



**Foundation Investigation Report**  
**MTO Patrol Yard – New Sand/Salt Storage Structure**  
**Rainy River Patrol Yard, Rainy River Township**  
**Tower Road, Rainy River, ON**  
**Latitude: 48.720827°, Longitude: -94.555453°**

**Assignment #7 6023-E-0030**  
**GWP No.: 6022-24-00**  
**Geocres No. 52D10-003**

**Prepared for:**  
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## Part A - FOUNDATION INVESTIGATION REPORT

### 1 Introduction

TBT Engineering Limited (TBTE) has been retained by the Ontario Ministry of Transportation Northwest Region (MTO) to provide foundation investigation services under the Northwest Region (NWR) Geotechnical Retainer Assignment. The site is located on Tower Road, approximately 300 m south of the intersection of Highway 11 and Tower Road, in Rainy River. The site coordinates are as follows:

- Latitude: 48.720827°, Longitude: -94.555453°

A Google Earth image illustrating the site location can be seen in Figure 1.1.

The investigation consisted of advancing four boreholes to depths of 10 m within the proposed structure footprint. It is understood that the proposed structure will be used to house sand/salt. The details on the size and shape of the structure were not known at the time of this report. Planned borehole locations were provided by the MTO in the Terms of Reference, however, final borehole locations were adjusted to suit field conditions. This report (Part A) describes the subsurface conditions encountered during the investigation.

The MTO Foundations Section has assigned Geocres No. 52D10-003 to this report.



Figure 1.1: A Google Earth Image Illustrating the Site Location.

## **2 Site Description**

The foundation investigation was conducted to investigate the subsurface conditions at the location of the proposed structure. The site is a relatively flat lot. The location for the proposed structure is south of the existing MTO garage in place of the existing sand dome.

### **2.1 Surficial Geology**

As defined by the Ontario Ministry of Natural Resources' Northern Ontario Engineering Geology Terrain Study (NOEGTS), Map No. 52DNE, the site is in an area which primarily consists of a clay/clayey glaciolacustrine plain. The area has low local relief and is generally dry.

Glaciolacustrine deltas are described in the NOEGTS as deposits with glaciolacustrine clay and silt at depths.

The presence of the above soils were confirmed from the field investigation.

## **3 Investigation Procedures**

A geotechnical site investigation was undertaken on October 16 to October 17, 2024. The field investigation consisted of advancing a total of four boreholes. Borehole locations are illustrated on the Borehole Location and Soil Strata Drawings (Appendix C). The boreholes were advanced to depths of 10.6 m.

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 a drill rig mounted on an all-terrain carrier equipped with hollow stem augers, a casing advancement system and apparatus used to carry out Standard Penetration Testing as per ASTM D1586.

During the drilling operations for the boreholes, soil samples were obtained from the auger flights and using the techniques of the Standard Penetration Test (SPT). SPTs are typically taken at a frequency of every 0.75 m for the first 3 m of the borehole, and every 1.5 m afterwards, to the termination depth of the borehole. Sample frequency may vary due to circumstances experienced in the field.

In addition, two thin-walled tube samples were taken within the cohesive materials.

Test hole locations were surveyed by TBTE with a level and rod and referenced to a temporary benchmark at the south-east corner of the MTO garage. The benchmark has an interpolated

elevation of 379.5 m from the H-915-11-1 surface as provided by the client. A hand-held Garmin GPS device was used in the field to record coordinates of the borehole locations, based on North American Data 1983 NAD83 (CSRS) v6 (2010 epoch).

A summary of the borehole location data is provided below and on the Borehole Location and Soil Strata Drawings (Appendix C).

**Table 3.1: Summary of Borehole Information.**

Tess Hole Number	Co-ordinates	Surface Elevation (m)	Depth of Exploration (m)
1	Lat 48.7207817 Lon –94.5559215 5397589 N, 385597 E	331.3	10.6
2	Lat 48.7207578 Lon –94.5563558 5397583 N, 614469 E	331.4	10.6
3	Lat 48.7204524 Lon –94.5563192 5397549 N, 614467 E	331.3	10.6
4	Lat 48.7204662 Lon –94.5559661 5397550 N, 614441 E	331.3	10.6

All boreholes have been backfilled with auger cuttings and bentonite in accordance with the Ontario Ministry of the Environment’s Regulation 903, as amended by Regulation 128/03 (water well regulation under the Ontario Water Resource Act).

#### **4 Laboratory Testing**

Soil samples obtained during the field investigation were subjected to routine laboratory testing. The routine testing included moisture content, Atterberg Limit tests, and grain size analysis. Typically, 100% of the recovered soil samples are tested for natural moisture content determination, and 25% of the recovered soil samples are chosen for grain size analysis and/or Atterberg limits testing, as applicable. The following test methods/standards are followed for the above testing: LS 602, LS 701, ASTM C136, ASTM D4318, ASTM D2216. The results of this testing are shown on the borehole logs (Appendix A) and on the laboratory data reports (Appendix B).

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## **5 Subsurface Conditions**

Details of the subsurface conditions are provided on the borehole logs (Appendix A), and on the Borehole Location and Soil Strata Drawings (Appendix C).

The subsurface soils at this site generally consist of fill at surface underlain by clay to the termination of the boreholes.

### **5.1 Fill**

Sand with some gravel and trace to some silt was present at the surface of all borehole locations (elev. 331.3 to 331.4 m) and extended to depths ranging from 1.0 to 1.4 m (elev. 329.9 to 330.3 m). The condition of this material is a compact with SPT N-values ranging from 13 to 15 blows per 0.3 m. The results of one grain size analyses indicates that this material can consist of 19 % gravel, 65 % sand, 16 % silt/clay sized particles.

### **5.2 Clay and Clayey Silt**

Clayey silt with various amounts of sand and gravel was encountered underlying the fill at all borehole locations except Borehole 1 where Clay was encountered below the fill at depths ranging from 1.0 to 1.4 m (elev. 329.9 to 330.3 m) and extended to the termination of the boreholes at depths of 10.6 m (elev. 320.7 to 320.8 m). It should be noted that cobbles were noted within this material. Atterberg limits testing indicates that this material is generally low plastic with one zone of high plasticity at Borehole 1 at a depth of 1.5 (elev. 329.8 m). The natural moisture contents are at or above the plastic limit. The results of eight grain size analyses indicate that the clay consisted of 0 % gravel, 10 % sand, 90 % silt/clay sized particles and the clayey silt consisted of 1 to 6% gravel, 18 to 35 % sand, 60 to 79 % silt/clay sized particles. This material generally has a firm to very stiff consistency based on SPT N-values ranging from 7 to 27 blows per 0.3 m, with one hard zone at Borehole 2 - 7.6 m (elev. 323.7 m) with SPT N-value of 40 blows per 0.3 m.

### **5.3 Groundwater**

Water level readings were taken upon completion of the boreholes, as shown below. Observed groundwater levels have been provided in the table below. Based on the soils encountered on site, the groundwater levels may not have had time to stabilize. Groundwater levels may vary from season to season and from the effects of heavy precipitation events.

**Table 5.1: Observed Groundwater Levels.**

Location	Surface Elevation (m)	Groundwater Level on Completion of Drilling	
		Depth (m)	Elev. (m)
Borehole 1	331.3	9.0	322.3
Borehole 2	331.4	8.8	322.6
Borehole 3	331.3	9.0	322.3
Borehole 4	331.3	8.5	322.8

## **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. The field operations were supervised by Ian Baumann and Allan Finke. Laboratory testing was managed by Rhyan Ariganello P.Eng.. This report was prepared and reviewed by Dean Vale, P.Eng., and Steven Seller, P.Eng. (TBTE's designated principal contact identified for MTO Foundation Engineering).

## **7 Limitations**

Conclusions and recommendations presented in this report are based on the information determined at a limited number of borehole locations. Subsurface and groundwater conditions between and beyond these locations may differ from those encountered. Conditions may become apparent during construction that were not detected and could not be anticipated at the time of the site investigation.

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 the dewatering procedures which may be considered during construction cannot readily be determined from site investigation or boreholes. These conditions include local and seasonal fluctuations of the groundwater level, changes in soil conditions between borehole locations, thin and/or discontinuous layers of highly permeable soils, etc.

In no way does the information contained within this report reflect any environmental aspect of the site or soil.



## 8 Closure

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

Yours truly,  
For TBT ENGINEERING



Dean Vale, P.Eng.  
Geotechnical Engineer



Steve Steller, P.Eng.  
Senior Engineer  
Principal Contact for MTO Foundations

## **APPENDIX A**

### **Borehole Logs**

## EXPLANATION OF TERMS

**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 63.5 kg, 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/condition.

**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

**Condition:** Cohesionless soils are described on the basis of denseness as indicated by SPT N values as follows:

N (Blows/0.3m)	0-4	4-10	10-30	30-50	>50
	Very Loose	Loose	Compact	Dense	Very Dense

**Minor Soil Components:** Terminology used to represent the amount of minor components based on their percent of the sample by weight as follows:

% by weight	0-10	10-20	20-35	35-50
	Trace	Some	"ey" or "y"	And

## ABBREVIATIONS AND SYMBOLS

### Field Sampling, Insitu Testing, Laboratory Testing

S S	Split Spoon	T P	Thin Wall Piston
A S	Auger	O S	Osterberg
W S	Wash	R C	Rock Core
S T	Slotted Tube	P H	T W Advanced Hydraulically
B S	Block	P M	T W Advanced Manually
C S	Chunk	F S	Foil
V T	Vane Test (kPa)	P P	Pocket Penetrometer (kg/cm <sup>2</sup> )
T W	Thin Wall Shelby Tube		

## EXPLANATION OF TERMS Cont'd.

### Stress and Strain

$u_w$	kPa	Pore Water Pressure
$u$		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 Stress
$\epsilon$	%	Linear Strain
$\epsilon_1, \epsilon_2, \epsilon_3$	%	Principal Strains
$E$	MPa	Young's Modulus
$G$	kPa	Modulus of Shear Deformation
$m$	MPa	Constrained Modulus
$\mu$		Coefficient of Friction

### Mechanical Properties of Soil

$m_v$	kPa <sup>-1</sup>	Coefficient of Volume Change
$C_c$		Compression Index
$C_s$		Swelling Index
$C_a$		Rate of Secondary Consolidation
$c_v$	m <sup>2</sup> /s	Coefficient of Consolidation
$H$	m	Drainage Path
$T_v$		Time Factor
$U$	%	Degree of Consolidation
$P'_o$	kPa	Effective Overburden Pressure
$P'_c$	kPa	Preconsolidation Pressure
$\tau_f$	kPa	Shear Strength
$c'$	kPa	Effective Cohesion Intercept
$\phi'$	°	Effective Angle of Internal Friction
$c_u$	kPa	Undrained Shear Strength
$s$		Sensitivity

### Physical Properties of Soil
















$\rho_s$	kg/m <sup>3</sup>	Density of Solid Particles	$e$	%	Void Ratio	$e_{min}$	%	Void Ratio in Densest State
$\gamma_s$	kN/m <sup>3</sup>	Unit Weight of Solid Particles	$n$	%	Porosity	$I_D$		Density Index $= \frac{e_{max}-e}{e_{max}-e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	Density of Water	$w$	%	Water Content	$D$	mm	Grain Diameter
$\gamma_w$	kN/m <sup>3</sup>	Unit Weight of Water	$s_r$	%	Degree of Saturation	$D_n$	mm	n Percent Diameter
$\rho$	kg/m <sup>3</sup>	Density of Soil	$w_L$	%	Liquid Limit	$C_u$		Uniformity Coefficient
$\gamma$	kN/m <sup>3</sup>	Unit Weight of Soil	$w_p$	%	Plastic Limit	$h$	m	Hydraulic Head or Potential
$\rho_d$	kg/m <sup>3</sup>	Density of Dry Soil	$w_s$	%	Shrinkage Limit	$q$	m <sup>3</sup> /s	Rate of Discharge
$\gamma_d$	kN/m <sup>3</sup>	Unit Weight of Dry Soil	$I_p$	%	Plasticity Index = $w_L - w_p$	$v$	m/s	Discharge Velocity
$\rho_{sat}$	kg/m <sup>3</sup>	Density of Saturated Soil	$I_L$		Liquidity Index = $\frac{w-w_p}{I_p}$	$i$		Hydraulic Gradient
$\gamma_{sat}$	kN/m <sup>3</sup>	Unit Weight of Saturated Soil	$I_c$		Consistency Index = $\frac{w_L-w}{I_p}$	$k$	m/s	Hydraulic Conductivity
$\rho'$	kg/m <sup>3</sup>	Density of Submerged Soil	$e_{max}$	%	Void Ratio in Loosest State	$j$	kN/m <sup>3</sup>	Seepage Force
$\gamma'$	kN/m <sup>3</sup>	Unit Weight of Submerged Soil						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 6022-24-00 LOCATION Rainy River Patrol Yard N:5399043.002; E:411043.136 MTM Zone:17 ORIGINATED BY IB  
DIST Thunder Bay HWY Tower Rd BOREHOLE TYPE Hollow Stem Auger COMPILED BY TG  
DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 48.7207817 LONGITUDE -94.5559215 CHECKED BY SS

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	● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)					
331.3 0.0	FILL - SAND - some gravel, brown		1	AS													Water level @ 9.0 m on completion.
330.3 1.0	CLAY - some sand, some organics, occasional cobbles, grey, stiff		2	SS	12												0 10 (90)
			3	SS	12												
	----- - brown		4	SS	12												
			5	SS	11												
327.0 4.3	SILT - Clayey, Sandy, trace gravel, trace organics		6	SS	13												6 34 (60)
																	
			7	TW													
																	
	----- - grey		8	SS	16												
																	
																	
			9	SS	20												
	----- - some silt, trace sand, brown/grey																
			10	SS	18												
320.7 10.6	End of Borehole @ 10.6 m.																





ONTARIO MTO MOD 24-179-7 RAINY RIVER.GPJ ONTARIO MTO.GDT 1-24-25

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 6022-24-00 LOCATION Rainy River Patrol Yard N:5399039.744; E:411011.231 MTM Zone:17 ORIGINATED BY IB  
DIST Thunder Bay HWY Tower Rd BOREHOLE TYPE Hollow Stem Auger COMPILED BY TG  
DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 48.7207578 LONGITUDE -94.5563558 CHECKED BY SS

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 ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE												
331.4 0.0	FILL - SAND & GRAVEL - brown							20	40	60	80	100						Water level @ 8.8 m on completion.			
	----- - compact		1	AS				331													
																			2 19 (79)		
		2	SS	15	330																
330.0 1.4	SILT - Clayey - some sand, trace gravel, trace organics, grey, stiff																				
			3	SS	10																
	----- - brown							329													
			4	TW																	
			5	SS	15			328													
			6	SS	16	327															
	----- - some sand, some gravel, occasional cobbles, hard		7	SS	40	326															
	----- - very stiff to stiff		8	SS	23	325															
	----- - Clayey, Sandy, trace gravel, grey		9	SS	13	324															
																</					



ONTARIO MTO MOD 24-179-7 RAINY RIVER.GPJ ONTARIO MTO.GDT 1-24-25

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 6022-24-00 LOCATION Rainy River Patrol Yard N:5399005.839; E:411014.568 MTM Zone:17 ORIGINATED BY IB  
DIST Thunder Bay HWY Tower Rd BOREHOLE TYPE Hollow Stem Auger COMPILED BY TG  
DATUM Geodetic DATE 2024.10.16 - 2024.10.16 LATITUDE 48.7204524 LONGITUDE -94.5563192 CHECKED BY SS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				w <sub>p</sub> — w — w <sub>L</sub>							
331.3 0.0	FILL - SAND - some gravel, trace silt, brown		1	AS												19 65 (16)			
	----- - compact		2	SS	13												Water level @ 9.0 m on completion.		
329.9																			
1.4	SILT - Clayey, some sand, some gravel, trace organics to 2.9 m, brown, firm		3	SS	7														
			4	SS	27														
			5	SS	19														
	----- - Clayey, Sandy, trace gravel		6	SS	20												1 35 (64)		
			7	SS	17														
	----- - grey	8	SS	12															




ONTARIO MTO MOD 24-179-7 RAINY RIVER.GPJ ONTARIO MTO.GDT 1-24-25

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 6022-24-00 LOCATION Rainy River Patrol Yard N:5399007.862; E:411040.516 MTM Zone:17 ORIGINATED BY IB  
DIST Thunder Bay HWY Tower Rd BOREHOLE TYPE Hollow Stem Auger COMPILED BY TG  
DATUM Geodetic DATE 2024.10.17 - 2024.10.17 LATITUDE 48.7204662 LONGITUDE -94.5559661 CHECKED BY SS

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 ● QUICK TRIAXIAL × LAB VANE														
331.3	0.0	FILL - SAND & GRAVEL - trace silt, brown		1	AS			331										Water level @ 8.5 m on completion.				
		----- - some organics, trace silt																				
330.2			2	SS	7			330														
1.1		SILT - Clayey, some sand, some organics to 1.4 m, trace gravel, grey, stiff																				
		----- - brown																				
				3	SS	10			329										2 29 (68)			
		----- - Clayey, Sandy, trace gravel																				
				4	SS	8			328													
				5	SS	7			327													
				6	SS	8		326														
			7	TW			325															

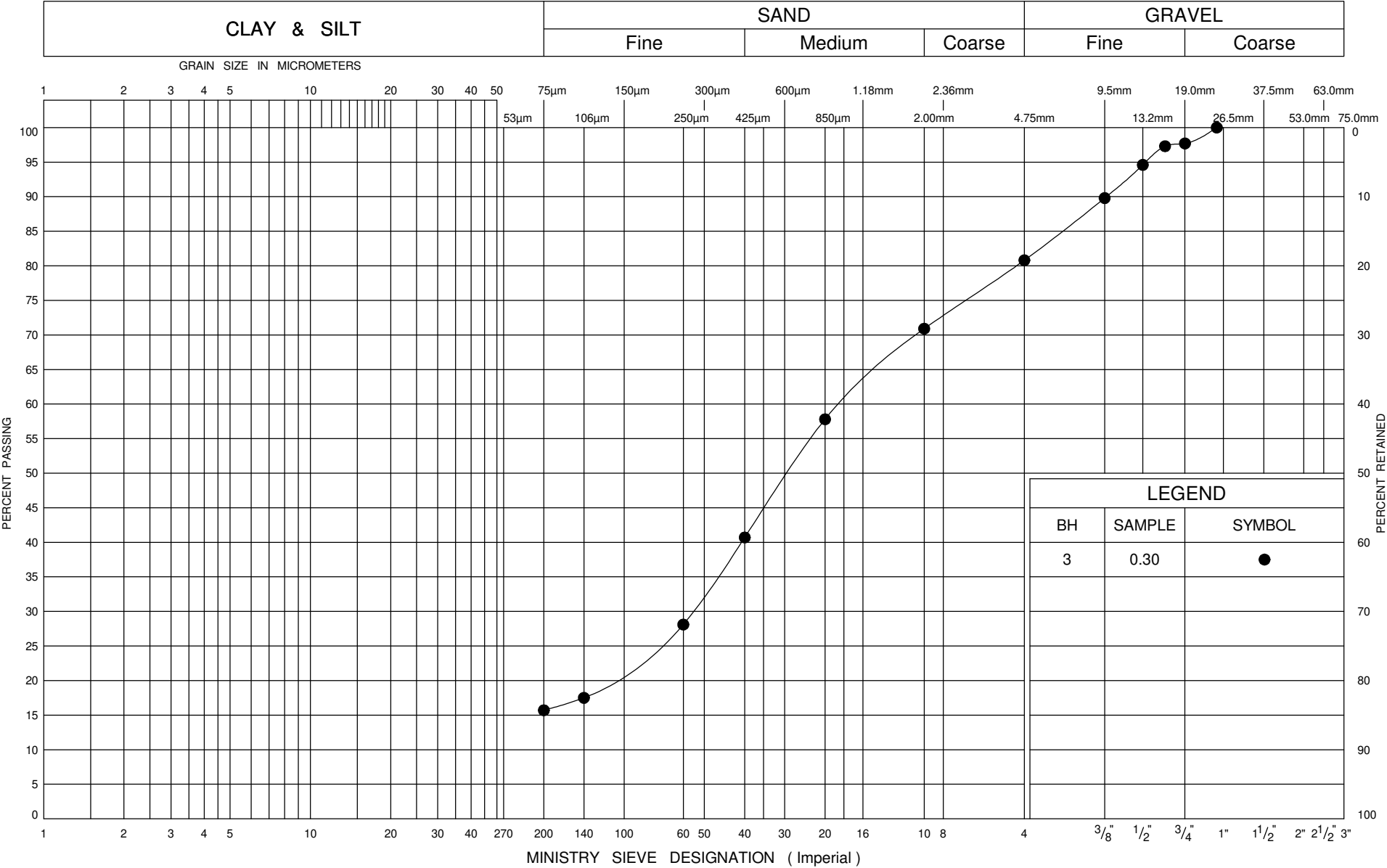
ONTARIO MTO MOD 24-179-7 RAINY RIVER.GPJ ONTARIO MTO.GDT 1-24-25



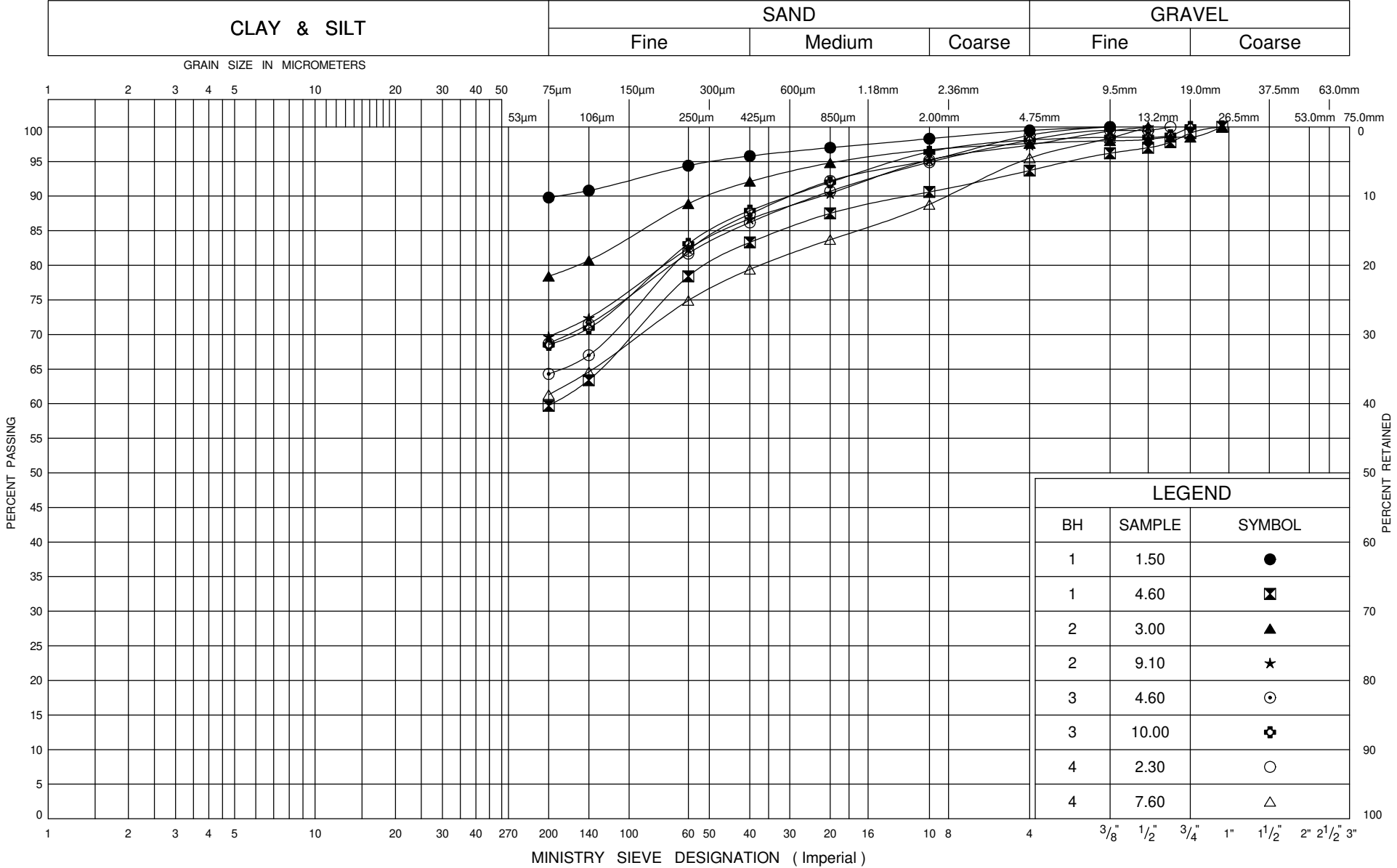
## **APPENDIX B**

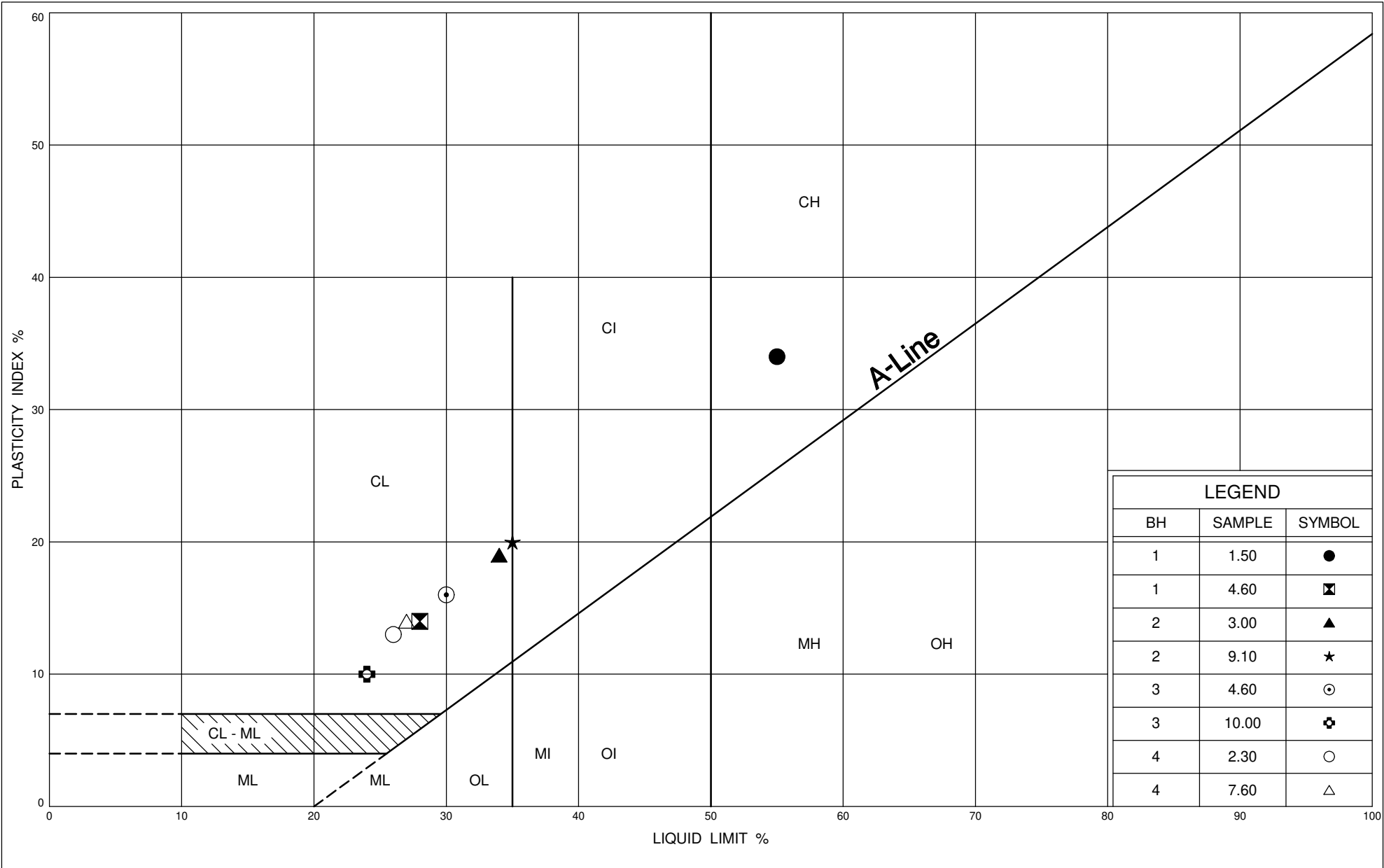
### **Laboratory Test Data**

UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM





Ministry of  
Transportation

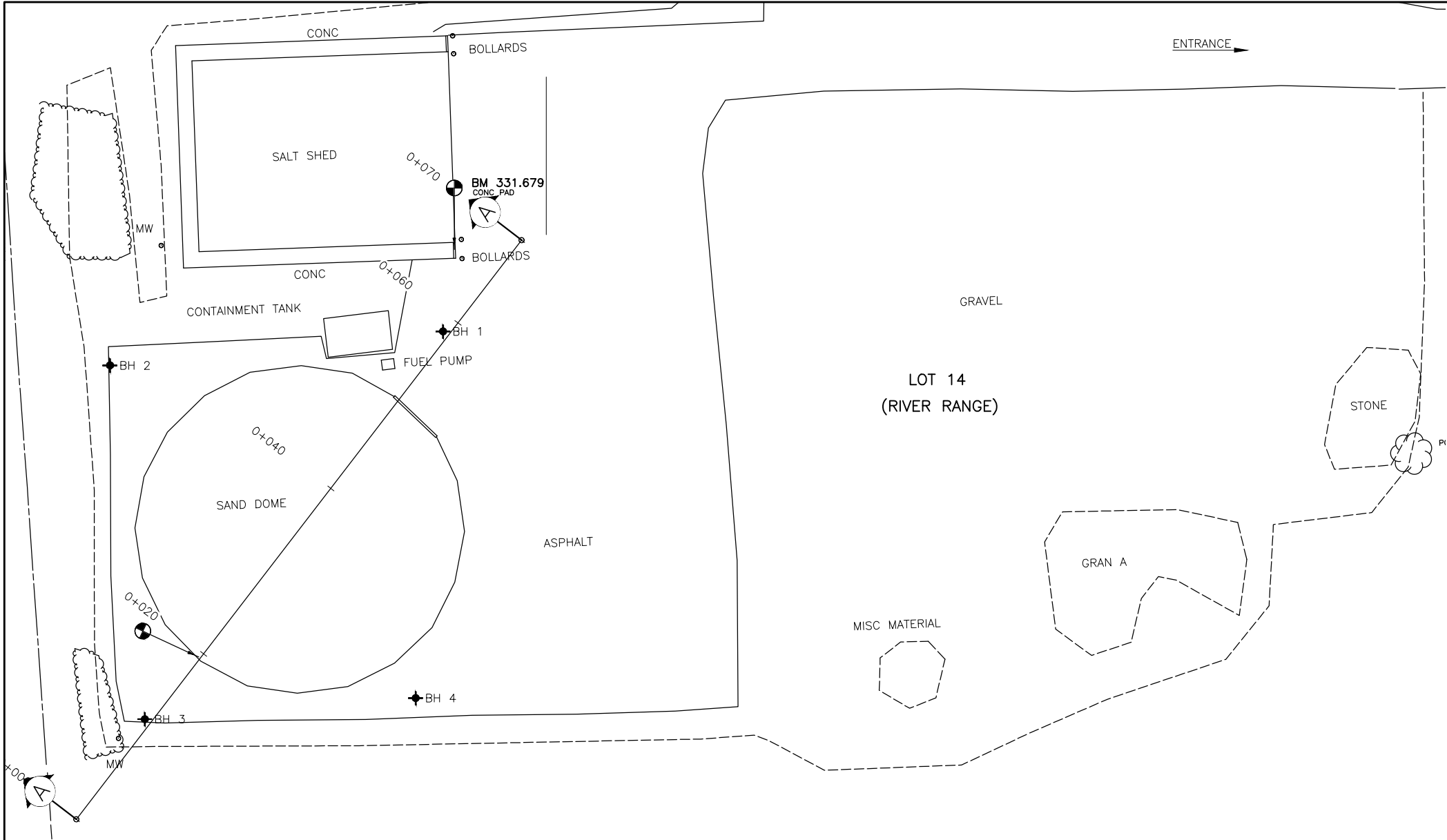
# PLASTICITY CHART

FIG No 3

W P 6022-24-00

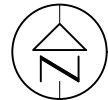
New Building

**APPENDIX C**  
**Borehole Location and Soil Strata Drawings**



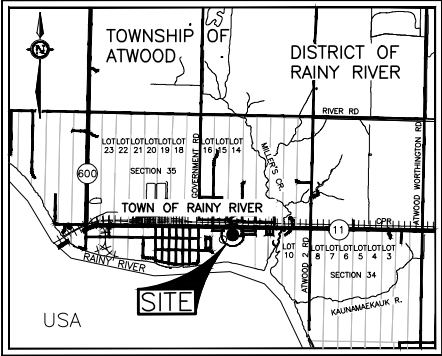
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN

**Ontario** Ministry of Transportation  
GEOCRES 52D10-003  
CONT -  
GWP 6022-24-00



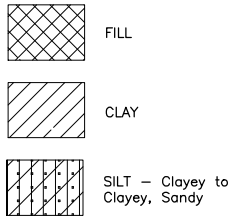
BOREHOLE LOCATIONS AND SOIL STRATA  
NEW BUILDING  
RAINY RIVER PATROL YARD

SHEET  
-

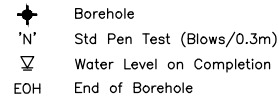


KEY PLAN  
1.0 km 0 1.0 km  
SCALE

SOIL STRATA SYMBOLS



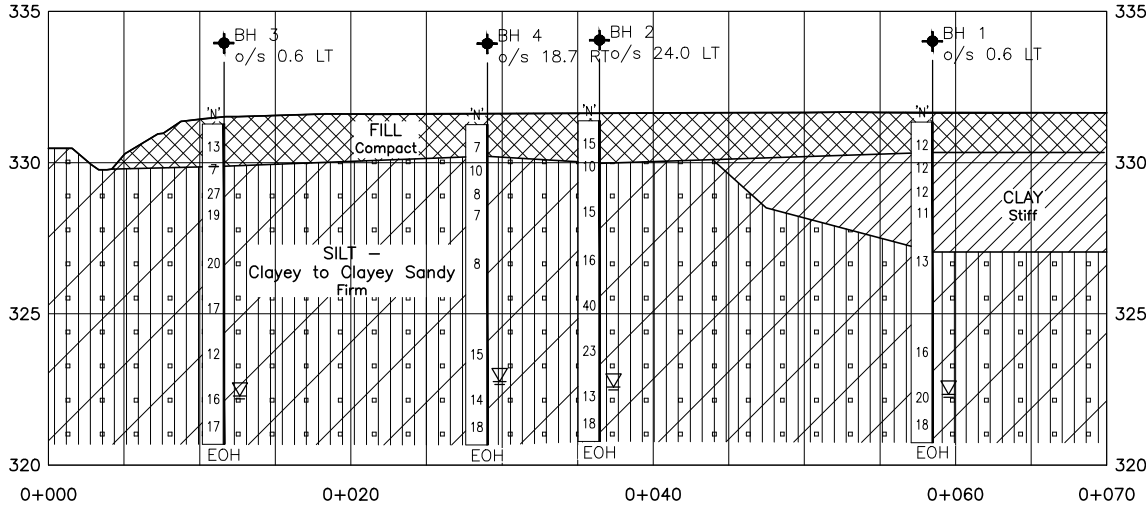
LEGEND



No	ELEVATION	CO-ORDINATES (MTM 17)	
		NORTH	EAST
BH 1	331.3	17 5 399 043	411 043
BH 2	331.4	17 5 399 040	411 011
BH 3	331.3	17 5 399 006	411 015
BH 4	331.3	17 5 399 008	411 041

NOTE

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



PROFILE SECTION A-A



REVISIONS					
			DESIGN	CHK	DATE
2	SS		ISSUED IN FINAL	24/01/25	
1	SS		ISSUED IN DRAFT		
DESIGN	XX	CHK DV	CODE XXXXXX	LOAD XXXX	DATE 13/12/24
DRAWN	TG	CHK SS	SITE XXXXX	DWG XXXXX	