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FOUNDATION INVESTIGATION AND DESIGN REPORT

HIGHWAY 7 & 8 INTERCHANGE – SIGN SUPPORT STRUCTURES

HIGHWAY 8, KITCHENER, ONTARIO
Agreement No. 3021-E-0029
Work Order No. 2
G.W.P. 3061-22-00
GEOCRES NO. 40P08-303

Client Name: MTO/Parsons
Date: October 17, 2024
File: 49053

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CITY OF KITCHENER, ONTARIO
G.W.P. 3061-22-00

GEOCRES NO.: 40P08-303

PART A: FACTUAL INFORMATION

1. INTRODUCTION

Thurber Engineering (Thurber) has been retained by Parsons on behalf of the Ministry of Transportation, Ontario (MTO) to undertake a geotechnical investigation in support of the proposed relocation of three (3) sign support structures as part of the works at the Highway 7 & 8 interchange in the City of Kitchener, Ontario. A site location map is provided on the Borehole Location Plan in Appendix A.

This work is completed as per the MTO Work Order Number 2 of the Retainer Agreement 3021-E-0029 dated March 6, 2024.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. SITE DESCRIPTION AND GEOLOGY

The proposed site is located on Highway 8 Westbound Lane between Hwy 7 & 8 interchange and approximately 520 m east of Highway 8 Underpass at Franklin St. South in the City of Kitchener, Ontario. The urban area adjacent to the highway is densely developed with commercial and residential buildings and municipal roadways.

The site is located within the Physiographic Region of Southern Ontario known as the Waterloo Sandhills. The area is characterized by a flat topography, heavy textured soil and poor drainage

(Chapman and Putnam, 1984). The overburden deposits generally consist of sands and silts underlain by sandy silt to silt till.

3. INVESTIGATION PROCEDURES

The foundation investigation was carried out between April 12 and 16, 2024, and involved the completion of a total of five (5) boreholes to an approximate depth of 8.2 m below ground surface.

Utility clearances and Permits were obtained prior to mobilization to the site. The borehole locations were marked in the field by Thurber field staff using a Trimble R10 survey unit. The coordinate system MTM NAD 83, Zone 10 was used for the borehole locations.

Boreholes BH-1, BH-3, BH-4 and BH-5 were advanced on the highway in the median or shoulder using truck mounted drill rig whereas Borehole BH-2 was advanced in the private property North of the Highway 8 travelled lane using a track mounted drill rig. The drill rigs were supplied and operated by Elements GEO of Hamilton, Ontario. Lane closure and traffic control were provided during drilling. Hollow-stem augers were used to advance the boreholes and the soil samples were obtained using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) per ASTM D1586.

The as-drilled borehole locations were surveyed using Trimble R10 GPS upon completion of drilling and are shown in the Borehole Location Plan included in Appendix A.

The drilling, sampling and in-situ testing operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

All boreholes were backfilled in general accordance with MOE Regulation 903 as amended by Regulation 372. Backfilling details for each borehole are provided on the Record of Borehole sheets in Appendix B.

The borehole locations, geographic coordinates, ground surface elevations and depths of termination are summarized in the table below.

Borehole	Northing	Easting	Ground Surface Elevation (m)	Depth of Borehole (m) / Elevation
BH-1	4811087.5	227524.2	322.2	8.2 / 314.0
BH-2	4810978.5	227797.2	325.1	8.2 / 316.9

Borehole	Northing	Easting	Ground Surface Elevation (m)	Depth of Borehole (m) / Elevation
BH-3	4810956.6	227789.3	323.1	8.2 / 314.9
BH-4	4810649.9	228489.5	329.9	8.2 / 321.7
BH-5	4810636.0	228483.5	329.4	8.2 / 321.2

Groundwater conditions in the open boreholes were observed throughout the drilling operation.

3.1 Laboratory Testing

The recovered soil samples were subjected to Visual Identification (VI) and natural moisture content determination. Selected samples were also subjected to grain size distribution analysis and Atterberg Limits testing where appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets in Appendix B and are shown on figures in Appendix C.

Analytical testing was carried out on samples of the fill and native soils to assess the potential for sulphate attack on buried concrete structures, as well as the potential for corrosion associated with buried steel elements of the structures. The results of the analytical testing are summarized in this report and presented in Appendix F.

4. SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and interpreted stratigraphic profile is presented in Appendix A. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following sections. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. Classification and descriptions of coarse-grained and fine-grained soils are made in general accordance with ASTM D2487 and MTO's Soil Classification Manual, respectively.

The boundaries between soil strata on the record of boreholes have been inferred from non-continuous sampling, observation of the progress of drilling, and the results of Standard Penetration Testing. Therefore, the boundaries represent the transitions between soil deposits rather than exact planes of geological change. Variation on the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

In general, the subsurface conditions below the pavement structure and fill materials consist of a native silty sand to sand deposit overlying sand and silt till.

A detailed description of the subsurface conditions is presented in the following sections.

4.1 Sign Relocation # 1 (Cantilever Structure)

Borehole BH-1 was drilled on the outside shoulder of SW ramp (Highway 8 westbound to Highway 7/8 westbound) near the proposed sign relocation # 1. The encountered soil conditions are discussed as follows:

4.1.1 Asphalt

Asphalt approximately 225 mm thick was encountered at the ground surface.

4.1.2 Fill

Fill material approximately 1.2 m thick and consisting of sand and gravel was encountered underlying the asphalt. The base of the fill was at elevation of 320.8 m.

The SPT 'N' values ranged from 22 to 77 blows per 0.3 m of penetration suggesting that the fill material is compact to very dense. Natural moisture contents ranged from 3 to 8 percent.

4.1.3 Sand

A 2.7 m thick native sand deposit with trace silt was encountered underlying the fill material and extended to an approximate depth of 4.1 m (elevation 318.1 m).

SPT 'N' values encountered within sand deposit ranged between 12 to 29 blows per 0.3 m of penetration indicating these deposits to be compact. Natural moisture contents ranged from 9 to 10 percent.

The results of grain size analysis testing conducted on a sample of the sand deposit are provided on the Record of Borehole Sheets in Appendix B and included on Figure 1 in Appendix C. The results are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	94
Silt + Clay	6

4.1.4 Sand and Silt (TILL)

A native sand and silt till, containing trace clay and trace to some gravel, was encountered below the sand deposit and extended to the termination depth of the borehole.

SPT 'N' values ranged between 11 to 24 blows per 0.3 m penetration indicating these soil deposits to be compact. The measured moisture contents generally ranged from 10 to 19 percent.

The results of grain size analysis testing conducted on a sample of the till is provided on the Record of Borehole Sheets in Appendix B and included on Figures 2 in Appendix C. The result is summarized as follows:

Soil Particles	(%)
Gravel	10
Sand	45
Silt	43
Clay	2

It should be noted that the glacial tills inherently contain cobbles and/or boulders.

4.2 Sign Relocation # 2 (Dual Sign Support)

Boreholes BH-2 and BH-3 were drilled at the site of proposed sign support structure #2. BH-2 was advanced near the north foundation element within the MTO property. The BH-2 location was accessed from the backyard of a private property due to the presence of a noise barrier retaining wall along the highway shoulder. BH-3 was drilled on the median of Hwy 8 westbound lane near the south foundation element location.

4.2.1 Topsoil

Topsoil approximately 75 mm thick was encountered at the ground surface in BH-2.

4.2.2 Asphalt

Approximately 330 mm thick asphalt was encountered at the ground surface in BH-3.

4.2.3 Fill

Fill material, approximately 2.9 m thick and consisting of sand and gravel and trace organics was encountered underlying the topsoil in BH-2. Occasional cobbles were also encountered at about

2.8 m. The base of the fill was at elevation of 322.1 m.

In BH-3, approximate 1.2 m thick sand and gravel fill was encountered below the pavement. The base of the fill was at elevation 321.6 m.

The SPT 'N' values ranged from 15 to 44 blows per 0.3 m of penetration suggesting that the fill material is compact to dense except at about 2.8 m depth in BH-2 where an SPT 'N' value of 55 blows for 0.225 m penetration was recorded possibly due to presence of occasional cobbles. Natural moisture content within the fill ranged from 5 to 22 percent.

4.2.4 Sand

A native sand deposit containing trace to some fines was encountered underlying the fill material and extended to approximate depths of 6.7 m (elevation 318.4 m) and 4.6 m (elevation 318.5 m) in BH-2 and BH-3, respectively. The sand deposit was 3.7 m and 3.1 m thick in BH-2 and BH-3, respectively.

SPT 'N' values encountered within the sand deposit ranged between 8 to 53 blows per 0.3 m of penetration indicating loose to very dense relative density. Natural moisture content generally ranged from 5 to 18 percent.

The results of grain size analysis testing conducted on samples of the sand deposits are provided on the Record of Borehole Sheets in Appendix B and included on Figure 1 in Appendix C. The results are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	88 to 95
Silt + Clay	5 to 12

4.2.5 Sand and Silt (TILL)

A sand and silt till deposit, containing trace gravel to gravelly and trace to some clay, was encountered underlying the sand deposit. Silty clay pockets were encountered within the sand and silt till deposit near the base of borehole in BH-3. Both BH-2 and BH-3 were terminated within the sand and silt till deposit.

SPT 'N' values in the till ranged between 22 to 57 blows per 0.3 m penetration indicating compact to very dense relative density. Natural moisture content generally ranged from 10 to 17 percent.

The results of grain size analysis testing conducted on samples of the sand and silt till deposit is provided on the Record of Borehole Sheets in Appendix B and included on Figure 2 and 3 in Appendix C. The result is summarized as follows:

Soil Particles	Sand and Silt Till (%)	Silty Clay Pockets (%)
Gravel	28	1
Sand	38	7
Silt	23	59
Clay	11	33

The results of Atterberg Limits testing conducted on the selected samples from the till are included on Figure 4 in Appendix C and summarized below.

Atterberg Limits	Sand and Silt Till (%)	Silty Clay Pockets (%)
Liquid Limit	20	34
Plastic Limit	12	17
Plasticity Index	8	17

It should be noted that the glacial tills inherently contain cobbles and/or boulders.

4.3 Sign Relocation # 3 (Dual Sign Support)

BH-4 and BH-5 were advanced at the proposed location of sign support structure # 3. BH-4 was advanced through the north shoulder of Highway 8 westbound lane and BH-5 was advanced through the highway median.

4.3.1 Asphalt

Approximately 300 mm thick asphalt was encountered at the ground surface in BH-4 whereas in BH-5, asphalt approximately 200 mm thick was encountered at the ground surface.

4.3.2 Fill

In BH-4, approximately 1.8 m thick sand and gravel fill material was encountered underlying the asphalt. The base of the fill was at elevation 327.8 m. In BH-5, sand and gravel fill was encountered underlying the asphalt in the upper 0.6 m followed by a 0.7 m thick layer of silty sand fill. The total thickness of the fill was 1.3 m. The base of the fill was at elevation 327.9 m.

The SPT ‘N’ values ranged from 33 to 61 blows per 0.3 m of penetration suggesting that the fill material is dense to very dense. An SPT ‘N’ value of 50 blows for 0.075 m penetration was encountered in BH-4 near the ground surface. Natural moisture contents within the fill ranged from 4 to 9 percent.

4.3.3 Sand to Silty Sand

Underlying the fill material in both boreholes, a native deposit consisting of sand, some silt to silty sand was encountered at an approximate depth of 2.1 m (elevation 327.8 m) in BH-4 and 1.5 m (elevation 327.9 m) in BH-5. Both boreholes were terminated within this deposit.

SPT ‘N’ values encountered within the sand to silty sand deposit ranged between 20 and 46 blows per 0.3 m of penetration indicating a compact to dense relative density. Natural moisture contents generally ranged from 4 to 9 percent.

The results of grain size analysis testing conducted on samples of the sand to silty sand deposit are provided on the Record of Borehole Sheets in Appendix B and included on Figure1 in Appendix C. The results are summarized as follows:

Soil Particles	Sand (%)	Silty Sand (%)
Gravel	0	0
Sand	84 to 88	61 to 73
Silt	-	27 to 38
Clay	-	0 to 1
Silt + Clay	12 to 16	-

4.4 Groundwater Conditions

Details of the water level observed in the boreholes upon completion of drilling are presented on the Record of Borehole sheets and summarized below.

Borehole	Groundwater Level (m)		Borehole Conditions at Borehole Completion
	Depth	Elevation	
BH-01	-	-	Borehole open, wet soil conditions below 4.1 m
BH-02	6.6	318.5	Borehole caved-in to 6.7 m, wet soil conditions below 3.0 m
BH-03	-	-	Borehole caved-in to 7.0 m, wet soil conditions below 4.6 m
BH-04	-	-	Borehole open and dry
BH-05	-	-	Borehole open and dry

Seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall. Perched water may be present in the fill material, old trench/infrastructure backfill and granular pavement base.

5. ANALYTICAL LABORATORY TESTING

A total of five selected samples (i.e. one sample per BH) were submitted for analytical testing for corrosivity analysis and sulphide content. The analytical test results are presented in Appendix F and are summarized below.

Borehole	BH-01	BH-02	BH-03	BH-04	BH-05
Sample	**SS3**	**SS4 (Fill)**	**SS3**	**SS2 (Fill)**	**SS3**
Depth (m)	1.5 – 2.1	2.3 – 2.9	1.5 – 2.1	0.8 – 1.4	1.5 – 2.1
Sulphide (Na_2CO_3) %	<0.01	<0.01	<0.01	<0.01	<0.01
Chloride (µg/g)	460	27	1700	350	1300
Sulphate (µg/g)	24	37	38	31	28
pH	8.58	8.53	8.90	9.50	8.87
Conductivity (µS/cm)	1020	236	4560	873	2710
Resistivity (Ohm-cm)	980	4240	219	1150	369
Redox Potential (mV)	191	204	274	260	254

6. MISCELLANEOUS

Elements Geo of Hamilton, Ontario supplied a truck mounted drill rig and a track mounted drill rig and conducted the drilling, sampling and in-situ testing operations.

The coordinates and elevations for the boreholes were obtained by Thurber using a Trimble R10.

The drilling and sampling operations in the field for the current investigation were supervised on a full-time basis by Thurber field technicians. Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory. Analytical testing was carried out by SGS Canada Inc.

Overall supervision of the field program, interpretation of the data, and preparation of the report was conducted by Mr. Puneet Verma, P.Eng. The report was reviewed by Mr. Keli Shi, P.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects.

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PART B: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This section of the report presents interpretation of the factual geotechnical data obtained from a foundation investigation carried out by Thurber for the proposed relocation of three existing sign support structures along the Highway 8 Westbound Lane in the City of Kitchener, Ontario. 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. Foundation assessment and recommendations are provided to assist the project team in designing suitable foundations for the proposed sign support structures.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation and their design consultant, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. Contractors must make their own interpretation based on the factual data in Part A of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

8. SIGN SUPPORT STRUCTURES

As part of the works at Hwy 7 & 8 Interchange, MTO is relocating three sign support structures i.e., 33X-0410/S0 (cantilever structure), 33X-0411/S0 (dual sign supports) and 33X-0413/S0 (dual sign supports) to approximately 20 m east of their existing locations. All three existing and proposed sign support structures are located on Highway 8 westbound lane as shown on the Borehole Location Plan in Appendix A.

8.1 Foundation Design

Foundation design for sign support structures should be carried out in accordance with the following documents:

- Ministry of Transportation, Ontario (2019) “Sign Support Manual”, Provincial Highways Management Division, Highway Standards Branch, Bridge Office. (Reference 1)
- Ministry of Transportation, Ontario (2004) “Guidelines for the Design of High Mast Pole Foundations – 4th Edition”, Engineering Standards Branch, Bridge Office. (Reference 2)
- Canadian Highway Bridge Design Code (2019) CAN/CSA-S6:19. (Reference 3)

It is understood that a typical sign support foundation consists of a single conventional augered caisson. Based on the soil stratigraphy and groundwater conditions encountered in the current geotechnical investigation, caisson foundations are considered suitable to support the proposed sign support structures.

It is recommended that MTO’s standard design in Reference 1 be used as a basis for design of sign support foundation. The recommended design parameters for the foundation design are provided in Table D1 in Appendix D. The foundation design parameters in Table D1 may be used in conjunction with References 2 and 3 to confirm that the standard design is adequate.

According to OPSD 3090.101, the depth of frost penetration at this site is 1.4 m and as such, the upper 1.4 m below the final grade should be neglected in the foundation design to account for frost action.

Where the sign support foundation is located adjacent to an existing slope, the full lateral soil resistance can only be mobilized if the horizontal distance between the foundation and the crest of the slope is at least six (6) times the diameter of foundation in the direction of horizontal load.

For sloping ground in front of a caisson, the magnitude of the mobilized passive resistance can be estimated by interpolating between zero passive resistance at the level where the slope face intersects the pile, and full passive resistance at the level where the slope face is at a horizontal distance equal to or greater than six (6) times the diameter of the caisson.

A resistance factor of 0.5 (consistent with a “typical” consequence level and degree of site understanding, per CHBDC (2019)) should be applied to the calculated unfactored ultimate lateral resistance to obtain the factored ultimate lateral resistance.

9. CORROSION POTENTIAL

The sulphate content analysis for the representative samples resulted in a sulphate concentration of 24 to 38 µg/g. The result was compared with the Canadian Standards Association (CSA) Standards A23.1 for sulphate attack potential on concrete structures, which indicates the site soils possess a “negligible” risk for sulphate attack on concrete material.

The California Department of Transportation (Caltrans) Corrosion guidelines define a corrosive environment for structures if one or more of the following conditions exist in the soil samples collected at this site:

- Chloride concentration is 500 ppm or greater;
- Sulphate concentration is 2000 ppm or greater;
- pH is 5.5 or less.

The chloride content analysis for the representative samples showed a concentration ranging from 27 to 1700 µg/g. Notably, Sample 3 in BH-3 and BH-5 had concentrations of 1700 µg/g and 1300 µg/g, respectively, while the remaining samples had chloride concentrations below 500 µg/g. The sulphate content analysis for the representative samples resulted in a sulphate concentration of 24 to 38 µg/g. The pH value in the represented samples ranged between 8.53 to 9.50.

Thus, based on the chloride content analysis results, the soil is considered to be corrosive to structural steel.

The corrosive effects of road de-icing salts should be considered.

10. CONSTRUCTION CONSIDERATIONS

Construction of the foundation caissons for the sign support structures should be carried out in accordance with OPSS.PROV 903.

Caisson installation may extend below the groundwater table in the cohesionless sands and silts. Appropriate equipment and procedures should be required to maintain borehole stability and minimize ground loss during caisson drilling. This could include the use of temporary steel liners, and/or the use of bentonite and/or polymer slurry.

Glacial tills inherently contain cobbles and/or boulders. Possible obstructions should be anticipated in the native sand and silt till deposits. Contractors should be prepared for such

conditions during construction.

The contract documents must contain an NSSP alerting the contract bidders of the specific aspects relating to the caisson construction for foundation support at this site. Suggested wording for this NSSP is included in Appendix E.

11. CONSTRUCTION INSPECTION AND TESTING

Caisson construction should be monitored by qualified geotechnical personnel as per OPSS.PROV 903 to verify the soil conditions and to confirm that those conditions are consistent with the design assumptions in this report.

12. CLOSURE

Engineering analysis and preparation of this report was carried out by Mr. Puneet Verma, M.Eng., P.Eng. The report was reviewed by Mr. Keli Shi, M.Eng., P.Eng., a Senior Geotechnical Engineer, and Dr. P.K. Chatterji, Ph.D., P.Eng., a Designated Principal Contact for MTO Foundations Projects at Thurber.

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THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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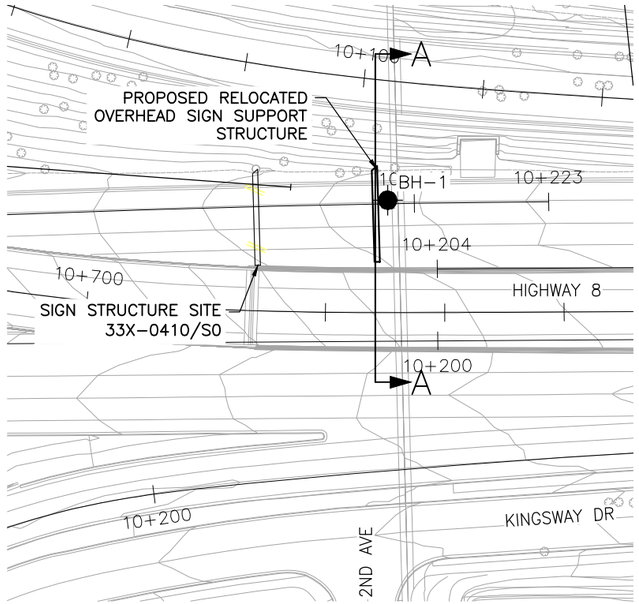
APPENDIX A

Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

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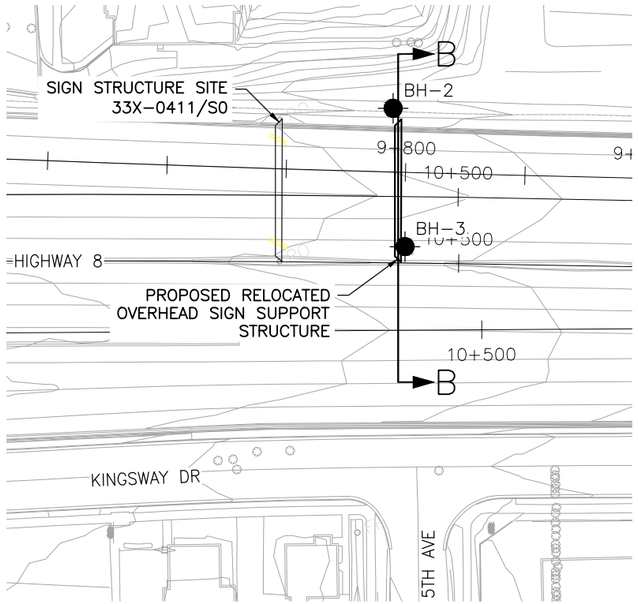

PLAN

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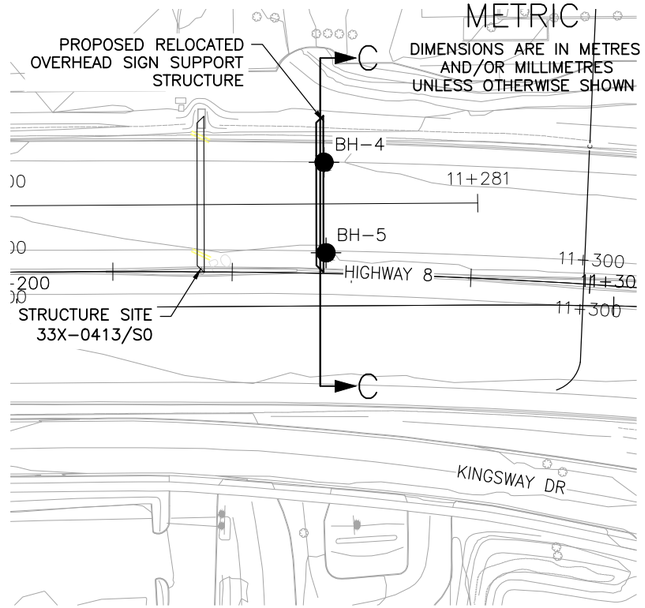

PLAN

20 0 20 40m

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LICENSED PROFESSIONAL ENGINEER
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2024/10/17
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P. K. CHATTERJI
2024/10/17
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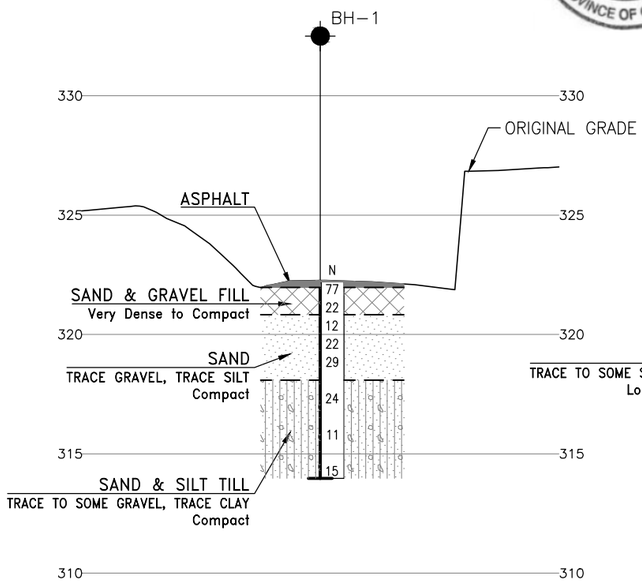
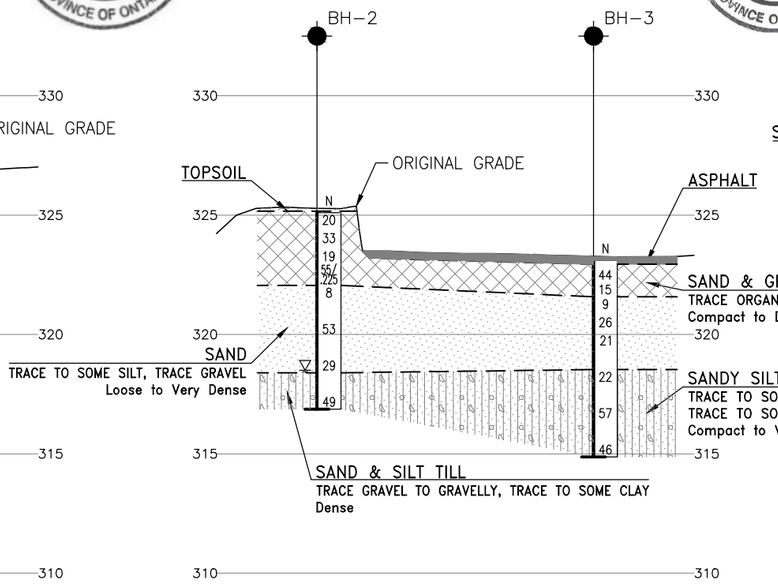


SECTION A–A

10 0 10 20m H 1:500

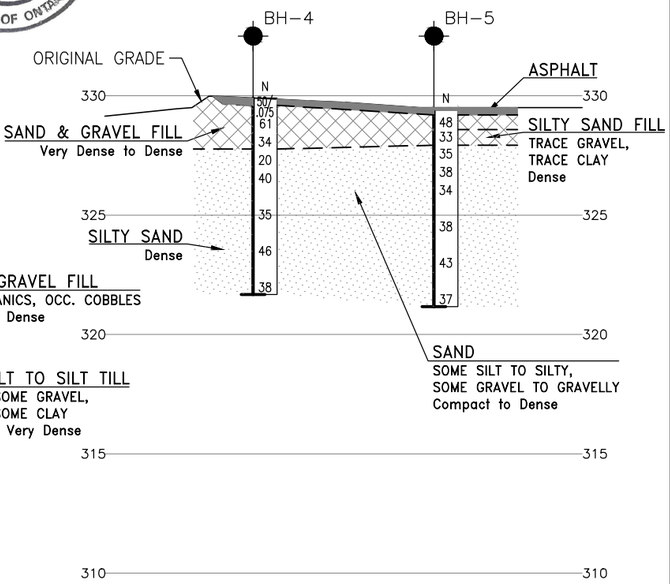
5 0 5 10m V 1:250



SECTION B–B

10 0 10 20m H 1:500

5 0 5 10m V 1:250



SECTION C–C

10 0 10 20m H 1:500

5 0 5 10m V 1:250

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

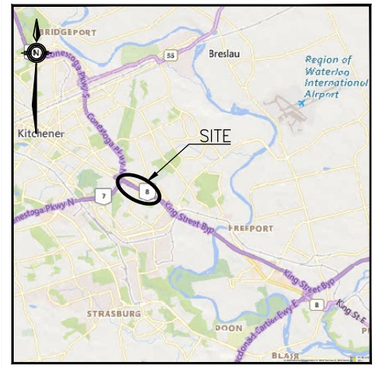
CONT No

WP No 3061-22-00

HIGHWAY 8
SIGN RELOCATION
3 SITES
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH-1	322.2	4 811 087.5	227 524.2
BH-2	325.1	4 810 978.5	227 797.2
BH-3	323.1	4 810 956.6	227 789.3
BH-4	329.9	4 810 649.9	228 489.5
BH-5	329.4	4 810 636.0	228 483.5

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 40P08-303

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN PV	CHK KS	CODE	LOAD	DATE OCTOBER 2024
DRAWN MFA	CHK PC	SITE	STRUCT	DWG 1

FILENAME: H:\Drafting\49000\49053\ED-49053-BHPP.dwg
PLOTDATE: 5/14/2024 11:38 AM

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APPENDIX B

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

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RECORD OF BOREHOLE No BH-1 1 OF 1 METRIC

W.P. 3061-22-00 LOCATION Sign Relocation #1 (Cantilever Structure): N 4 811 087.5 E 227 524.2 ORIGINATED BY HC

DIST Western HWY 7/8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.04.15 - 2024.04.15 LATITUDE 43.435710 LONGITUDE -80.454558 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.2	GROUND SURFACE										
0.0	**ASPHALT:** (225mm)						322				
0.2	**SAND** and **GRAVEL** Very Dense to Compact Brown Dry (FILL)		1	SS	77				○		
320.8			2	SS	22		321		○		
1.4	**SAND**, trace gravel, trace silt Compact Light Brown Moist		3	SS	12				○		0 94 6 (SI+CL)
			4	SS	22		320		○		
			5	SS	29		319		○		
318.1											
4.1	**SAND** and **SILT**, trace to some gravel, trace clay Compact Greyish Brown Wet (TILL)		6	SS	24		318		○		
			7	SS	11		317		○		10 45 43 2
			8	SS	15		316		○		
314.0							315				
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN WITH WET SOIL CONDITION BELOW 4.1m. BOREHOLE BACKFILLED WITH SOIL CUTTINGS TO 2.3m AND BENTONITE TO 0.8m,CONCRETE TO 0.1m, AND COLD PATCH ASPHALT TO THE SURFACE.						314				

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No BH-2 1 OF 1 METRIC

W.P. 3061-22-00 LOCATION Sign Relocation #2 (Dual Sign Supports): N 4 810 978.5 E 227 797.2 ORIGINATED BY HC

DIST Western HWY 7/8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.04.12 - 2024.04.12 LATITUDE 43.434758 LONGITUDE -80.451171 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.1	GROUND SURFACE						325				
0.0	**TOPSOIL:** (75mm)										
0.1	**SAND** and **GRAVEL**, trace organics Compact to Dense Brown Moist (FILL)		1	SS	20				○		
			2	SS	33		324		○		
			3	SS	19				○		
							323				
	Occasional cobbles Wet		4	SS	55/ 0.225				○		
322.1							322				
3.0	**SAND**, some silt, trace gravel Loose Brown Wet		5	SS	8				○		0 88 12 (SI+CL)
							321				
	Very Dense		6	SS	53				○		
							320				
	Flowing sands encountered		7	SS	29	▽	319		○		
318.4											
6.7	**SAND** and **SILT**, trace gravel to gravelly, trace to some clay Dense Brown Wet (TILL)						318				
			8	SS	49				⊣●		28 38 23 11
316.9							317				
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE CAVED TO A DEPTH OF 6.7m WITH WET SOIL CONDITIONS ENCOUNTERED AT 3.0m. WATER LEVEL WAS ENCOUNTERED AT 6.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH MIXTURE OF BENTONITE AND SOIL CUTTINGS TO 0.4m AND WITH SOIL CUTTINGS TO THE SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No BH-3 1 OF 1 METRIC

W.P. 3061-22-00 LOCATION Sign Relocation #2 (Dual Sign Supports): N 4 810 956.6 E 227 789.3 ORIGINATED BY HC

DIST Western HWY 7/8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.04.15 - 2024.04.15 LATITUDE 43.434560 LONGITUDE -80.451265 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
323.1	GROUND SURFACE										
0.0 / 322.8	**ASPHALT:** (330mm)						323				
0.3 / 321.6	**SAND** and **GRAVEL** Compact to Dense Light Brown Moist (FILL)		1	SS	44				○		
			2	SS	15		322		○		
1.5 / 318.5	**SAND**, trace silt Loose to Compact Brown Moist		3	SS	9				○		0 95 5 (SI+CL)
			4	SS	26		321		○		
			5	SS	21		320		○		
4.6	Sandy **SILT** to **SILT**, trace to some gravel, trace to some clay Compact to Very Dense Brown Wet (TILL)		6	SS	22		319		○ ○		
			7	SS	57		318		○		
314.9	Silty clay pocket		8	SS	46		317		○		1 7 59 33
							316				
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE CAVED TO A DEPTH OF 7.0m WITH WET SOIL CONDITIONS ENCOUNTERED AT 4.6m. BOREHOLE BACKFILLED WITH SOIL CUTTINGS TO 2.3m AND BENTONITE TO 0.8m, CONCRETE TO 0.1m AND COLD PATCH ASPHALT TO THE SURFACE.						315				

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No BH-4 1 OF 1 METRIC

W.P. 3061-22-00 LOCATION Sign Relocation #3 (Dual Sign Supports): N 4 810 649.9 E 228 489.5 ORIGINATED BY HC

DIST Western HWY 7/8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.04.16 - 2024.04.16 LATITUDE 43.431871 LONGITUDE -80.442574 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
329.9	GROUND SURFACE										
0.0 329.6	**ASPHALT:** (300mm)										
0.3	**SAND** and **GRAVEL** Very Dense to Dense Brown Dry (FILL)		1	SS	50/0.075						
			2	SS	61		329		○		
327.8			3	SS	34		328		○		
2.1	**SAND**, some silt to silty Compact to Dense Brown Moist		4	SS	20				○		0 84 16 (SI+CL)
	Gravelly		5	SS	40		327		○		
325.8							326				
4.1	Silty **SAND** Dense Brown Moist		6	SS	35		325		○		0 73 27 0
			7	SS	46		324		○		
			8	SS	38		323				
321.7							322		○		
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH SOIL CUTTINGS TO 2.3m AND BENTONITE TO 0.8m, CONCRETE TO 0.1m AND COLD PATCH ASPHALT TO THE SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No BH-5 1 OF 1 METRIC

W.P. 3061-22-00 LOCATION Sign Relocation #3 (Dual Sign Supports): N 4 810 636.0 E 228 483.5 ORIGINATED BY HC

DIST Western HWY 7/8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.04.16 - 2024.04.16 LATITUDE 43.431745 LONGITUDE -80.442647 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
329.4	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	**SAND** and **GRAVEL** Dense Brown Moist		1	SS	48		329		○		
328.6	(FILL)										
0.8	Silty **SAND**, trace gravel, trace clay Dense Brown Moist		2	SS	33				○		
327.9	(FILL)						328				
1.5	**SAND**, some silt to silty Dense Brown/Grey Moist		3	SS	35				○		0 61 38 1
			4	SS	38		327		○		
	Some gravel		5	SS	34		326		○		
			6	SS	38		325		○		
			7	SS	43		324				
			8	SS	37		323		○		
321.2							322				0 88 12 (SI+CL)
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH SOIL CUTTINGS TO 2.3m AND BENTONITE TO 0.8m, CONCRETE TO 0.1m AND COLD PATCH ASPHALT TO THE SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE

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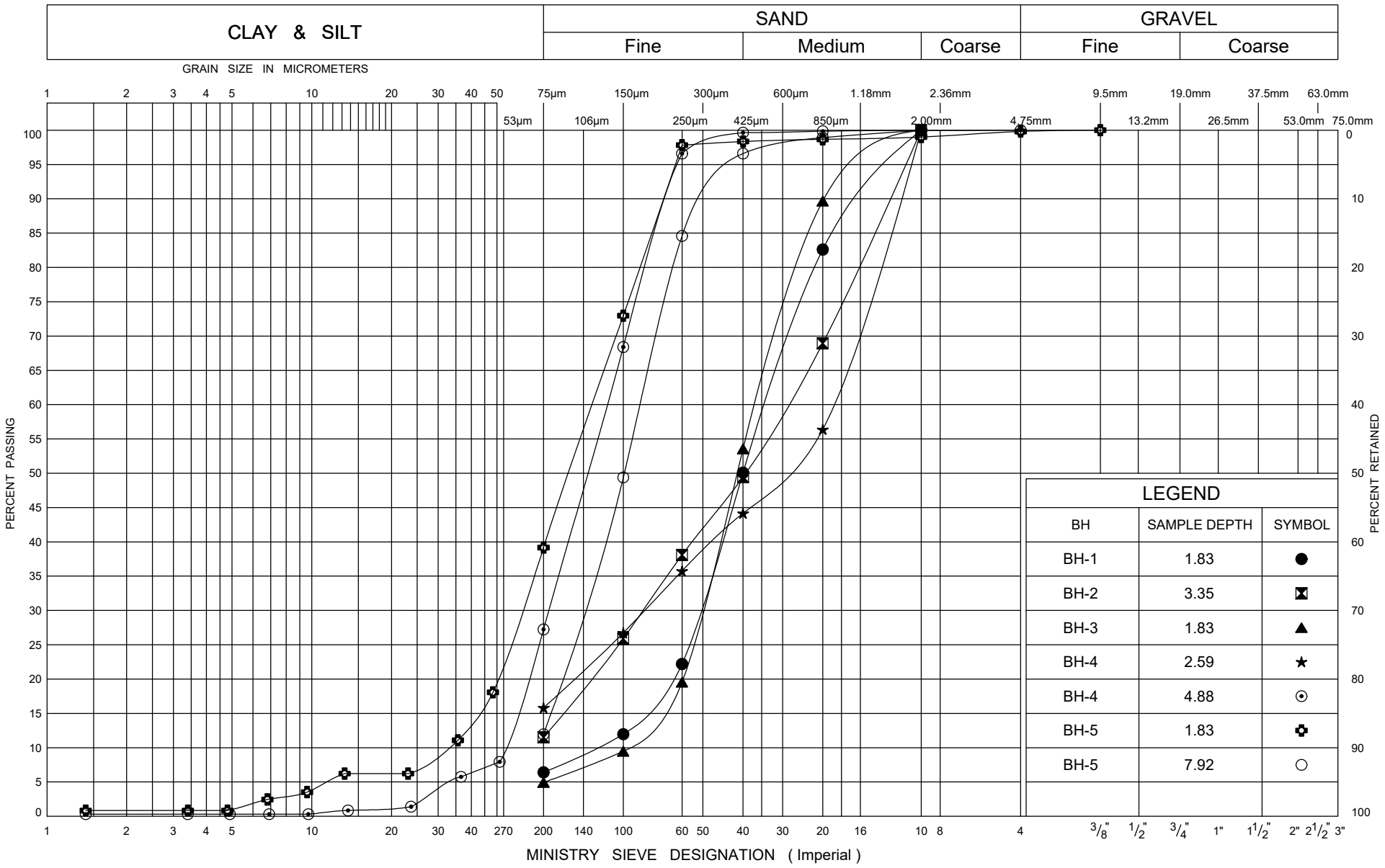
APPENDIX C

Geotechnical Laboratory Test Results



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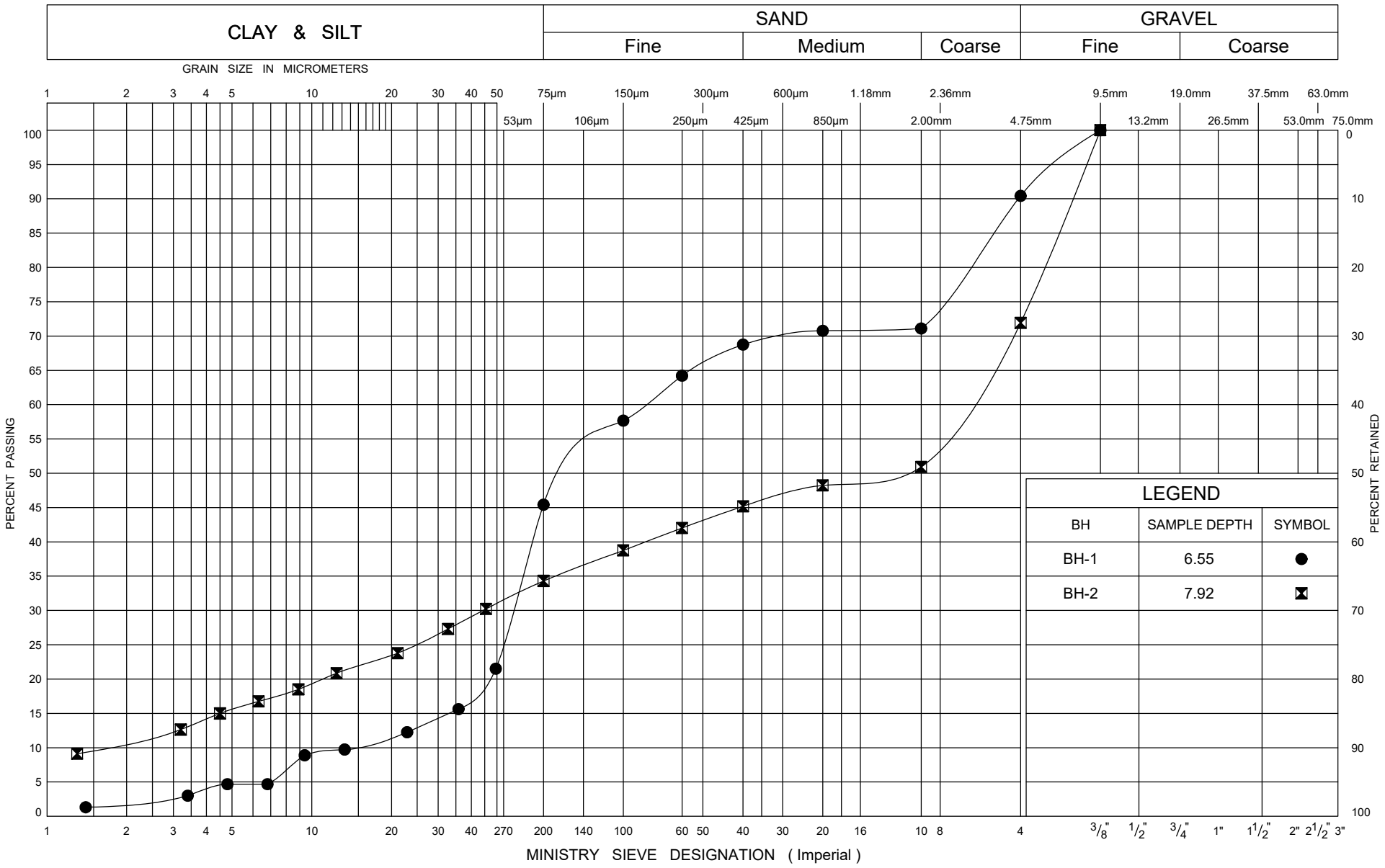
GRAIN SIZE DISTRIBUTION

SAND to Silty SAND

FIG No 1

W.P. 3061-22-00

ONTARIO MOT GRAIN SIZE 3 MTO-49053.GPJ ONTARIO MOT.GDT 5/10/24



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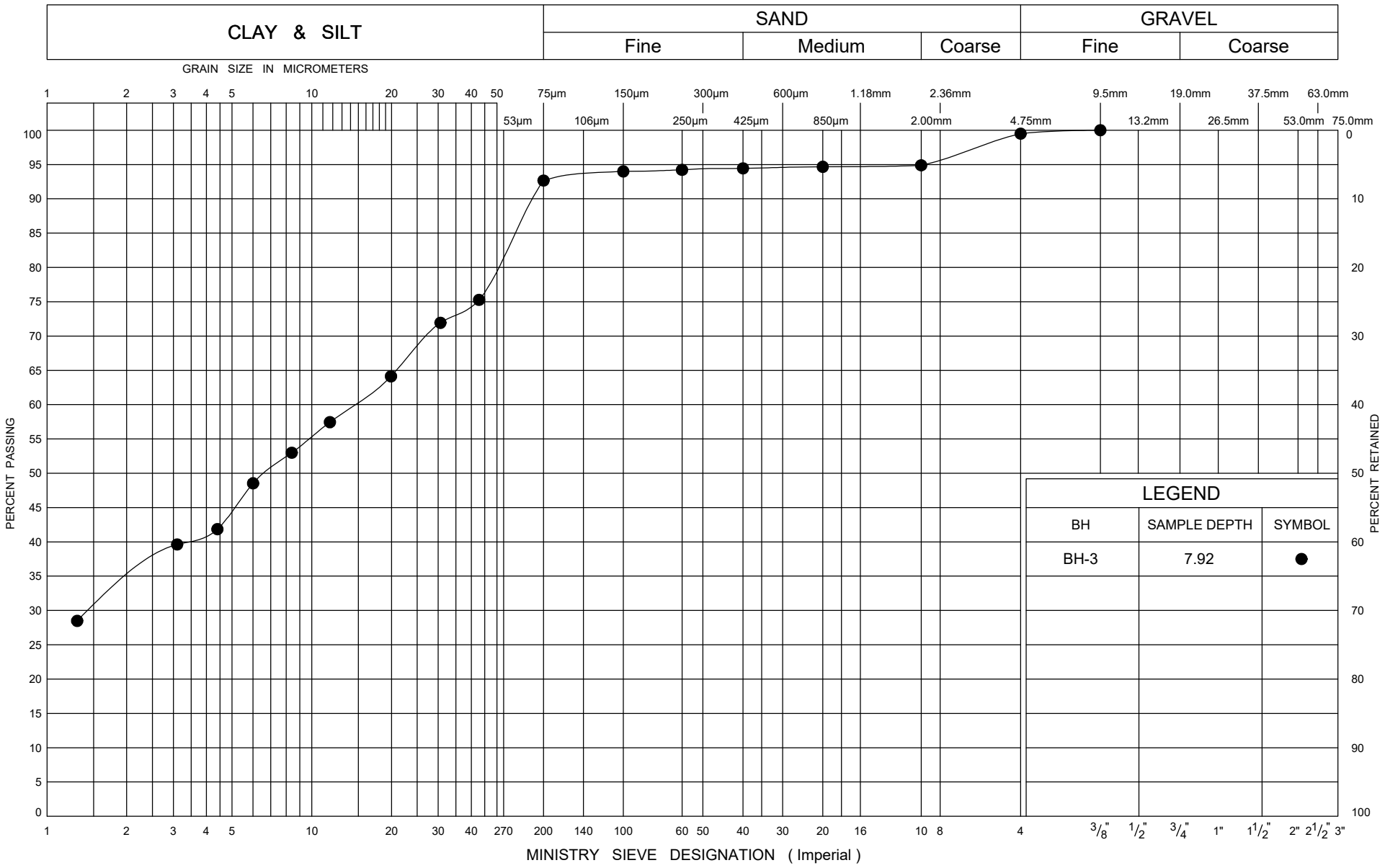
GRAIN SIZE DISTRIBUTION

SAND and SILT TILL

FIG No 2

W.P. 3061-22-00



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GRAIN SIZE DISTRIBUTION

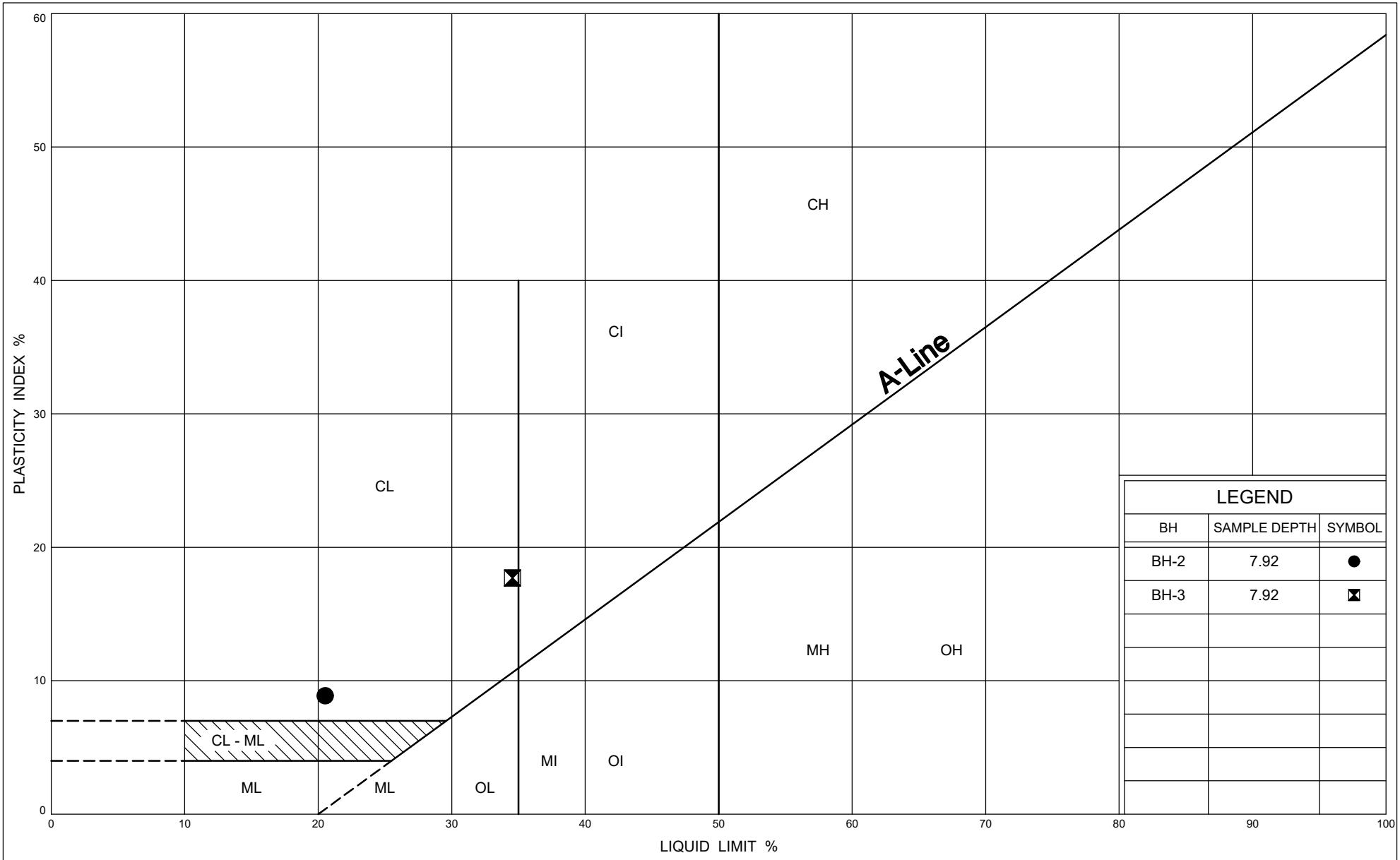
SAND and SILT TILL (Silty CLAY Pockets)

FIG No 3

W.P. 3061-22-00

ONTARIO MOT GRAIN SIZE 3 MTO-49053.GPJ ONTARIO MOT.GDT 5/10/24

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART 2 MTO-49053.GPJ ONTARIO MOT.GDT 5/10/24

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PLASTICITY CHART

FIG No 4

W.P. 3061-22-00

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APPENDIX D

Foundation Design Parameters

THURBER ENGINEERING LTD.

TABLE D1: FOUNDATION ENGINEERING PARAMETERS FOR THE DESIGN OF SIGN SUPPORTS

Structure	Borehole No. / Ground Elevation (m)	Soil Deposit	Depth Below Existing Grade (m)	Design Parameters				Design Groundwater Elevation (m)
				γ / γ' (kN/m^3)	Φ' (°)	n_h (kN/m^3)	K_p	
Sign Relocation 1	BH-1 322.2	Dense Sand and Gravel Fill	0.2 – 1.4	21 / 11	34	7500	3.5	320
		Compact Sand	1.4 – 4.1	21 / 11	33	5000	3.4	
		Compact Sand and Silt Till	4.1 – 8.2	21 / 11	32	3500	3.3	
Sign Relocation 2	BH-2 325.1	Dense Sand and Gravel Fill	0.1 – 3.0	21 / 11	34	7500	3.5	322
		Loose Sand	3.0 - 4.1	20 / 10	30	2000	3.0	
		Compact to Very Dense Sand	4.1 – 6.7	21 / 11	34	5500	3.5	
		Dense Sand and Silt Till	6.7 – 8.2	21 / 11	34	5500	3.5	
	BH-3 323.1	Dense Sand and Gravel Fill	0.3 – 1.5	21 / 11	34	7500	3.5	321
		Loose Sand	1.5 – 2.1	20 / 10	30	3000	3.0	
		Compact Sand	2.1 – 4.6	21 / 11	34	5500	3.5	
		Compact to Very Dense Sandy Silt Till	4.6 – 8.2	21 / 11	33	5000	3.4	
Sign Relocation 3	BH-4 329.9	Dense Sand Gravel Fill	0.3 – 2.1	21 / 11	34	7500	3.5	-
		Dense Sand to Silty Sand	2.1 – 8.2	21 / 11	34	5500	3.5	
	BH 5 329.4	Dense Sand and Gravel Fill	0.2 – 0.8	21 / 11	34	7500	3.5	-
		Dense Silty Sand Fill	0.8 – 1.5	21 / 11	32	5000	3.3	
		Dense Sand	1.5 – 8.2	21 / 11	34	5500	3.5	

Where:

γ = Bulk unit weight (kN/m^3)
γ' = Effective unit weight below groundwater level (kN/m^3)
Φ' = Effective friction angle (°)
n_h = Coefficient related to the soil density (kN/m^3)
K_p = Passive earth pressure coefficient

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APPENDIX E

List of OPSS and OPSD Documents and NSSP’s

THURBER ENGINEERING LTD.

1. List of OPSS and OPSD Documents relevant to this Project

- OPSS.PROV 903 (Construction Specification for Deep Foundations)
- OPSD 3090.101 (Foundation Frost Depths for Southern Ontario)

2. Suggested Text for NSSP on Augered Caisson Construction for Sign Support Foundation

The Contractor is advised that variable types of subsurface materials may be encountered at the locations of the sign support foundations. For additional information regarding subsurface conditions, the Contractor is referred to the Foundation Investigation Report.

The Contractor is alerted to the following:

1. Cobbles and/or boulders may be encountered within the glacial till deposits. In addition to the above, man-made obstructions may also be present within the embankment fills. The soil matrix is anticipated to become harder or denser with depth. Caisson installation equipment must be able to dislodge, handle, remove or otherwise penetrate these obstructions and hard/very dense layers.

2. Water seepage and/or soil sloughing into the caisson hole will occur from exiting fill and cohesionless soils which would be susceptible to disturbance (basal and sidewall) under conditions of unbalanced hydrostatic head. Temporary liners shall be available on site to support the caisson sidewalls and provide partial seepage cut-off where required. A balancing water/slurry head shall be maintained inside the caisson hole where required. A combination of the above along with feasible techniques of advancing the caisson hole shall be employed to minimize disturbance at the base and the sides of the caisson foundation. Consideration should be given to using the tremie technique to place the concrete.

The Contractor is responsible for constructing all the sign support foundations without disturbing the material at the sides or bases of the foundations.

THURBER ENGINEERING LTD.

APPENDIX F

Analytical Test Results

FINAL REPORT

CA40137-APR24 R1

49053

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	250 Thompson Drive Cambridge, ON N1T 2H9. Canada
Contact	Puneet Verma
Telephone	905-829-8666
Facsimile	
Email	pverma@thurber.ca
Project	49053
Order Number	
Samples	Soil (5)

LABORATORY DETAILS

Project Specialist	Jill Campbell, B.Sc.,GISAS
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	2165
Facsimile	705-652-6365
Email	jill.campbell@sgs.com
SGS Reference	CA40137-APR24
Received	04/17/2024
Approved	04/26/2024
Report Number	CA40137-APR24 R1
Date Reported	04/26/2024

COMMENTS

Temperature of Sample upon Receipt: 6 degrees C
Cooling Agent Present: Yes
Custody Seal Present: Yes

Chain of Custody Number: 036941

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Jill Campbell, B.Sc.,GISAS

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 49053
Project Manager: Puneet Verma
Samplers: Hayden Clarke

MATRIX: SOIL

Sample Number		5	6	7	8	9
Sample Name		BH1 SS-3	BH2 SS-4	BH3 SS3	BH4 SS-2	BH5 SS-3
Sample Matrix		Soil	Soil	Soil	Soil	Soil
Sample Date		15/04/2024	12/04/2024	15/04/2024	15/04/2024	16/04/2024
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index							
Corrosivity Index	none	1	14	4	14	13	14
Soil Redox Potential	mV	no	191	204	274	260	254
Sulphide (Na2CO3)	%	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
pH	pH Units	0.05	8.58	8.53	8.90	9.50	8.87
Resistivity (calculated)	ohms.cm	-9999	980	4240	219	1150	369
General Chemistry							
Conductivity	uS/cm	2	1020	236	4560	873	2710
Metals and Inorganics							
Moisture Content	%	0.1	7.1	9.0	6.9	3.2	8.7
Sulphate	µg/g	0.4	24	37	38	31	28
Other (ORP)							
Chloride	µg/g	0.4	460	27	1700	350	1300

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-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
Chloride	DIO0447-APR24	µg/g	0.4	<0.4	2	35	99	80	120	110	75	125
Sulphate	DIO0447-APR24	µg/g	0.4	<0.4	3	35	94	80	120	95	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

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
Sulphide (Na2CO3)	ECS0068-APR24	%	0.01	< 0.01								

Conductivity

Method: 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	EWL0529-APR24	uS/cm	2	< 2	0	20	100	90	110	NA		

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	EWL0529-APR24	pH Units	0.05	NA	0		101			NA		

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

Results relate only to the sample tested.
Data reported represent the sample as submitted to SGS. 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 and Excess Soil Quality" 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.

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS Industries & Environment - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Request for Laboratory Services and CHAIN OF CUSTODY

No: 036941

Page ___ of ___

Laboratory Information Section - Lab use only

Received By: Myeed Almudaris
Received Date: APR 1 7 2024 (mm/dd/yy)
Received Time: 16 08 (hr : min)

Received By (signature): Myeed Almudaris
Custody Seal Present: Yes ☐ No ☐
Custody Seal Intact: Yes ☑ No ☐

Cooling Agent Present: Yes ☑ No ☐ Type: Ice
Temperature Upon Receipt (°C): 6 5 7 C

LAB LIMS #: Apr 40137 AK

REPORT INFORMATION

Company: Thurber Engineering Ltd
Contact: Puneet Verma
Address: 250 Thompson Drive, Cambridge, ONT
Phone: 905-829-8666
Fax:
Email: pverma@thurber

INVOICE INFORMATION

☑ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email: Accounting@thurber.ca

Quotation #:
Project #: 40053
P.O. #: 40053
Site Location/ID:

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

*NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

☐ O.Reg 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ___ ; ☐ Res/Park ☐ Ind/Com ☐ Agri/Other ; Appx. ___ ; Soil Texture: ☐ Coarse ☐ Medium/Fine ; Soil Volume ☐ <350m3 ☐ >350m3

☐ O.Reg 406/19

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☐ PWQO ☐ CCME ☐ MISA ☐ MMER ☐ Other: ___ ☐ ODWS Not Reportable *See note

Sewer By-Law: ☐ Sanitary ☐ Storm ; Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

M & I: Field Filtered (Y/N); Metals & Inorganics (incl CrVI, CN, Hg pH,(B(HWS),EC,SAR-soil) (Cl, Na-water)); Full Metals Suite (ICP metals plus B(HWS-soil only) Hg, CrVI); ICP Metals only (Sb,As,Ba,Be,B,Cd, Cr,Co,Cu,Pb,Mo,Ni,Se,Ag,Tl,U,V,Zn)
SVOC: PAHs only; SVOCs (all incl PAHs, ABNs, CPs)
PCB: PCBs ☐ Total ☐ Aroclor
PHC: F1-F4 + BTEX; F1-F4 only (no BTEX)
VOC: VOCs (all incl BTEX); BTEX only
Pest: Pesticides (Organochlorine or specify other)
Other (please specify): Corrosivity suite; Sewer Use: Specify pkg:; Water Characterization Pkg ☐ General ☐ Extended
SPLP: Specify tests ☐ Metals ☐ VOC ☐ 1,4-Dioxane ☐ OCP ☐ ABN
TCLP: Specify tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.

#	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Corrosivity suite	COMMENTS
1	BH1 SS-3	15/4/24	5:00AM	1	S	✓	
2	BH2 SS-4	12/4/24	11:00AM	1	S	✓	
3	BH3 SS3	16/4/24	4:00AM	1	S	✓	
4	BH4 SS-2	16/4/24	11:00AM	1	S	✓	
5	BH5 SS-3	16/4/24	[illegible]	1	S	✓	
6							
7							
8							
9							
10							
11							
12							

Observations/Comments/Special Instructions

Sampled By (NAME): Hayden Clarke Signature: Hayden Clarke Date: 17 / 4 / 24 (mm/dd/yy)
Relinquished by (NAME): Nathan Curriston Signature: [signature] Date: 17 / 4 / 2024 (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

Revision #: 1.7
Date of Issue: 07 JUNE 2023

Note: Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection/handling and transportation of samples. {2} Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). {3} Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm. (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.