Foundation Investigation and Design Report

Breakaway Sign Support Structures

Highway 401 Improvements from 0.6 km East of Essex Road 42 to 1.5 km West of Merlin Road, Tilbury

MTO DB 2020-3011, West Region

Submitted to:

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FOUNDATION INVESTIGATION REPORT
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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Dillon Consulting Limited (Dillon) on behalf of Coco Paving (Coco) to provide detailed foundation engineering services as part of the Design-Build (DB) project for the Highway 401 improvements from 0.6 kilometres (km) east of Essex Road 42 easterly about 11.2 km to 1.5 km west of Merlin Road. As part of DB 2020-3011, Highway 401 will be widened from four to six lanes with the new lanes constructed towards the median. This report specifically addresses two breakaway sign support structures that are to be located along the south side of the Highway 401 eastbound lanes at the following approximate locations:

- Station 16+987 (Township of Tilbury North)
- Station 10+650 (Township of Tilbury East)

The terms of reference for the scope of work are outlined in MTO's Request for Proposal and in Golder's proposal dated October 17, 2019. The work was carried out in accordance with our Quality Control Plan for Foundations Engineering dated November 2012.

2.0 SITE DESCRIPTION

2.1 General

The project is located, as shown on the Key Plan, Figure 1, approximately 1.3 km west of Tilbury, Ontario. The area of the site is generally flat and land use is primarily agricultural. In the vicinity of the proposed signs, Highway 401 has been constructed on embankment fill approaching the Queen Street overpass structure.

2.2 Site Geology

The site lies in the physiographic region of southern Ontario known as the St. Clair Clay Plains, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984[1]). Within this region, Essex County and the southwestern part of Kent County are normally discussed as a sub-region known as the Essex Clay Plain. The clay plain was deposited during the retreat of ice sheets (late Pleistocene Era) when a series of glacial lakes inundated the area. In general, the ice sheets deposited materials with a glacial-till-like gradation in the Essex County area. Depending on the locations of the glacial ice sheets and depths of water in the ice-contact glacial lakes, the materials may have been directly deposited at the contact between the ice sheet and the bedrock or, as the lake levels rose and the ice sheets retreated and floated, the soil and rock debris within and at the base of the ice were deposited through the lake water (glaciolacustrine depositional environment). The term "glacial till", in its common usage, often indicates a very dense or hard composition resulting from consolidation and densification under the weight of the ice sheet and the mineral soil particles typically have a distribution of grain sizes ranging from cobbles to clay. In many areas of Essex County, however, the majority of the soils described as "glacial till" were deposited through water and have a soft to firm consistency below an upper "crust" that has since become stiff to hard through weathering and desiccation. The bedrock is reportedly about at about elevation 135 to 140

[1] Chapman, L.J. and Putnam, D.F., 1984, *The Physiography of Southern Ontario*, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.

m, or about 35 to 40 below the ground surface[2], and is described as limestone, dolostone and shale belonging to the Dundee formation of the Hamilton group[3].

3.0 INVESTIGATION PROCEDURES

The field work was carried out on August 16 and September 14, 2021 at which time two boreholes, identified as BH-101 and BH-110, were drilled to provide coverage for the proposed breakaway signs, in conjunction with the geotechnical investigation for the proposed noise barrier wall in this same area. The Record of Borehole sheets are attached to this report and the results of laboratory testing are provided in Appendix A.

The approximate locations of the boreholes are shown on the Borehole Location Plan, Drawing 1. It is noted that these boreholes were drilled along the Highway 401 eastbound median shoulder, based on lane restrictions in place for construction operations at the time of the investigation. The table below summarizes the approximate borehole location coordinates, ground surface elevations at the borehole locations and borehole depths.

Borehole	Approximate Location				Ground Surface Elevation (m)	Depth (m)
	Northing (m)	Easting (m)	Latitude (°)	Longitude (°)		
BH-101	4,681,073.7	309,973.7	42.269221	-82.437287	178.2	10.5
BH-110	4,681,300.4	310,944.0	42.271255	-82.425522	178.2	11.1

The field work was carried out using track-mounted drilling equipment supplied and operated by a specialist drilling contractor. In the boreholes, samples of the overburden were obtained at generally 0.76 m intervals of depth using 50 millimetre (mm) outside diameter split spoon sampling equipment in accordance with ASTM D1586 using an automatic hammer. The results of the Standard Penetration Testing (SPT), as presented on the Record of Borehole sheets and in Section 4, are unmodified (not standardized for hammer efficiency, borehole diameter, rod length, etc.).

The samplers limit the maximum particle size that can be sampled and tested to about 40 mm. Therefore, particles that may exist within the soils that are larger than this dimension will not be sampled or represented in the grain size distributions. Larger particle sizes, including cobbles and boulders, are known to be present in the native soils, as discussed in the text of this report.

The boreholes were terminated about 10.5 m and 11.1 m below the existing ground surface. Groundwater conditions in the boreholes were observed throughout the drilling operations. Upon completion of drilling and sampling, the boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 903 (as amended).

The field work was monitored on a full-time basis by Golder staff who also located the boreholes in the field, monitored the drilling, sampling and in situ testing operations and logged the boreholes. The samples were

[2] Sado, E.V. and Fought, R.B., 1981, *Bedrock Topography of the Chatham Area, Southern Ontario*, Ontario Geological Survey Preliminary Map P.2436, Bedrock Topography Series, Scale 1:50,000

[3] Ontario Geological Survey, 1991, *Bedrock Geology of Ontario, Southern Sheet,* Ontario Geological Survey, Map 2544, Scale 1:1,000,000.

identified in the field, placed in labelled containers and transported to Golder's London laboratory for further examination and testing. Index and classification tests, consisting of water content determinations, grain size distribution analyses and Atterberg limits determinations, were carried out on selected soil samples. The results of the testing are shown on the Record of Borehole sheets and in Appendix A.

4.0 SUBSURFACE CONDITIONS

4.1 General

Detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the geotechnical laboratory testing carried out on selected samples, are presented on the borehole records (provided in Appendix A) and Drawing 1. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous samples and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

Groundwater levels/conditions encountered in the boreholes during and shortly after drilling may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized. Groundwater levels and seepage conditions in the area will fluctuate seasonally and in response to precipitation events.

In general, the subsurface conditions encountered in the boreholes consist of fill materials overlying a deposit of silty clay to clayey silt till. These ground conditions are described in additional detail below.

4.2 Soil Conditions

4.2.1 Fill

Granular fill materials associated with the existing pavement were encountered to about 0.8 m depth in BH 101 and BH 110, corresponding to Elevation 177.4 m. The compact to very dense granular fill materials had a Standard Penetration Test (SPT) N value of 15 blows per 0.3 m of penetration in BH 101, and SPT N values ranging from 10 to 86 blows per 0.3 m of penetration for other boreholes drilled for the proposed noise barrier wall (reported under separate cover). Samples of the granular fill had water contents ranging from about 8 to 9 per cent in other boreholes drilled in this area for the proposed noise barrier wall.

Silty clay fill materials were encountered beneath the granular materials, with the cohesive fill surface at Elevation 177.4 m and extending to about Elevation 175.2 m to 175.9 m. The stiff clayey fill had SPT N values of 9 to 11 blows per 0.3 m of penetration in these two boreholes. Samples of the clayey fill had water contents that ranged from about 14 to 21 per cent. Atterberg limits tests were not completed on samples from BH 101 and 110, but were completed on samples from other boreholes for the proposed noise barrier walls in this area and indicated plastic limits of about 18 to 20 per cent and liquid limits of about 37 to 48 per cent. Grain size distribution curves for samples of the clayey fill are shown on Figure A-1 in Appendix A.

4.2.2 Silty Clay to Clayey Silt Till

Beneath the fill in the above-noted boreholes, silty clay to clayey silt till was encountered with the till surface at about Elevation 175.2 m to 175.9 m. Both boreholes were terminated in the silty clay to clayey silt till at elevations of 167.1 m to 167.7 m. The clayey silt to silty clay till had Standard Penetration Test (SPT) N values ranging from 1 to 19 blows per 0.3 m of penetration. Field vane shear tests attempted in the softer zones of the silty clay to clayey silt till indicated undrained shear strengths ranging from about 65 kPa to 85 kPa. Samples of the silty clay to clayey silt till had water contents that ranged from about 14 to 23 per cent. Atterberg limits determinations completed on three samples of the silty clay to clayey silt till from these two boreholes indicated plastic limits of about 15 to 18 per cent and liquid limits of about 34 to 36 per cent. These data are shown on the Plasticity Chart on Figure A-2 in Appendix A. Grain size distribution curves for samples of the silty clay to clayey silt till are shown on Figure A-3 in Appendix A.

Although not explicitly encountered during the investigation, cobbles and boulders should be expected in the glacial till strata.

4.3 Groundwater Conditions

Both boreholes remained free of observable water during drilling in August and September 2021. These are not considered to represent long-term, stabilized groundwater levels. The long-term groundwater level is inferred to be between about elevation 175 and 176 m.

5.0 CLOSURE

This report was prepared by Michael E. Beadle, P.Eng., an Associate with Golder Associates. An independent quality review of this report was carried out by Lisa C. Coyne, P.Eng., the Designated MTO Foundations Contact and Quality Control Auditor for this assignment.

Golder Associates Ltd.

Michael E. Beadle, P. Eng.
Associate

Lisa C. Coyne, P. Eng.
Principal, Designated MTO Foundations Contact

MEB/LCC/cr

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https://golderassociates.sharepoint.com/sites/124899/project files/6 deliverables/ph 1000-fdn/rpts/r06-rev0 ground mounted signs/20141385-1000-r06-rev0 (final) fidr breakaway signs_02nov2021.docx

PART B

FOUNDATION DESIGN REPORT
Breakaway Sign Support Structures
Highway 401 Improvements from 0.6 km East of Essex Road 42 to 1.5 km West of Merlin Road, Tilbury
MTO DB 2020-3011, West Region

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides our geotechnical recommendations for the ground-mounted steel column breakaway sign supports. The recommendations are based on our interpretation of the factual information obtained during the current investigation at this site. This Foundation Investigation and Design Report, with the interpretation and recommendations, is intended for the use of the design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of factual information provided as it may affect equipment section, proposed construction methods and scheduling.

6.2 Sign Foundations

Foundations for ground-mounted, steel column breakaway signs are typically designed with a “standard” foundation design consisting of 1,600 mm to 2,800 mm deep, 450 mm diameter holes into which the steel columns are placed and backfilled, in accordance with the requirements in Section 5 of MTO’s Sign Support Manual (2015). Typical details are provided on Standard Drawing SS118-30. It is noted that the 2019 Sign Support Manual no longer addresses such ground-mounted signs, and hence reference is still made to the 2015 Manual in accordance with current foundation engineering practice.

Per Section 5.1.5 (Footings) of the 2015 Sign Support Manual, the indicated footing depths on Figure 5.4.3 of the Manual are based on a minimum passive earth pressure of 68 kPa at Serviceability Limit States which is derived from the modified Brom’s equation based on a cohesive soil with an undrained shear strength of 50 kPa. Based on the encountered soil conditions in the boreholes, the minimum passive earth pressure condition and minimum undrained shear strength criterion are satisfied, and the foundation depths given in Section 5.4.3 of the Manual are appropriate; foundation depths of 2,100 mm and 2,400 mm are applicable for the signs at Stations 10+650 and 16+987, and no site-specific foundation design is required for these signs.

6.3 Construction Considerations

The final grade surrounding the sign support should be shaped to promote drainage of surface water away from the sign foundation. For the sign support at Station 16+987, it is understood that regrading is required to satisfy the geometric constraints of the Sign Support Manual; such regrading may consist of earth fill or granular fill, placed and compacted to a minimum of 95% of the material’s Standard Proctor maximum dry density.

As indicated in Part A of this report, while not explicitly encountered during the investigation, cobbles and boulders should be expected in the silty clay to clayey silt till strata and the contractor should be prepared to address their presence, if required.

7.0 CLOSURE

This report was prepared by Michael E. Beadle, P.Eng., an Associate with Golder Associates. An independent quality review of this report was carried out by Lisa C. Coyne, P.Eng., the Designated MTO Foundations Contact and Quality Control Auditor for this assignment.

Golder Associates Ltd.

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https://golderassociates.sharepoint.com/sites/124899/project files/6 deliverables/ph 1000-fdn/rpts/r06-rev0 ground mounted signs/20141385-1000-r06-rev0 (final) fidr breakaway signs_02nov2021.docx

MINISTRY OF TRANSPORTATION, ONTARIO

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

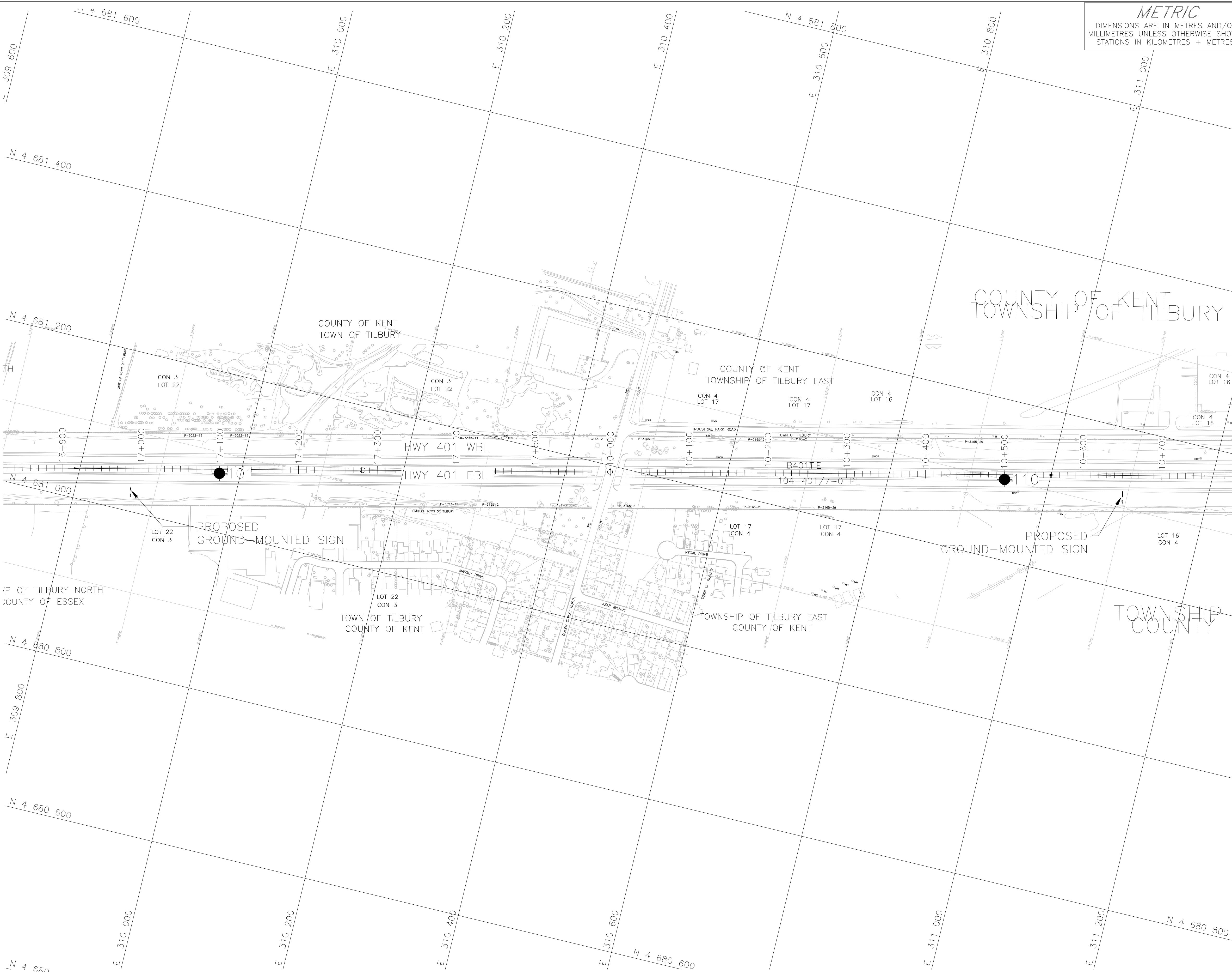
CONT No. DB 2020-3011
GWP No. 3034-19-01

SHEET

GROUND-MOUNTED SIGNS

BOREHOLE LOCATION PLAN

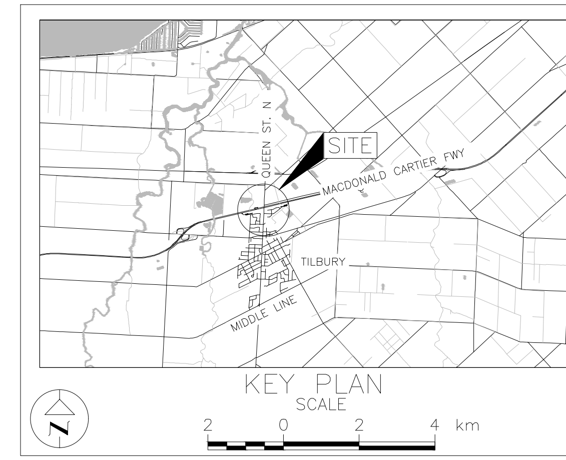
GOLDER
MEMBER OF WSP



PLAN

SCALE

50 0 50 100 m



KEY PLAN

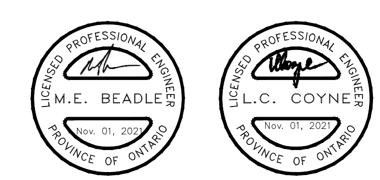
SCALE

2 0 2 4 km

LEGEND

● Borehole – Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
101	178.2	4681073.7	309973.7
110	178.2	4681300.4	310944.0



NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

REFERENCE

Base plans provided in digital format by Dillon Consulting, drawing file nos. B401TIN1.dwg and B401TIE1.dwg, received September 2021.
Alignment provided in digital format by Dillon, file no. Contract 2020-3011 – Alignment (Highway 401).xml, received October 1, 2021.
Proposed ground-mounted signs provided in digital format by Dillon, file no. DB 2020-3011 – Breakaway sign locations.dwg, received October 28, 2021.

NO.	DATE	BY	REVISION

Geocres No. 40J8-83

HWY. 401		PROJECT NO. 20141385	DIST.
SUBM'D. MD	CHKD. MEB	DATE: 11/1/2021	SITE:
DRAWN: SA	CHKD. MEB	APPD. LCC	DWG. 1

PLOT DATE: November 1, 2021
FILENAME: S:\Clients\MTO\Hwy_401_Essex_Rd_W\99_PROJ\20141385_Dillon\40_PROD\0002_Ground-Mounted_Signs\20141385-0002-BG-0001.dwg

APPENDIX A

Records of Boreholes and Laboratory Test Results

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS
MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS[1,2]

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (*i.e.,* SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (*i.e.,* some sand)
≤ 10	trace (*i.e.,* trace fines)

1. Only applicable to components not described by Primary Group Name.
2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve friction (f_s) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

COARSE-GRAINED SOILS

Compactness[1]

Term	SPT 'N' (blows/0.3m)[2]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

3. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.
4. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$ - u)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
U	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
E	void ratio
N	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength (ϕ = 0 analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes:
1. $\tau = c' + \sigma' \tan \phi'$
2. shear strength = (compressive strength)/2

GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No 101

SHEET 1 OF 1 **METRIC**

PROJECT 20141385
G.W.P. 3034-19-01 LOCATION N 4681073.7; E 309973.7 MTM NAD 83 ZONE 11 (LAT. 42.269221; LONG. -82.437287) ORIGINATED BY MD
DIST HWY 401 BOREHOLE TYPE COMPILED BY
DATUM Geodetic DATE August 16, 2021 CHECKED BY MEB

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
178.2	GROUND SURFACE							
0.0	SAND (SM) and gravel, some silt (FILL) Compact Brown		SS	15				
177.4 / 0.8	FILL - SILTY CLAY (CL-CI), some sand, trace topsoil Stiff Brown-grey	1	SS	9	1	12	40	47
		2	SS	11				
		3	SS	9				
175.2 / 3.1	SILTY CLAY (CL-CI), some sand, trace gravel Stiff to very stiff Brown turning grey at a depth of 6.1 m	4	SS	19	1	15	41	43
		5	SS	15				
		6	SS	13				
		7	SS	12	2	15	39	44
		8	SS	8				
		9	SS	9				
		10	SS	5				
		11	SS	3	0	17	40	43
		12	SS	6				
		13	SS	7				
167.7 / 10.5	END OF BOREHOLE							

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (178 to 168); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED; 20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (10, 20, 30); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GOLDER
MEMBER OF WSP

RECORD OF BOREHOLE No 110

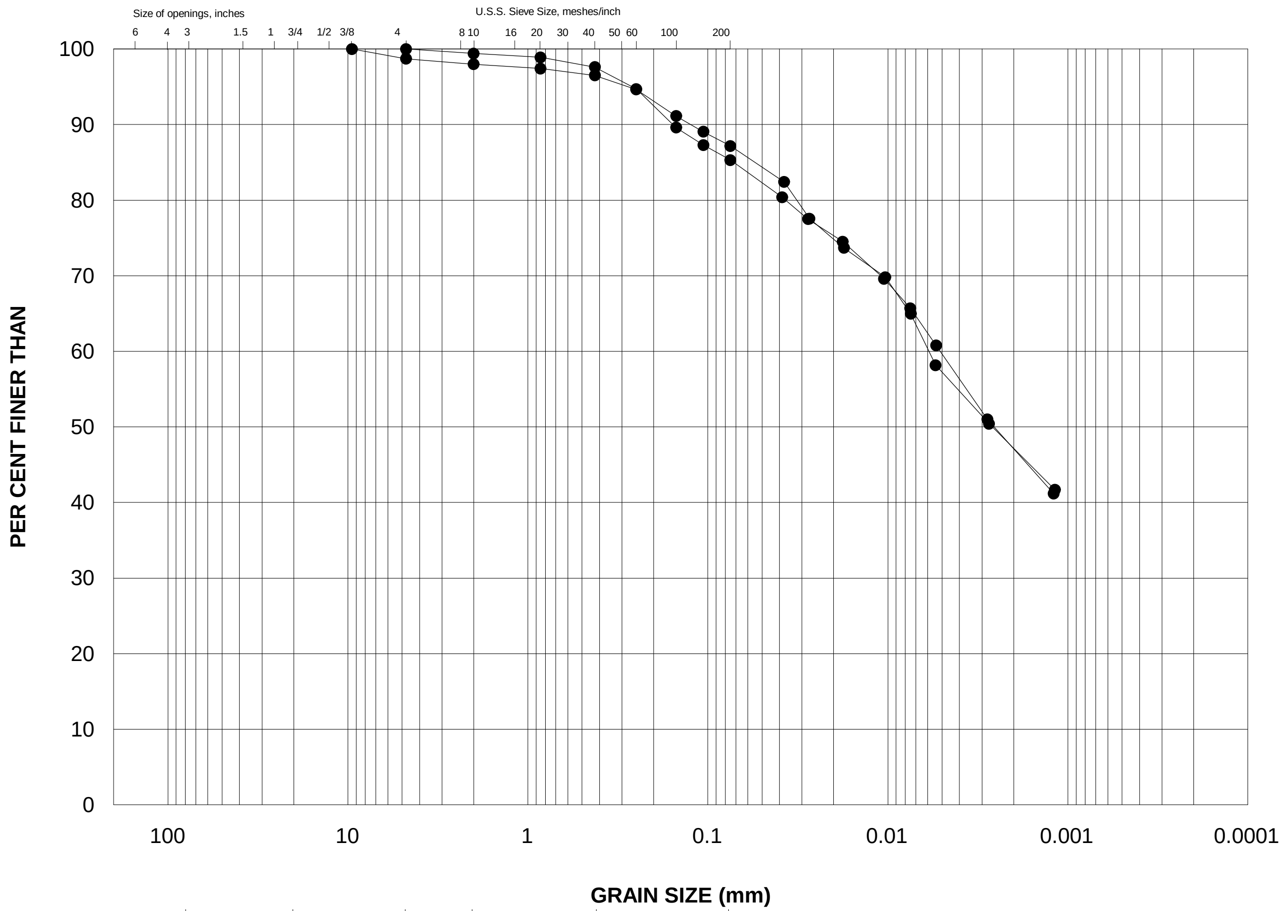
SHEET 1 OF 1 **METRIC**

PROJECT 20141385
G.W.P. 3034-19-01
LOCATION N 4681300.4; E 310944.0 MTM NAD 83 ZONE 11 (LAT. 42.271255; LONG. -82.425522)
ORIGINATED BY MD
DIST HWY 401
BOREHOLE TYPE
COMPILED BY
DATUM Geodetic
DATE September 14, 2021
CHECKED BY MEB

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	NATURAL MOISTURE CONTENT / LIMITS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
178.2	GROUND SURFACE					
0.0	SAND (SM) and gravel, some silt (FILL) Brown					
177.4 / 0.8	SILTY CLAY (CI), some sand, trace gravel, trace roots (FILL) Stiff Brown	1	SS	11		
		2	SS	9		0 15 38 47
175.9 / 2.3	SILTY CLAY (CL-CI), some sand, trace gravel Stiff to soft Brown turning grey at a depth of 3.8 m	3	SS	8		
		4	SS	14		
		5	SS	9	wP–w–wL	2 16 41 41
		6	SS	6		
		7	SS	4		
		8	SS	6		
		9	SS	4		
		10	SS	3	wP–w–wL	1 17 39 43
		11	SS	1		
		12	SS	2		
167.1 / 11.1	END OF BOREHOLE					

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (178–168); DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED, 20 40 60 80 100; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³.

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

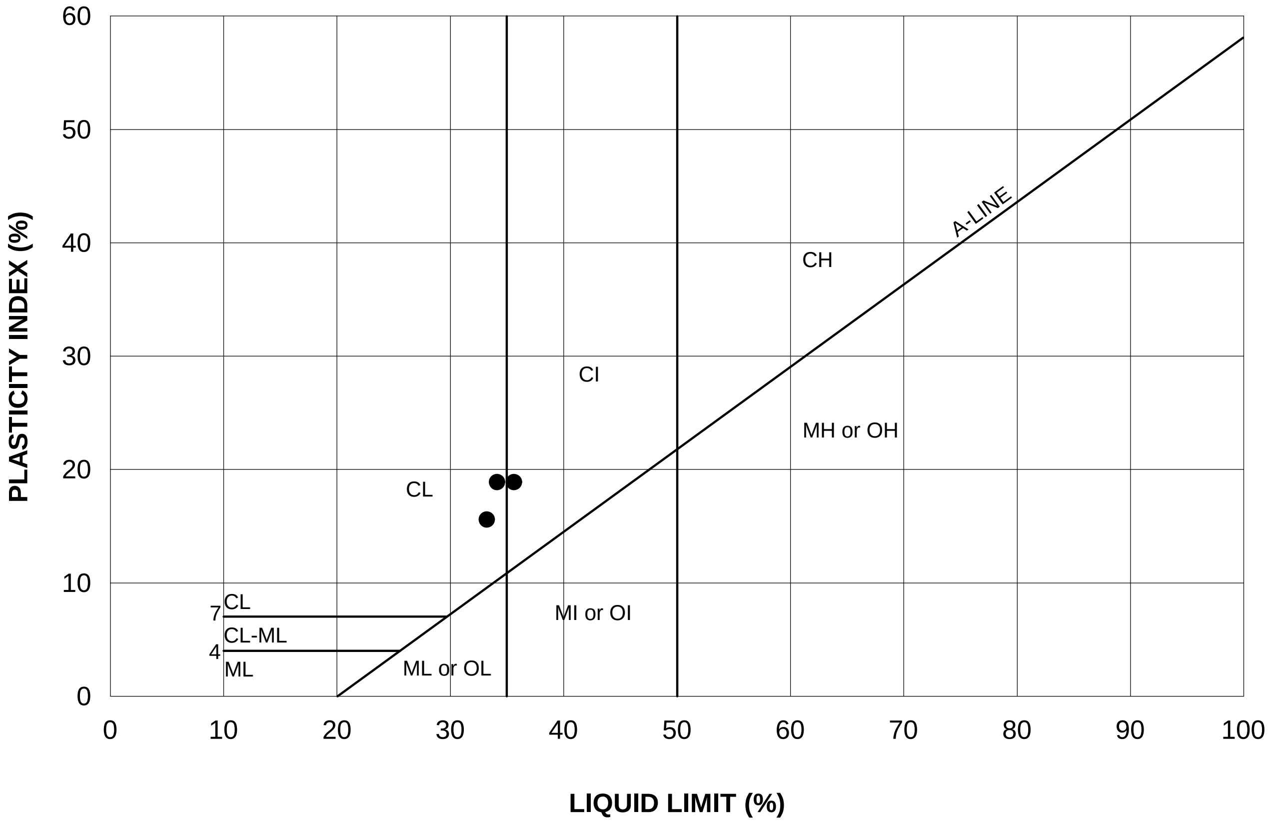
PROJECT

GROUND MOUNTED SIGNS
DB 2020-3011

TITLE

GRAIN SIZE DISTRIBUTION
CLAYEY FILL

GOLDER				
PROJECT No.		20141385	FILE No.	
			SCALE AS SHOWN	REV. 0
DRAWN	MEB	OCT 4/21	FIGURE A-1	
CHECK				



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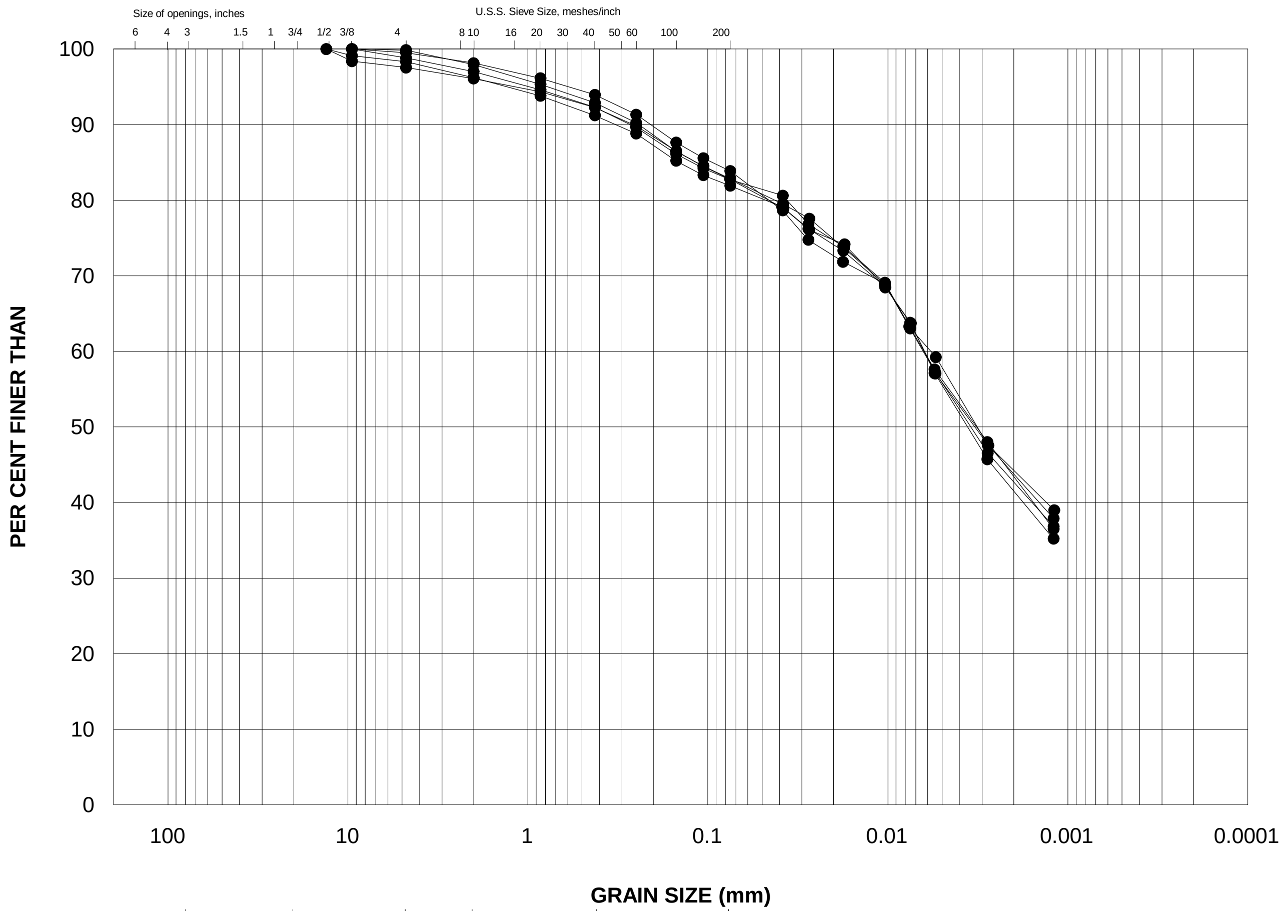
PROJECT GROUND MOUNTED SIGNS DB 2020-3011					
TITLE **PLASTICITY CHART** **SILTY CLAY TO CLAYEY SILT TILL**					
GOLDER	PROJECT No.		20141385	FILE No.	A-2
				SCALE AS SHOWN	REV. 0
	DRAWN	MEB	OCT 1/21	**FIGURE A-2**	
	CHECK				



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

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PROJECT

GROUND MOUNTED SIGNS
DB 2020-3011

TITLE

GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAYEY SILT TILL

GOLDER

PROJECT No.	20141385	**FILE No.**	
		SCALE AS SHOWN	**REV.** 0
DRAWN	MEB	OCT 4/21	**FIGURE A-3**
CHECK	[signature]		

GOLDER

MEMBER OF WSP

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