Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

DRAFT
GEOTECHNICAL REPORT
TESTON ROAD IMPROVEMENTS
250 M WEST OF PINE VALLEY DRIVE TO KLEINBURG SUMMIT WAY
CITY OF VAUGHAN, ONTARIO

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1.0 INTRODUCTION

Terraprobe has been retained by HDR Corporation (HDR), to provide geotechnical engineering services in support of the Municipal Class Environmental Assessment Study and preliminary designs for improvements to Teston Road, from 250 m west of Pine Valley Drive to Kleinburg Summit Way, in the City of Vaughan, Ontario. A site location plan is provided as Figure 1.

The purpose of this study was to explore the subsurface conditions at the site, by borehole drilling, pavement coring, in-situ testing and, laboratory testing on soil samples. The data obtained from this investigation was used to provide Borehole Location Plans, Log of Borehole Sheets, Pavement Borehole Logs, Asphalt Core Logs, laboratory test results, a description of the subsurface conditions and design recommendations.

2.0 SITE AND PROJECT DESCRIPTION

Teston Road is an east-west oriented collector road in the City of Vaughan. The west project limit is Sta. 1+000 and the east project limit is Sta. 3+175, with chainage increasing from west to east. Teston Road is a two-lane road with a rural cross section between Sta. 1+000 and Sta. 2+850 and an urban cross section between Sta. 2+850 and Sta. 3+175. Within the project limits, Teston Road intersects with Kleinburg Summit Way, Kipling Avenue and Ballantyne Boulevard.

The terrain is rolling to gently undulating consisting mainly of farmland and private residences. There are also multiple culvert crossings that convey watercourse flows below Teston Road within the project limits.

3.0 INVESTIGATION PROCEDURES

The fieldwork for this project was carried out from December 08 to 13, 2021 after obtaining utility clearances and permits. The work was carried out during the lane closure times specified by the City of Vaughan. Details of the field investigations are presented below:

- Drilling six foundation boreholes through the existing Teston Road pavement platform to depths ranging from 6.6 m to 9.6 m below ground surface;
- Drilling ten pavement boreholes through the existing Teston Road pavement each to a depth of 1.5 m below ground surface;
- Asphaltic concrete coring of the Teston Road main lanes at two locations; and
- Manually excavating fifteen shallow test pits to estimate topsoil thicknesses.

The boreholes were marked in the field by Terraprobe's staff in relation to existing features shown on the drawings provided by HDR. The foundation boreholes were surveyed for coordinates and geodetic elevation with a Trimble R10 Receiver connected to the Global Navigation Satellite System. The borehole data is summarized in the following table and the approximate borehole and test pit locations are shown on Figures 2 and 3.

Foundation Boreholes

Borehole No.	Coordinates (UTM NAD 83, Zone 17)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
BH C1	4 856 363.8	611 181.3	205.5	8.1
BH C2	4 856 529.0	611 700.5	203.6	8.1
BH C3	4 856 659.2	612 108.4	202.6	9.6
BH RW1	4 856 597.8	611 908.3	205.2	6.6

Foundation Boreholes

Borehole No.	Coordinates (UTM NAD 83, Zone 17)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
BH RW2	4 856 805.5	612 585.3	220.1	6.6
BH 2+295	4 856 697.0	612 229.5	209.5	6.6

Pavement Boreholes

Approx. Station	Location EB (East Bound) WB (West Bound)	Borehole Depth (m)
1+000	West Bound Lane	1.50
1+395	West Bound Lane	1.50
1+595	East Bound Lane	1.50
1+800	West Bound Lane	1.50
2+000	East Bound Lane	1.50
2+405	East Bound Lane	1.50
2+600	West Bound Lane	1.50
2+800	West Bound Lane	1.50
2+975	East Bound Lane	1.50
3+100	East Bound Lane	1.50

The boreholes were drilled with a truck-mounted drill rig supplied and operated by a specialist drilling contractor. Terraprobe's staff observed and recorded the drilling, sampling and in situ testing operations and logged the boreholes.

In the foundation boreholes, soil samples were obtained at intervals of 0.75 m and 1.5 m depth, using a 50 mm outer diameter (O.D.) split-spoon sampler in conjunction with the Standard Penetration Testing (SPT) procedures as specified in ASTM Method D 1586[1]. Samples of soil and granular material were also collected from auger cuttings retrieved from the 1.5 m deep boreholes drilled through the existing pavements.

Ground water conditions in the open boreholes were observed during the drilling operations and standpipe piezometers consisting of a 50 mm diameter PVC pipe with a slotted screen were installed in Boreholes C1, C2 and C3 to permit longer term ground water level monitoring.

The recovered soil samples were visually inspected in the field, placed in labelled plastic containers, and transferred to Terraprobe's Brampton laboratory for further examination and testing. The recovered soil samples were subjected to Visual Identification (VI) and select soil samples were subjected to a laboratory testing programme consisting of natural moisture content and grain size distribution analyses in accordance with MTO and/or ASTM Standards as appropriate. The results of the soil testing program are presented on the Log of Borehole Sheets and Pavement Borehole Logs in Appendix A and on the figures in Appendix B.

Soil samples were submitted to SGS Canada Inc. (SGS) for chemical testing and two asphalt cores were also submitted to Agat Laboratories to test for the presence of asbestos. The results of the chemical tests are provided in Appendix C.

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[1] ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

A visual pavement condition evaluation was carried out in January, 2022 in accordance with the Ministry of Transportation of Ontario, (MTO) *Manual for Condition Rating of Flexible Pavements Distress Manifestations, SP-024*. The Pavement Condition Evaluation Forms are included in Appendix D, and site photographs are presented in Figures 4 to 7.

4.0 SUBSURFACE CONDITIONS

4.1 General

Reference is made to the Pavement Borehole Logs and Log of Borehole Sheets in Appendix A. Details of the encountered soil stratigraphy are presented in this appendix. An overall description of the stratigraphy is given in the following paragraphs.

The stratigraphic boundaries shown on the Log of Borehole Sheets are inferred from non-continuous soil sampling 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.

In summary, topsoil, pavement, and fill material consisting of compact sandy gravel, firm to stiff silty clay, and loose silty sand were encountered at the site. The native overburden deposits consist of firm to hard silty clay to clayey silt till, loose to compact silt and sand to sand and silt, compact silt, and firm to stiff silty clay.

4.2 Pavement

A flexible pavement consisting of 75 mm to 175 mm thick asphaltic concrete, underlain by granular base/subbase material ranging in composition from sand and gravel to gravelly sand fill was encountered. The average pavement structure of Teston Road is summarized in the following table.

Road	Location	Average Thickness (mm)		
		HMA	Granular	Total
Teston Road	Sta. 1+000 to Sta. 2+720	130	470	600
	Sta. 2+720 to Sta. 3+175	165	475	640

The measured SPT N-values of Standard Penetration tests carried out in the base/subbase material range from 15 blows to 47 blows for 0.3 m of penetration, indicating a compact to dense relative density. The natural water content of nine samples of the granular base/subbase material varies from 1% to 14% by weight.

The grain size distribution curves of two samples of the granular base/subbase material are depicted on Figure B1, in Appendix B. The results are compared to the Ontario Provincial Standards (OPSS) gradation specifications for Granular A and Granular B Type II.

4.2.1 Pavement Condition

A visual pavement condition survey of Teston Road was carried out in January 2022. The pavements were evaluated in accordance with the Ministry of Transportation of Ontario, (MTO) *Manual for Condition Rating of Flexible Pavements Distress Manifestations, SP-024*. The Pavement Condition Evaluation Forms are included in Appendix D and, the observed pavement distresses and pavement condition of the evaluated pavement sections are summarized in the following table.

Section	Overall Condition	General Distresses
Teston Road Sta. 1+000 to Sta. 1+180	PCR* = 95 RCR** = 9.5 Excellent	▪ Few very slight ravelling and coarse aggregate loss; and ▪ Few very slight random/map cracking.
Teston Road Sta. 1+180 to Sta. 2+720	PCR* = 65 RCR** = 6.5 Good	▪ Frequent slight ravelling and coarse aggregate loss; ▪ Intermittent slight wheel track rutting; ▪ Few slight distortion; ▪ Few slight single and multiple longitudinal wheel track cracking; ▪ Intermittent moderate single and multiple centre line cracking; ▪ Intermittent slight alligator centre line cracking; ▪ Frequent slight single and multiple pavement edge cracking; ▪ Intermittent slight alligator pavement edge cracking; ▪ Few slight half, full and multiple transverse cracking; ▪ Few slight alligator transverse cracking; and ▪ Intermittent slight random/map cracking.
Teston Road Sta. 2+720 to Sta. 3+175	PCR* = 95 RCR** = 9.5 Excellent	▪ Few very slight ravelling and coarse aggregate loss.

* PCR = Pavement Condition Rating. ** RCR = Ride Condition Rating.

4.2.2 Subgrade Soils

The pavement subgrade as encountered in the 1.5 m deep pavement boreholes, generally consist of sand and gravel, silty sand, and silty clay soils.

A sample of the silty sand subgrade was subjected to a grain size distribution test and the grain size distribution curve is illustrated in Figure B2, in Appendix B. The test results show a grain size distribution consisting of 19% gravel, 49% sand, 24% silt and, 8% clay size particles. The moisture contents of two samples of the silty sand subgrade soils are 9% and 16% by weight. The moisture contents of two samples of the silty clay subgrade soils are 20% and 22% by weight.

4.3 Topsoil

Topsoil layers ranging in thickness from 140 mm to 180 mm were encountered at this site. Topsoil thickness will vary between and beyond the borehole and test pit locations.

4.4 Fill – Sandy Gravel

Sandy gravel fill material was encountered at Borehole C1. The sandy gravel fill layer is approximately 0.8 m thick and extends to a depth of 1.4 m (elevation 204.1 m) below ground surface. A Standard Penetration test performed in the sandy gravel fill measured a SPT N-value of 23 blows for 0.3 m of penetration, indicating a compact relative density.

4.5 Fill – Silty Clay

Silty clay fill material was encountered in some of the boreholes. The locations, thicknesses, depths, and base elevations of the silty clay fill encountered in the foundation boreholes are summarized in the following table.

Borehole No.	Fill Thickness (m)	Fill Depth (m)	Fill Base Elevation (m)
BH C1	1.5	2.9	202.6
BH C2	0.6	1.2	202.4
BH C3	2.3	2.9	199.7
BH RW1	1.5	2.1	203.1
BH RW2	1.6	2.1	218.0
BH 2+295	0.7	1.4	208.1

Standard Penetration tests performed in the silty clay fill measured SPT N-values of 5 blows to 12 blows for 0.3 m of penetration, indicating a firm to stiff consistency. The natural water content of samples of the silty clay fill varies from 11% to 23% by weight.

A sample of the silty clay fill was subjected to a grain size distribution test and the grain size distribution curve is illustrated in Figure B3, in Appendix B. The test results show a grain size distribution consisting of 3% gravel, 25% sand, 52% silt and; 20% clay size particles.

4.6 Fill – Silty Sand

Silty sand fill material was encountered at Borehole RW1. The silty sand fill layer is approximately 1.6 m thick and extends to a depth of 3.7 m (elevation 201.5 m) below ground surface. Standard Penetration tests performed in the silty sand fill measured SPT N-values of 6 blows and 7 blows for 0.3 m of penetration, indicating a loose relative density. The natural water content of a sample of the silty sand fill is 17% by weight.

4.7 Silty Clay to Clayey Silt Till

Till deposits with a soil matrix composition that ranges from silty clay to clayey silt were encountered at this site. The locations, thicknesses, depths, and base elevations of the silty clay to clayey silt till encountered in the foundation boreholes are summarized in the following table.

Borehole No.	Thickness (m)	Depth (m)	Base Elevation (m)
BH C1	4.2	7.1	198.4
BH C2	5.2	8.1*	195.5
BH C3	2.7	5.6	197.0
BH RW1	2.2	6.6*	198.6
BH RW2	4.5	6.6*	213.5
BH 2+295	4.4	6.6*	202.9

*Borehole termination depth.

Standard Penetration tests performed in the silty clay to clayey silt till measured SPT N-values of 7 blows to 47 blows for 0.3 m of penetration, indicating a firm to hard consistency. The natural water content of samples of the silty clay to clayey silt till range from 10% to 21% by weight.

Four samples of the silty clay to clayey silt till deposit were subjected to grain size distribution tests and the grain size distribution curves are illustrated in Figure B4 in Appendix B. The test results show a grain size distribution consisting of 1% to 4% gravel, 7% to 21% sand, 54% to 70% silt and, 21% to 23% clay size particles. Till soils can also be expected to contain random cobble and boulder inclusions.

4.8 Silt and Sand to Sand and Silt

Deposits ranging in composition from silt and sand to sand and silt were encountered at this site and the locations, thicknesses, depths, and base elevations of these cohesionless deposits encountered in the foundation boreholes are summarized in the following table.

Borehole No.	Thickness (m)	Depth (m)	Base Elevation (m)
BH C1	1.0	8.1*	197.4
BH C3	4.0	9.6*	193.0
BH 2+295	0.8	2.2	207.3

* Borehole termination depth.

Standard Penetration tests performed in the silt and sand to sand and silt deposits measured SPT N-values of 7 blows to 20 blows for 0.3 m of penetration, indicating a loose to compact relative density. The natural water content of samples of the silt and sand to sand and silt deposits range from 15% to 28% by weight.

Two samples of the silt and sand to sand and silt deposits were subjected to grain size distribution tests and the grain size distribution curves are illustrated in Figure B5, in Appendix B. The test results show a grain size distribution consisting of 0% and 1% gravel, 39% and 50% sand, 45% and 50% silt and, 5% and 10% clay size particles.

4.9 Silt

A layer of silt was encountered at Borehole C2. The silt deposit is approximately 0.8 m thick and extends to a depth of 2.9 m (elevation 200.7 m) below ground surface. A Standard Penetration test carried out in the silt deposit measured a SPT N-value of 15 blows for 0.3 m of penetration, indicating a compact relative density. The natural water content of a sample of the silt deposit is 20% by weight.

A sample of the silt deposit was subjected to a grain size distribution test and the grain size distribution curve is illustrated in Figure B6, in Appendix B. The test results show a grain size distribution consisting of 0% gravel, 9% sand, 82% silt and, 9% clay size particles.

4.10 Silty Clay

Native silty clay deposits were encountered at this site. The locations, thicknesses, depths, and base elevations of the silty clay deposits encountered in the foundation boreholes are summarized in the following table.

Borehole No.	Thickness (m)	Depth (m)	Base Elevation (m)
BH C2	0.9	2.1	201.5
BH RW1	0.7	4.4	200.8

Standard Penetration tests performed in the silty clay deposits measured SPT N-values of 7 blows and 8 blows for 0.3 m of penetration, indicating a firm to stiff consistency.

4.11 Ground Water Conditions

Ground water conditions were observed in the boreholes during and upon completion of drilling. Boreholes C1, C2 and C3 were instrumented with a 50 mm diameter standpipe piezometer. Tabulated below are the ground water levels that were measured on separate visits after the completion of drilling.

Borehole Number	Date	Water Levels	
		Depth (m)	Elevation (m)
BH C1	January 06, 2022 January 31, 2022	5.7 5.8	199.8 199.7
BH C2	January 06, 2022 January 31, 2022	1.4 1.6	202.2 202.0
BH C3	January 06, 2022 January 31, 2022	2.1 2.3	200.5 200.3

The ground water is expected to follow the topography along the alignment and the phreatic surface is expected to fall gradually from high ground to the watercourse crossings. The ground water in the vicinity of the watercourse crossings will also be controlled by the free water levels in these waterbodies. Ground water is also expected to fluctuate seasonally and can be expected to rise during wet periods of the year and perched water can also be expected to occur where more permeable deposits overlie relatively impermeable deposits.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

This section of the report presents interpretations of the factual geotechnical data and provides geotechnical recommendations for preliminary design. The discussions and recommendations presented herein are based on our understanding of the project and our interpretation of the factual data obtained from the subsurface investigations.

The preliminary design recommendations provided herein are for the following project components:

- Culvert replacements at Sta. 1+200, Sta. 1+740 and Sta. 2+175;
- Retaining walls at multiple locations within the project limits;
- Embankment widening and earth cuts within the project limits at various locations; and
- Pavement structures of Teston Road between Sta. 1+000 and Sta. 3+175.

5.2 Consequence and Site Understanding Classification

Teston Road is a collector road with a relatively high traffic volume. This transportation corridor if impacted; will also impact alternative transportation corridors and/or structures.

Therefore, a "typical consequence level" is considered appropriate as outlined in Section 6.5 of the *Canadian Highway Bridge Design Code (CHBDC) S6-19*. A "typical degree of site and prediction model understanding" has also been utilized given the scope of the foundation investigation and laboratory testing programme.

The consequence factor (ψ) and geotechnical resistance factors (Φ_{gu} & Φ_{gs}) used for designs and stipulated in Clause 6.5.2 and Clause 6.9 of the CHBDC S6-19, are based on a "typical consequence level" and a "typical degree of site and prediction model understanding".

5.3 Seismic Design

5.3.1 Seismic Site Classification

Ground conditions for seismic site characterization were established based on the field investigation and laboratory testing data. The energy-corrected average penetration resistance, $\overline{N}_{60}$, as well as the subsurface conditions, were used to define the seismic site classification in accordance with Table 4.1 of the CHBDC. Based on this methodology and the borehole data, the site is generally classified as Site Class D with one area in the vicinity of BH C3 that is classified as Site Class E.

5.3.2 Spectral Response Values

The CHBDC requires that the seismic hazard values associated with the design earthquake be established based on the National Building Code of Canada (NBCC). These values, Peak Ground Acceleration (PGA), Peak Ground Velocity (PGV) and Spectral Acceleration (Sa) can be obtained from the Geological Survey of Canada (GSC) *"2015 National Building Code of Canada Seismic Hazard Calculator"* and are for a reference ground condition of Site Class C.

In accordance with Section 4.4.3.3 of the CHBDC, the NBCC values were adjusted to reflect local site conditions i.e., Site Class D and Site Class E. As per Section 4.4.3.3 of the CHBDC, the value of PGA_{ref} for use with Tables 4.2 to 4.9 was taken as 80% of the PGA since the Sa(0.2)/PGA ratio is less than 2.0.

A PGA_{ref} value of 0.077 for the 2,475 year return was used. The NBCC spectral response values and the site-specific design values are tabulated below.

NBCC Seismic Hazard Values 2% Exceedance in 50 years (2,475 Year Return Period)							
PGA (g)	**PGV (m/s)**	**Sa (0.2) (g)**	**Sa (0.5) (g)**	**Sa (1.0) (g)**	**Sa (2.0) (g)**	**Sa (5.0) (g)**	**Sa (10.0) (g)**
0.096	0.074	0.154	0.092	0.051	0.026	0.006	0.003
Site Specific Design Seismic Hazard Values Site Class D 2% Exceedance in 50 years (2,475 Year Return Period)							
0.124	0.109	0.191	0.135	0.079	0.041	0.009	0.004
Site Specific Design Seismic Hazard Values Site Class E 2% Exceedance in 50 years (2,475 Year Return Period)							
0.174	0.183	0.253	0.227	0.143	0.075	0.018	0.008

6.0 CULVERTS AND RETAINING WALLS

6.1 Geotechnical Resistances

The recommended founding depths and geotechnical resistances for footings (minimum footing width of 1.5 m) founded on undisturbed competent native soils are tabulated below:

Borehole Number	Existing Ground Surface Elevation (m)	Recommended Bottom of Footing Level Below Existing Ground Surface (m)	Founding Elevation (m)	Factored Geotechnical Resistance at ULS (kPa)	Factored Geotechnical Resistance at SLS (kPa) (25 mm Settlement)	Ground Bearing Surface
BH C1	205.5	Below 2.9	Below 202.6	400	300	Silty Clay Till
BH C2	203.6	Below 2.9	Below 200.7	380	285	Silty Clay Till
BH C3	202.6	Below 2.9	Below 199.7	185	140	Silty Clay Till
BH RW1	205.2	3.7 to 4.4 Below 4.4	201.5 to 200.8 Below 200.8	150 475	110 380	Silty Clay Silty Clay Till
BH RW2	220.1	Below 2.1	Below 218.0	475	380	Silty Clay Till
BH 2+295	209.5	1.4 to 2.2 Below 2.2	208.1 to 207.3 Below 209.2	285 350	200 280	Silt and Sand Silty Clay Till

The groundwater table shall be lowered and temporarily maintained at least 0.5 m below the bearing surface during construction. Expeditiously pour a 75 mm thick layer of lean concrete (mud mat) on the bearing surface after approval by a geotechnical engineer. Soft/weak soils if encountered at the bearing surface must be removed and replaced with OPSS Granular “A” compacted to 95% Standard Proctor Maximum Dry Density.

The factored ULS and SLS values tabulated above are for vertical, concentric loads only. Effects of load inclination and eccentricity should be considered as outlined in Clause 6.10 of the CHBDC S6-19.

The SLS values provided correspond to a total settlement of 25 mm or less and are based on the assumption that the founding soils will be undisturbed during construction.

6.2 Horizontal Geotechnical Resistances

The ultimate geotechnical horizontal resistance shall be evaluated in accordance with Clause 6.10.4 of the CHBDC S6-19. In accordance with Clause 6.10.4 of the CHBDC S6-19, the ultimate geotechnical horizontal resistance within the ground, close to the ground-structure interface (R_{ug}) and; the ultimate geotechnical horizontal shear resistance at the interface between the footing and the ground (R_{ui}), shall be derived based on the following effective angle of internal friction values (ϕ').

- Silty Clay to Clayey Silt Till – internal friction angle ϕ' = 29º;
- Silt and Sand – internal friction angle ϕ' = 30º
- Silty Clay – internal friction angle ϕ' = 28º.

Along the interface between a shallow foundation and ground, an effective friction angle (δ_i') equivalent to 2/3 of the soil's effective angle of internal friction (ϕ') shall be used.

6.3 Lateral Earth Pressure

6.3.1 Static Conditions

Earth pressures are generally calculated using the following expression:

$P_h = K(\gamma h + q)$
P_h = horizontal pressure on the wall (kPa)
K = lateral earth pressure coefficient
γ = unit weight of retained soil (kN/m^3)
h = depth below top of fill where pressure is computed (m)
q = value of any surcharge (kPa)

It is recommended that earth pressures acting on the structure be computed in accordance with Clause 6.12 of the CHBDC S6-19 and according to Clause 6.12.3 of the CHBDC S6-19; a compaction surcharge shall also be added. For soils with an angle of internal friction ranging from 30º to 35º the magnitude shall be 12 kPa at the top of the fill decreasing linearly to 0 kPa at a depth of 1.7 m; or decreasing linearly to 0 kPa at a depth of 2.0 m for soils with an angle of internal friction that exceeds 35º. Compaction equipment including hand operated vibratory equipment shall comply with OPSS.MUNI 501.

The lateral earth pressure coefficients are dependent on the material used as backfill and typical values are provided in the following table.

Wall Condition	**Lateral Earth Pressure Coefficient (K)**			
	OPSS Granular A or OPSS Granular B Type II ϕ = 35°; γ = 22.8 kN/m^3		OPSS Granular B Type I ϕ = 32°; γ = 21.2 kN/m^3	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.38	0.30	0.46
At rest (Restrained Wall)	0.43	-	0.47	-
Passive (Movement Towards Soil Mass)	3.70	-	3.25	-

The lateral earth pressure coefficients provided in the table above are "ultimate" values that require certain structural movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.27 in the Commentary to the CHBDC S6.1-19.

6.3.2 Seismic Conditions

In accordance with Section 4.6 of the CHBDC, seismic loads must be considered in the design. The designs shall take into consideration:

- The wall should be designed to withstand the combined static lateral loads plus the earthquake induced loads;
- The horizontal seismic coefficient (k_h) used to calculate the seismic active pressure coefficient is taken as 1.0 times the PGA for structures that do not permit lateral yielding and 0.5 times PGA for structures that permit lateral yielding; and
- Where sloping backfill exists above the top of the wall, the weight of the backfill above the top of the wall should be treated as a surcharge when calculating the lateral earth pressure under seismic conditions.

The Mononobe-Okabe (M-O) method was used to calculate the active earth pressure coefficients for yielding and non-yielding walls assuming that the angle of friction between the wall and backfill material is 0.5 ϕ. The seismic active earth pressure coefficients provided in the following table shall be used for designs.

Location	**Wall Condition**	**Seismic Active Earth Pressure Coefficients (K)**	
		OPSS Granular A or OPSS Granular B Type II ϕ = 35°; δ = 17.5° γ = 22.8 kN/m^3	OPSS Granular B Type I ϕ = 32°; δ = 16.0° γ = 21.2 kN/m^3
		Horizontal Surface Behind Wall	Horizontal Surface Behind Wall
Site Class D	K_{AE} (Yielding Wall)	0.28	0.32
	K_{AE} (Non-Yielding Wall)	0.32	0.36
Site Class E	K_{AE} (Yielding Wall)	0.30	0.33
	K_{AE} (Non-Yielding Wall)	0.36	0.40

6.4 Culvert Backfill

Equal heights of backfill should be maintained on both sides of the structure during all stages of backfill placement. Heavy compaction equipment should not be used adjacent to the walls and roof of the culvert. Compaction equipment should be restricted in accordance with OPSS.MUNI 501.

The excavated soil can be used for backfilling purposes provided they are free of organics and other deleterious material. To achieve the specified compaction, soils must neither be too wet nor too dry of their optimum moisture content. Soils that are too wet (such as the silty clay to clay) cannot be used immediately because the material will have to be dried to a moisture content of 2%± of optimum. If the construction operations are time sensitive, the use of imported granular material may be considered. Soils that are dry of optimum can be used immediately provided that the material is moisture conditioned (i.e., water added) to achieve a moisture content of 2%± of optimum.

6.5 Erosion Protection (Culvert Inlets and Outlets)

Erosion protection shall be provided at the forward and side slopes of the culverts as well as at the culvert inlets and outlets. A clay seal can be provided such that water flow is channelled through the culvert and does not seep through the backfill around and underneath the structure. The clay seal shall extend to cover all the granular backfill materials, shall be a continuous layer around the culvert, shall have a minimum compacted thickness of 0.6 m, and shall extend at least 1 m above the high water level. The clay seal should also be protected by a layer of rip-rap. Material used for the clay seal shall conform to the requirements stipulated in OPSS.MUNI 1205. Alternatively, concrete cut-off and head walls can be constructed at the culvert inlets and outlets to protect the granular backfill and prevent seepage around the culverts.

Design of an erosion protection scheme for the stream bed in the inlet and outlet areas will depend on hydrologic, hydraulic and/or other concerns. Typically, rip-rap protection should be provided to these areas. The rip-rap layer should cover all surfaces on the embankment slopes with which creek water is likely to be in contact.

We recommend that a qualified Hydraulics Engineer be consulted to design the specifics of the channel, culvert outlets and inlets (i.e., thickness and extent of protection) and scour depth. Footings must also be placed below the scour depth.

7.0 DESIGN FROST DEPTH

Footings should be founded at a minimum depth of 1.2 m of earth cover below the lowest surrounding grade to provide adequate protection against frost penetration, as per OPSD 3090.101. In addition, footings should extend below any existing fill and surficial organic materials, where present.

8.0 TEMPORARY PROTECTION SYSTEMS

Temporary protection systems shall be designed in accordance with OPSS.MUNI 539 by a licensed Professional Engineer experienced in shoring design. The shape of the soil pressure distribution diagram behind a temporary protection system depends upon the type of soil to be supported and the amount of movement that can be permitted. The sequence of work will also alter the shape of the pressure diagram during the various construction phases.

Earth pressure computations must also take into account the ground water level. Above the ground water level, earth pressure is computed using the bulk unit weight of the retained soil. Below the ground water level, the earth pressures are computed using the submerged unit weight of the soil. A hydrostatic pressure is also applied if the retained soil is not fully drained.

Flexible shoring shall be designed based on the active earth pressure coefficient (K_a). In this case, the performance level should be Level 2 – Angular Distortion 1:200 but shall not be more than 25 mm. Where limited shoring movement (Performance Level 1A or 1B) is required, the design shall be based on the at rest earth pressure coefficient (K_o). For "kick out" design the lateral resistance shall be computed based on the passive earth pressure coefficient (K_p).

9.0 GROUND WATER CONTROL

While the design of the dewatering system is the Contractor's responsibility, provided herein are general approaches to ground water control. Surface water and ground water control will be necessary to enable construction below the ground water table. Around the perimeter of the excavations, an interceptor perimeter trench should also be installed to prevent surface water from entering the excavations.

The Ontario Ministry of Environment and Climate Change (MOECC) requires a Permit to Take Water (PTTW) for any ground water and storm water takings more than 400 m^3/day. If the ground water and storm water taking is between 50 m^3/day and 400 m^3/day, then the activity must be registered on the Environmental Activity and Sector Registry (EASR).

10.0 EXCAVATIONS

All excavations shall be carried out in accordance with the guidelines outlined in the *Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects*. Where workers must enter excavations deeper than 1.2 m, the trench walls must be suitably sloped and/or braced in accordance with the OHSA. Within the envisaged depths of temporary excavations, the OHSA soil classifications for this site are:

- Fill Soils – Type 3 soil above the ground water table and Type 4 soil below the ground water table;
- Silty Clay to Clayey Silt Till – Type 3 soil; and
- Silt and Sand to Sand and Silt / Silt / Silty Clay – Type 3 soil above the ground water table and Type 4 soil below the ground water table.

The side slopes of temporary excavations may be formed no steeper than 1H:1V for Type 3 soils and 3H:1V or flatter for Type 4 soils. Excavations shall be carried out in accordance with OPSS.MUNI 902.

11.0 EMBANKMENTS & EARTH CUTS

11.1 Embankments

In road widening areas no global stability problems are anticipated for up to 4.0 m high embankments, provided that the side slope geometry is 2 Horizontal to 1 Vertical (2H:1V) or flatter. Where earth fill embankments are higher than 8 m, mid-height berms should be incorporated in the design. The berms should:

- extend for the length through which the embankment height exceeds 8 m;
- be at least 2 m wide; and
- have 2% positive drainage to shed run-off water.

Materials used for embankment construction should be placed in lifts not exceeding 300 mm (before compaction), and each lift should be uniformly compacted to at least 95 % of the material's SPMDD. Embankment construction should be carried out in accordance with OPSS.MUNI 206 and OPSS.MUNI 501. Borrow material must meet the requirements of OPSS.MUNI 212 and bonding between existing fill and new fill should be carried out by benching in accordance with OPSD 208.010.

It is recommended that any deleterious material, soft/loose and other unsuitable soils be removed within an envelope given by an imaginary slope not steeper than 1H:1V from the toe of the widened embankment. The exposed subgrade should be inspected, approved, and properly compacted from the surface in accordance with OPSS MUNI 501.

11.2 Earth Cuts

In road widening areas no global stability problems are anticipated for up to 4.0 m high earth cuts, provided that the side slope geometry is 2H:1V or flatter. Where earth cuts are higher than 6 m, mid-height berms should be incorporated in the design. The berms should:

- extend for the length through which the embankment height exceeds 6 m;
- be at least 2 m wide; and
- have 2% positive drainage to shed run-off water.

11.3 Erosion Protection

Proper erosion control measures should be implemented both during construction and permanently. Temporary erosion and sediment control must be provided in accordance with OPSS.MUNI 805 and slopes must be reinstated with permanent erosion protection in accordance with OPSS.MUNI 803 and OPSS.MUNI 804.

12.0 PAVEMENT DESIGN

12.1 Traffic Data

The traffic data provided by HDR, the interpreted data and the derived Equivalent Single Axle Loads (ESALs) are tabulated below. The ESAL calculations are provided in Tables E1 and E2 in Appendix E.

Parameters	Kleinburg Summit Way to Kipling Avenue	Kipling Avenue to Pine Valley Drive
AADT (2019)	7,300	-
AADT (2020)	-	6,100
Projected AADT (2022)	8,548	6,880
Projected AADT (2031)	13,722	11,822
Projected AADT (2041)	20,115	20,115
Average Annual Growth Rate	5.4%	6.2%
Percent Commercial Vehicles	2.5%	4.9%
Cumulative Design ESALs (2022 – 2031) Cumulative Design ESALs (2022 – 2041)	281,370 799,950	455,880 1,364,400
Adopted Design ESALs (2022 – 2031) Adopted Design ESALs (2022 – 2041)	455,900 1,364,400	

12.2 Pavement Designs

The pavements were designed based on the traffic information provided by HDR and the data obtained from the field investigations. The following references and guidelines were used for the pavement designs.

- MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, MI-183", March 19, 2008;
- American Association of State Highway and Transportation Officials, "*AASHTO Guide for Design of Pavement Structures"*, 1993; and
- *Procedures for Estimating Traffic Loads for Pavement Designs*," Hajek. J., 1995.

The pavement design parameters that were selected for the pavement designs are summarised in the following table.

Design Parameter	Values	
Initial/Terminal Serviceability Index	P_i = 4.4	P_t = 2.2
Loss in Serviceability Index	2.2	
Reliability (%) & Standard Deviation	R = 85%	SD = 0.44
Design Period (years)	9 & 19	
Estimated Resilient Modulus of Subgrade Soil (MPa)	30 to 35	
Layer Coefficients of Hot Mix Asphalt (HMA)	New HMA = 0.42	Existing HMA = 0.28
Layer Coefficient of Granular Materials	New 20mm CRL* = 0.14 Existing Granular = 0.12 and 0.09	New 50mm CRL = 0.09
Drainage Coefficient of Granular Materials	m = 1 (new granular base and subbase) m = 0.9 (existing granular base and subbase)	
Design ESALs (2022 – 2031) Design ESALs (2022 – 2041)	455,900 1,364,400	

* CRL = Crusher Run Limestone.

12.2.1 Pavement Structure (Widening Areas)

The pavement was designed based on the pavement design parameters tabulated in Section 12.2 above, taking into consideration that the pavement thickness shall not be less than the minimum pavement requirements stipulated by the City of Vaughan for Industrial, Collector & Arterial Roads. Based on our analysis, the City of Vaughan minimum pavement requirements will apply and the recommended conventional flexible pavement structure for Teston Road is:

Pavement Component/Parameter	Teston Road (mm)
HL3 Surface Course	50
HL8 Binder Course	75
20mm CRL Base Course	125
50mm CRL Subbase Course	350*
Total Pavement Thickness	600
Design Structural Number (Horizon Year = 2031) Design Structural Number (Horizon Year = 2041)	87 102
Structural Number Provided	103

* Additional 40 mm of 50 mm CRL Subbase Course required between Sta. 2+720 and Sta. 3+175 to provide lateral drainage across the pavement platform.

12.2.2 Pavement Structure (Rehabilitation)

The preliminary design profiles indicate that significant grade adjustments ranging from up to 2.2 m of grade lowering to 2.0 m of grade raises are required for most of the alignment between Sta. 1+000 and Sta. 2+720. Since the grade adjustments occur over relatively short distances, implementing different rehabilitation strategies over short sections is not practical. It would also be most beneficial to have one pavement structure to ensure uniform pavement performance. Therefore, between Sta. 1+000 and Sta. 2+720 we recommend that the road be reconstructed in accordance with the City of Vaughan minimum pavement requirements outlined in Section 12.2.1.

Based on our visual pavement condition evaluation and data obtained from field investigations, it is noted that Teston Road's pavement has been recently rehabilitated towards the east project limit, i.e., between Sta. 2+720 and Sta. 3+175. Provided that no grade lowering is required in this section, we recommend 50 mm partial depth milling and repaving with a 50 mm thick HL3 surface course. The existing pavement structure for this section is adequate for the 2031 Horizon Year and no rehabilitation is warranted.

12.2.3 Material Types

The following mix types as specified in the City of Vaughan's specification (Engineering Design Criteria & Standard Drawings – Section 1.2 Municipal Infrastructure – Road dated December 2020) and OPSS.MUNI 1150 are considered suitable for this project.

HL3	Surface Course; and
HL8	Binder Course.

CRL (20 mm diameter) conforming to the OPSS.MUNI 1010 specifications for Granular A and the City of Vaughan specifications shall be used for the base course. CRL (50 mm diameter) conforming to the OPSS.MUNI 1010 specifications for Granular B Type II and the City of Vaughan specifications is recommended as subbase course.

12.2.4 Asphalt Cement Grade

Performance graded asphalt cement PG 64-28 conforming to the OPSS.MUNI 1101 is recommended for the surface and binder courses. Asphalt cement used in the manufacture of hot mix asphalt surface and binder courses should not contain Vacuum Tower Asphalt Extenders (VTAE), Refined Engine Oil Bottoms (REOB) or Waste Engine Oil Residue (WEOR). Therefore, we recommend testing the Asphalt Cement properties and attributes in accordance with Table 1 of OPSS.MUNI 1101.

12.2.5 Tack Coat

A tack coat (SS1) should be applied to all construction joints prior to placing hot mix asphalt to create an adhesive bond. Prior to placing hot mix asphalt, SS1 tack coat must also be applied to all existing surfaces and between all new lifts.

12.2.6 Compaction

Asphalt concrete shall be placed and compacted in accordance with OPSS.MUNI 310 and City of Vaughan's specifications. Granular base and subbase material shall be placed in 150 mm lifts and compacted to 100% of the material's Standard Proctor Maximum Dry Density (SPMDD) at ±2% of its Optimum Moisture Content (OMC) in accordance with OPSS.MUNI 501 and City of Vaughan's specifications. Subgrade soils shall be compacted to 98% of the material's SPMDD prior to placement of the granular base and subbase. Granular base and subbase materials shall be placed in accordance with OPSS.MUNI 314 and City of Vaughan's specification.

12.2.7 Subgrade Preparation

All topsoil, organics, soft/loose and otherwise disturbed soils shall be removed from the subgrade areas. The design subgrade is expected to consist of fine-grained cohesive soils and cohesionless soils. The fine-grained cohesive soils and cohesionless soils (such as silty clays, clayey silts and sands and silts) will be weakened by construction traffic when wet, especially if site work is carried out during periods of wet weather. During these weather conditions, an adequate granular working surface would be required to minimize subgrade disturbance. Subgrade preparation and fill construction should not be done in the winter.

Immediately prior to placing the granular base course, the subgrade soils should be compacted and then proofrolled with a heavy rubber-tired vehicle (such as a loaded gravel truck). The subgrade should be inspected for signs of rutting or displacement. Areas displaying signs of rutting or displacement should be recompacted and retested or, the material should be excavated and replaced with well-compacted and clean fill. To avoid leaving undrained pockets in excavations and as outlined in OPSS.MUNI 206, the selected fill shall be similar to the unexcavated adjacent soils.

The fill may consist of either granular material or local inorganic soils provided that their moisture contents are within ±2% of optimum. Fill material should be placed and compacted in accordance with OPSS.MUNI 501 and the upper 300 mm thick layer of the subgrade soils should be compacted to 98% of the material's SPMDD.

12.2.8 Pavement Removals

Refer to the tabulated average pavement component thicknesses in Section 4.2 for the appropriate asphaltic concrete and granular thicknesses to use for estimating purposes.

12.2.9 Reuse of Existing Granular Material

The grain size analyses of two selected samples of the pavement base and subbase material indicates that the sampled material generally does not meet the OPSS.MUNI 1010 gradation requirements for Granular A and Granular B Type II.

Therefore, this existing granular material shall not be used to construct the pavement base and subbase courses. This granular material can be used as non-structural fill elsewhere.

12.2.10 Stripping

Based on the topsoil thicknesses encountered at test pit locations, we recommend an average topsoil stripping depth of 150 mm for estimating purposes.

12.2.11 Drainage

To provide positive surface water run-off as well as drainage across the pavement platform, the pavement surface shall be sloped normally 2% and the pavement subgrade shall be sloped at 3% towards the sides as illustrated in the City of Vaughan Curb and Subdrain Detail Drawing R-126. Urban sections will also require full length subdrains placed beneath the curb in accordance with OPSD 216.020 and the City of Vaughan Curb and Subdrain Detail Drawing R-126.

12.2.12 Sidewalks

Sidewalks shall be constructed in accordance with the City of Vaughan Sidewalk and Ramp Detail Drawing R-128.

13.0 CHEMICAL ANALYSIS

13.1 Metals and Inorganics

Five soil samples were submitted to a CAEAL Certified Laboratory (SGS Environmental, Health & Safety) for chemical characterization with respect to general inorganic parameters including metals, pH, sodium adsorption ratio (SAR) and electrical conductivity (EC). Based on visual and/or olfactory screening of soil samples, these nominal parameters are analysed when there are no indications of environmental impacts. The Certificates of Analysis are included in Appendix C.

The analytical results were compared to Tables 1 (Agricultural) of the *MOE Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act*, April 15, 2011. Comparison of the test results to the MOE Standard indicates that the tested soil parameters were generally below the guideline values. However, exceedances in electrical conductivity and sodium adsorption ratio were reported for all tested samples as summarized in the following table.

Sample ID*	Approx. Station	Sample Depth (m)	Exceedances	
			EC	SAR
BH C1 – Granular	1+195	0.1 – 0.6	✓	✓
BH C2 – SS2	1+740	0.6 – 1.2	✓	✓
BH 8 – Granular	2+000	0.2 – 0.6	✓	✓
GL1 – SS2	2+295	0.8 – 1.4	✓	✓
RW2 – Granular	2+665	0.1 – 0.5	✓	✓

*As Reported on Certificate of Analysis.

13.2 Asbestos

Two asphalt core samples were subjected to testing for the presence of asbestos. Asbestos was not detected in any of the core samples.

14.0 LIMITATIONS AND RISK

14.1 Procedures

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained by Terraprobe.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment, and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

14.2 Changes in Site and Scope

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Ground water levels are particularly susceptible to seasonal fluctuations.

The discussion and recommendations are based on the factual data obtained from this investigation made at the site by Terraprobe and, are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructability issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report.

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15.0 CLOSURE

This report was prepared by Ms Sepideh D-Monfared, P.Eng., and reviewed by Mr. Rehman Abdul, P.Eng., a Senior Geotechnical Engineer and Principal with Terraprobe.

Terraprobe Inc.

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Sepideh D-Monfared, P.Eng.
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Rehman Abdul.

Rehman Abdul, P.Eng.
Principal, Senior Geotechnical Engineer

REFERENCES

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Ministry of Transportation Ontario. *Pavement Design and Rehabilitation Manual (SDO 90-01)*, 1990.

Ministry of Transportation Ontario, *Manual for Condition Rating of Flexible Pavements - Distress Manifestations (SP-024)*, August 1989.

Ontario Provincial Standard Specifications (OPSS)

OPSS.MUNI 206	Construction Specification For Grading.
OPSS.MUNI 212	Construction Specification For Earth Borrow.
OPSS.MUNI 310	Construction Specification for Hot Mix Asphalt.
OPSS.MUNI 314	Construction Specification For Untreated Subbase, Base, Surface Shoulder, Selected Subgrade and Stockpiling.
OPSS.MUNI 501	Construction Specification For Compacting.
OPSS.MUNI 539	Construction Specification For Temporary Protection Systems
OPSS.MUNI 803	Construction Specification For Sodding.
OPSS.MUNI 804	Construction Specification For Seed and Cover.
OPSS.MUNI 805	Construction Specification For Temporary Erosion And Sediment Control Measures.
OPSS.MUNI 902	Construction Specification For Excavating and Backfilling – Structures.
OPSS.MUNI 1010	Material Specification For Aggregates – Base, Subbase, Select Subgrade and Backfill Material.
OPSS.MUNI 1101	Material Specification for Performance Graded Asphalt Cement.
OPSS.MUNI 1150	Material Specification for Hot Mix Asphalt.
OPSS.MUNI 1205	Material Specification for Clay Seal.

Ontario Provincial Standard Drawings (OPSD)

OPSD 208.010	Benching of Earth Slopes
OPSD 216.020	Hot Mix, Concrete, and Composite Pavement on Granular Base, Urban Section
OPSD 3090.101	Foundation, Frost Penetration Depths For Southern Ontario

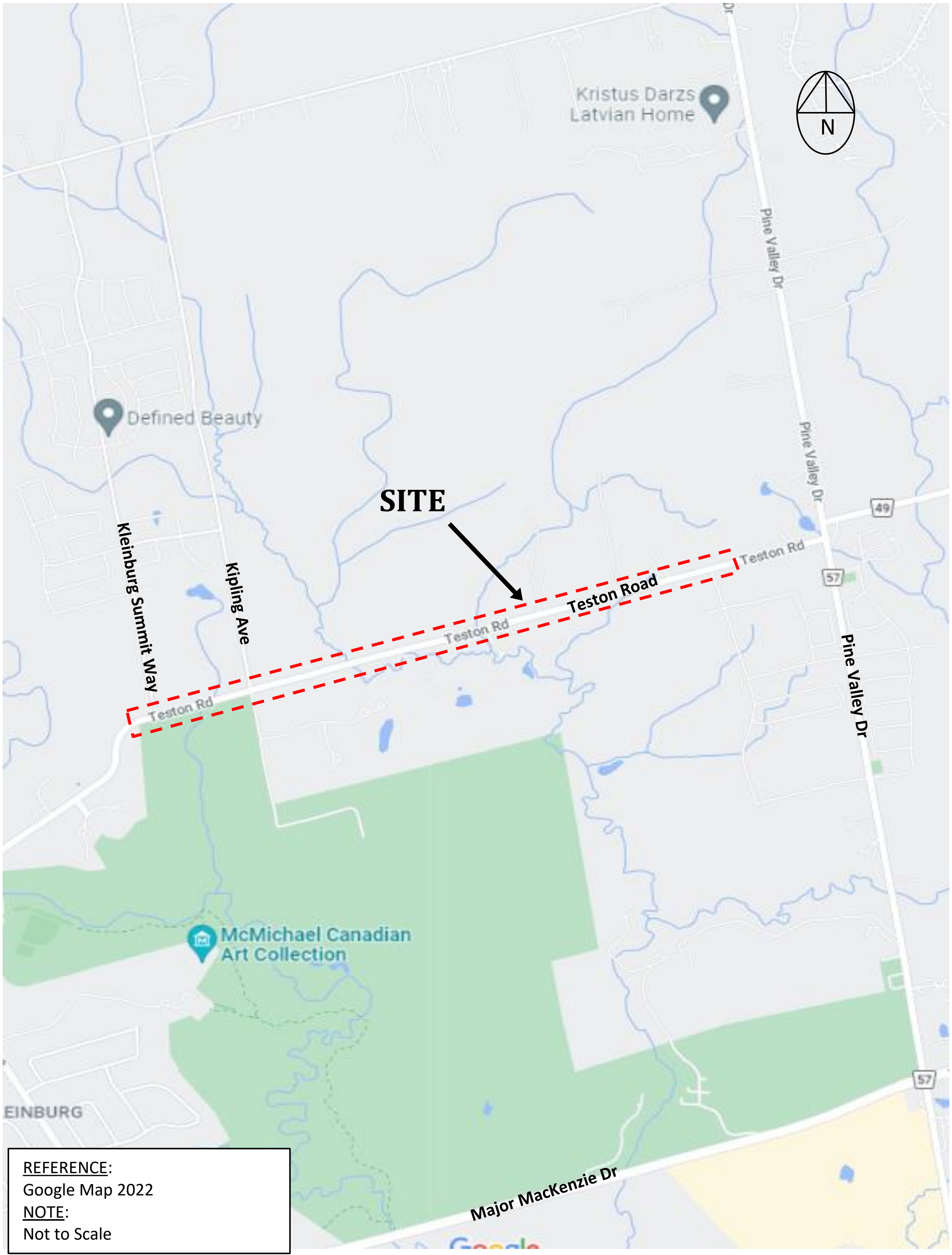
City of Vaughan Standard Drawings

Standard Drawing R-126	Curb and Subdrain Detail Drawing
Standard Drawing R-128	Sidewalk and Ramp Detail Drawing

City of Vaughan Specification

Engineering Design Criteria & Standard Drawings (December 2020)

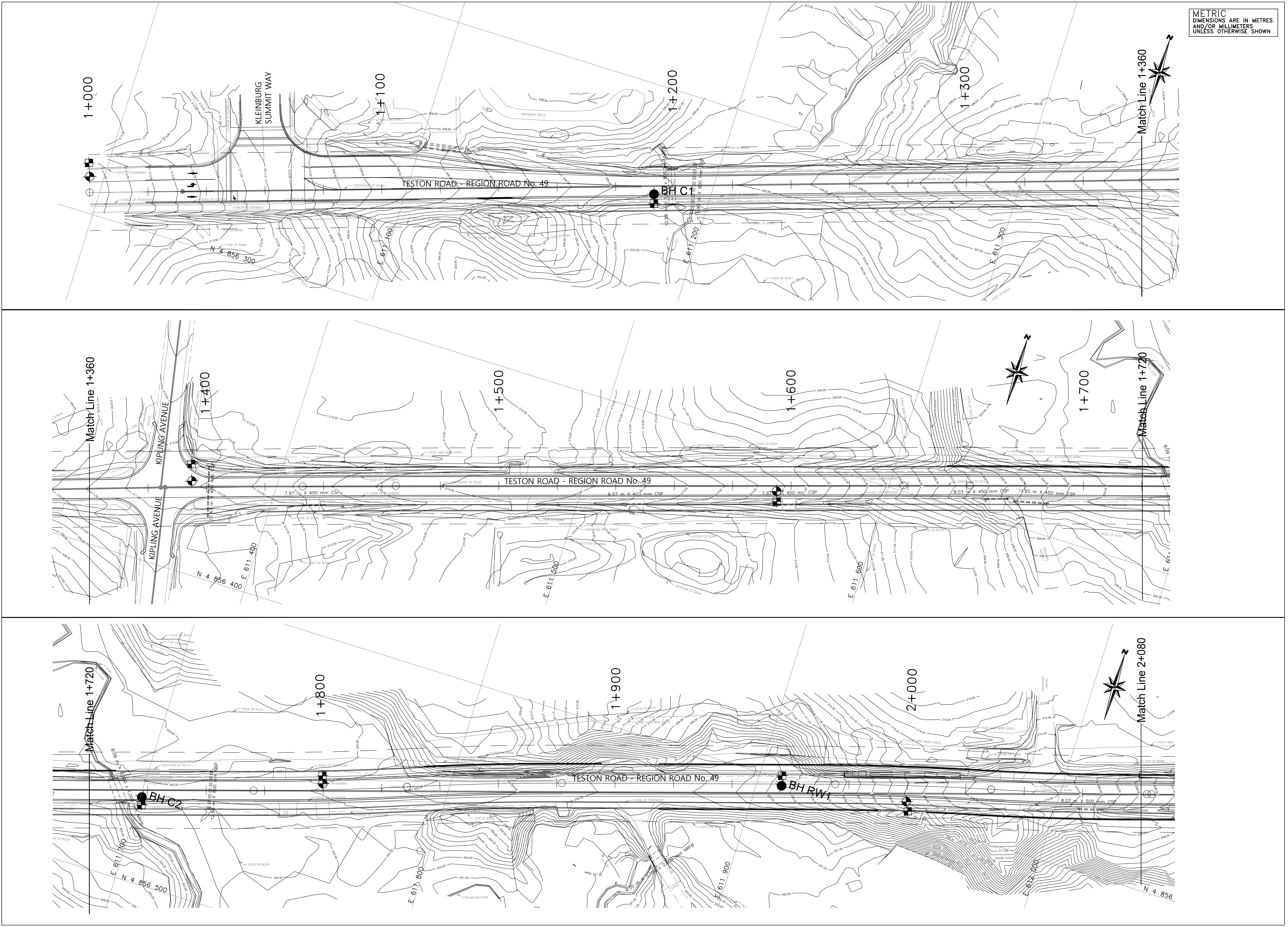
FIGURES



REFERENCE:
Google Map 2022
NOTE:
Not to Scale

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials, Inspection & Testing
11 Indell Lane - Brampton Ontario L6T 3Y3 (905) 796-2650

Title:	SITE LOCATION PLAN	Figure: 1
File No.:	1-20-0160	



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

TESTON ROAD
(WEST OF PINE VALLEY DRIVE
TO KLEINBURG SUMMIT WAY)
THE CITY OF VAUGHAN, ONTARIO

SHEET

BOREHOLE LOCATION PLAN

HDR

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Construction Materials Engineering, Inspection & Testing
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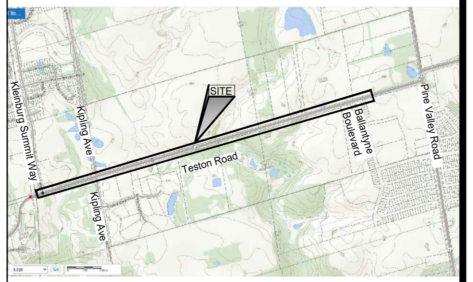

NOT TO SCALE

KEY PLAN

LEGEND	
●	Borehole
⊕	Pavement Borehole
▨	Test Pit

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, ZONE 17)	
		NORTHING (m)	EASTING (m)
C1	205.5	4 856 363.8	611 181.3
C2	203.6	4 856 529.0	611 700.5
RW1	205.2	4 856 597.8	611 908.3

SCALE

10 5 0 5 10 15 20m

NOTE

This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The subsurface conditions can be expected to vary between and beyond the borehole locations.

REFERENCE

Drawings provided in digital format by HDR, received November 12, 2021.

REVISIONS	DATE	BY	DESCRIPTION

HWY. --	PROJECT No.	1-20-0160	DIST.
SUBM'D. SD	CHKD. RA	DATE: FEB. 2022	SITE: ----
DRAWN: KC	CHKD. RA	APPD: RA	DWG. 2

\\10.70.216.35\tss\1-Project Files\2020\1-20-0160 - Teston Road - Pine Valley Dr -Kleinburg Summit Way\A. Dwgs, Logs\AutoCAD\1-20-0160 Figures 2022-02-03.dwg, DWG To PDF.pc3,
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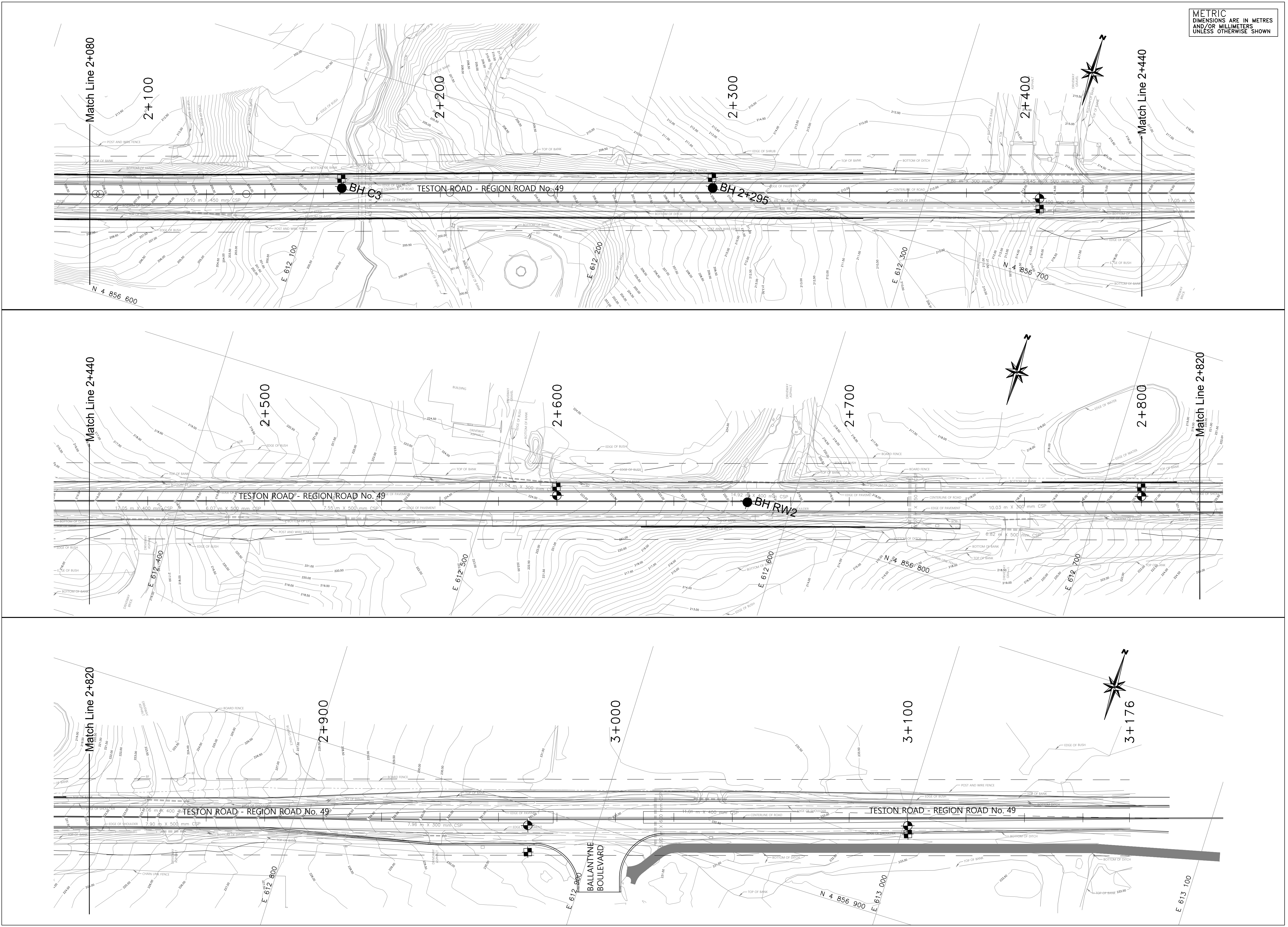
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



TESTON ROAD
(WEST OF PINE VALLEY DRIVE
TO KLEINBURG SUMMIT WAY)
THE CITY OF VAUGHAN, ONTARIO

SHEET

BOREHOLE LOCATION PLAN

HDR

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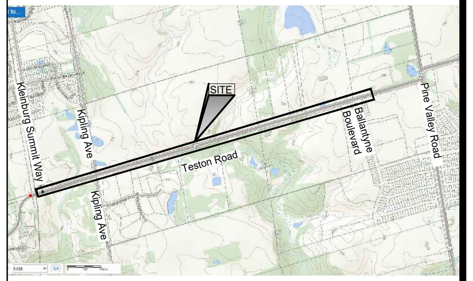

NOT TO SCALE

KEY PLAN

	LEGEND
●	Borehole
◒	Pavement Borehole
▚	Test Pit

BH No.	ELEV. (m)	COORDINATES (UTM, NAD83, ZONE 17)	
		NORTHING (m)	EASTING (m)
C3	202.6	4 856 659.2	612 108.4
2+295	209.5	4 856 697.0	612 229.5
RW2	220.1	4 856 805.5	612 585.3

SCALE

10 5 0 5 10 15 20m

NOTE
This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The subsurface conditions can be expected to vary between and beyond the borehole locations.

REFERENCE
Drawings provided in digital format by HDR, received November 12, 2021.

REVISIONS	DATE	BY	DESCRIPTION

HWY. --	PROJECT No. 1-20-0160		DIST.
SUBM'D. SD	CHKD. RA	DATE: FEB. 2022	SITE: ----
DRAWN: KC	CHKD. RA	APPD: RA	DWG. 3

\\10.70.216.35\tss\1-Project Files\2020\1-20-0160 - Teston Road - Pine Valley Dr -Kleinburg Summit Way\A. Dwgs, Logs\AutoCAD\1-20-0160 Figures 2022-02-03.dwg, DWG To PDF.pc3, Kamal, Kamal

SITE PHOTOGRAPHS | **FIGURE 4**

Photo 1: Teston Road at Sta. 1+000, Looking East

Photo 2: Teston Road at Sta. 1+120, Looking West

Project No. : 1-20-0160
Date : Feb, 2022

Terraprobe

Prepared by : LB
Checked by : SD

SITE PHOTOGRAPHS

FIGURE 5

Photo 3: Teston Road at Sta. 1+450, Looking West

Photo 4: Teston Road at Sta. 2+050, Looking East

Project No. : 1-20-0160

Date : Feb, 2022

Terraprobe

Prepared by : LB

Checked by : SD

SITE PHOTOGRAPHS

FIGURE 6

Photo 5: Teston Road at Sta. 2+600, Looking East

Photo 6: Teston Road at Sta. 2+600, Looking West

Project No. : 1-20-0160

Date : Feb, 2022

Terraprobe

Prepared by : LB

Checked by : SD

SITE PHOTOGRAPHS

FIGURE 7

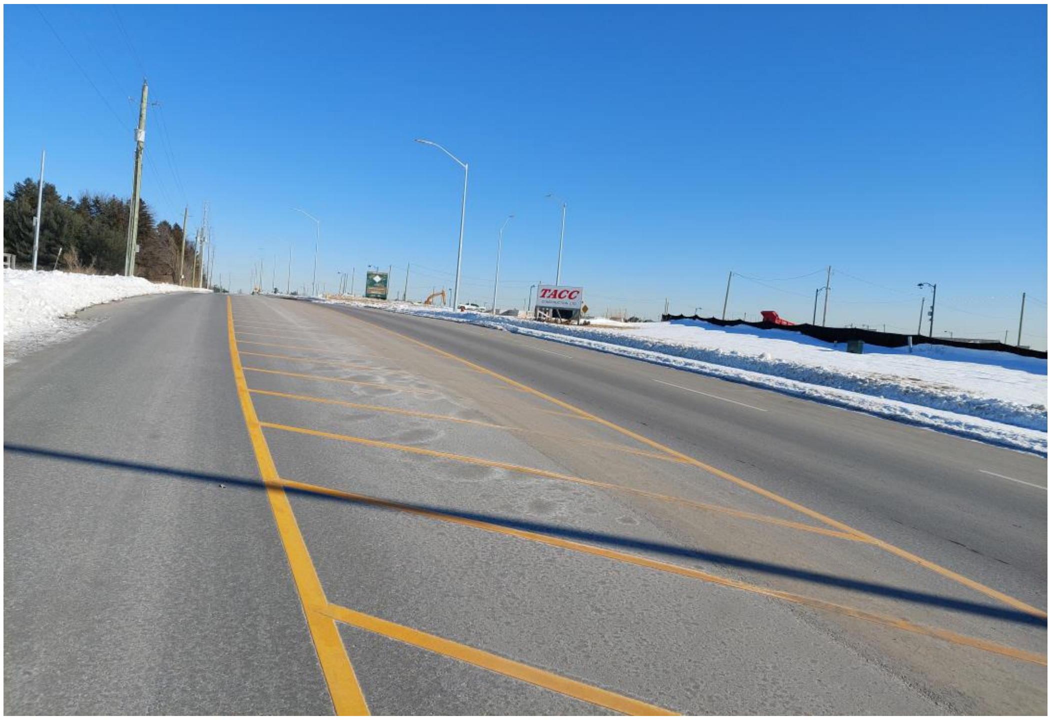

Photo 7: Teston Road at Sta. 2+950, Looking East

Photo 8: Teston Road at Sta. 3+175, Looking West

Project No. : 1-20-0160

Date : Feb, 2022

Terraprobe

Prepared by : LB

Checked by : SD

APPENDIX A

Log of Borehole Sheets

Accep	acceptable
Agg	aggregate
Amor	amorphous
Asph	asphalt
BH	borehole
Bl	blue
Bld (y)	boulder (y)
Blds	boulders
Blk	black
Br	brown
BR	bedrock
BU	break up
CF	channel face
Cl (y)	clay (ey)
Co	coarse
Cob	cobbles
Comp	compact
Conc	concrete
Contam	contaminated
Cord	corduroy
Cr	crushed
D	dense
Decomp	decomposed
Dk	dark
D_R	relative density
E	earth
F	fine
FB	frost boil
FH	frost heave
Fib	fibrous
Fr Wat	free water
Gr (y)	gravel (ly)
Gran	granular
Grn	green
Gry	grey
H	heavy
Hi	highly
HM	hot mix
HP	high plasticity
Ip	plasticity index
L	loose
Liq	liquid
Lo	loam
Lt	light
Matl	material
Max	maximum
MDD	maximum dry density
Med	medium
Mod	moderate
Mott	mottled
MP	medium plasticity
Mrl	marl
Mul	mulch
MWD	maximum wet density
NFP	no further progress
NFP (blds)	no further progress (boulders)
Num	numerous
Ob	overburden
Occ	occasional
Ora	orange
Org	organic
Org M	organic matter
Pavt	pavement
Pedo	pedological
Pen Mac	penetration macadam
Poss	possible
PST	prime and surface treated
Psty	polystyrene
Quant	quantity
Reinf	reinforced
RF	rock fill
RSS	remoulded shear strength
Sa (y)	sand (y)
Sat	saturated
SH	shale
Sh Rk	shot rock
Si (y)	silt (y)
Sl (y)	slight (ly)
SP	slight plasticity
SSM	select subgrade material
St	sensitivity
Stn (y)	stone (y)
Stks	streaks
Surf	surface
Temp	temperature
TH	test hole
TP	test pit
Tps	topsoil
Tr	trace
Unreinf	unreinforced
USS	undisturbed shear strength
Varv	varved
VF	very fine
w	field moisture content
W	with
W_L	liquid limit
Wd (y)	wood (y)
Weath	weathered
Wopt	optimum moisture content
Wp	plastic limit
WT	water table
Yel	yellow

SUSCEPTIBILITY TO FROST HEAVING

HSFH – High
MSFH – Medium
LSFH – Low

ONTARIO PROVINCIAL STANDARD DRAWING

Nov 2006 Rev 1

ABBREVIATIONS

GEOTECHNICAL

OPSD 100.060

Terraprobe

ABBREVIATIONS AND TERMINOLOGY

SAMPLING METHODS

AS	Auger sample
GS	Grab sample
SS	Split spoon
ST	Shelby tube
WS	Wash sample
RC	Rock core
SC	Soil core

PENETRATION RESISTANCE

Standard Penetration Test (SPT) N-value (penetration resistance) is defined as the number of blows required to advance a standard 50 mm (2 in.) diameter split spoon sampler for a distance of 0.3 m (12 in.) with a hammer weighing 63.5 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.).

Dynamic Cone Penetration Test (DCPT) resistance is defined as the number of blows required to advance a conical steel point 50 mm (2 in.) base diameter tapered 60° to the apex and attached to 'A' size drill rods for a distance of 0.3 m (12 in.), with a hammer weighing 63.5 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.).

COHESIONLESS SOILS

Relative Density	N-value Blows/0.3m
Very loose	< 5
Loose	5 – 10
Compact	10 – 30
Dense	30 – 50
Very dense	> 50

COHESIVE SOILS

Consistency	N-value Blows/0.3m	Undrained Shear Strength (kPa)
Very soft	< 2	< 12
Soft	2 – 4	12 – 25
Firm	4 – 8	25 – 50
Stiff	8 – 15	50 – 100
Very stiff	15 – 30	100 – 200
Hard	> 30	> 200

MINOR SOIL CONSTITUENTS

Modifier (e.g)	% by weight
trace (trace silt)	< 10
some (some silt)	10 – 20
(ey) or (y) (sandy)	20 – 35
and (sand and silt)	> 35

TESTS AND SYMBOLS

MH	combined sieve and hydrometer analysis
w,	water content
w_L,	liquid limit
w_P,	plastic limit
I_P,	plasticity index
k	coefficient of permeability
γ	soil unit weight, bulk
G_s	specific gravity
Φ'	effective angle of internal friction
c'	effective cohesion
c_u	undrained shear strength ($\Phi = 0$ analysis)

▽	Unstabilized water level
▼	1st water level measurement
▼	2nd water level measurement
▼	Most recent water level measurement
3.0 +	Undrained shear strength from field vane (with sensitivity)
C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
c_v	coefficient of consolidation
m_v	coefficient of compressibility (volume change)
e	void ratio

FIELD MOISTURE DESCRIPTIONS

Dry	refers to a soil sample with a moisture content well below optimum ($w < w_{opt}$), absence of moisture, dusty, dry to the touch.
Moist	refers to a soil sample with a moisture content at or near optimum ($w \approx w_{opt}$), no visible pore water.
Wet	refers to a soil sample with a moisture content well above optimum ($w > w_{opt}$), has visible pore water.

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LOG OF BOREHOLE C1

Project No. : 1-20-0160	Client : HDR Corporation	Originated by : DH
Date started : December 8, 2021	Project : Teston Road, E.A. Study	Compiled by : LB
Sheet No. : 1 of 1	Location : City of Vaughan, Ontario	Checked by : SD

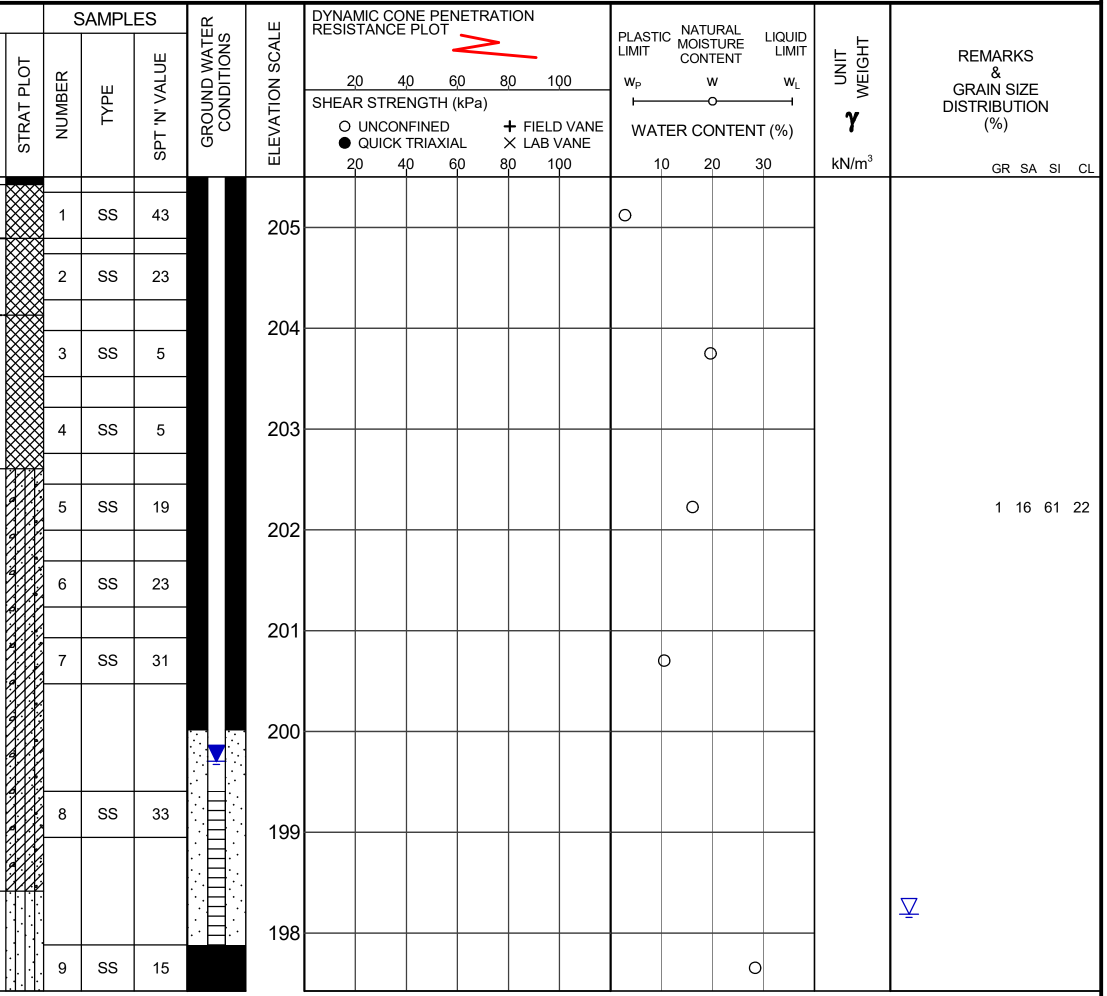
Position : E: 611181.3, N: 4856363.8 (UTM 17T)
Rig type : Truck-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
205.5	**GROUND SURFACE**
	75mm **ASPHALTIC CONCRETE**
204.9 0.6	535mm **FILL**, sand and gravel to gravelly sand, some silt, dense, brown, dry
	FILL, sandy gravel, trace to some silt, frequent crushed rock inclusions, compact, brown, dry
204.1 1.4	**FILL**, silty clay, trace to some sand, trace gravel, firm, brown, moist to wet
202.6 2.9	**SILTY CLAY**, trace sand to sandy, trcae gravel, stiff to hard, brown, moist to wet (GLACIAL TILL)
198.4 7.1	**SAND AND SILT**, trace to some clay, compact, brown, wet
197.4 8.1	**END OF BOREHOLE**

SAMPLES

NUMBER	TYPE	SPT 'N' VALUE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	43	
2	SS	23	
3	SS	5	
4	SS	5	
5	SS	19	1 16 61 22
6	SS	23	
7	SS	31	
8	SS	33	
9	SS	15	



END OF BOREHOLE

Piezometer installation consists of a 50mm diameter PVC pipe with a 1.5m long slotted screen.

Unstabilized water level measured at 7.3 m below ground surface; borehole was open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Jan 6, 2022	5.7	199.8
Jan 31, 2022	5.8	199.7

file: 1-20-0160 bh logs.gpj

+^{3}, ×^{3}: Numbers refer to Sensitivity

○$^{3\%}$ STRAIN AT FAILURE

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LOG OF BOREHOLE C2

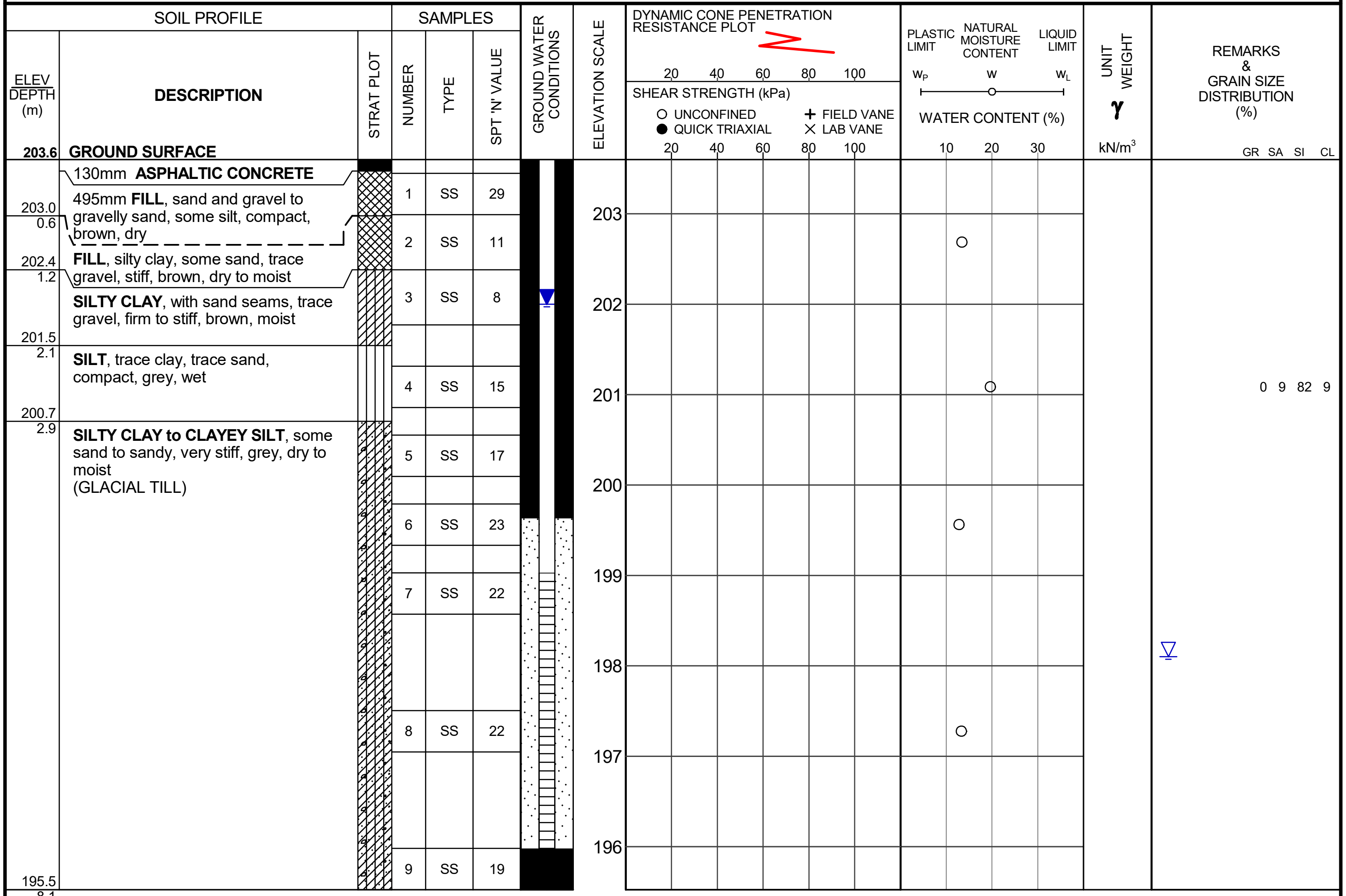
Project No. : 1-20-0160
Date started : December 8, 2021
Sheet No. : 1 of 1

Client : HDR Corporation
Project : Teston Road, E.A. Study
Location : City of Vaughan, Ontario

Originated by : DH
Compiled by : LB
Checked by : SD

Position : E: 611700.5, N: 4856529.0 (UTM 17T)
Rig type : Truck-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers



ELEV DEPTH (m)	DESCRIPTION
203.6	**GROUND SURFACE**
	130mm **ASPHALTIC CONCRETE**
	495mm **FILL**, sand and gravel to gravelly sand, some silt, compact, brown, dry
203.0 0.6	**FILL**, silty clay, some sand, trace gravel, stiff, brown, dry to moist
202.4 1.2	**SILTY CLAY**, with sand seams, trace gravel, firm to stiff, brown, moist
201.5 2.1	**SILT**, trace clay, trace sand, compact, grey, wet
200.7 2.9	**SILTY CLAY to CLAYEY SILT**, some sand to sandy, very stiff, grey, dry to moist (GLACIAL TILL)
195.5 8.1	**END OF BOREHOLE**

NUMBER	TYPE	SPT 'N' VALUE	GR SA SI CL
1	SS	29	
2	SS	11	
3	SS	8	
4	SS	15	0 9 82 9
5	SS	17	
6	SS	23	
7	SS	22	
8	SS	22	
9	SS	19	

END OF BOREHOLE

Piezometer installation consists of a 50mm diameter PVC pipe with a 3.0m long slotted screen.

Unstabilized water level measured at 5.5 m below ground surface; borehole was open upon completion of drilling.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Jan 6, 2022	1.4	202.2
Jan 31, 2022	1.6	202.0

file: 1-20-0160 bh logs.gpj

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

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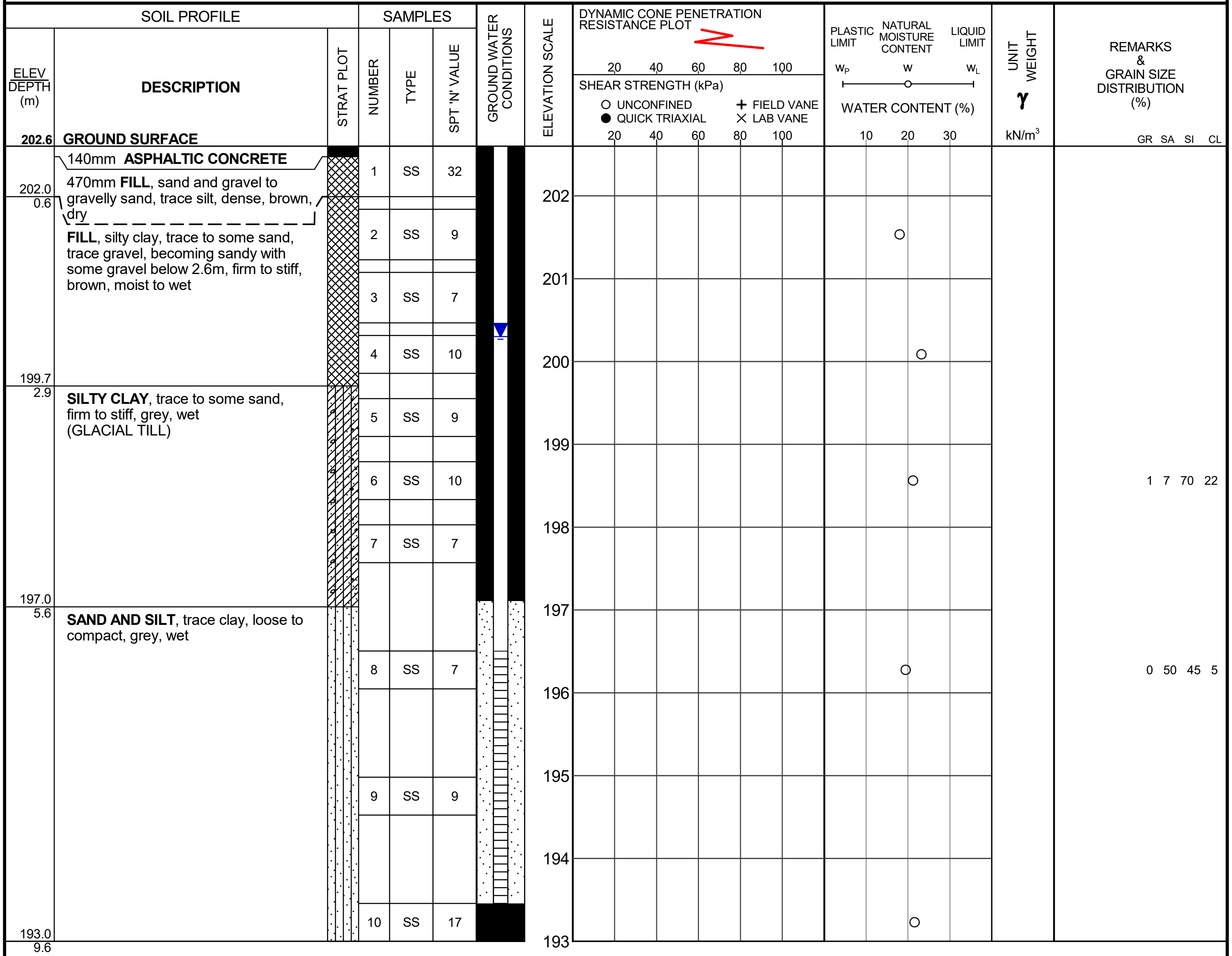
LOG OF BOREHOLE C3

Project No. : 1-20-0160	Client : HDR Corporation	Originated by : DH
Date started : December 13, 2021	Project : Teston Road, E.A. Study	Compiled by : LB
Sheet No. : 1 of 1	Location : City of Vaughan, Ontario	Checked by : SD

Position : E: 612108.4, N: 4856659.2 (UTM 17T)
Rig type : Truck-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers



ELEV DEPTH (m)	DESCRIPTION
202.6	**GROUND SURFACE**
	140mm **ASPHALTIC CONCRETE**
	470mm **FILL**, sand and gravel to gravelly sand, trace silt, dense, brown, dry
202.0 0.6	**FILL**, silty clay, trace to some sand, trace gravel, becoming sandy with some gravel below 2.6m, firm to stiff, brown, moist to wet
199.7 2.9	**SILTY CLAY**, trace to some sand, firm to stiff, grey, wet (GLACIAL TILL)
197.0 5.6	**SAND AND SILT**, trace clay, loose to compact, grey, wet
193.0 9.6	**END OF BOREHOLE**

NUMBER	TYPE	SPT 'N' VALUE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	32	
2	SS	9	
3	SS	7	
4	SS	10	
5	SS	9	
6	SS	10	1 7 70 22
7	SS	7	
8	SS	7	0 50 45 5
9	SS	9	
10	SS	17	

END OF BOREHOLE

Piezometer installation consists of a 50mm diameter PVC pipe with a 3.0m long slotted screen.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Jan 6, 2022	2.1	200.5
Jan 31, 2022	2.3	200.3

file: 1-20-0160 bh logs.gpj

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

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LOG OF BOREHOLE RW1

Project No. : 1-20-0160	Client : HDR Corporation	Originated by : DH
Date started : December 9, 2021	Project : Teston Road, E.A. Study	Compiled by : LB
Sheet No. : 1 of 1	Location : City of Vaughan, Ontario	Checked by : SD

Position : E: 611908.3, N: 4856597.8 (UTM 17T)

Elevation Datum : Geodetic

Rig type : Truck-mounted

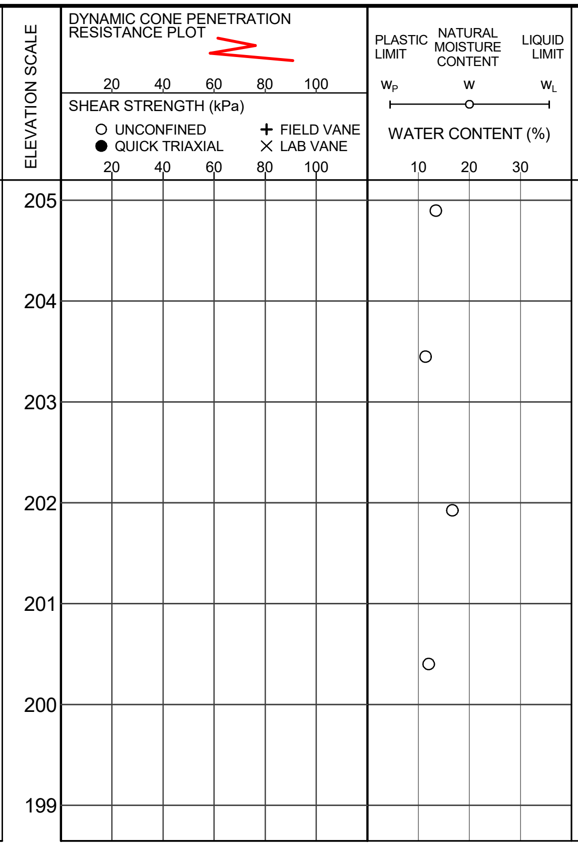
Drilling Method : Solid stem augers

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
205.2	**GROUND SURFACE**
	130mm **ASPHALTIC CONCRETE**
	485mm **FILL**, sand and gravel to gravelly sand, trace silt, compact, brown, wet
204.6 0.6	**FILL**, silty clay, some sand to sandy, trace gravel, firm to stiff, brown, dry
203.1 2.1	**FILL**, silty sand, some clay, trace gravel, loose, brown, wet
201.5 3.7	**SILTY CLAY**, some sand, trace gravel, trace to some organics, firm, grey, moist
200.8 4.4	**SILTY CLAY**, some sand to sandy, trace gravel, very stiff to hard, brown to 5.3m, grey below, moist to wet (GLACIAL TILL)
198.6 6.6	**END OF BOREHOLE**

SAMPLES

NUMBER	TYPE	SPT 'N' VALUE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	15	
2	SS	12	3 25 52 20
3	SS	8	
4	SS	6	
5	SS	7	
6	SS	7	
7	SS	22	
8	SS	36	



UNIT WEIGHT γ kN/m^3

Unstabilized water level measured at 5.3 m below ground surface; borehole was open upon completion of drilling.

file: 1-20-0160 bh logs.gpj

$+^3$, $\times^3$: Numbers refer to Sensitivity   ○ $^{3\%}$ STRAIN AT FAILURE

LOG OF BOREHOLE RW2

Project No. : 1-20-0160
Date started : December 9, 2021
Sheet No. : 1 of 1

Client : HDR Corporation
Project : Teston Road, E.A. Study
Location : City of Vaughan, Ontario

Originated by : DH
Compiled by : LB
Checked by : SD

Position : E: 612585.3, N: 4856805.5 (UTM 17T)
Rig type : Truck-mounted

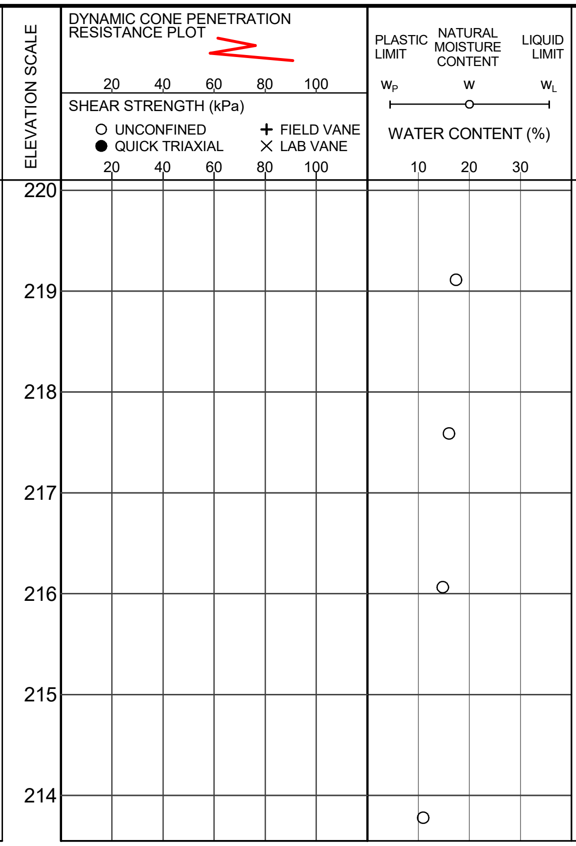
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
220.1	**GROUND SURFACE**
	130mm **ASPHALTIC CONCRETE**
219.6 0.5	380mm **FILL**, sand and gravel to gravelly sand, trace silt, trace clay, dense, brown, dry
	FILL, silty clay, some sand to sandy, trace gravel, stiff, brown, moist
218.0 2.1	**SILTY CLAY**, some sand to sandy, trace gravel, very stiff to hard, brown, dry to moist (GLACIAL TILL)
213.5 6.6	**END OF BOREHOLE**

SAMPLES

NUMBER	TYPE	SPT 'N' VALUE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	47	
2	SS	10	
3	SS	12	
4	SS	23	2 12 63 23
5	SS	31	
6	SS	32	
7	SS	29	
8	SS	47	



GROUND WATER CONDITIONS

UNIT WEIGHT γ kN/m^3

Borehole was dry and open upon completion of drilling.

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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LOG OF BOREHOLE 2+295

Project No. : 1-20-0160
Date started : December 13, 2021
Sheet No. : 1 of 1

Client : HDR Corporation
Project : Teston Road, E.A. Study
Location : City of Vaughan, Ontario

Originated by : DH
Compiled by : LB
Checked by : SD

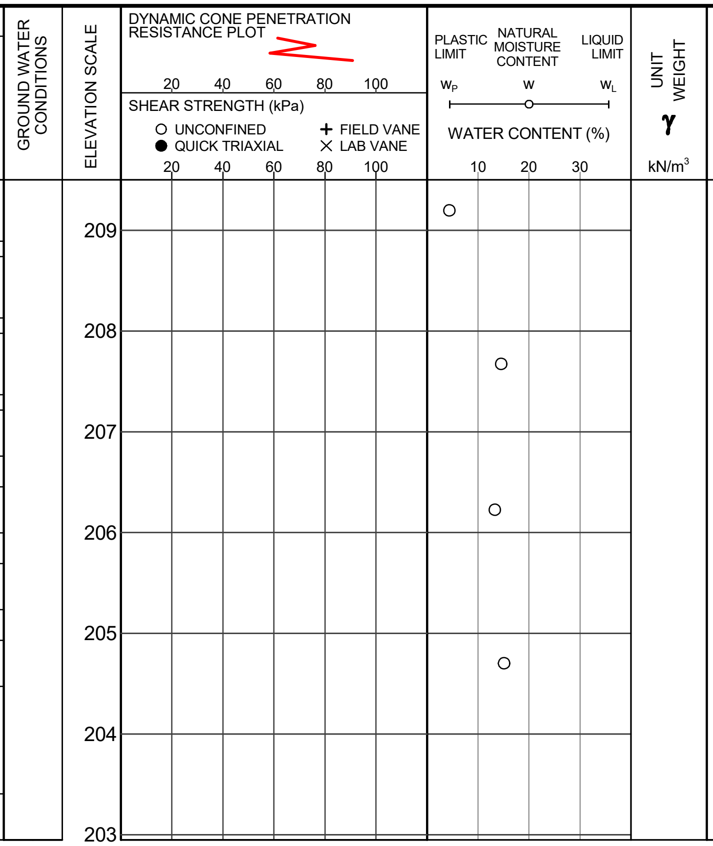
Position : E: 612229.5, N: 4856697.0 (UTM 17T)
Rig type : Truck-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
209.5	**GROUND SURFACE**
	140mm **ASPHALTIC CONCRETE**
208.8 0.7	510mm **FILL**, sand and gravel to gravelly sand, some silt, trace clay, compact, brown, dry
208.1 1.4	**FILL**, silty clay, some sand to sandy, trace gravel, stiff, brown, dry
207.3 2.2	**SILT AND SAND**, trace to some clay, trace gravel, compact, brown, wet
202.9 6.6	**SILTY CLAY**, some sand to sandy, stiff to very stiff, brown to 3.8m, grey below, dry to moist (GLACIAL TILL)

SAMPLES

NUMBER	TYPE	SPT 'N' VALUE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	28				
2	SS	11				
3	SS	20	1	39	50	10
4	SS	22				
5	SS	25	4	21	54	21
6	SS	14				
7	SS	18				
8	SS	19				



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 1-20-0160 bh logs.gpi

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

PAVEMENT BOREHOLE LOGS

Teston Road, from Station 1+000 to Station 3+175

1+000	**WBL**
0 - 140	Asph
140 - 620	Br Gran, Some Si to Si(y), Dry
620 - 1.50	Br Si(y) Cl , Some Sa to Sa(y), Tr Gr, Moist to Wet*

*Sample Depth = 620 - 1.50
w = 22%

1+395	**WBL**
0 - 110	Asph
110 - 690	Br Gran, Some Si, Dry
690 - 1.20	Br Si(y) Sa, Tr Gr, Tr Cl, Dry
1.20 - 1.50	Br Si(y) Cl , Some Sa to Sa(y), Tr Gr, Moist to Wet*

*Sample Depth = 1.20 - 1.50
w = 20%

1+595	**EBL**
0 - 130	Asph
130 - 650	Br Gran, Some Si to Si(y), Dry*
650 - 1.50	Br Si(y) Cl, Some Sa to Sa(y), Tr Gr, Dry to Moist

*Sample Depth = 130 - 650
Passing 26.5 mm = 100%
19 mm = 100%
13.2 mm = 93%
9.5 mm = 89%
4.75 mm = 74%
1.18 mm = 46%
300 µm = 31%
75 µm = 20%
w = 4%
Not Accep Gran A
Not Accep Gran B, Type I

1+800	**WBL**
0 - 130	Asph
130 - 485	Br Gran, Some Si to Si(y), Dry
485 - 1.05	Br Sa & Gr, Some Si to Si(y), Dry to Moist
1.05 - 1.50	Gry Si(y) Sa, Tr to Some Gr, Moist*

*Sample Depth = 1.05 - 1.50
w = 9%

2+000	**EBL**
0 - 155	Asph
155 - 595	Br Gran, Some Si to Si(y), Wet*
595 - 1.05	Br Si(y) Sa, Some Gr to Gr(y), Wet
1.05 - 1.50	Br Sa(y) Si, Some Gr, Tr Cl, Wet

Fr Wat @ 1.05 m

*Sample Depth = 155 - 595
w = 14%

2+405	**EBL**
0 - 125	Asph
125 - 490	Br Gran, Some Si to Si(y), Dry*
490 - 1.50	Gry Si(y) Cl, Some Sa to Sa(y), Tr Gr, Dry to Moist

*Sample Depth = 125 - 490
w = 3%

2+600	**WBL**
0 - 120	Asph
120 - 610	Br Gran, Some Si to Si(y), Dry
610 - 1.05	Br Sa & Gr, Tr to Some Si, Dry
1.05 - 1.50	Blk Si(y) Cl, Some Sa to Sa(y), Tr Gr, Moist

2+800	**WBL**
0 - 160	Asph
160 - 655	Br Gran, Some Si to Si(y), Dry*
656 - 1.20	Br Si(y) Sa, Some Gr, Tr Cl, Moist to Wet**
1.20 - 1.50	Br Si(y) Cl, Some Sa to Sa(y), Tr Gr, Moist

*Sample Depth = 160 - 655
Passing 26.5 mm = 100%
19 mm = 100%
13.2 mm = 96%
9.5 mm = 94%
4.75 mm = 78%
1.18 mm = 49%
300 µm = 33%
75 µm = 21%
w = 3%
Not Accep Gran A
Not Accep Gran B, Type I

**Sample Depth = 655 - 1.20
Passing 4.75 mm = 81%
2.00 mm = 77%
425 µm = 59%
75 µm = 32%
5 µm = 11%
2 µm = 8%
w = 16%
Frost Susc. = LSFH
K factor = 0.15

2+975	**EBL**
0 - 170	Asph
170 - 655	Br Gran, Some Si to Si(y), Dry*
655 - 1.50	Br Si(y) Cl , Some Sa to Sa(y), Tr Gr, Dry

*Sample Depth = 170 - 655
w = 1%

3+100	**EBL**
0 - 175	Asph
175 - 630	Br Gran, Some Si to Si(y), Dry*
630 - 1.50	Br Si(y) Cl , Some Sa to Sa(y), Tr Gr, Dry

*Sample Depth = 175 - 630
w = 2%

ASPHALT CORE PHOTOGRAPHS AND DATA

Sta. 1+395
WBL

Lift Type	Thickness (mm)
HL3	50
HL3	60
Total	110

Sta. 2+665 - BH RW2
EBL

Lift Type	Thickness (mm)
HL3	60
HL8	70
Total	130

Project No. : 1-20-0160
Date : February, 2022

Terraprobe

Prepared by : DP
Checked by : RA

TOPSOIL THICKNESSES

Teston Road, from Station 1+000 to Station 3+175

Teston Road

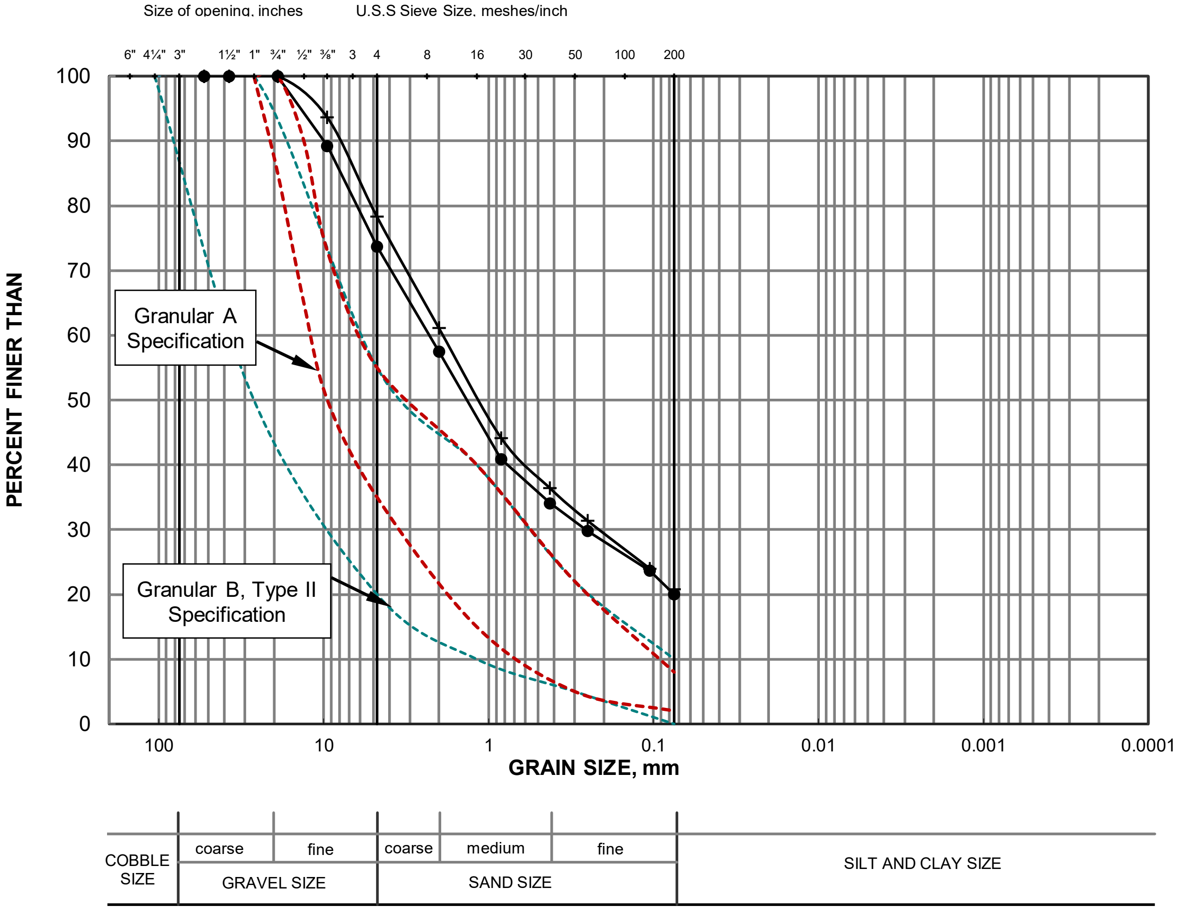
Approximate Station No.	Location	Topsoil Thickness (mm)
1+000	North of Centre Line	165
1+195	South of Centre Line	140
1+395	North of Centre Line	180
1+595	South of Centre Line	165
1+740	South of Centre Line	150
1+800	North of Centre Line	180
1+960	North of Centre Line	140
2+000	South of Centre Line	140
2+165	North of Centre Line	150
2+295	North of Centre Line	150
2+405	South of Centre Line	150
2+600	North of Centre Line	150
2+800	North of Centre Line	165
2+975	South of Centre Line	150
3+100	South of Centre Line	180

APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION	FIGURE B1

GRANULAR BASE/SUBBASE



LEGEND

SYMBOL	STATION	LOCATION	DEPTH (m)
●	1+600	EBL	0.13 - 0.65
+	2+800	WBL	0.16 - 0.66

Project No: 1-20-0160
Date: Jan, 2022

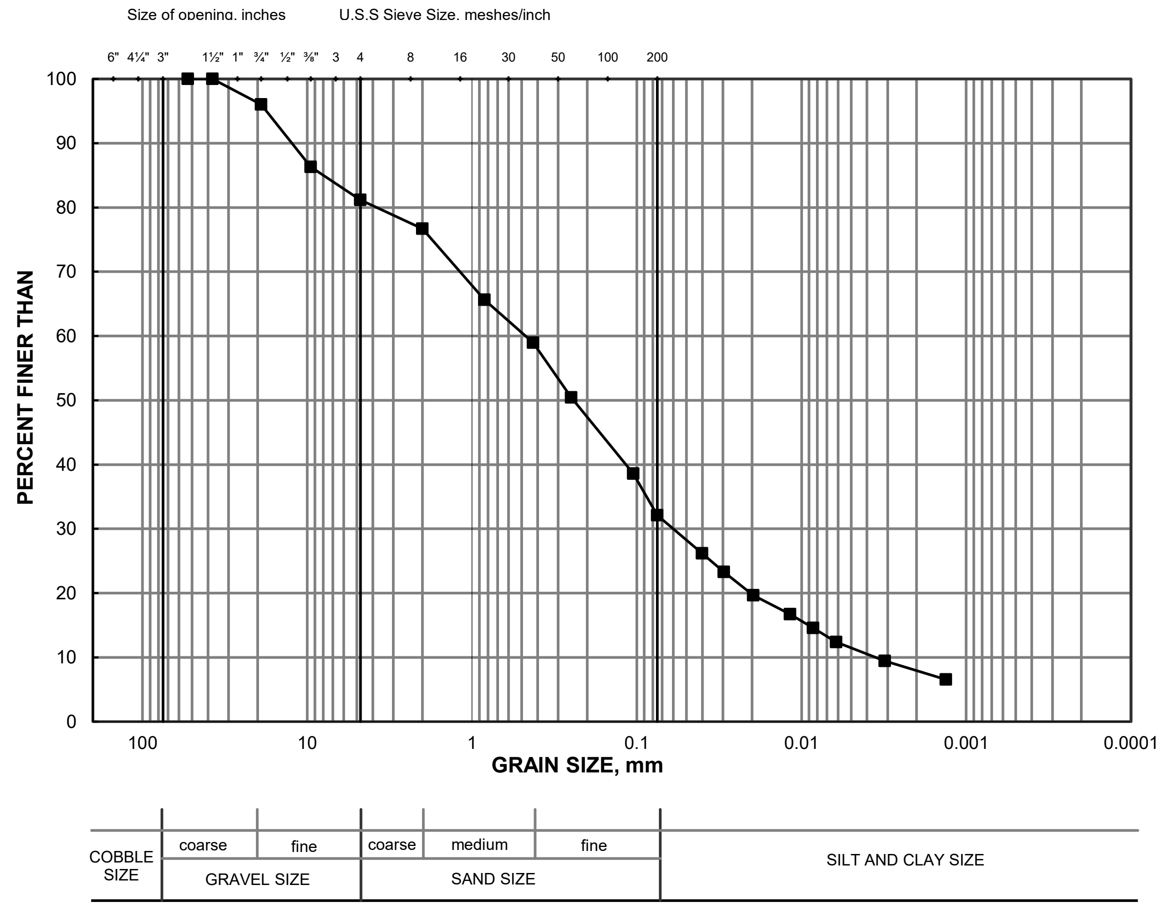
Terraprobe

Prepared by : LB
Checked by : SD

GRAIN SIZE DISTRIBUTION

FIGURE B2

SUBGRADE (Silty Sand)



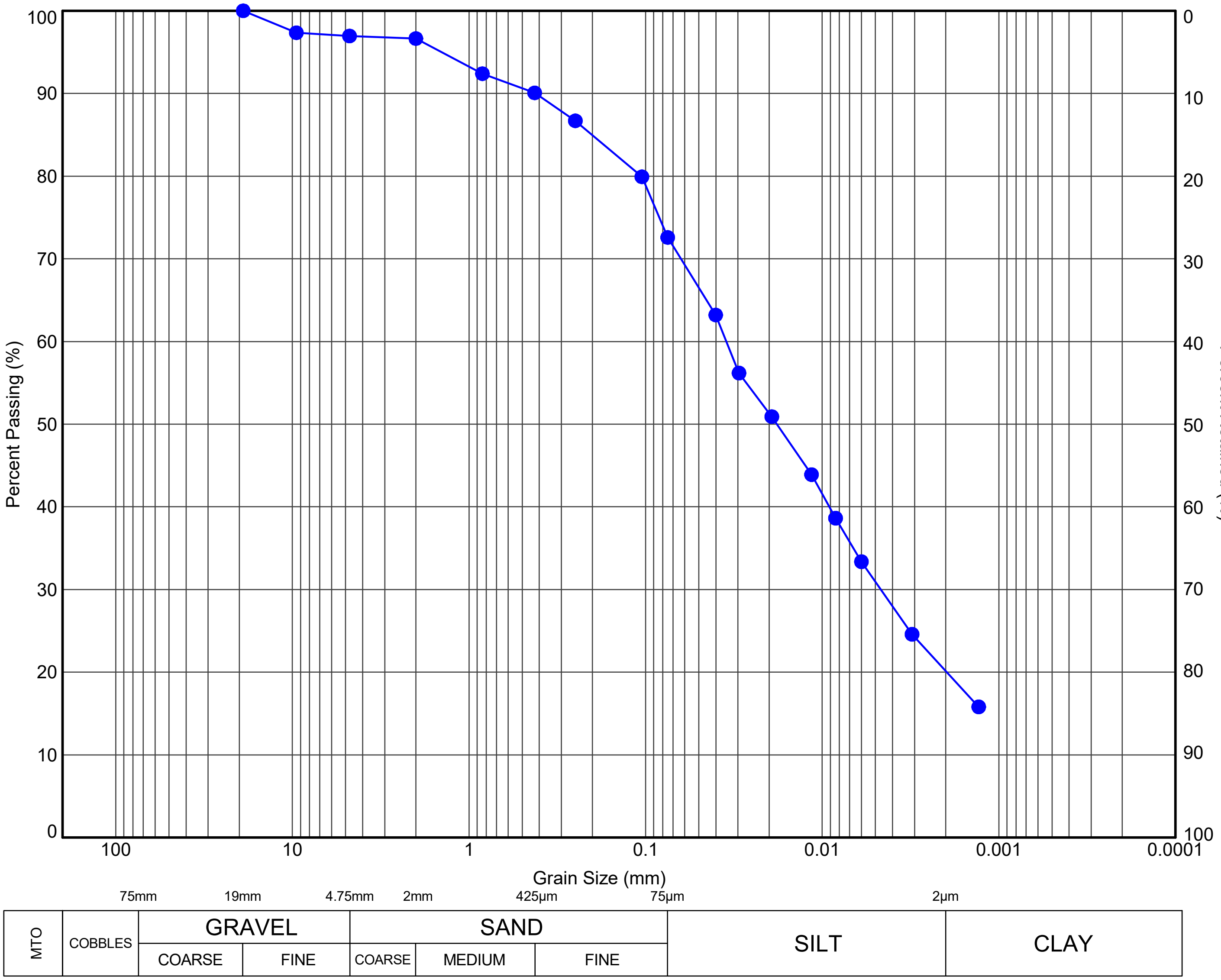
LEGEND

SYMBOL	STATION	LOCATION	DEPTH (m)
■	2+800	WBL	0.66 - 1.20

Project No: 1-20-0160
Date: Jan, 2022

Terraprobe

Prepared by : LB
Checked by : SD



	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**RW1**	SS2	1.0	204.2	3	25	52	20	

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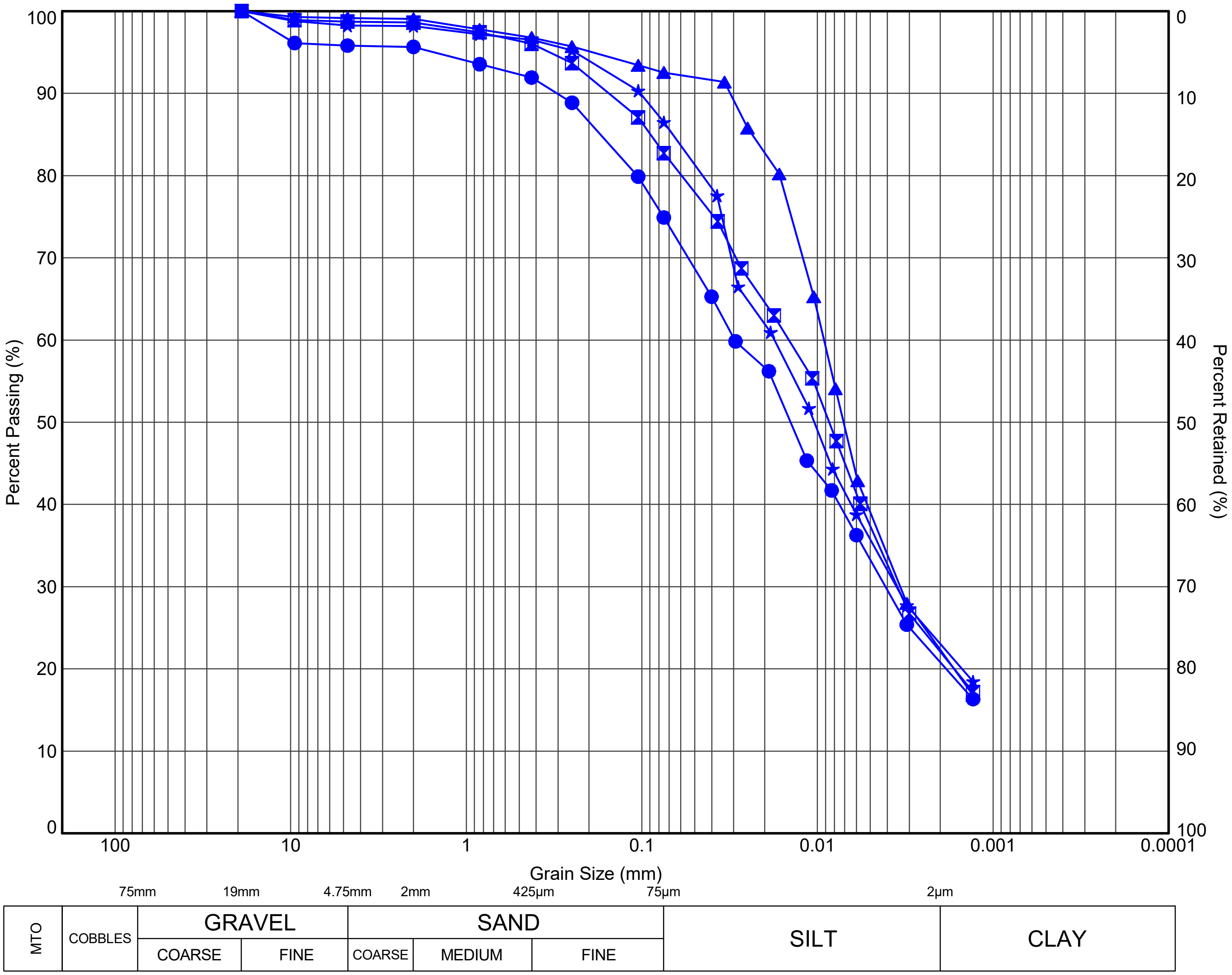
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
FIGURE B3 - FILL-SILTY CLAY

File No.: **1-20-0160**



	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**2+295**	SS5	3.3	206.2	4	21	54	21	
☒	**C1**	SS5	3.3	202.2	1	16	61	22	
▲	**C3**	SS6	4.0	198.6	1	7	70	22	
★	**RW2**	SS4	2.5	217.6	2	12	63	23	

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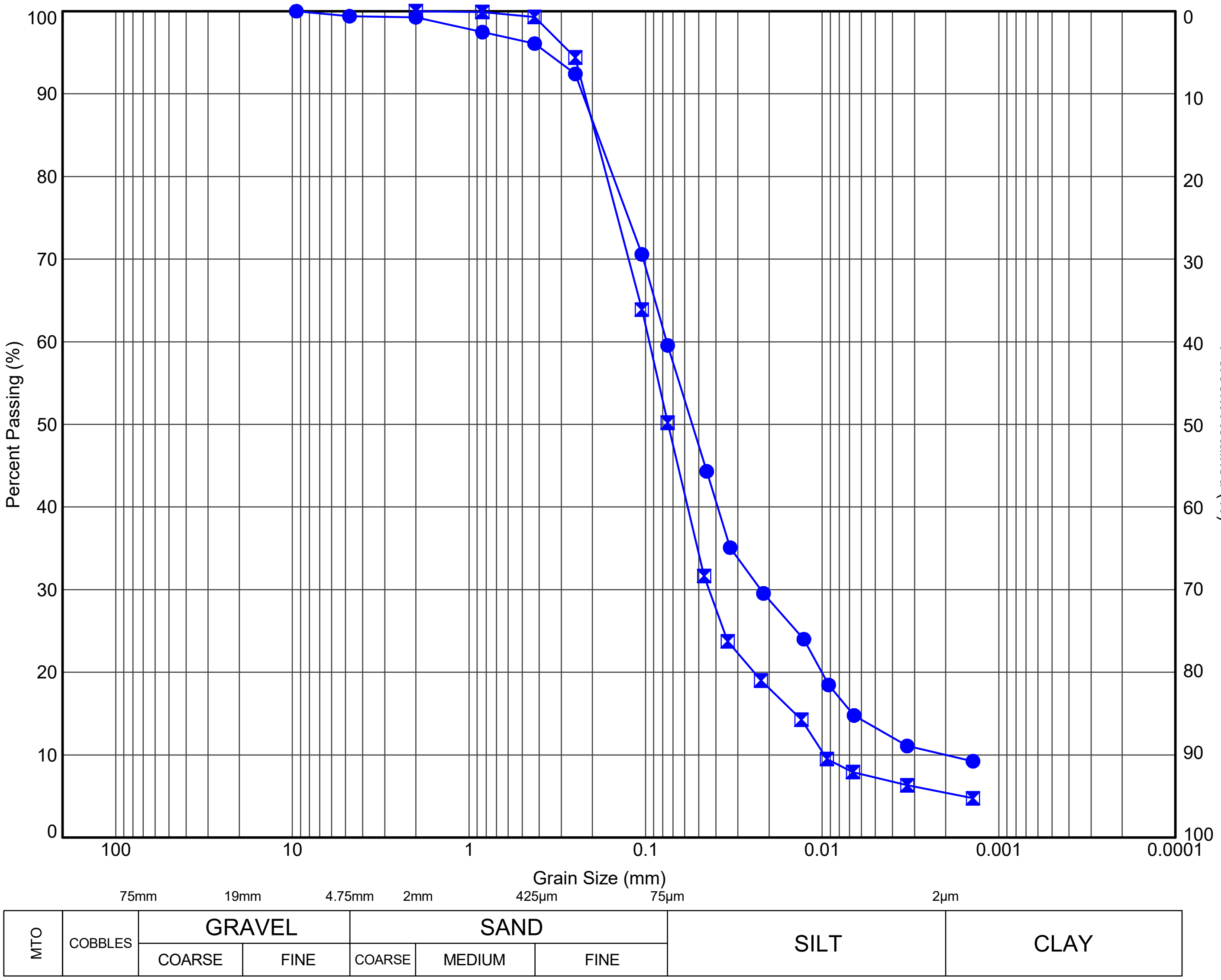
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
FIGURE B4 - SILTY CLAY (GLACIAL TILL)

File No.:

1-20-0160



	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**2+295**	SS3	1.8	207.7	1	39	50	10	
☒	**C3**	SS8	6.3	196.3	0	50	45	5	

Terraprobe

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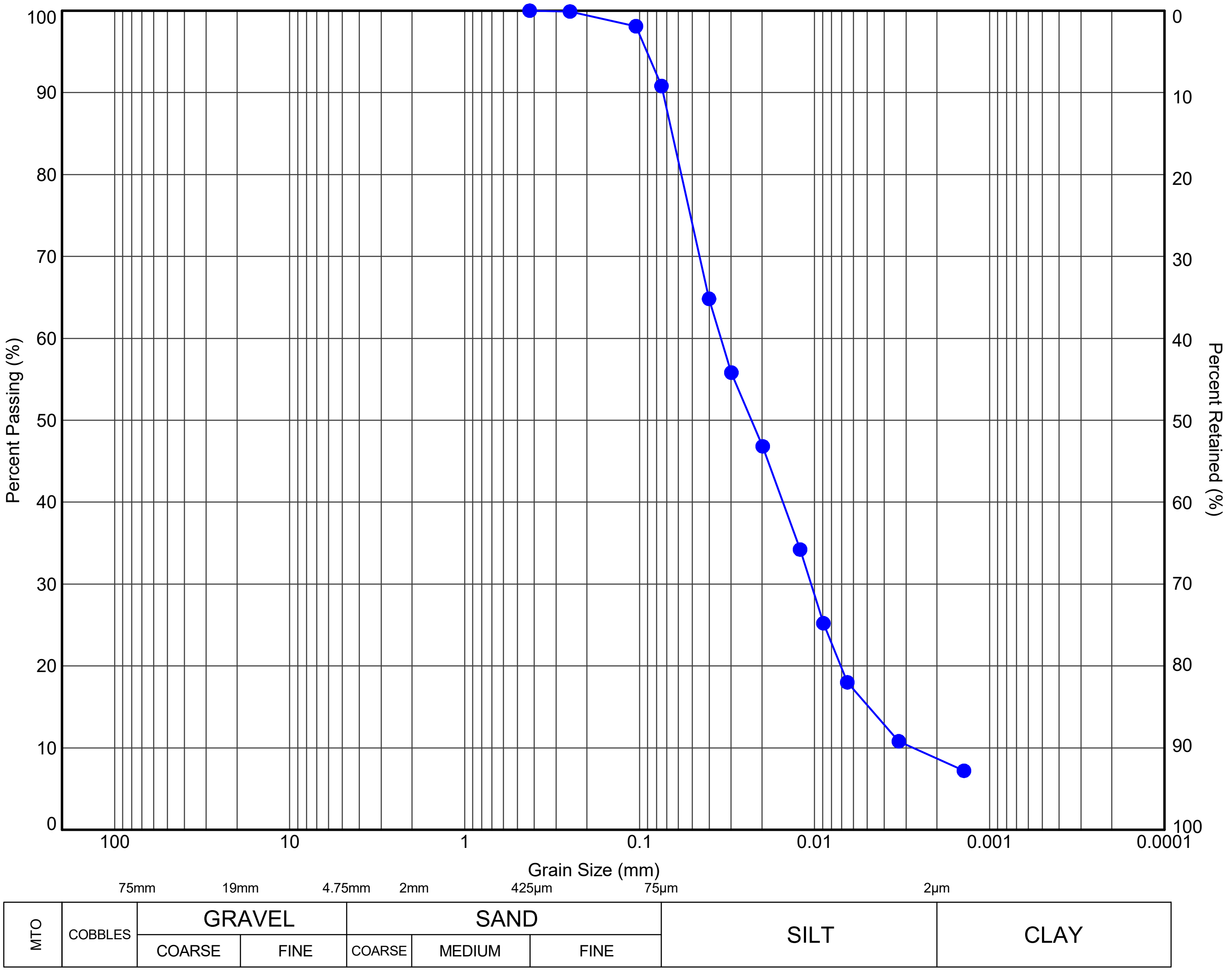
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
FIGURE B5 - SILT AND SAND TO SAND AND SILT

File No.: **1-20-0160**



	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**C2**	SS4	2.5	201.1	0	9	82	9	

Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
FIGURE B6 - SILT

File No.:

1-20-0160

APPENDIX C

Certificates of Analysis

FINAL REPORT

CA40648-DEC21 R

1-20-0160, Teston Rd, C.aledon

Prepared for

Terraprobe Inc

FINAL REPORT

First Page

CLIENT DETAILS

Client	Terraprobe Inc
Address	11 Indell Lane Brampton, ON L6T 3Y3. Canada
Contact	Leila Baninajarian
Telephone	(905) 796-2650
Facsimile	(905) 796-2250
Email	lbaninajarian@terraprobe.ca
Project	1-20-0160, Teston Rd, C.aledon
Order Number	
Samples	Soil (5)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
Facsimile	705-652-6365
Email	brad.moore@sgs.com
SGS Reference	CA40648-DEC21
Received	12/23/2021
Approved	01/05/2022
Report Number	CA40648-DEC21 R
Date Reported	01/05/2022

COMMENTS

Temperature of Sample upon Receipt: 5 degrees C

Cooling Agent Present:Yes

Custody Seal Present:Yes

Chain of Custody Number:026449

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

Client: Terraprobe Inc

Project: 1-20-0160, Teston Rd, C.aledon

Project Manager: Leila Baninajarian

Samplers: Leila. B

MATRIX: SOIL

L1 = REG153 / SOIL / COARSE - TABLE 1 - Agricultural/Other - UNDEFINED

			Sample Number	13	14	15	16	17
			Sample Name	C1_Granular (75mm-610mm)	C2_SS2_(2'-4')	BH8_Granular (155mm-595mm)	GL1_SS2 (2.5'-4.5')	RW2_Granular (132mm-510mm)
			Sample Matrix	Soil	Soil	Soil	Soil	Soil
			Sample Date	08/12/2021	08/12/2021	13/12/2021	13/12/2021	09/12/2021
Parameter	**Units**	**RL**	**L1**	**Result**	**Result**	**Result**	**Result**	**Result**
Hydrides								
Antimony	µg/g	0.8	1	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Arsenic	µg/g	0.5	11	3.9	2.3	2.9	3.5	3.6
Selenium	µg/g	0.7	1.2	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Metals and Inorganics								
Moisture Content	%	no		3.2	13.1	4.7	12.2	4.4
Barium	µg/g	0.1	210	42	43	15	41	16
Beryllium	µg/g	0.02	2.5	0.20	0.41	0.09	0.46	0.11
Boron	µg/g	1	36	6	3	6	3	6
Cadmium	µg/g	0.05	1	0.06	0.12	0.21	0.09	0.20
Chromium	µg/g	0.5	67	7.5	14	3.2	15	3.6
Cobalt	µg/g	0.01	19	4.1	6.8	2.1	7.9	2.6
Copper	µg/g	0.1	62	25	14	7.4	21	8.8
Lead	µg/g	0.1	45	7.6	7.5	13	12	12
Molybdenum	µg/g	0.1	2	0.6	0.3	0.4	0.3	0.3
Nickel	µg/g	0.5	37	9.8	14	6.2	19	6.7
Silver	µg/g	0.05	0.5	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Thallium	µg/g	0.02	1	0.07	0.08	0.04	0.13	0.05
Uranium	µg/g	0.002	1.9	0.41	0.37	0.14	0.44	0.17
Vanadium	µg/g	3	86	12	21	7	22	7
Zinc	µg/g	0.7	290	35	37	93	42	81

MATRIX: SOIL

L1 = REG153 / SOIL / COARSE - TABLE 1 - Agricultural/Other - UNDEFINED

			Sample Number	13	14	15	16	17
			Sample Name	C1_Granular (75mm-610mm)	C2_SS2_(2'-4')	BH8_Granular (155mm-595mm)	GL1_SS2 (2.5'-4.5')	RW2_Granular (132mm-510mm)
			Sample Matrix	Soil	Soil	Soil	Soil	Soil
			Sample Date	08/12/2021	08/12/2021	13/12/2021	13/12/2021	09/12/2021
Parameter	**Units**	**RL**	**L1**	**Result**	**Result**	**Result**	**Result**	**Result**
Other (ORP)								
Mercury	ug/g	0.05	0.16	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sodium Adsorption Ratio	No unit	0.2	1	4.5	12.8	3.0	9.2	15.3
SAR Calcium	mg/L	0.2		51.3	24.5	16.8	8.7	12.5
SAR Magnesium	mg/L	0.3		27.4	14.9	19.0	4.5	7.4
SAR Sodium	mg/L	0.1		162	326	76.6	134	276
Conductivity	mS/cm	0.002	0.47	1.4	1.8	0.63	0.68	1.4
pH	pH Units	0.05		8.20	7.82	8.42	7.93	8.33
Chromium VI	μg/g	0.2	0.66	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Free Cyanide	μg/g	0.05	0.051	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	REG153 / SOIL / COARSE - TABLE 1 - Agricultural/Other - UNDEFINED L1
C1_Granular (75mm-610mm)				
Conductivity	EPA 6010/SM 2510	mS/cm	1.4	0.47
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	No unit	4.5	1
C2_SS2_(2'-4')				
Conductivity	EPA 6010/SM 2510	mS/cm	1.8	0.47
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	No unit	12.8	1
BH8_Granular (155mm-595mm)				
Conductivity	EPA 6010/SM 2510	mS/cm	0.63	0.47
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	No unit	3.0	1
GL1_SS2 (2.5'-4.5')				
Conductivity	EPA 6010/SM 2510	mS/cm	0.68	0.47
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	No unit	9.2	1
RW2_Granular (132mm-510mm)				
Conductivity	EPA 6010/SM 2510	mS/cm	1.4	0.47
Sodium Adsorption Ratio	MOE 4696e01/EPA 6010	No unit	15.3	1

QC SUMMARY

Conductivity

Method: EPA 6010/SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0008-JAN22	mS/cm	0.002	<0.002	0	10	100	90	110	NA		
Conductivity	EWL0027-JAN22	mS/cm	0.002	<0.002	9	10	100	90	110	NA		

Cyanide by SFA

Method: SM 4500 | Internal ref.: ME-CA-[ENV]SFA-LAK-AN-005

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Free Cyanide	SKA5108-DEC21	μg/g	0.05	<0.05	ND	20	98	80	120	99	75	125

Hexavalent Chromium by SFA

Method: EPA218.6/EPA3060A | Internal ref.: ME-CA-[ENV]SKA-LAK-AN-012

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chromium VI	SKA5106-DEC21	ug/g	0.2	<0.2	ND	20	100	80	120	93	75	125

QC SUMMARY

Mercury by CVAAS

Method: EPA 7471A/EPA 245 | Internal ref.: ME-CA-[ENV]SPE-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Mercury	EMS0191-DEC21	ug/g	0.05	<0.05	ND	20	97	80	120	107	70	130

Metals in aqueous samples - ICP-OES

Method: MOE 4696e01/EPA 6010 | Internal ref.: ME-CA-[ENV]SPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
SAR Calcium	ESG0001-JAN22	mg/L	0.2	<0.09	6	20	107	80	120	113	70	130
SAR Magnesium	ESG0001-JAN22	mg/L	0.3	<0.02	7	20	106	80	120	112	70	130
SAR Sodium	ESG0001-JAN22	mg/L	0.1	<0.15	13	20	106	80	120	129	70	130
SAR Calcium	ESG0002-JAN22	mg/L	0.2	<0.09	2	20	103	80	120	105	70	130
SAR Magnesium	ESG0002-JAN22	mg/L	0.3	<0.02	2	20	104	80	120	105	70	130
SAR Sodium	ESG0002-JAN22	mg/L	0.1	<0.15	17	20	100	80	120	85	70	130

QC SUMMARY

Metals in Soil - Aqua-regia/ICP-MS

Method: EPA 3050/EPA 200.8 | Internal ref.: ME-CA-[ENV]SPE-LAK-AN-005

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Silver	EMS0191-DEC21	ug/g	0.05	<0.05	ND	20	95	70	130	116	70	130
Arsenic	EMS0191-DEC21	μg/g	0.5	<0.5	3	20	92	70	130	114	70	130
Barium	EMS0191-DEC21	ug/g	0.1	<0.1	1	20	95	70	130	93	70	130
Beryllium	EMS0191-DEC21	μg/g	0.02	<0.02	6	20	98	70	130	109	70	130
Boron	EMS0191-DEC21	μg/g	1	<1	3	20	99	70	130	94	70	130
Cadmium	EMS0191-DEC21	ug/g	0.05	<0.05	3	20	95	70	130	119	70	130
Cobalt	EMS0191-DEC21	μg/g	0.01	<0.01	2	20	91	70	130	114	70	130
Chromium	EMS0191-DEC21	μg/g	0.5	<0.5	1	20	91	70	130	114	70	130
Copper	EMS0191-DEC21	μg/g	0.1	<0.1	1	20	93	70	130	114	70	130
Molybdenum	EMS0191-DEC21	μg/g	0.1	<0.1	16	20	94	70	130	122	70	130
Nickel	EMS0191-DEC21	ug/g	0.5	<0.5	3	20	95	70	130	120	70	130
Lead	EMS0191-DEC21	ug/g	0.1	<0.1	5	20	92	70	130	96	70	130
Antimony	EMS0191-DEC21	μg/g	0.8	<0.8	ND	20	95	70	130	104	70	130
Selenium	EMS0191-DEC21	μg/g	0.7	<0.7	ND	20	106	70	130	117	70	130
Thallium	EMS0191-DEC21	μg/g	0.02	<0.02	11	20	93	70	130	101	70	130
Uranium	EMS0191-DEC21	μg/g	0.002	<0.002	0	20	99	70	130	104	70	130
Vanadium	EMS0191-DEC21	μg/g	3	<3	1	20	94	70	130	116	70	130
Zinc	EMS0191-DEC21	μg/g	0.7	<0.7	2	20	92	70	130	117	70	130

FINAL REPORT

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	ARD0128-DEC21	pH Units	0.05		0	20	100	80	120			

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act” published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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-- End of Analytical Report --

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: **TERRAPROBE INC.**
11 INDELL LANE
BRAMPTON, ON L6T3Y3
(905) 796-2650

ATTENTION TO: **Leila-B**

PROJECT: **1-20-0160**

AGAT WORK ORDER: **22T860561**

ASBESTOS REVIEWED BY: **Ian Seddon, Analyst**

DATE REPORTED: **Feb 08, 2022**

PAGES (INCLUDING COVER): **4**

VERSION*: **1**

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.*
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Certificate of Analysis

AGAT WORK ORDER: 22T860561

PROJECT: 1-20-0160

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: TERRAPROBE INC.

ATTENTION TO: Leila-B

SAMPLING SITE:Teston Road

SAMPLED BY:Dhruvish

Bulk Asbestos

DATE RECEIVED: 2022-02-04

DATE REPORTED: 2022-02-08

			SAMPLE DESCRIPTION:	BH3, WBL Lane 1	BH-RW2, EB-L1
			SAMPLE TYPE:	Asphalt	Asphalt
			DATE SAMPLED:	2021-12-09	2021-12-09
Parameter	**Unit**	**G / S**	**RDL**	**3480927**	**3480928**
Asbestos (Bulk)	%		0.5	ND	ND

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

3480927-3480928 Condition of sample was satisfactory at time of arrival in laboratory.

"ND" - Not Detected

As per Reg 278/05 and AGAT SOP, all non-detect results have been analyzed and confirmed three times.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Method Summary

CLIENT NAME: TERRAPROBE INC.

PROJECT: 1-20-0160

SAMPLING SITE:Teston Road

AGAT WORK ORDER: 22T860561

ATTENTION TO: Leila-B

SAMPLED BY:Dhruvish

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Asbestos (Bulk)	INOR-249-6010	modified from EPA 600/R-93/116 & NIOSH 9002	PLM

APPENDIX D

Flexible Pavement Condition Evaluation Forms

Ministry of Transportation
Ontario

Flexible Pavement Condition Evaluation Form

Location: Teston Road

From: Station 1+000 **To:** Station 1+180

LHRS ☐☐☐☐☐ begins ☐☐☐☐ offset km **Section Length** 0 1 8 0 m

Survey Date 2 2 year 0 1 month **PCR** 9 5 % **RCR** 9 . 5

Contract No. ☐☐ - ☐☐☐ **WP No.** ☐☐☐☐☐☐☐☐☐

District ☐☐ **Highway** ☐☐☐☐

Traffic Direction B — B - both directions; N - northbound; S - southbound; E - eastbound; W - westbound

Facility A — A - all lanes; C - collector; E - express; O - others (additional lanes)

Class C — F - freeway; A - arterial; C - collector; L - local; S - secondary

Ride Condition Rating (at 80 km/hr)	10	Excellent (smooth)								
	8	Good (comfortable)								
	6	Fair (uncomfortable)								
	4	Poor (v. rough/bumpy)								
	2	Very Poor, (dangerous, at 80 km/hr)								
	0									

				Severity of Distress					Density of Distress Extent of Occurrence %				
				Very Slight	Slight	Moderate	Severe	Very Severe	Few <10	Intermittent 10-20	Frequent 20-50	Extensive 50-80	Throughout 80-100
PAVEMENT				1	2	3	4	5	1	2	3	4	5
Surface Defects		Ravelling & C. Agg. Loss	1	✓					✓				
		Flushing	2										
Surface Deformations		Rippling and Shoving	3										
		Wheel Track Rutting	4										
		Distortion	5										
CRACKING	Longitudinal Wheel Track	Single and Multiple	6										
		Alligator	7										
	Centre Line	Single and Multiple	8										
		Alligator	9										
	Pavement Edge	Single and Multiple	10										
		Alligator	11										
	Transverse	Half, Full and Multiple	12										
		Alligator	13										
	Longitudinal Meander and Midlane		14										
	Random / Map		15	✓					✓				

Distress Comments: (items not covered above)

Shoulders			**Severity of Distress**				**Density of Distress** Extent of Occurrence, %			
			Right		Left		Right		Left	
Dominant Type		Distress	Mod. 1	Sev. 2	Mod. 1	Sev. 2	10-30 1	>30 2	10-30 1	>30 2
Paved Full		Cracking								
		Pavement Edge/ Curb Separation								
Paved Partial		Distortion								
Surface Treated		Breakup/Separtion								
		Edge Break								
Primed		Breakup/Separtion								
Gravel										

Maintenance Treatment		**EXTENT OF OCCURRENCE, %**				
		<10 1	10-20 2	20-50 3	50-80 4	>80 5
Pavement	Manual Patching					
	Machine Patching	✓				
	Spray Patching					
	Rout and Seal Cracks				✓	
	Chip Seal					
Shoulders	Manual Patching					
	Machine Patching					
	Rout and Seal Cracks					
	Chip Seal					

Other Comments: (e.g., subsections, additional contracts)

Evaluated by: Sepideh D-Monfared, P.Eng.

Ministry of Transportation
Ontario

Flexible Pavement Condition Evaluation Form

Location: Teston Road

From: Station 1+180 **To:** Station 2+720

LHRS ☐☐☐☐☐ begins ☐☐.☐ km offset

Section Length 1 5 4 0 m

Survey Date 2 2 year 0 1 month

PCR 6 5 %

RCR 6 . 5

Contract No. ☐☐ - ☐☐☐

WP No. ☐☐☐☐☐☐☐☐☐

District ☐☐

Highway ☐☐☐☐

Traffic Direction B — B - both directions; N - northbound; S - southbound; E - eastbound; W - westbound

Facility A — A - all lanes; C - collector; E - express; O - others (additional lanes)

Class C — F - freeway; A - arterial; C - collector; L - local; S - secondary

Ride Condition Rating (at 80 km/hr)				Severity of Distress					Density of Distress Extent of Occurrence %				
10 8 6 4 2 0	Excellent (smooth) Good (comfortable) Fair (uncomfortable) Poor (v. rough/bumpy) Very Poor, (dangerous, at 80 km/hr)			Very Slight	Slight	Moderate	Severe	Very Severe	Few <10	Intermittent 10-20	Frequent 20-50	Extensive 50-80	Throughout 80-100
PAVEMENT				1	2	3	4	5	1	2	3	4	5
Surface Defects		Ravelling & C. Agg. Loss	1		✓						✓		
		Flushing	2										
Surface Deformations		Rippling and Shoving	3										
		Wheel Track Rutting	4		✓					✓			
		Distortion	5		✓				✓				
CRACKING	Longitudinal Wheel Track	Single and Multiple	6		✓				✓				
		Alligator	7										
	Centre Line	Single and Multiple	8			✓				✓			
		Alligator	9		✓					✓			
	Pavement Edge	Single and Multiple	10		✓						✓		
		Alligator	11		✓					✓			
	Transverse	Half, Full and Multiple	12		✓				✓				
		Alligator	13		✓				✓				
	Longitudinal Meander and Midlane		14										
	Random / Map		15		✓					✓			

Distress Comments: (items not covered above)

Shoulders			**Severity of Distress**				**Density of Distress** Extent of Occurrence, %			
			Right		Left		Right		Left	
Dominant Type		Distress	Mod.	Sev.	Mod.	Sev.	10-30	>30	10-30	>30
			1	2	1	2	1	2	1	2
Paved Full		Cracking								
		Pavement Edge/ Curb Separation								
Paved Partial		Distortion								
Surface Treated		Breakup/Separtion								
		Edge Break								
Primed		Breakup/Separtion								
Gravel	✓									

Maintenance Treatment		EXTENT OF OCCURRENCE, %				
		<10	10-20	20-50	50-80	>80
		1	2	3	4	5
Pavement	Manual Patching					
	Machine Patching	✓				
	Spray Patching					
	Rout and Seal Cracks		✓			
	Chip Seal					
Shoulders	Manual Patching					
	Machine Patching					
	Rout and Seal Cracks					
	Chip Seal					

Other Comments: (e.g., subsections, additional contracts)

Evaluated by: Sepideh D-Monfared, P.Eng.

Flexible Pavement Condition Evaluation Form

Ministry of Transportation

Ontario

Location: Teston Road

From: Station 2+720 **To:** Station 3+175

District ☐☐ **Highway** ☐☐☐☐

LHRS ☐☐☐☐☐ (begins) ☐☐.☐ km (offset) **Section Length** 0 4 5 5 m

Traffic Direction B — B - both directions; N - northbound; S - southbound; E - eastbound; W - westbound

Survey Date 2 2 (year) 0 1 (month) **PCR** 9 5 % **RCR** 9 . 5

Facility A — A - all lanes; C - collector; E - express; O - others (additional lanes)

Contract No. ☐☐ - ☐☐☐ **WP No.** ☐☐☐☐☐☐☐☐☐

Class C — F - freeway; A - arterial; C - collector; L - local; S - secondary

Ride Condition Rating (at 80 km/hr)	
10	Excellent (smooth)
8	Good (comfortable)
6	Fair (uncomfortable)
4	Poor (v. rough/bumpy)
2	Very Poor, (dangerous, at 80 km/hr)
0	

			Severity of Distress					Density of Distress Extent of Occurrence %				
			Very Slight	Slight	Moderate	Severe	Very Severe	Few <10	Intermittent 10-20	Frequent 20-50	Extensive 50-80	Throughout 80-100
PAVEMENT			1	2	3	4	5	1	2	3	4	5
Surface Defects	Ravelling & C. Agg. Loss	1	✓					✓				
	Flushing	2										
Surface Deformations	Rippling and Shoving	3										
	Wheel Track Rutting	4										
	Distortion	5										
CRACKING — Longitudinal Wheel Track	Single and Multiple	6										
	Alligator	7										
CRACKING — Centre Line	Single and Multiple	8										
	Alligator	9										
CRACKING — Pavement Edge	Single and Multiple	10										
	Alligator	11										
CRACKING — Transverse	Half, Full and Multiple	12										
	Alligator	13										
CRACKING	Longitudinal Meander and Midlane	14										
	Random / Map	15										

Shoulders			**Severity of Distress**				**Density of Distress** Extent of Occurrence, %			
			Right		Left		Right		Left	
Dominant Type		Distress	Mod. 1	Sev. 2	Mod. 1	Sev. 2	10-30 1	>30 2	10-30 1	>30 2
Paved Full		Cracking								
		Pavement Edge/ Curb Separation								
Paved Partial		Distortion								
Surface Treated		Breakup/Separtion								
		Edge Break								
Primed		Breakup/Separtion								
Gravel										

Maintenance Treatment		**EXTENT OF OCCURRENCE, %**				
		<10 1	10-20 2	20-50 3	50-80 4	>80 5
Pavement	Manual Patching					
	Machine Patching					
	Spray Patching					
	Rout and Seal Cracks					
	Chip Seal					
Shoulders	Manual Patching					
	Machine Patching					
	Rout and Seal Cracks					
	Chip Seal					

Distress Comments: (items not covered above)

Other Comments: (e.g., subsections, additional contracts)

Evaluated by: Sepideh D-Monfared, P.Eng.

APPENDIX E

Pavement Design Data

Table E1
Teston Road
250m West of Pine Valley Dr. to Kleinburg Summit Way
City of Vaughan
Equivalent Single Axle Load Calculations (AADT DATA)

Description - Teston Road (Kleinburg Summit Way to Kipling Avenue)					
Traffic Data Year		**2019**	**2022**	**2031**	**2041**
Design Year			**2022**		
Analysis Period		3	9	10	
1a) Average Annual Daily Traffic (AADT)		7,300	8,548	13,722	20,115
Annual Growth Rate (%)		5.40%	5.40%	5.40%	
1b) Truck fraction of total traffic			2.5%	2.5%	
Number of lanes in one direction			1	1	
1c) Directional Factor			0.5	0.5	
1d) Lane distribution Factor			1	1	
	Daily Truck Volume		**107**	**172**	
Road Classification			**Rural Collector**		
2) Breakdown of Truck Proportions					
	Class 1		90.0%	90.0%	
	Class 2		2.0%	2.0%	
	Class 3		4.0%	4.0%	
	Class 4		4.0%	4.0%	
3) Daily Truck Volumes (4 Classes)			**2022 to 2031**	**2031 to 2041**	
	Class 1		96	155	
	Class 2		2	3	
	Class 3		4	7	
	Class 4		4	7	
4) Truck Factors (4 Classes)					
	Class 1		0.5	0.5	
	Class 2		2.3	2.3	
	Class 3		1.6	1.6	
	Class 4		5.5	5.5	
5) Daily ESALs per Truck Class (4 Classes)					
	Class 1		48	77	
	Class 2		5	8	
	Class 3		7	11	
	Class 4		24	38	
6) Total Daily ESALs in Design Lane			**83**	**134**	
7) Total Base Year ESALs			**2022**	**2031**	
Number of Days of Truck Traffic			300	300	
	Total Base Year ESALs		**24,900**	**40,200**	
8) Cumulative ESALs for Design Period					
Design Period			9	10	
Annual Growth Rate (%)			5.40%	5.40%	
Geometric Growth Factor			11.3	12.9	
			281,370	518,580	
	Cumulative ESALs for the Design Period			**799,950**	

Note: ESAL Calculations are based on "Procedures for Estimating Traffic Loads for Pavement Design",Hajek, J., 1995, and "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (MI-83), 2008.

Table E2
Teston Road
250m West of Pine Valley Dr. to Kleinburg Summit Way
City of Vaughan
Equivalent Single Axle Load Calculations (AADT DATA)

Description - Teston Road (Kipling Avenue to Pine Valley Drive)					
Traffic Data Year		**2020**	**2022**	**2031**	**2041**
Design Year			**2022**		
Analysis Period		2	9	10	
1a) Average Annual Daily Traffic (AADT)		6,100	6,880	11,822	20,115
Annual Growth Rate (%)		6.20%	6.20%	6.20%	
1b) Truck fraction of total traffic			4.9%	4.9%	
Number of lanes in one direction			1	1	
1c) Directional Factor			0.5	0.5	
1d) Lane distribution Factor			1	1	
Daily Truck Volume			**169**	**290**	
Road Classification			**Rural Collector**		
2) Breakdown of Truck Proportions					
	Class 1		90.0%	90.0%	
	Class 2		2.0%	2.0%	
	Class 3		4.0%	4.0%	
	Class 4		4.0%	4.0%	
3) Daily Truck Volumes (4 Classes)			**2022 to 2031**	**2031 to 2041**	
	Class 1		152	261	
	Class 2		3	6	
	Class 3		7	12	
	Class 4		7	12	
4) Truck Factors (4 Classes)					
	Class 1		0.5	0.5	
	Class 2		2.3	2.3	
	Class 3		1.6	1.6	
	Class 4		5.5	5.5	
5) Daily ESALs per Truck Class (4 Classes)					
	Class 1		76	131	
	Class 2		8	13	
	Class 3		11	19	
	Class 4		37	64	
6) Total Daily ESALs in Design Lane			**131**	**226**	
7) Total Base Year ESALs			**2022**	**2031**	
Number of Days of Truck Traffic			300	300	
Total Base Year ESALs			**39,300**	**67,800**	
8) Cumulative ESALs for Design Period					
Design Period			9	10	
Annual Growth Rate (%)			6.20%	6.20%	
Geometric Growth Factor			11.6	13.4	
			455,880	908,520	
Cumulative ESALs for the Design Period				**1,364,400**	

Note: ESAL Calculations are based on "Procedures for Estimating Traffic Loads for Pavement Design",Hajek, J., 1995, and "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions" (MI-83), 2008.

Table E3

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.: 1-20-0160

Project Name: Teston Road Environmental Assessment

Design Section: Station 1+000 to Station 3+175

Design Structural Number for Future Traffic

Horizon Year:	**2031**	**2041**
Design ESALs:	455,900	1,364,500
Initial Serviceability:	4.4	4.4
Terminal Serviceability:	2.2	2.2
Level of Reliability (%):	85	85
Overall Standard Deviation:	0.44	0.44
Subgrade Resilient Modulus (MPa):	30	30
Design Structural Number:	87	102

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA				
Base Course				
Subbase Course				
Total				

The existing pavement is structurally inadequate.

New Pavement Structure Design

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	125	0.42	1.0	53
Base Course	125	0.14	1.0	18
Subbase Course	350	0.09	1.0	32
Total	600			103

The designed pavement is structurally adequate.

Table E4

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.:	1-20-0160
Project Name:	Teston Road Environmental Assessment
Design Section:	Station 2+720 to Station 3+175

Design Structural Number for Future Traffic

Horizon Year:	**2031**
Design ESALs:	455,900
Initial Serviceability:	4.4
Terminal Serviceability:	2.2
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	35
Design Structural Number:	82

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	165	0.28	1.0	47
Base Course	150	0.12	0.9	17
Subbase Course	325	0.09	0.9	27
Total	640			91

The existing pavement is structurally adequate.

Table E5

1993 AASHTO FLEXIBLE PAVEMENT DESIGN

File No.: 1-20-0160

Project Name: Teston Road Environmental Assessment

Design Section: Station 2+720 to Station 3+175

Design Structural Number for Future Traffic

Horizon Year:	**2041**
Design ESALs:	1,364,500
Initial Serviceability:	4.4
Terminal Serviceability:	2.2
Level of Reliability (%):	85
Overall Standard Deviation:	0.44
Subgrade Resilient Modulus (MPa):	35
Design Structural Number:	97

Effective Structural Number of Existing Pavement

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
HMA	165	0.28	1.0	47
Base Course	150	0.12	0.9	17
Subbase Course	325	0.09	0.9	27
Total	640			91

The existing pavement is structurally inadequate.

Mill and HMA Overlay Design

Mill (mm): **50**

HMA Overlay (mm): **50**

Pavement Components	Thickness (mm)	Structural Coefficient	Drainage Coefficient	Structural Number
New HMA	50	0.42	1.0	21
Remaining AC	115	0.28	1.0	33
Base Course	150	0.12	0.9	17
Subbase Course	325	0.09	0.9	27
Total	640			98

The designed pavement is structurally adequate.