Foundation Investigation and Design Report

Argon Park Rest Area Washroom Facility
Assignment #6 6019-E-0042
District Thunder Bay
Highway 17

Prepared for
NWR Ministry of Transportation
615 James Street South
Thunder Bay, ON
P7E 6P6

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October 28, 2020 Ref. No. 20-108-6

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APPENDICIES

Part A - FOUNDATION INVESTIGATION REPORT

1 Introduction

TBT Engineering Limited (TBTE) has been retained by the Ministry of Transportation (MTO) – North West Region to provide a foundation investigation and design services for the proposed new, year round, rest area washroom facility located at Argon Park rest area on Highway 17, in the district of Thunder Bay. It is understood that the final building footprint has not been finalized, however, sizing provided by MTO show that the proposed new washroom building footprint may be constructed up to 7.5 m x 7.5 m (56.25 m^2). Currently, there is an existing building with two drop toilets at the proposed investigation area. The rest area is located approximately 40 km South East of Upsala, ON along Highway 17 and is approximately 104 km North West of Thunder Bay. The site co-ordinates for the site are as follows:

- Argon Park Rest Area, lat: 48.90278, lon: -90.02845

A foundation investigation was carried out to investigate subsurface conditions for the proposed new washroom facility. The investigation consisted of advancing four boreholes at the site. This report (Part A) describes the subsurface conditions encountered during the investigation.

MTO Foundations Section has assigned an assignment No. 6 6019-E0042 to this site.

2 Site Description

Argon park rest area is located on Highway 17, approximately 104 km North West of Thunder Bay, ON and approximately 40 km South East of Upsala, ON. The existing rest area consists of a large asphalt parking lot, several picnic areas, and two privy/outhouse buildings (one located at the middle of the rest area and one at the back of the site).

Vegetation surrounding the rest area is dense. Several trees and other dense vegetation are located at the center of the rest area, to possibly act as a privacy/sound dampening barrier for the asphalt parking lot located at the back of the site. Trails leading around the back of the site were cleared and easily accessible. The terrain is gently sloping from South to North towards ditching adjacent to the highway.

Figure 1: Existing privy at the rear of Argon park rest stop (area of investigation)

Figure 2: Area of investigation, looking towards Highway 17

2.1 Surficial Geology

As defined by the Ontario Ministry of Natural Resources' Northern Ontario Engineering Geology Terrain Study (NOEGTS), 1981, Map No. 52BNE “Lac des Mille Lacs”, the site is located in an area which consists of sand/sandy outwash plain with valley terrain. A subordinate landform consisting of peat/muck organic terrain veneer, overlying sandy, sand outwash plain is also present. The terrain is plain, with low local relief, dry surface condition and wet subordinate terrain.

Sandy soils were encountered within the upper 1.5 m of the borehole investigation.

3 Investigation Procedures

A geotechnical site investigation was undertaken from October 5, 2020 to October 6, 2020 and consisted of advancing four boreholes to depths of ranging from 7.0 m to 10.3 m. The boreholes were completed using a track mounted drill rig.

The drill rig was equipped for geotechnical testing and sampling. Hollow stem auger methods were utilized. Soil samples were obtained at the boreholes using a split spoon sampler as a part of the Standard Penetration Testing (SPT). The SPT involves driving a thick-walled sampler into the soils under a standardized energy (63.5 kg, falling 760 mm). The number of blows required to drive the sampler 0.3 m is known as the SPT blow count (N). In addition, thin walled tube samples were taken, and field vane test were carried out on cohesive soils. Auger refusal was not encountered in any of the boreholes.

Temporary standpipes were installed to 2.9 m within each borehole. All boreholes and temporary standpipes have been backfilled and/or decommissioned with auger cuttings and bentonite in accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the water well regulation under the Ontario Water Resources Act).

The location of boreholes was established in the field by TBTE personnel and service clearances were completed prior to mobilization the drill rig to site. Borehole locations were surveyed by TBTE and were referenced to North American Datum 1983 (NAD83 CSRS CBNv6-2010.0) 3 Degree Modified Transverse Mercator (MTM) Zone 15, Central Scale Factor 0.9999 Grid Coordinates. Borehole Locations and Soil Stratification drawings have been provided in Appendix C.

4 Laboratory Testing

Samples which were obtained during the field investigation were subjected to routine laboratory testing. The routine testing included Atterberg limits, moisture content, and grain size analysis conducted on select samples. The results of these tests are shown on the Borehole Logs (Appendix A) and on the laboratory data reports (Appendix B).

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 generalized subsurface soils at this site consists of topsoil and/or fill overlying sands which are underlain by clays with occasional silt layers.

5.1 Topsoil

50 mm of topsoil was encountered at the surface of Boreholes BH-2, BH-3, and BH-4 beginning at elevations 465.1 m, 465.6 m, and 465.3 m, respectively.

5.2 Fill

Variable fill consisting of brown silty sand to sand and gravel was observed at ground surface at Borehole 1, and below the topsoil at Borehole 3 and 4 and extends to depth of 0.2 m to 0.8 m (El. 463.8 m to 465.3 m).

5.3 Sands

A layer of sand with some silt and a trace of gravel to sand and silt exists below the fills at Boreholes 1, 3 and 4, and below the topsoil at Borehole 2. The sands extend to depths of 0.9 m to 1.4 m (El. 463.2 m to 464.4 m). Based on grain size analyses (3 tests) completed on select samples, this material consists of 0 to 6 % gravel, 54 to 87 % sand and 7 to 46 % silt/clay sized particles. The condition of this material is loose to compact with SPT N values ranging from 5 to 12 blows / 0.3 m. This substratum is highly frost susceptible and capable of forming ice lenses and heaving upon freezing.

A 1.0 m thick lower layer of silty sand with some gravel was encountered within the varved clay substratum in Borehole 3 at a depth of 8.7 m (El. 456.9 m) and extended to a depth of 9.7 m (El. 455.9 m). Based on grain size analysis (1 test) this material consists of 24 % gravel, 43 % sand

and 33 % silt/clay sized particles. The condition of this material is compact with an SPT N value of 13 blows / 0.3 m.

5.4 Silt Layers

Two silt layers were identified at Borehole 1: the first at a depth of 1.4 m (El. 463.2 m) extending to a depth of 2.2 m (El. 462.4 m), and the second at depth of 5.7 m (El. 458.9 m) extending to a depth of 7.2 m (El. 457.4 m). Atterberg limit testing indicates that this material is non plastic. The condition of this material is loose with SPT N values ranging from 5 to 6 blows / 0.3 m. This substratum is highly frost susceptible and capable of forming ice lenses and heaving upon freezing.

5.5 Clays

Two distinct clay substrata have been identified. The upper substratum consists of a massive silty clay overlies a lower varved clay substratum.

5.5.1 Silty Clay

An upper clay substratum of silty clay exists below a silt layer at Borehole 1 and below the upper sands at Boreholes 2 to 4. The silty clay starts at depth of 0.9 to 2.2 m (El. 462.4 m to 464.4 m) and extends to depths of 2.2 m to 7.1 m (El. 458.5 m to 462.9 m). Occasional sand seams within the clay were observed at some locations. The silty clay has a firm to stiff consistency with SPT N values ranging from 4 to 10 blows / 0.3 m. Field vanes varied from 38 to 75 kPa indicating the clay is firm to very stiff; however, field vanes may have intercepted sand seams which can inflate the test results. Two lab vanes carried out on select thin walled tube samples indicate shear strengths of 50 to 55 kPa indicating a firm to stiff consistency. Two Atterberg limit tests completed on selected samples indicate this material is silty clay with the natural moisture content exceeding the liquid limit.

A lower silty, sandy clay stratum with trace gravel was observed below a lower sand layer at Borehole 3 at a depth of 9.7 m (El. 455.9 m) and extended to the limits of the borehole at a depth of 10.3 m (El. 455.3 m). This lower silty clay layer has a firm consistency and has an SPT N value of 5 blows / 0.3 m.

5.5.2 Varved Clay

A substratum of varved clay was observed below the upper silty clay substratum starting at depth of 2.2 m to 7.1 m (El. 458.5 m to 462.9 m) and extends the limits Boreholes 1, 2, and 4 and to a depth of 8.7 m (El. 456.9 m) at Borehole 3. The varved clay has a layered structure with alternating layers varying in colour, plasticity, and silt content. The layers generally varied in thickness between 3-4 mm. The varved clay has a very soft to stiff consistency. SPT N values ranged from 1 to 7 blows / 0.3 m. Field vanes varied from 38 to 100+ kPa; however, field vanes may have intercepted silt varves which can inflate the test results.

Atterberg limit tests (two tests) carried out on samples with combined layers indicate that the combined material varies from silty clay to clay of low plasticity. The natural moisture contents are at or exceed the liquid limit.

5.6 Refusal

Auger refusal and/or bedrock was not encountered in any of the boreholes.

5.7 Groundwater

The groundwater levels were read upon completion of drilling and within temporary standpipe piezometers installed in each borehole. Measured groundwater levels have been provided below. Groundwater levels will vary from season to season and from the effects of heavy precipitation events.

Table 1: Groundwater levels

Location	Surface Elevation (m)	Groundwater Upon Completion of Drilling, Depth (m)	Groundwater Measured in Temporary Standpipes on October 6, 2020	
			Depth (m)	Days After Completion
BH-1	99.2	1.5	1.8	1
BH-2	99.7	5.7	2.5	1
BH-3	101.2	6.1	2.1	1
BH-4	99.8	5.8	1.6	1

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 Al Finke. Laboratory testing was supervised by Forch Valela, C.Tech. This report was prepared and reviewed by James Huber, E.I.T., Steven Seller, P.Eng. (TBTE designated principal contact identified for this MTO Foundation Engineering project) and Gordon Maki, P.Eng.

Part B - FOUNDATION DESIGN RECOMMENDATIONS

7 Introduction

TBT Engineering Limited (TBTE) has been retained by the Ministry of Transportation (MTO) – North West Region to provide foundation investigation and design services for the proposed new, year round, rest area washroom facility located at the existing Argon Park rest area on Highway 17, in the district of Thunder Bay. The site is located approximately 40 m South East of Upsala, ON along Highway 17 and is approximately 104 km North West of Thunder Bay. It is understood that the final building footprint has not been finalized, however, sizing provided by MTO show that the proposed new washroom building footprint may be constructed up to 7.5 m x 7.5 m (56.25 m^2).

The foundation investigations as described in Part A, were completed to investigate subsurface conditions at this site. Part A describes the subsurface conditions encountered during the investigation.

The generalized subsurface soils at this site consists of topsoil and/or fill overlying sands which are underlain by clays with occasional silt layers.

The purpose of this section of the report (Part B) is to provide foundation design recommendations for the proposed new structure. Bearing capacities have been prepared in terms of limit states design (ULS and SLS) and are based on the conditions encountered at the borehole locations, TBTE's interpretation of the subsurface conditions at the site, and an estimate of settlement of the subsurface soils. This report will also provide an assessment of frost depth and recommendations of perimeter foundations for heated structures and backfill requirements. Seismic site class have also been estimated in accordance with the Ontario Building code.

All design recommendations presented in this report assume that an adequate level of construction monitoring during excavation and construction will be provided. An adequate level of construction monitoring is examination of all excavation surfaces prior to fill and/or concrete placement to ensure the integrity of the subgrade. Full-time monitoring, materials testing, and compaction testing should be provided.

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

8 Shallow Foundations

Shallow foundations have been considered for the new washroom facility. A slab with conventional footings and/or a slab with thickened bearing areas founded on the native sand soils with and without a compacted granular pad have been considered.

8.1 Bearing Capacity

All foundation reactions and resistances provided are subject to the following conditions:

- The footings or bearing areas must have a minimum depth of cover (distance between the lowest adjacent grade to the underside of footing) of 0.4 m.
- For footings or bearing areas founded on native sand, any deleterious soils, topsoil, organic soil, existing fills, very loose sands, soft / weak soils, and slough/disturbed materials must be removed from below the proposed foundations to expose native loose to compact sand.
- For footings or bearing areas founded on compacted granular pad, any deleterious soils, topsoil, organic soil, existing fills, soft / weak soils, and slough/disturbed materials must be removed from below the proposed pad to expose native very loose to compact sand.
- Subgrade inspection will be required to ensure the subgrade is as expected based on the findings of this geotechnical investigation.
- Where the use of a granular pad is considered below the foundation, the pad must be constructed in accordance with the recommendations provided in Section 9.2.

Table 2: Factored Geotechnical Resistance and Reactions for Strip Footings

Effective Footing Size (m)	Founded on Native Sand		Founded on 0.5 m Thick Granular Pad on Native Sand	
	Factored Gross Geotechnical Resistance (ULS) (kPa)	Geotechnical Reaction (SLS) for 25 mm Settlement (kPa)	Factored Gross Geotechnical Resistance (ULS) (kPa)	Geotechnical Reaction (SLS) for 25 mm Settlement (kPa)
0.6	55	Exceeds ULS	90	90
0.9	60	50	100	60
1.2	70	40	115	50

Table 3: Factored Geotechnical Resistance and Reactions for Square Footings

Effective Footing Size (m)	Founded on Native Sand		Founded on 0.5 m Thick Granular Pad Over Native Sand	
	Factored Gross Geotechnical Resistance (ULS) (kPa)	Geotechnical Reaction (SLS) for 25 mm Settlement (kPa)	Factored Gross Geotechnical Resistance (ULS) (kPa)	Geotechnical Reaction (SLS) for 25 mm Settlement (kPa)
0.6 x 0.6	70	Exceeds ULS	110	Exceeds ULS
0.9 x 0.9	70	Exceeds ULS	115	Exceeds ULS
1.2 x 1.2	75	Exceeds ULS	125	125

If the provided resistances and/or reactions do not meet the structural requirements, alternative foundation configurations can be assessed (eg. thicker granular pads). The SLS reactions have been calculated based on estimated consolidation properties (based on correlations with index testing).

The above geotechnical resistances utilize a resistance factor of 0.5 in terms of Ultimate Limits States Design. The geotechnical reactions have been estimated based on a maximum of 25 mm of settlement due to foundation loading only. Should a raise in grade be considered, additional settlements may be realized (see Section 10). To avoid stress overlap and additional settlement from adjacent footings, footings should be separated with a clear spacing of at least one footing width.

8.2 Granular Pad

The granular pad should consist of Granular B; Type 1 (Ontario Provincial Standard Specifications, OPSS) compacted to at least 98% standard Proctor maximum dry density (SPMDD). The base of the compacted granular pad shall extend horizontally beyond the edge of the foundation by a minimum distance equal to the as built thickness of the pad bellow the underside of the foundation.

If construction conditions require working in the “wet”, the granular pad can be replaced with 19 mm clear stone fill (completely wrapped with a heavy non-woven geotextile). The 19 mm clear stone may be placed below the water level without compaction; however, the clear stone pad should be surface compacted (once above the water level) to tighten up the fill and minimize settlements. Once above the water level, compacted Granular B, Type 1 fill may be used over the clear stone; however, a non-woven geotextile filter must be used between the Granular B and clear stone.

9 Floor slab-on-grade

Any existing fills and/or organic soils must be removed from below the floor slab on grade to expose inorganic native soil. Granular materials directly below the slab should consist of 200 mm of Granular A, or Granular B Type I with 100 % passing the 25 mm screen. The fill shall be compacted to 98% of SPMDD. Requirements for a vapour barrier under the slab on grade should be coordinated with the flooring supplier.

10 Raise In Site Grade

Where a raise in grade is considered, settlements may be realized. A significant raise in grade can induce deep stresses that could impact the lower softer clays. Settlements of up to 15 mm have been estimated for a raise in grade of up to 0.3 m over an area of 10 m x 10 m.

11 Subgrade Preparation - General

In general, any existing fills and/or organic soils shall be removed from below the building footprint. At foundation areas, additional measures are required as identified in Section 9.1. Excavations are not anticipated to extend below the groundwater table (as identified during this investigation).

Foundation excavations and bearing surfaces should be protected from rain, freezing temperature, excessive drying or the ingress of groundwater before, during and after construction.

Should abandoned foundations and/or services are encountered during sub-grade preparation, these foundations, services, and associated fills must be removed from below the proposed building's footprint.

12 Frost Penetration and Protection Measures

12.1.1 Estimated Frost Penetration

Estimated frost penetration is based on Environment Canada's published weather data for Thunder Bay, ON. and the methodology prescribed by the Canadian Foundation Engineering Manual 4th Edition. Based on the subsurface soils known to exist on site, the estimated design depth of frost penetration is 2.5 m.

12.1.2 Frost Protection for Heated Structures

Shallow perimeter foundations of heated structures require synthetic insulation for protection from frost heave. Where the minimum interior temperature of the structure will be 18 degrees Celsius, a layer of horizontal rigid extruded polystyrene insulation 50 mm thick will be required extending at least 1.2 m beyond edge of footing. Where the minimum interior temperature of the structure will be 7 degrees Celsius, a layer of horizontal rigid extruded polystyrene insulation 75 mm thick will be required extending at least 2.4 m beyond the edge of footing. The thickness of the insulation should be doubled within 1.2 m or 2.4 m of outside corners for minimum interior building temperatures of 18 and 7 degrees Celsius, respectively. The insulation should be continuous and extend up the full distance of the foundation wall to the perimeter wall to prevent thermal “short circuits”. The insulation should be provided with physical protection as per the manufacturer’s recommendations. The above recommendations assume the slab-on-grade is not insulated so as to restrict heat flow to the perimeter foundations.

To limit the effects of frost jacking, the perimeter foundation excavations should extend at least 0.5 m from the edge of foundation and have side slopes no steeper than 1H:1V. The excavation should be backfilled with a non-frost susceptible, free draining fill such as Granular “B” Type 1 (OPSS). The backfill should be capped with a less permeable soil and surface grade provided to shed runoff before it enters the backfill.

13 Seismic Site Classification

The site classification for seismic site response has been determined to be Site Class E, in accordance with the 2012 Ontario Building Code.

14 Potential Construction Issues

No major construction difficulties are foreseen at this site. Issues which may require consideration include the following:

- Removal of trees and brush surrounding the subject site should be carried out prior to construction.
- Existing privy to be removed, with any existing foundations and services.
- Where compact silt and sand subgrade is present together with a high groundwater level, the subgrade may be subject to “pumping” conditions during

compaction. Should “pumping” conditions occur, compaction efforts should cease until the “pumping” conditions subside, as further compaction may aggravate the condition. Delays of several hours to a few days may be required for the first few lifts.

- Should a high groundwater table be present during excavations, dewatering will be required to facilitate placement and compaction of fill in dry conditions.

15 Limitations

Conclusions and recommendations presented in this report are based on the information determined at a limited number of test hole 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.

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.

16 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

James Huber, EIT.
Project Manager

Gordon Maki, P.Eng
Vice President of Engineering

Steven Seller, 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^2)
T W	Thin Wall Shellby Tube		

EXPLANATION OF TERMS Cont'd.

Stress and Strain

u_w	kPa	Pore Water Pressure
$_u$		Pore Pressure Ratio
σ	kPa	Total Normal Stress
σ'	kPa	Effective Normal Stress
τ	kPa	Shear Stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal Stress
ε	%	Linear Strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal Strains
E	MPa	Young's Modulus
G	kPa	Modulus of Shear Deformation
m	MPa	Constrained Modulus
μ		Coefficient of Friction

Mechanical Properties of Soil

m_v	kPa^{-1}	Coefficient of Volume Change
C_c		Compression Index
C_s		Swelling Index
C_a		Rate of Secondary Consolidation
c_v	m^2/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
τ_f	kPa	Shear Strength
c'	kPa	Effective Cohesion Intercept
ϕ'	°	Effective Angle of Internal Friction
c_u	kPa	Undrainded Shear Strength
s		Sensitivity

Physical Properties of Soil

ρ_s	kg/m^3	Density of Solid Particles	e	%	Void Ratio	e_{min}	%	Void Ratio in Densest State
γ_s	kN/m^3	Unit Weight of Solid Particles	n	%	Porosity	I_D		Density Index $= \frac{e_{max}-e}{e_{max}-e_{min}}$
ρ_w	kg/m^3	Density of Water	w	%	Water Content	D	mm	Grain Diameter
γ_w	kN/m^3	Unit Weight of Water	s_r	%	Degree of Saturation	D_n	mm	n Percent Diameter
ρ	kg/m^3	Density of Soil	w_L	%	Liquid Limit	C_U		Uniformity Coefficient
γ	kN/m^3	Unit Weight of Soil	w_P	%	Plastic Limit	h	m	Hydraulic Head or Potential
ρ_d	kg/m^3	Density of Dry Soil	w_S	%	Shrinkage Limit	q	$m\ ^3/_5$	Rate of Discharge
γ_d	kN/m^3	Unit Weight of Dry Soil	I_P	%	Plasticity Index $= w_L - w_P$	v	m/s	Discharge Velocity
ρ_{sat}	kg/m^3	Density of Saturated Soil	I_L		Liquidity Index $= \frac{w-w_P}{I_P}$	i		Hydraulic Gradient
γ_{sat}	kN/m^3	Unit Weight of Saturated Soil	I_C		Consistency Index $= \frac{w_L-w}{I_P}$	k	m/s	Hydraulic Conductivity
ρ'	kg/m^3	Density of Submerged Soil	e_{max}	%	Void Ratio in Loosest State	j	kN/m^3	Seepage Force
γ'	kN/m^3	Unit Weight of Submerged Soil						

RECORD OF BOREHOLE No 1

METRIC

W.P. 6019-E-0042 LOCATION N:5418221.095; E:302672.813 MTM Zone:15 ORIGINATED BY AF

DIST NWR HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TG

DATUM Geodetic DATE 2020.10.03 LATITUDE 48.9022856 LONGITUDE -90.0290143 CHECKED BY SS

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
464.6 / 0.0	FILL - SAND & GRAVEL - - - - - - SAND - Silty, some gravel, brown	1 2	AS AS		Water level @ 1.5 m on completion. Cave @ 6.5 m. 3 81 16
463.8 / 0.8	SAND - some silt, trace gravel, grey, loose	3	SS	5	Water level @ 1.8 m on October 06, 2020.
463.2 / 1.4	SILT - layered, trace sand, grey, loose	4	SS	6	Non Plastic.
462.4 / 2.2	CLAY - Silty, grey, stiff	5	SS	9	
461.6 / 3.0	CLAY - varved, grey/brown, firm to stiff	6 7	SS TW	6	Standpipe installed to 2.9 m. No Recover on TW. Took SS.
458.9 / 5.7	SILT - grey, loose	8	SS	5	Non Plastic.
457.4 / 7.2	CLAY - varved, occasional silt seam, grey/brown, very soft to stiff	9 10	SS SS	1 1	
454.6 / 10.0	End of Borehole @ 10.0 m.				

Column headings: SOIL PROFILE (ELEV, DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE (464–455); DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L, WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL.

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE PP=Pocket Penetrometer (Kg/cm²)

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 2

METRIC

W.P.	6019-E-0042	LOCATION	N:5418210.38; E:302653.959 MTM Zone:15	ORIGINATED BY	AF
DIST	NWR HWY 17	BOREHOLE TYPE	Hollow Stem Auger	COMPILED BY	TG
DATUM	Geodetic	DATE	2020.10.05 LATITUDE 48.9022035 LONGITUDE -90.0293194	CHECKED BY	SS

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS
465.1					
465.0 / 0.1	TOPSOIL - 50 mm, Sandy SAND - Silty, brown, compact	1	AS		Water level @ 5.7 m on completion. Water level @ 2.5 m on October 06, 2020. Cave @ 5.9 m.
		2	SS	12	
463.7 / 1.4	CLAY - Silty, grey, firm	3	SS	6	
462.9 / 2.2	CLAY - varved, light/dark grey seams 3 - 4 mm, soft to stiff	4	TW		PP = 2.5
		5	SS	5	
		6	SS	2	
		7	SS	4	
458.1 / 7.0	End of Borehole @ 7.0 m.				

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (465, 464, 463, 462, 461, 460, 459); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L, WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+³, ×³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE PP=Pocket Penetrometer (Kg/cm²)

ONTARIO MTO MOD 20-108-6 MTO UPSALA.GPJ ONTARIO MTO.GDT 10-28-20

RECORD OF BOREHOLE No 3

METRIC

W.P. 6019-E-0042	LOCATION N:5418229.012; E:302635.055 MTM Zone:15		ORIGINATED BY AF
DIST NWR HWY 17	BOREHOLE TYPE Hollow Stem Auger		COMPILED BY TG
DATUM Geodetic	DATE 2020.10.05	LATITUDE 48.9023436 LONGITUDE -90.0295158	CHECKED BY SS

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
465.6	
465.5 / 0.1	TOPSOIL - 50 mm
465.3	FILL - SAND - trace silt, brown
0.3	SAND & SILT - brown, loose
464.2 / 1.4	CLAY - Silty, grey, firm to stiff
	- - - - - - occasional sand seam
458.5 / 7.1	CLAY - varved, light/dark grey, very soft to firm
456.9 / 8.7	SAND - Silty, some gravel, grey, compact
455.9 / 9.7	CLAY - Silty, Sandy, trace gravel, grey, firm
455.3 / 10.3	End of Borehole @ 10.3 m.

SAMPLES

NUMBER	TYPE	"N" VALUES
1	AS	
2	SS	9
3	SS	7
4	SS	10
5	TW	
6	SS	4
7	TW	
8	SS	1
9	SS	13
10	SS	5

GROUND WATER CONDITIONS | ELEVATION SCALE: 465, 464, 463, 462, 461, 460, 459, 458, 457, 456

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Water level @ 6.1 m on completion. Cave @ 6.5 m.

0 54 46

Water level @ 2.1 m on October 06, 2020.

Standpipe installed to 2.9 m. PP = 3.5

No Recovery, took SS.

24 43 33

+³, ×³: Numbers refer to Sensitivity

○³% STRAIN AT FAILURE

PP=Pocket Penetrometer (Kg/cm²)

RECORD OF BOREHOLE No 4

METRIC

W.P. 6019-E-0042 LOCATION N:5418251.421; E:302642.044 MTM Zone:15 ORIGINATED BY AF

DIST NWR HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY TG

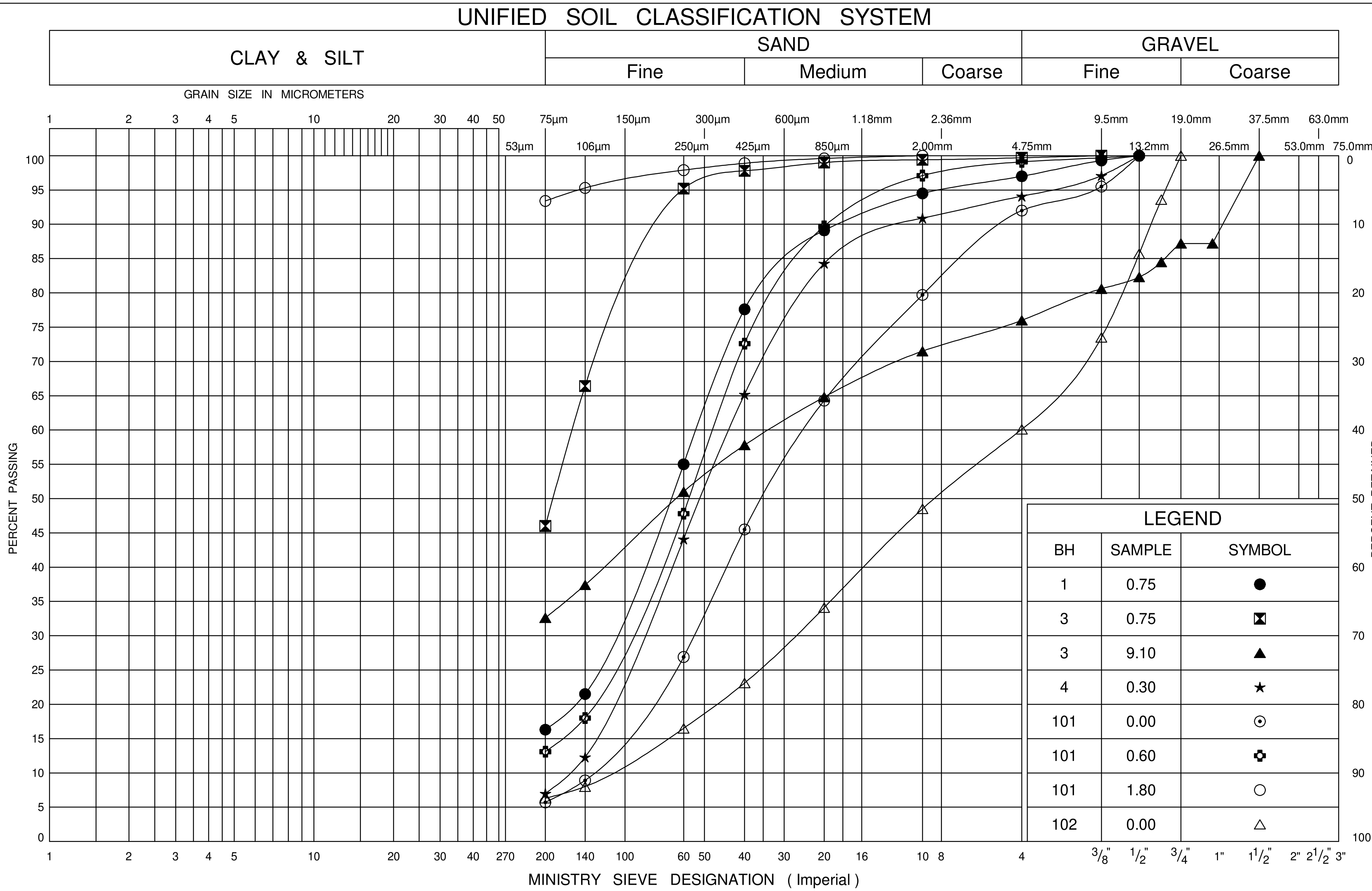
DATUM Geodetic DATE 2020.10.05 LATITUDE 48.9025474 LONGITUDE -90.0293946 CHECKED BY SS

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
465.3					
465.2 / 0.1	TOPSOIL - 50 mm				
465.1 / 0.2	FILL - SAND & GRAVEL	1	AS		
	SAND - trace silt, trace gravel, brown	2	AS		6 87 7
					Water level @ 5.8 m on completion. Water level @ 1.6 m on October 06, 2020. Cave @ 6.0 m.
464.4 / 0.9	CLAY - Silty, grey, firm to stiff	3	SS	8	
		4	TW		PP = 3.75
		5	SS	10	
462.4 / 2.9	CLAY - varved, grey/brown, soft to firm				Standpipe installed to 2.9 m.
		6	SS	7	
		7	TW		No Recovery, took SS.
	- - - - - - grey/brown	8	SS	3	
458.3 / 7.0	End of Borehole @ 7.0 m.				

Column headings: STRAT PLOT; GROUND WATER CONDITIONS; ELEVATION SCALE (465, 464, 463, 462, 461, 460, 459); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L, WATER CONTENT (%) (20, 40, 60); UNIT WEIGHT γ kN/m³.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE PP=Pocket Penetrometer (Kg/cm²)

APPENDIX B
Laboratory Test Data



Ministry of Transportation Ontario

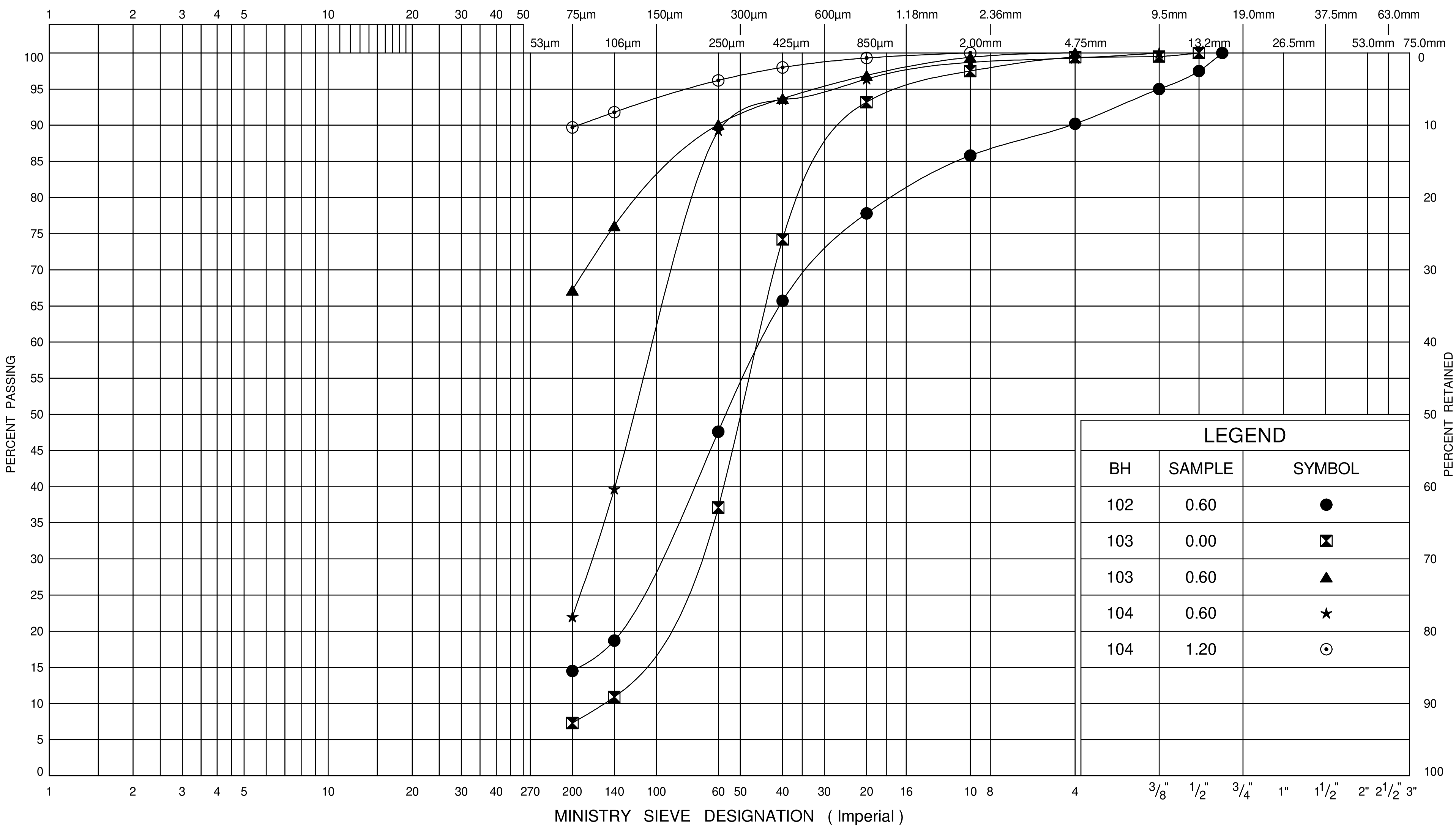
GRAIN SIZE DISTRIBUTION
TILLS

FIG No 1

W P 6019-E-0042

Argon Park

78 12 M



BH	SAMPLE	SYMBOL
102	0.60	●
103	0.00	⊠
103	0.60	▲
104	0.60	★
104	1.20	⊙

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
TILLS

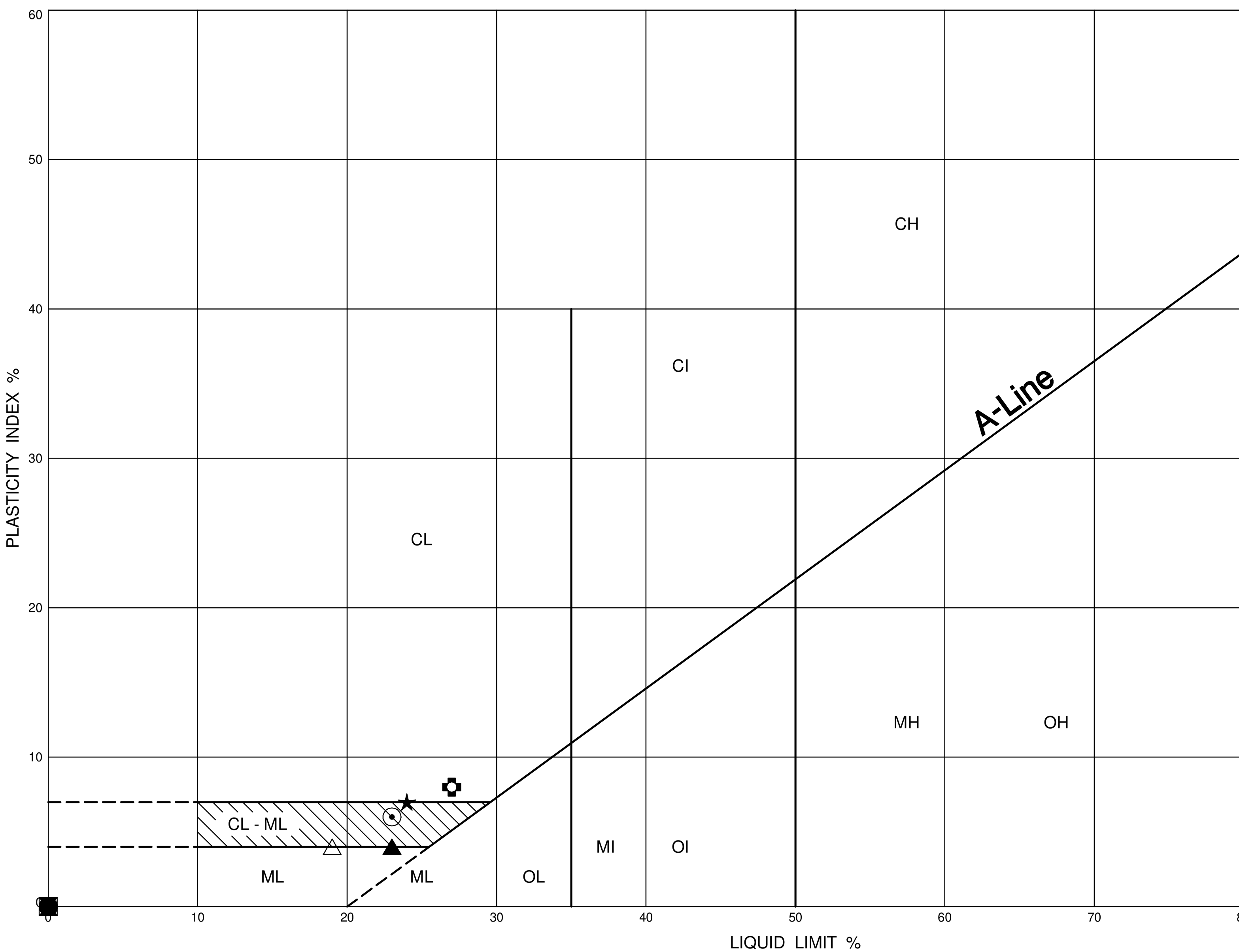
FIG No 2

W P 6019-E-0042

Argon Park

ONTARIO MOT GRAIN SIZE 20-108-6 MTO UPSALA.GPJ ONTARIO MOT.GDT 10-28-20

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
1	1.50	●
1	6.10	⧗
2	2.30	▲
2	4.60	★
3	3.00	⊙
4	1.50	✿
101	1.80	○
103	0.60	△

Ministry of Transportation
Ontario

PLASTICITY CHART

.

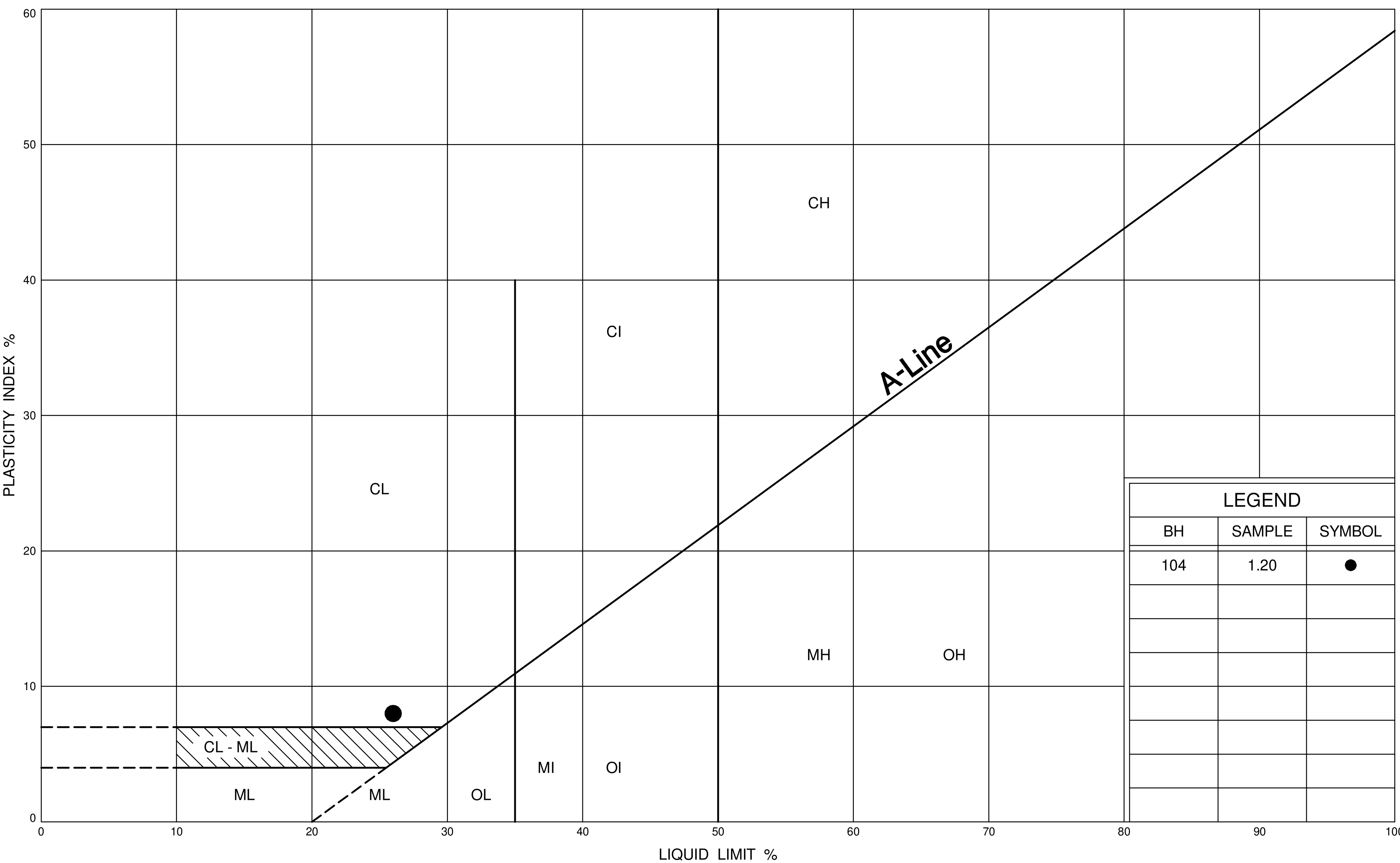
FIG No 3

W P 6019-E-0042

Argon Park

ONTARIO MOT PLASTICITY CHART 20-108-6 MTO UPSALA.GPJ ONTARIO MOT.GDT 10-28-20

Oct 75, FF - S - 21



LEGEND

BH	SAMPLE	SYMBOL
104	1.20	●

Ministry of Transportation
Ontario

PLASTICITY CHART

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FIG No 4	
W P	6019-E-0042
Argon Park	

APPENDIX C
Borehole Locations and Soil Strata Drawing

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

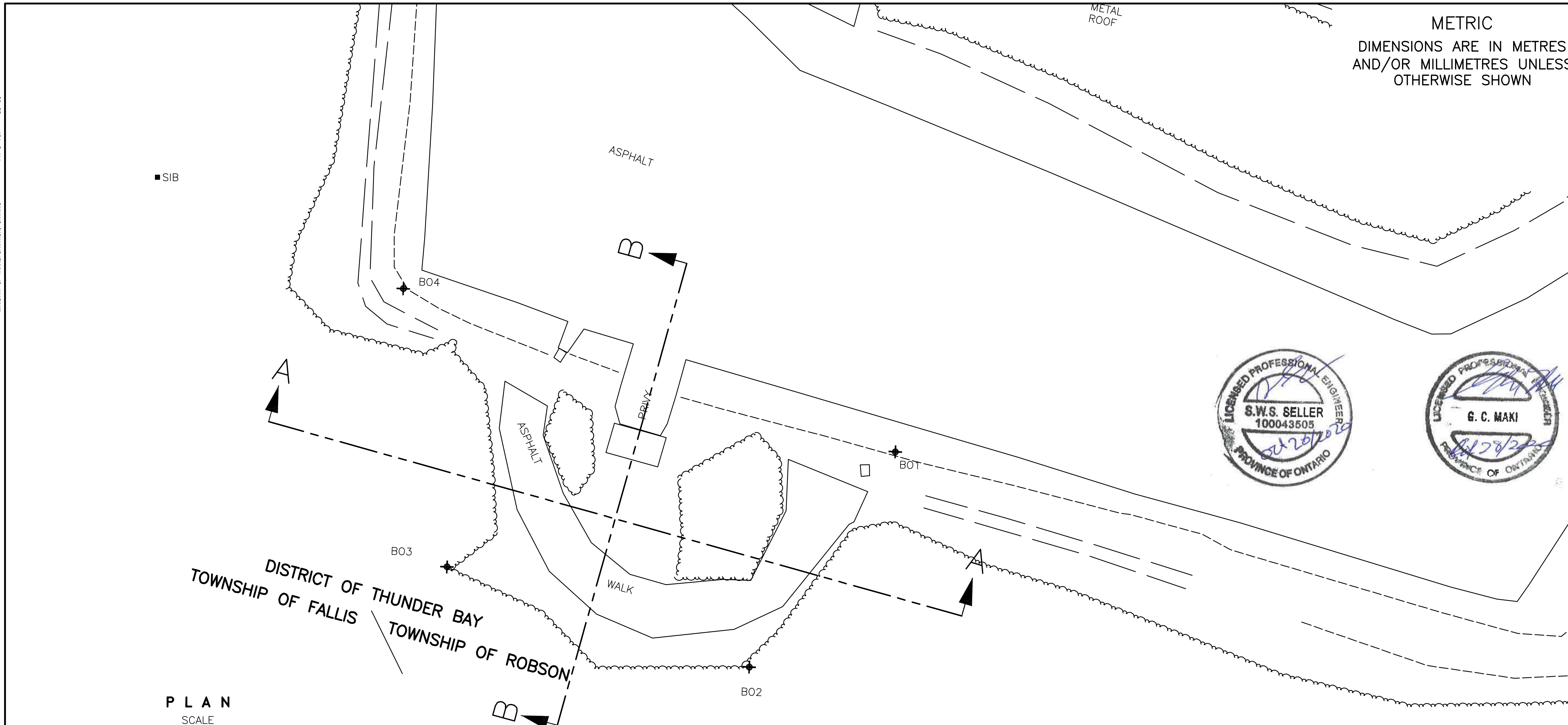
GEOCRES	No. XXX–XXX
CONT	No. 201x–xx
WP	No. 6019–E–0042

ARGON PARK REST AREA
FOUNDATION INVESTIGATION
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Ontario — Ministry of Transportation, Northwestern Region

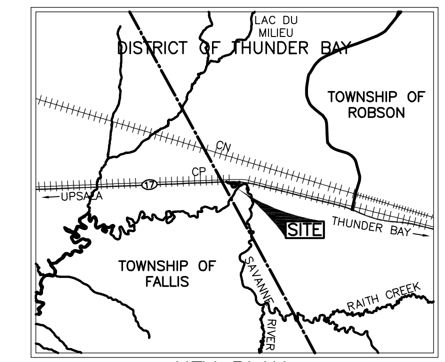
TBT ENGINEERING CONSULTING GROUP



PLAN

SCALE

10 0 10 m



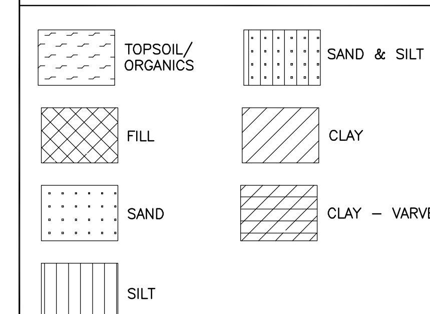
KEY PLAN

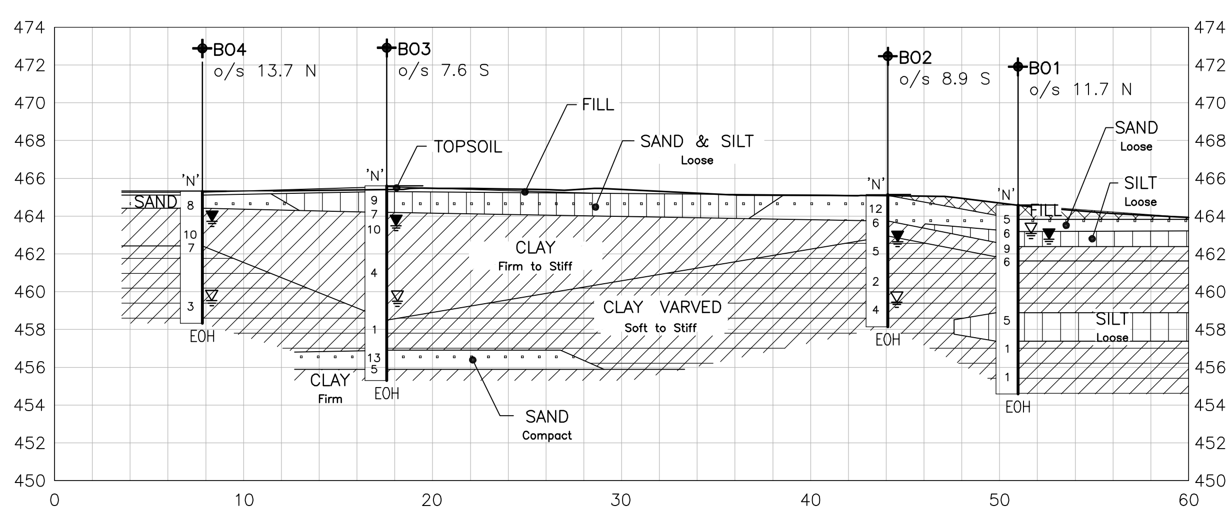
2.0 km 0 2.0 km

LEGEND

Symbol	Meaning
✦	Borehole
'N'	Std Pen Test (Blows/0.3m)
▼	Water Level
▽	Water Level on Completion
EOH	End of Hole

No	ELEVATION	CO–ORDINATES (MTM) NORTH	EAST
B01	464.6	15 5 418 221	302 673
B02	465.1	15 5 418 210	302 654
B03	465.6	15 5 418 229	302 635
B04	465.3	15 5 418 251	302 642

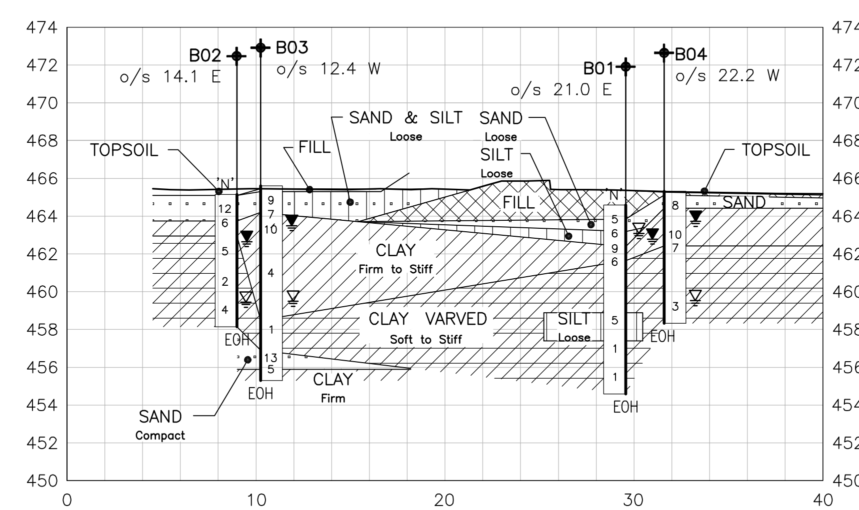




SECTION A – A

SCALE

10 0 10 m



SECTION B – B

SCALE

10 0 10 m

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

REVISIONS		
28/10/20	BY	ISSUED FOR REVIEW
DATE	BY	DESCRIPTION

DESIGN		CHK		CODE XXXXX–XX	LOAD XX–XXX–XXX	DATE 28/10/20	
DRAWN	TB	CHK	SS	SITE XXX–XXX		DWG	1