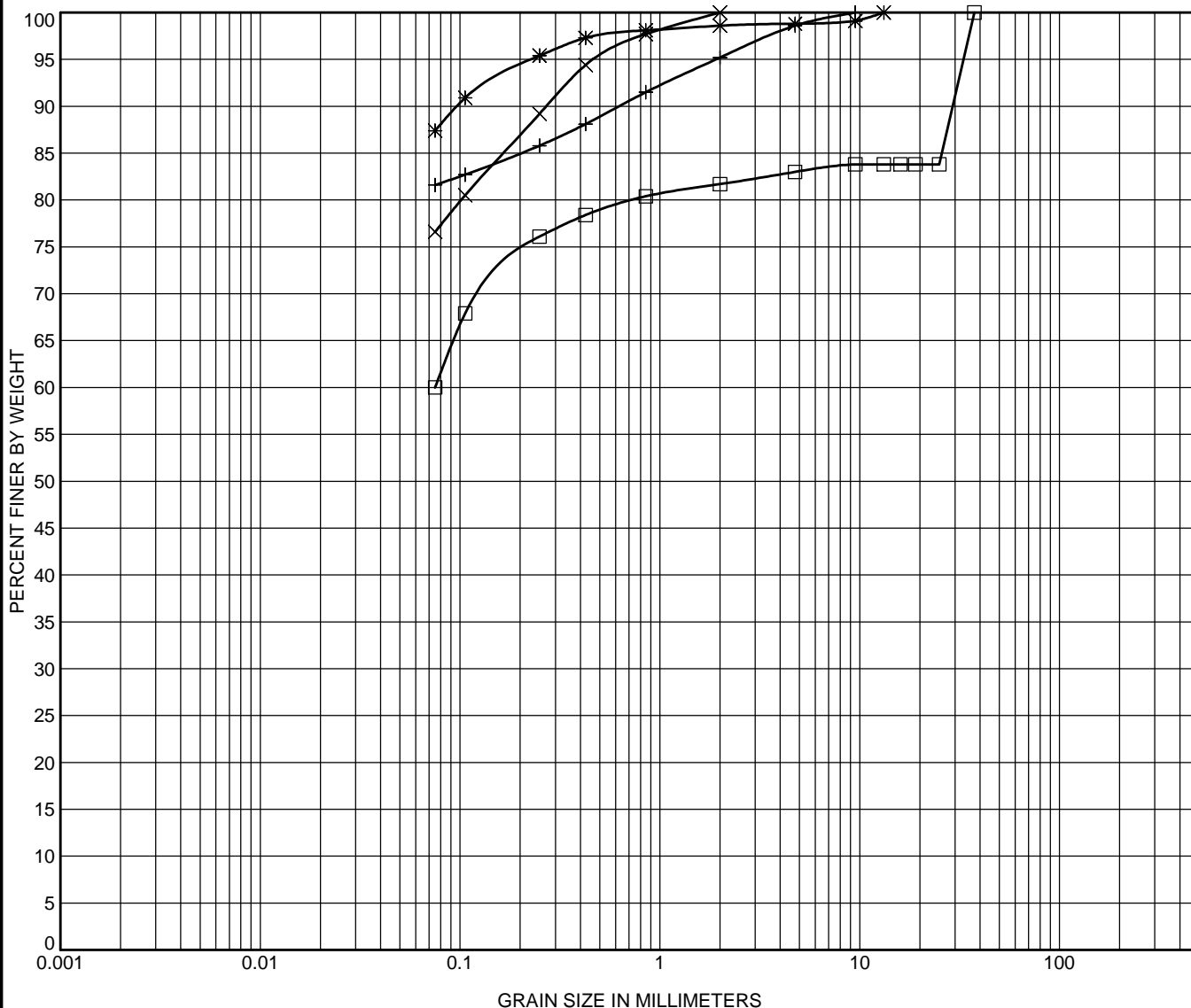
TBT Engineering Limited  
1918 Yonge Street  
Thunder Bay, Ontario P7C 6T9  
PH: 807-624-5160  
FX: 807-264-5161  
Email: [tbte@tbte.ca](mailto:tbte@tbte.ca)  
Web: [www.tbte.ca](http://www.tbte.ca)

## GRAIN SIZE DISTRIBUTION

Project: Hwy 11/17 - 4 Laning

W P: 125-90-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:  
SILTS - Sandy SILTS

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 3-14	1.50	37.5	0.075			17.0	23.0	60.0	
* 3-3	2.10	13.2				1.2	11.4	87.4	
× 3-4	1.90	2				0.0	23.4	76.6	
+ 3-7	2.60	9.5				1.4	17.0	81.6	



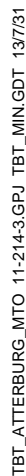
TBT Engineering Limited  
1918 Yonge Street  
Thunder Bay, Ontario P7C 6T9  
PH: 807-624-5160  
FX: 807-264-5161  
Email: [tbte@tbte.ca](mailto:tbte@tbte.ca)  
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## GRAIN SIZE DISTRIBUTION

Project: Hwy 11/17 - 4 Laning

W P: 125-90-00

DIST: 61 HWY: 11/17



## ATTERBERG LIMIT RESULTS

Highway: 11/17



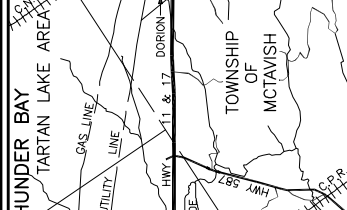
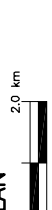

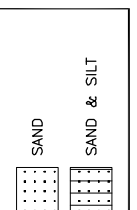
**APPENDIX C-2**  
**Culvert at Station 42+130**  
**Borehole Locations, Drawings and Sections**



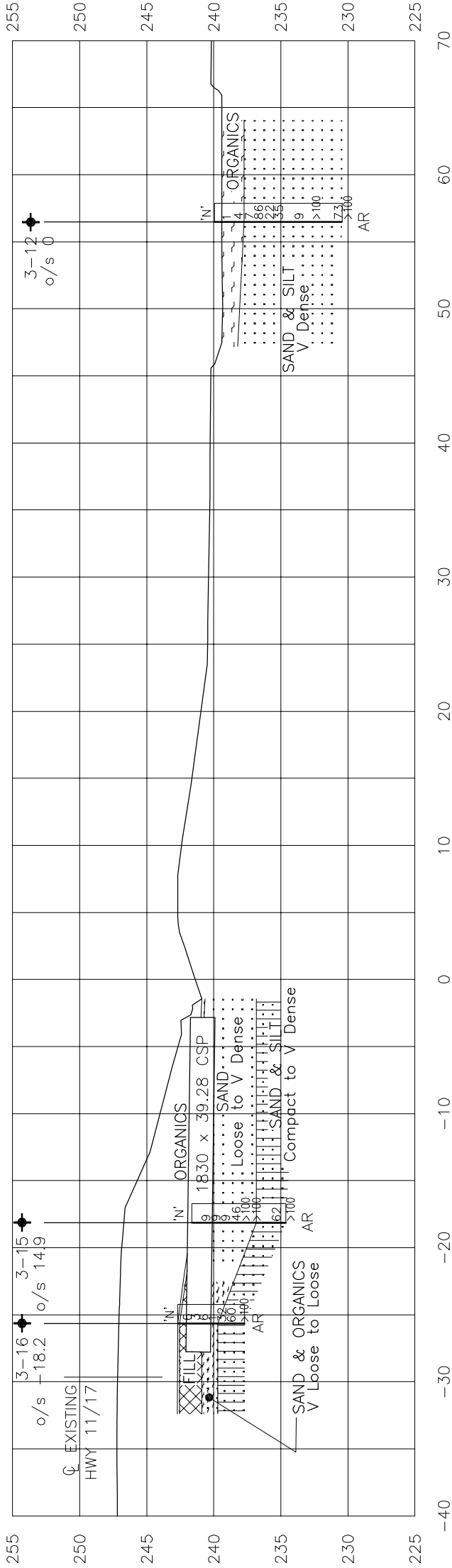


METRIC

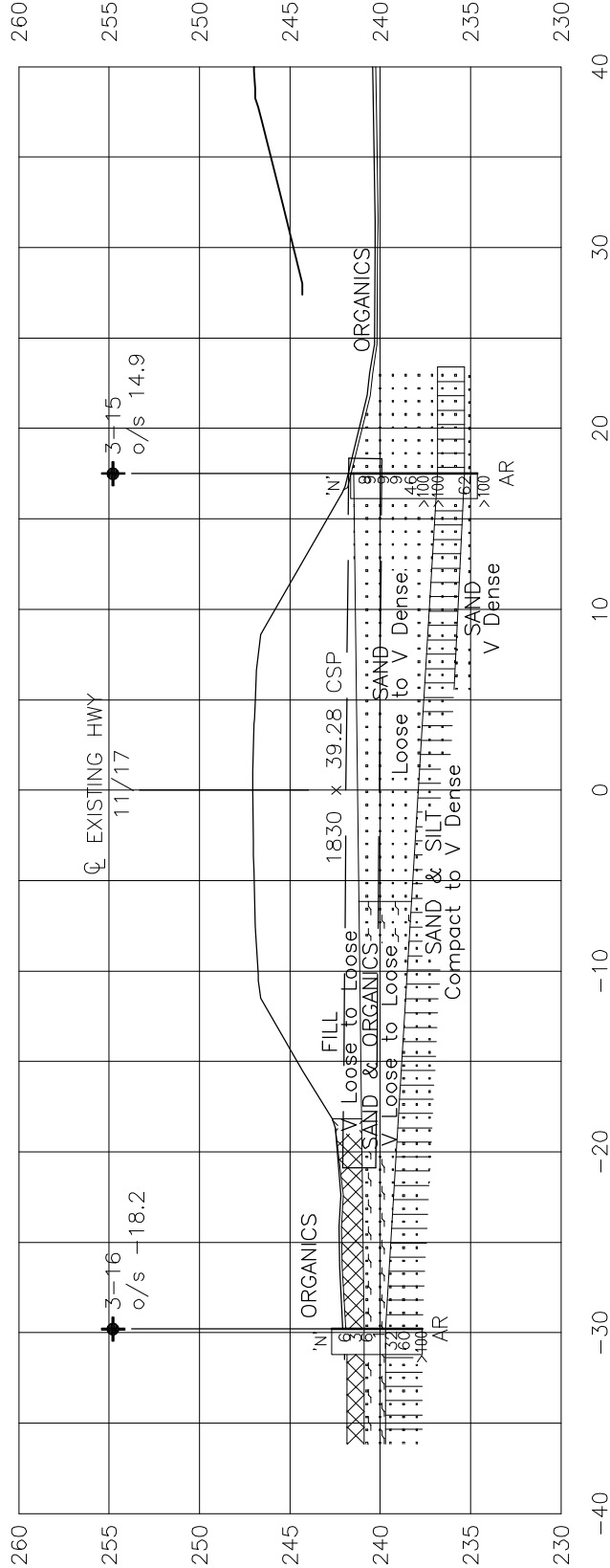
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN

DIST	No.	XXX-XXX
CONT	No.	2007-xx
WP	No.	XXXX-XX-XX
CULVERT @ 42+140 AT HWY 11/17 FOUNDATION INVESTIGATION BOREHOLE LOCATIONS AND SOIL STRATA		
Ministry of Transportation Northwestern Region Structural Section		
		
		
		
		
		
		
No	ELEVATION	CD-ORDINATES (MTM)
3-9	241.2	NORTH
3-10	240.3	EAST
3-11	240.0	15 5 384 930
3-12	240.0	15 5 384 820
3-13	240.0	15 5 384 850
3-14	241.6	15 5 384 858
3-15	241.6	15 5 384 934
3-16	242.7	15 5 384 933

-NOTE-  
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

[illegible]

# SECTION A-A



# SECTION B-B

