



THURBER ENGINEERING LTD.

Foundation Investigation Report

**Proposed Over Head Sign and High Mast Light Pole Supports
Highway 401 Westbound Core and Collector Rehabilitation
from Whites Road to Neilson Road
Agreement No. 2020-E-0052
G.W.P. 2117-20-00**

Latitude: 43.796914°, Longitude: -79.157138°

GEOCRES No. 30M14-661

Client Name: Egis Group (formerly McIntosh Perry)
Date: January 15, 2025
File: 31958



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FOUNDATION INVESTIGATION REPORT
PROPOSED OVER HEAD SIGN AND HIGH MAST LIGHT POLE SUPPORTS
HIGHWAY 401 WESTBOUND CORE AND COLLECTOR REHABILITATION
FROM WHITES ROAD TO NEILSON ROAD
AGREEMENT NO. 2020-E-0052
G.W.P. 2117-20-00
GEOCRES No. 30M14-661

PART A – FACTUAL INFORMATION

1. INTRODUCTION

This report presents the data obtained from a foundation investigation carried out by Thurber Engineering Ltd (Thurber) near the proposed Over Head Sign Supports (OHSS) and the proposed High Mast Light Pole (HMLP) support located along Highway 401 Westbound from Whites Road to Morningside Avenue, Pickering to Scarborough, Ontario.

The purpose of this investigation was to explore the subsurface conditions near the proposed OHSS and HMLP support locations and, based on the data obtained, to provide borehole location plans, records of borehole, laboratory test results, and a written description of the subsurface conditions.

Thurber carried out the investigation as a subconsultant to Egis Group (formerly McIntosh Perry), under the Ministry of Transportation, Ontario (MTO) Assignment No. 2020-E-0052.

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

In the area of the proposed OHSS and HMLP supports, Highway 401 WB collectors have three lanes in a generally east-to-west direction. The proposed sign types and locations and the HMLP location are summarized in Table 2-1 below.

TABLE 2-1 PROPOSED SIGN TYPES AND HMLP LOCATIONS

Structure ID	Type	Support Location
HMLP 1	High Mast Light Pole	WB Highway 401 to Morningside off-ramp
OHSS 1	Cantilever Sign	WB collector to express turn-off, west of Whites Road
OHSS 2	Cantilever Sign	WB collector (Median), Meadowvale
OHSS 3	Cantilever Sign	WB collector (Shoulder), Kingston Road to Highway 401 on-ramp
OHSS 4-1	Trichord Sign	WB collector shoulder
OHSS 4-2		WB collector to express median

In general, the area to the north of Highway 401 comprises residential subdivisions, undeveloped public lands, and a hydro line corridor north of the proposed OHSS 1, OHSS 2, and HMLP-1 locations.

Highway 401 traverses a west-to-east gradient with an elevation relief of approximately 40 metres. The elevations vary from 138 m to 98 m along the stretch between Morningside Avenue and Whites Road.

3. INVESTIGATION PROCEDURE

The foundation investigation was carried out between December 4 and 7, 2023, consisting of drilling and sampling six boreholes to depths ranging from 7.8 m to 9.8 m. The boreholes were advanced at the outside shoulder or the median of the highway near the proposed locations of the signs and HMLP.

The relevant Record of Borehole sheets are included in Appendix B.

Co-ordinates of the as-drilled borehole locations were obtained by Thurber using in-house survey equipment and provided to Egis. Borehole elevations were obtained by Egis from project survey data and provided to Thurber. The locations of the boreholes as presented on the record of boreholes, and as shown on the plans in Appendix A are positioned relative to coordinate system MTM NAD 83, Zone 10. The borehole locations, geographic coordinates, ground surface elevations and termination depths are summarized in summarized in Table 3.1.

TABLE 3-1 BOREHOLE INFORMATION

Borehole	Northing (Latitude, °)	Easting (Longitude, °)	Ground Surface Elevation (m)	Depth of Borehole (m)
HMLP-01	4 850 896 (43.797618)	329 509 (-79.192938)	138.5	9.8
OHSS 1-01	4 850 985 (43.798398)	330 070 (-79.185971)	133.1	8.2
OHSS 2-01	4 850 988 (43.798421)	330 163 (-79.184811)	132.8	8.0
OHSS 3-01	4 850 822 (43.796845)	332 386 (-79.157195)	122.5	7.7
OHSS 4-01	4 852 395 (43.810907)	335 016 (-79.124425)	95.9	8.0
OHSS 4-02	4 852 376 (43.810730)	335 031 (-79.124241)	96.3	8.0

Boreholes were advanced using a truck-mounted drill rig with solid stem augers. Soil samples were obtained at selected intervals using a split-spoon sampler driven by automatic hammers in general accordance with ASTM D1586 Standard Penetration Testing (SPT) procedures. The maximum particle size that can be sampled from the standard split-spoon hammer used in the investigation is limited to 35 mm and therefore, particles that may exist within the soils larger than this dimension would not be recovered or represented in the grain size analyses.

Upon completion of drilling, all boreholes were decommissioned in general accordance with O.Reg. 903 (as amended), backfilled using bentonite pellets and soil cuttings, and topped up with asphalt.

The investigation was supervised by a member of our technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling, and in situ testing operations, logged the boreholes, and visually identified the soil samples. The samples were placed in appropriate containers / bags, labelled, and transported to our Pickering geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All laboratory tests were carried out to MTO and/or ASTM standards, as appropriate. Routine classification testing consisting of moisture content on all recovered soil samples; grain size analysis, and Atterberg limits were carried out on selected soil samples.

4. SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The site lies within the physiographic region known as the Iroquois Plain, as delineated in the Physiography of Southern Ontario (Chapman and Putnam, 1984). The Iroquois Plain extends around the western shores of Lake Ontario and in the St. Catharines area, the Plain is located between the present Lake Ontario shore bluffs and the foot of the Niagara Escarpment. The Plain is comprised of a flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession.

The surficial soils in the Iroquois Plain are typically comprised of glaciolacustrine clays and silts; however, surficial deposit of beach sands and gravels are present in some areas. In general, the surficial clays and silts are underlain by an extensive till deposit containing interlayers of glaciolacustrine clay deposits (Halton Till). These deposits are underlain by shale bedrock of the Georgian Bay and Blue Mountain Formations.

4.2 General Description of Subsurface Conditions

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B. 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. Soil classification is in general accordance with MTO practice and ASTM D2487.

The boundaries between soil deposits 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 of the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

In general, the subsurface conditions consist of pavement structure and embankment fill comprised of sand and silty clay, overlying native sand to silty sand layers at some locations. These soils are in turn underlain by native deposits of glacial tills.



4.3 Asphalt

Asphalt was encountered at ground surface in all boreholes within the highway and with a recorded thickness of about 50 mm to 230 mm.

4.4 Fill

4.4.1 Gravelly Sand to Sandy Gravel Fill

Granular fill consisting of gravelly sand to sandy gravel with trace to some silt and trace clay, was encountered beneath the asphalt in all boreholes and extends to depths ranging from 0.7 m to 1.4 m below ground surface (Elevations 95.2 m and 137.1 m). It is likely that much of this granular fill forms the base and subbase of the pavement structure.

The moisture content of the granular fill ranged from 5 percent to 10 percent. The results of a grain size analysis carried out on a sample of the gravelly sand fill are presented in Figure C-1 of Appendix C. The results of the tests are summarized in Table 4.1 and on the Record of Borehole OHSS2-01 in Appendix B.

TABLE 4-1 GRADATION RESULTS FOR GRAVELLY SAND FILL

Soil Particle	Percentage (%)
Gravel	15
Sand	55
Silt	17
Clay	13

4.4.2 Embankment Fill

Sand fill with trace silt and gravel was encountered beneath the granular fill in Borehole OHSS4-01 and extended to a depth of 1.4 m below ground surface (Elevation 94.5 m). Measured SPT N-value was 6 blows per 0.3 m of penetration indicating a loose condition. The moisture content of the sand fill was 17 percent.

Silty clay fill with trace silt and gravel was encountered beneath the sand fill layer in Borehole OHSS4-01 and extended to 2.2 m depth below grade (Elevation 93.7 m). The moisture content of the clay fill was 18 percent.

4.5 Sand to Silty Sand

A layer of sand to silty sand containing trace to some gravel (locally sand and gravel) and trace clay was encountered beneath the fill layer in Boreholes HMPL-01, OHSS1-01, OHSS2-01, and extended to depths ranging from 4.1 m (Elevation 128.7 m) to 5.6 m (Elevation 132.9 m). SPT N-values measured in the sand to silty sand were between 16 and 48 blows per 0.3 m of penetration indicating a compact to dense condition.

The moisture content of the sand to silty sand ranges from 3 percent to 18 percent. The results of grain size analysis completed on samples of these cohesionless soils are presented on Figure C-2 of Appendix C. The results of the test are summarized in Table 4.2 and on the Record of Borehole sheets in Appendix B.

TABLE 4-2 GRADATION RESULTS FOR SILTY SAND TO SAND (GRAVELLY)

Soil Particle	Percentage (%)
Gravel	2 to 48
Sand	47 to 88
Silt	4 to 20
Clay	1 to 2

4.6 Glacial Till

Glacial till deposits were encountered below the sand to silty sand layers in Boreholes HMPL-01, OHSS1-01, OHSS2-01 and below the embankment fill in OHSS3-01, OHSS4-01, OHSS4-02.

All boreholes were terminated within glacial till at depths ranging from 7.7 m to 9.8 m (Elevations 87.9 m to 128.7 m)

4.6.1 Cohesive Till

Cohesive till consisting of silty clay to clayey silt with sand and trace to some gravel was encountered beneath the earth fill or cohesionless till layers in all boreholes except in Boreholes OHSS1-01 and OHSS3-01. SPT N-values measured in the cohesive till were between 7 and 64 blows per 0.3 m of penetration, and greater than 100 blows for less than 0.3 m of penetration, inferring a firm to hard consistency.

The moisture content of cohesive till ranges from 8 percent to 21 percent. The results of grain size analysis completed on samples of silty clay to clayey silt till are presented on Figure C-3 of

Appendix C. The results of the test are summarized in Table 4.3 and on the Record of Borehole sheets in Appendix B.

TABLE 4-3 GRADATION RESULTS FOR COHESIVE TILL

Soil Particle	Percentage (%)
Gravel	0 to 10
Sand	26 to 38
Silt	39 to 51
Clay	13 to 23

The results of Atterberg limit tests completed on samples of the cohesive till are presented on Figure C-4 of Appendix C. The results of the tests are summarized in Table 4-4 and on the Record of Borehole sheets in Appendix B. The results indicate that the material is of low plasticity (CL) to slight plasticity (CL-ML).

TABLE 4-4 ATTERBERG LIMIT RESULTS FOR COHESIVE TILL

Parameter	Value
Liquid Limit	16 to 26
Plastic Limit	10 to 16
Plasticity index	7 to 13

4.6.2 Cohesionless Till

Cohesionless till consisting of sand and silt with trace to some clay and trace gravel to gravelly was encountered beneath the earth fill, sand to silty sand and cohesive till layers in all boreholes except in Borehole OHSS2-01. SPT N-values measured in the cohesive till were between 30 and 89 blows per 0.3 m of penetration, and greater than 100 blows for less than 0.3 m of penetration, inferring a dense to very dense condition. N-values exceeding 100 blows were typically associated with inferred cobbles and/or the amount of gravel as noted on the record of boreholes.

The moisture content of the cohesionless till ranges from 5 percent to 16 percent . The results of grain size analysis completed on samples of the sand and silt till are presented on Figure C-5 of Appendix C. The results of the test are summarized in Table 4-5 and on the Record of Borehole sheets in Appendix B.

TABLE 4-5 GRADATION RESULTS FOR SAND AND SILT TILL

Soil Particle	Percentage (%)
Gravel	3 to 12
Sand	40 to 53
Silt	31 to 50
Clay	4 - to10

The results of Atterberg limit tests completed on samples of the sand and silt till are presented on Figure C-6 of Appendix C. The results of the tests are summarized in Table 4-6 and on the Record of Borehole sheets in Appendix B. The results indicate that the material is of slight to no plasticity. (ML).

TABLE 4-6 ATTERBERG LIMITS RESULTS FOR SAND AND SILT TILL

Parameter	Value
Liquid Limit	14
Plastic Limit	11
Plasticity index	3

4.7 Groundwater Conditions

Details of the water level observed in the boreholes upon completion of drilling are presented on the record of boreholes and summarized in Table 4.7.

TABLE 4-7 MEASURED WATER LEVELS IN THE OPEN BOREHOLES

Borehole	Date of Reading	Depth and Elevation of Groundwater (m)	Remarks
HMLP-01	2023-12-06	4.6 / 133.9	Borehole caved to 4.6 m upon completion
OHSS 1-01	2023-12-06	6.7 / 126.4	Borehole open upon completion
OHSS 2-01	2023-12-07	7.9 / 124.9	Borehole open upon completion
OHSS 3-01	2023-12-05	Dry	Boreholes open and dry upon completion of drilling.
OHSS 4-01	2023-12-07	Dry	
OHSS 4-02	2023-12-05	7.3 / 89.0	Borehole caved to 7.3 m upon completion

It should be noted that the groundwater level is subject to seasonal fluctuations and is expected to be at a higher elevation after snowmelt and periods of significant or prolonged precipitation.

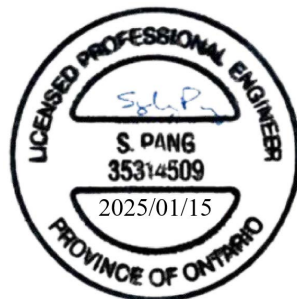
5. MISCELLANEOUS

Young's Drilling Inc. of Bowmanville, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, and in-situ testing. The drilling and sampling operations were supervised on a full-time basis by Sergey Gladkiy, EIT of Thurber. The Interpretation of the field data and preparation of this report was completed by Messrs. Ali Rajaei, P.Eng. and Rod de Castro, P.Eng. The report was reviewed by Messrs. Sydney Pang, P.Eng. and P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

Date: **January 15, 2025**

File: **31958**

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

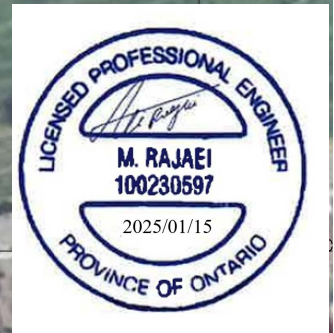
The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or 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.



APPENDIX A

DRAWINGS

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



CONT No2020-E-0052
WP No 2117-20-00

HIGHWAY 401

SHEET

BOREHOLE LOCATIONS AND SOIL STRATA

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
HMLP-01	138.5	4 850 896.0	329 509.0
OHSS1-01	133.1	4 850 985.0	330 070.0
OHSS2-01	132.8	4 850 988.0	330 163.0

-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. 30M14-661

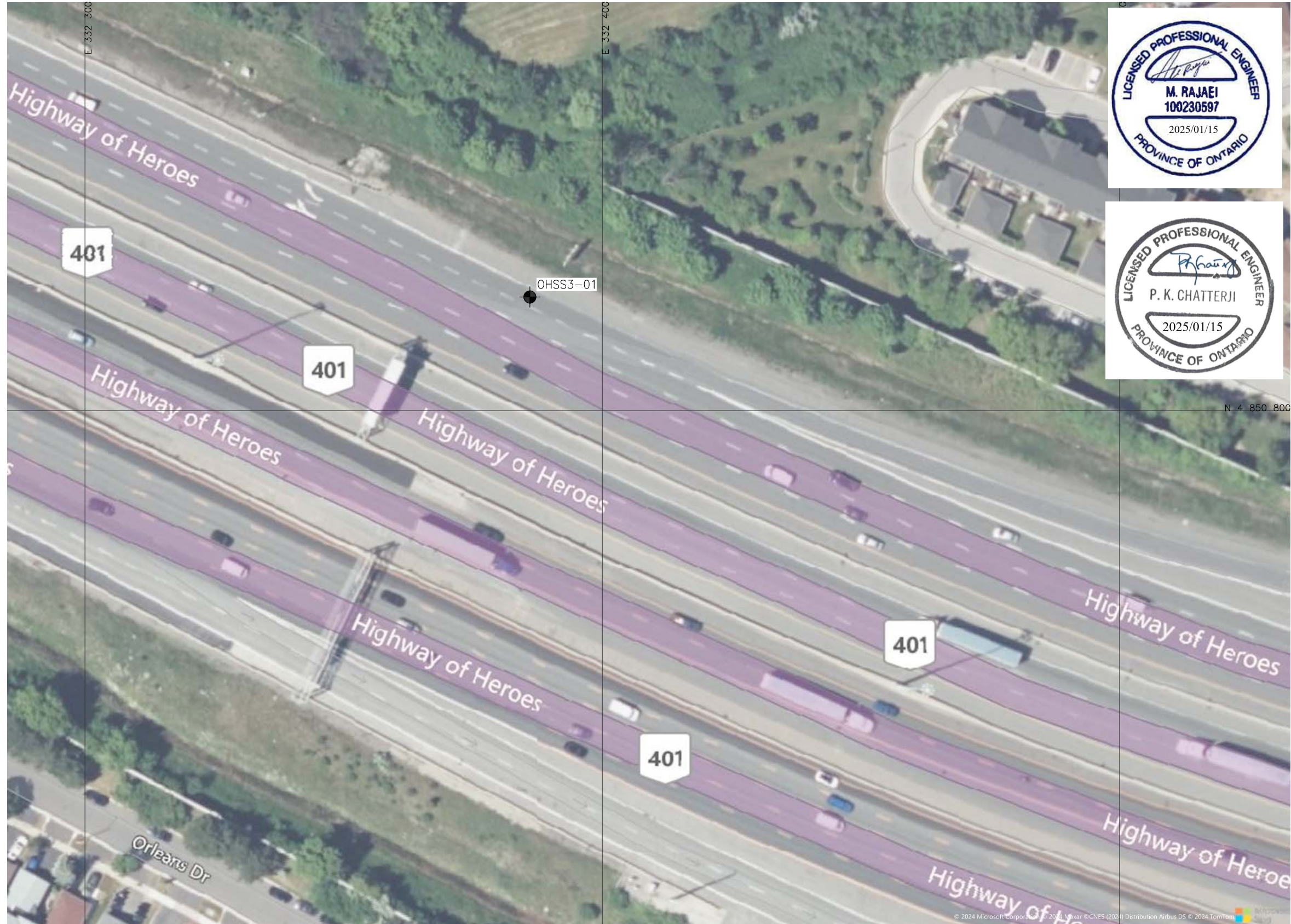
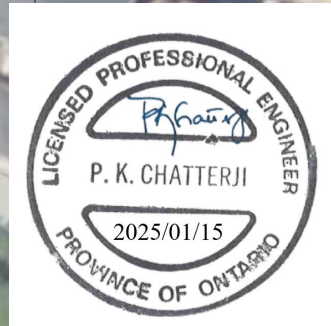
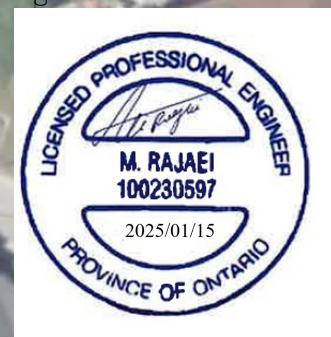
REVISIONS	
DATE	BY

DESIGN	AR	CHK	RdC	CODE	LOAD	DATE	JUN 2024
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METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



CONT No2020-E-0052
WP No 2117-20-00

HIGHWAY 401

BOREHOLE LOCATIONS AND SOIL STRATA



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
OHSS3-01	122.5	4 850 822.0	332 386.0

-NOTES-

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GEOCRES No. 30M14-661

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	AR	CHK	RdC	CODE
DRAWN	AN	CHK	AR	SITE
		LOAD	DATE	JUN 2024
		STRUCT	DWG	2

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

CONT No2020-E-0052
WP No 2117-20-00



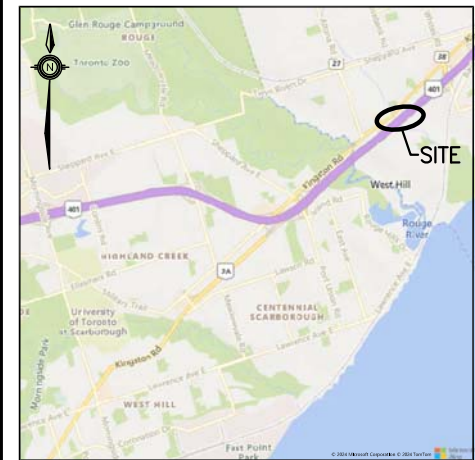
HIGHWAY 401

SHEET

BOREHOLE LOCATIONS AND SOIL STRATA



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
OHSS4-01	95.9	4 852 395.0	335 016.0
OHSS4-02	96.3	4 852 376.0	335 031.0

-NOTES-

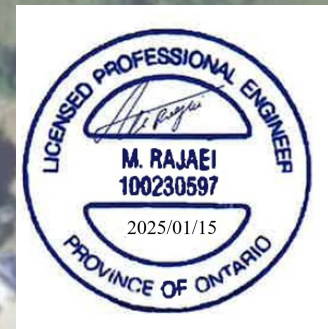
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GEOCRES No. 30M14-661

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	AR	CHK	RdC	CODE	LOAD	DATE	JUN 2024
DRAWN	AN	CHK	AR	SITE	STRUCT	DWG	3

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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
 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			

RECORD OF BOREHOLE No HMLP-01

1 OF 2

METRIC

GWP# 2117-20-00 LOCATION MTM NAD83 Zone 10: N 4 850 896.0 E 329 509.0 ORIGINATED BY SG
DIST Central HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AS
DATUM Geodetic DATE 2023.12.06 - 2023.12.06 LATITUDE 43.797615 LONGITUDE -79.192943 CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
138.5	GROUND SURFACE													
0.0	ASPHALT: (150mm)													
0.2	Gravelly SAND, some silt Compact to Loose Brown Moist (FILL)		1	SS	18		138							
			2	SS	6									
137.1							137							
1.4	Silty SAND, trace to some gravel, trace clay Compact to Dense Brown Moist		3	SS	20									
			4	SS	17		136							
			5	SS	34		135							4 74 20 2
							134							
	Wet		6	SS	16		133							
132.9							132							
5.6	Clayey SILT, with sand, trace to some gravel Very Stiff Grey Wet (TILL)		7	SS	27		131							
			8	SS	16		130							10 35 42 13
129.8														
8.7	SAND AND SILT, trace clay, trace gravel Very Dense Grey Wet (TILL)		9	SS	61		129							7 45 44 4
128.7														
9.8	END OF BOREHOLE AT 9.8m.													

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

RECORD OF BOREHOLE No OHSS1-01

1 OF 1

METRIC

GWP# 2117-20-00 LOCATION MTM NAD83 Zone 10: N 4 850 985.0 E 330 070.0 ORIGINATED BY SG
 DIST Central HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AS
 DATUM Geodetic DATE 2023.12.06 - 2023.12.06 LATITUDE 43.798397 LONGITUDE -79.185967 CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
133.1	GROUND SURFACE															GR SA SI CL
0.0	ASPHALT: (230mm)															
0.2	Gravelly SAND, some silt Dense Brown Moist (FILL)		1	SS	31											
			2	SS	39											
131.7																
1.4	SAND, trace to some gravel, trace silt and clay Dense Brown Moist		3	SS	48											
			4	SS	39											2 88 9 1
			5	SS	32											
129.0																
4.1	SAND AND SILT, trace to some clay, trace gravel Very Dense Grey Wet (TILL)		6	SS	49											3 43 44 10
	Inferred cobbles		7	SS	100/ 0.025											Split spoon bouncing

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHSS2-01

1 OF 1

METRIC

GWP# 2117-20-00 LOCATION MTM NAD83 Zone 10: N 4 850 988.0 E 330 163.0 ORIGINATED BY SG
DIST Central HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AS
DATUM Geodetic DATE 2023.12.06 - 2023.12.07 LATITUDE 43.798421 LONGITUDE -79.184811 CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
132.8	GROUND SURFACE												
0.0	ASPHALT: (200mm)												
0.2	Gravelly SAND , some silt and clay Dense Brown Moist (FILL)		1	SS	41		132						24 55 17 4
131.4			2	SS	45								
1.4	SAND , some gravel, trace clay Compact to Dense Brown Moist		3	SS	29		131						
			4	SS	38		130						
129.8													
3.0	Gravelly SAND , trace silt and clay Dense Brown Moist		5	SS	43		129						48 47 4 1
128.7													
4.1	Silty CLAY , with sand, trace gravel Hard Grey Moist (TILL)		6	SS	64		128						
							127						
			7	SS	42		126						0 26 51 23
124.8			8	SS	100/ 0.125		125						
8.0	END OF BOREHOLE AT 8.0m. BOREHOLE WAS OPEN AND WATER LEVEL WAS MEASURED AT 7.9m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS / SOIL CUTTINGS, COLD PATCH ASPHALT AT SURFACE.												

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+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHSS3-01

1 OF 1

METRIC

GWP# 2117-20-00 LOCATION MTM NAD83 Zone 10: N 4 850 822.0 E 332 386.0 ORIGINATED BY SG
DIST Central HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AS
DATUM Geodetic DATE 2023.12.05 - 2023.12.05 LATITUDE 43.796847 LONGITUDE -79.157195 CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L
122.5	GROUND SURFACE							20 40 60 80 100						
0.0 0.1	ASPHALT: (50mm)													
	Gravelly SAND, some silt Dense to Compact Brown Moist (FILL)		1	SS	36		122							
			2	SS	26									
121.1							121							
1.4	SAND AND SILT, trace to some gravel, trace clay Dense to Very Dense Brown Moist (TILL)		3	SS	44									
			4	SS	74		120							5 45 41 9
	Gravelly		5	SS	100/ 0.075		119							Resistance to augering at 3.6m depth
	Becoming grey		6	SS	38		118							
							117							
	Gravelly		7	SS	100/ 0.275		116							12 41 39 8
														Resistance to augering at below 7.2m depth
							115							
114.8	END OF BOREHOLE AT 7.7m. BOREHOLE WAS OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE PELLETS / SOIL CUTTINGS, COLD PATCH ASPHALT AT SURFACE.		8	SS	100/ 0.125									
7.7														

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OHSS4-02

1 OF 1

METRIC

GWP# 2117-20-00 LOCATION MTM NAD83 Zone 10: N 4 852 376.0 E 335 031.0 ORIGINATED BY SG
DIST Central HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AS
DATUM Geodetic DATE 2023.12.04 - 2023.12.05 LATITUDE 43.810731 LONGITUDE -79.124239 CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						WATER CONTENT (%) W P W W L					
96.3	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (230mm)							20	40	60	80	100							
0.2	SAND, some gravel, some silt Compact Brown Moist (FILL)		1	SS	26		96												
95.6																			
0.7	Silty CLAY, with sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		2	SS	8		95												
			3	SS	17		94												
			4	SS	13		94												
	Becoming firm and grey																		
			5	SS	7		93												
92.2																			
4.1	SAND AND SILT, trace to some gravel, trace clay Dense to Very Dense Grey Moist (TILL)		6	SS	35		92												
							91												
			7	SS	89		90												
			8	SS	100/ 0.200		89												
88.3																			
8.0	END OF BOREHOLE AT 8.0m. BOREHOLE CAVED TO 7.3m AND WATER LEVEL WAS MEASURED AT 7.3m. BOREHOLE BACKFILLED WITH BENTONITE PELLETS AND, COLD PATCH ASPHALT AT SURFACE.																		

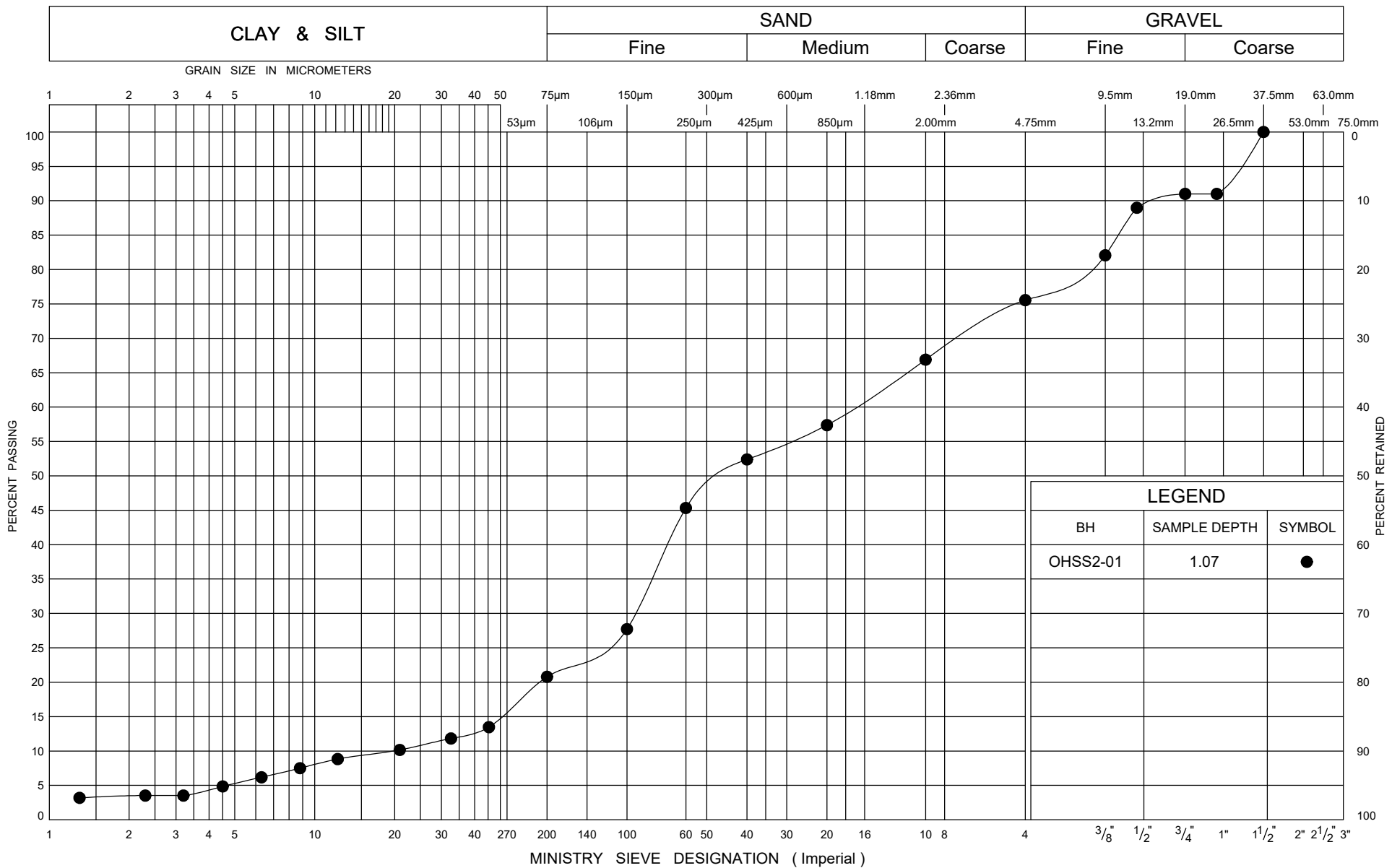
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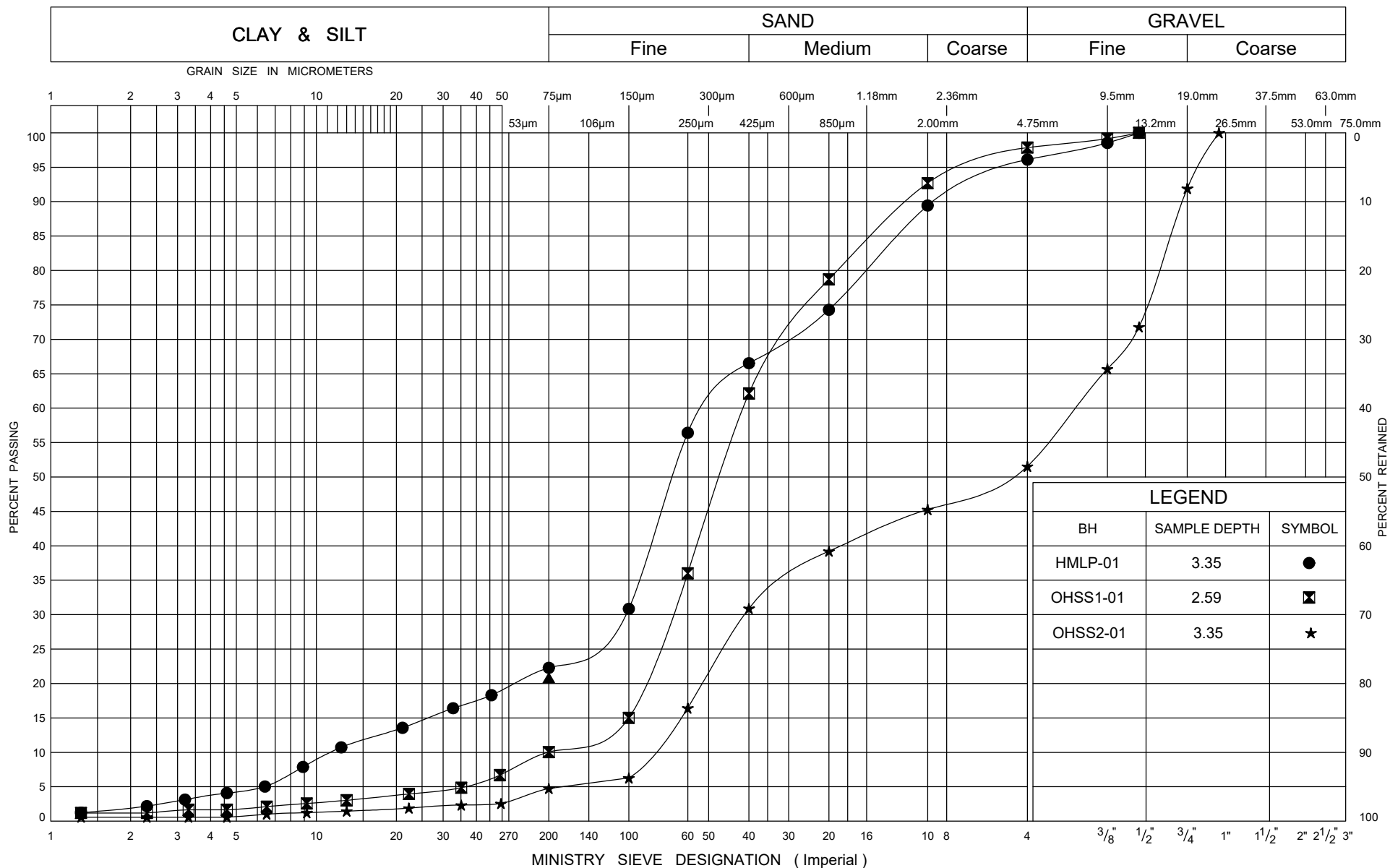
+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

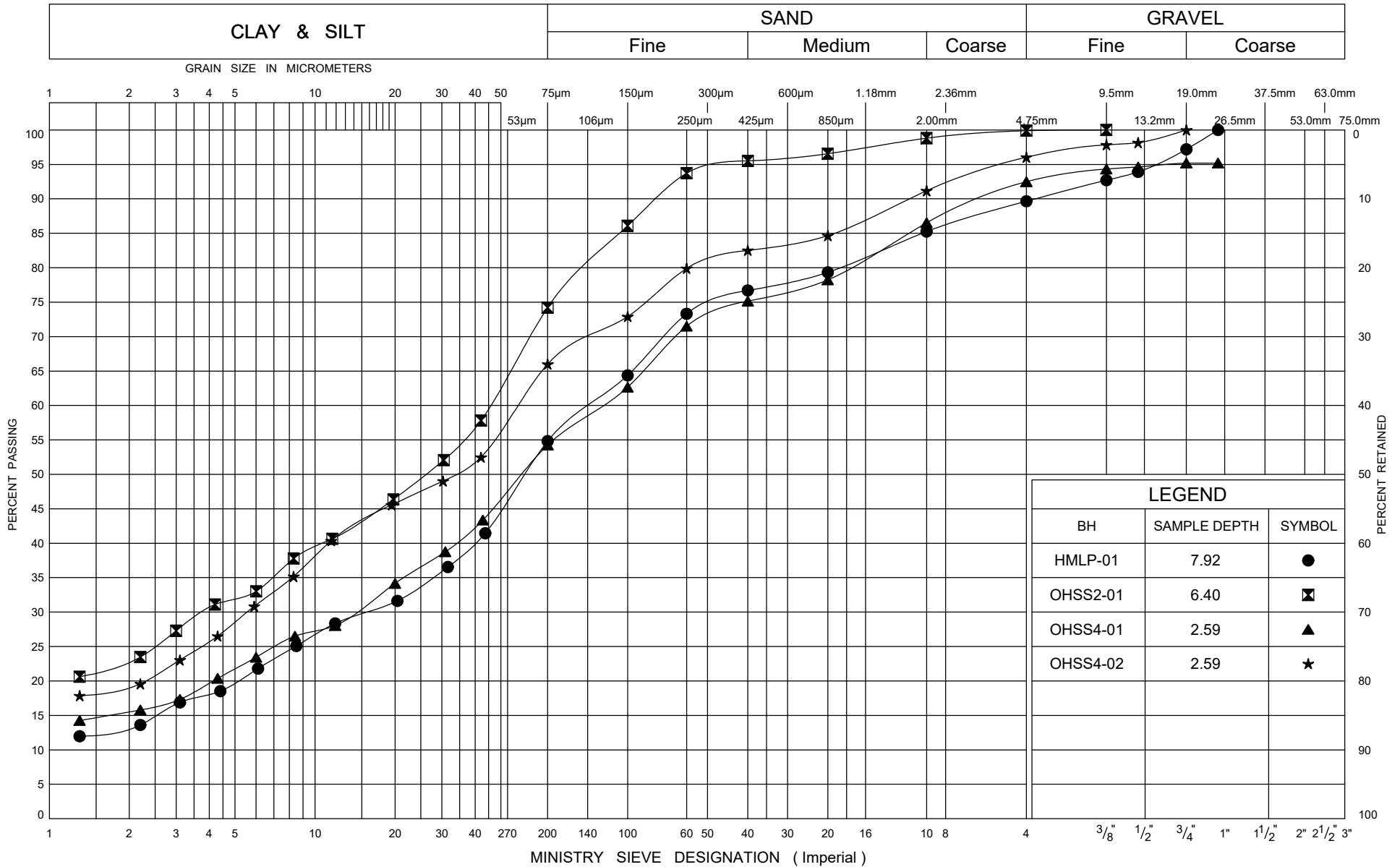


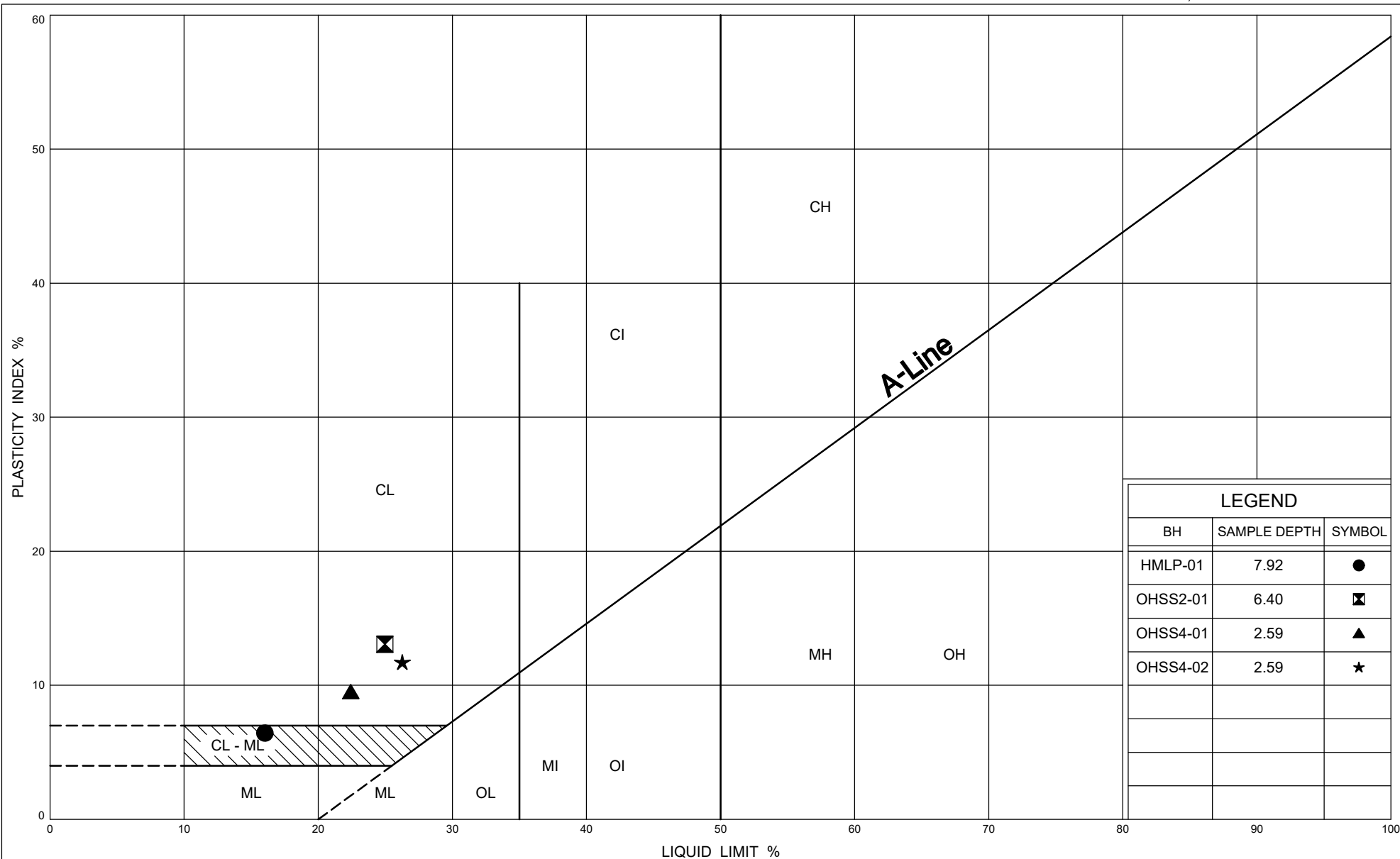
APPENDIX C

GEOTECHNICAL LABORATORY SOIL TEST RESULTS

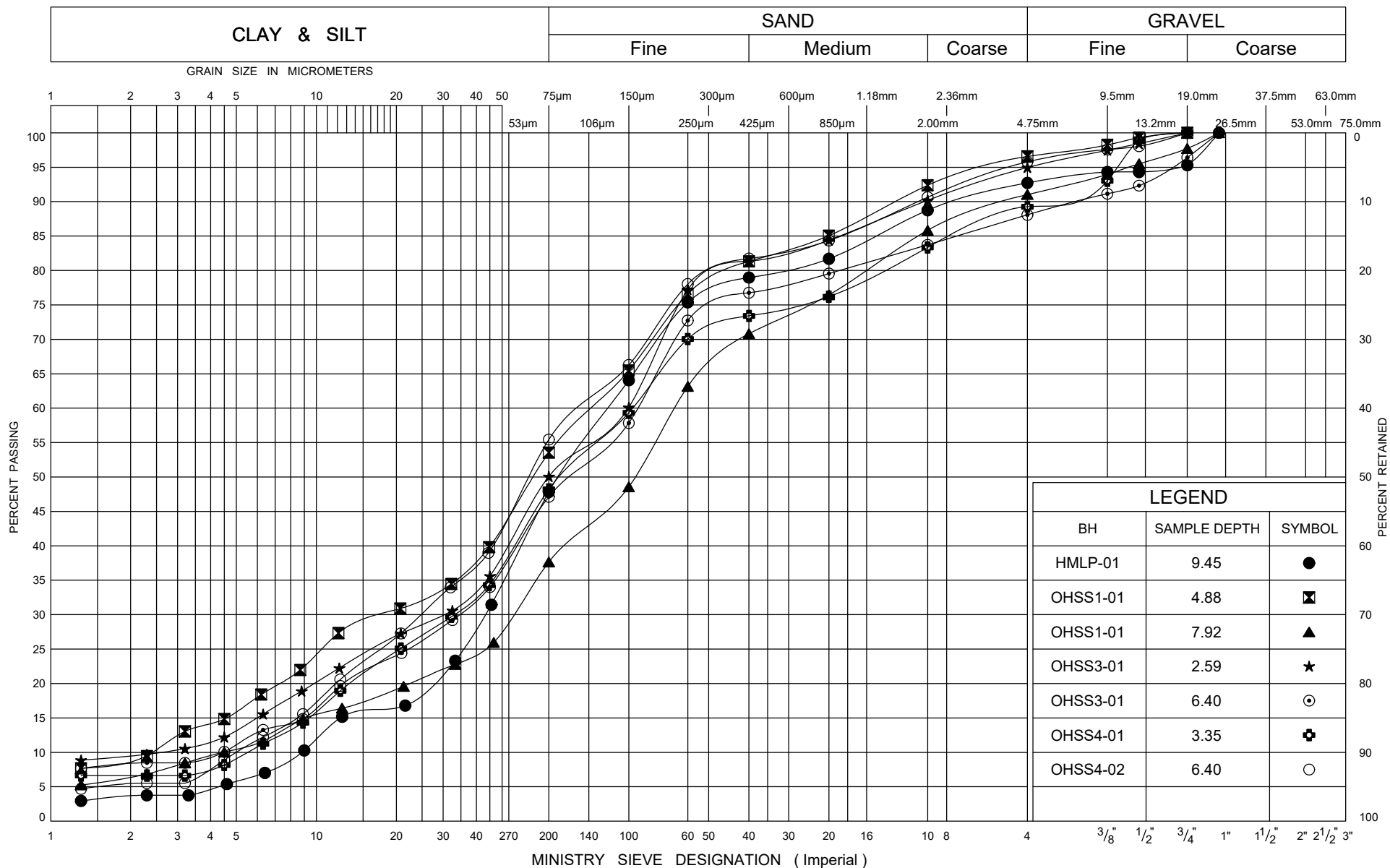


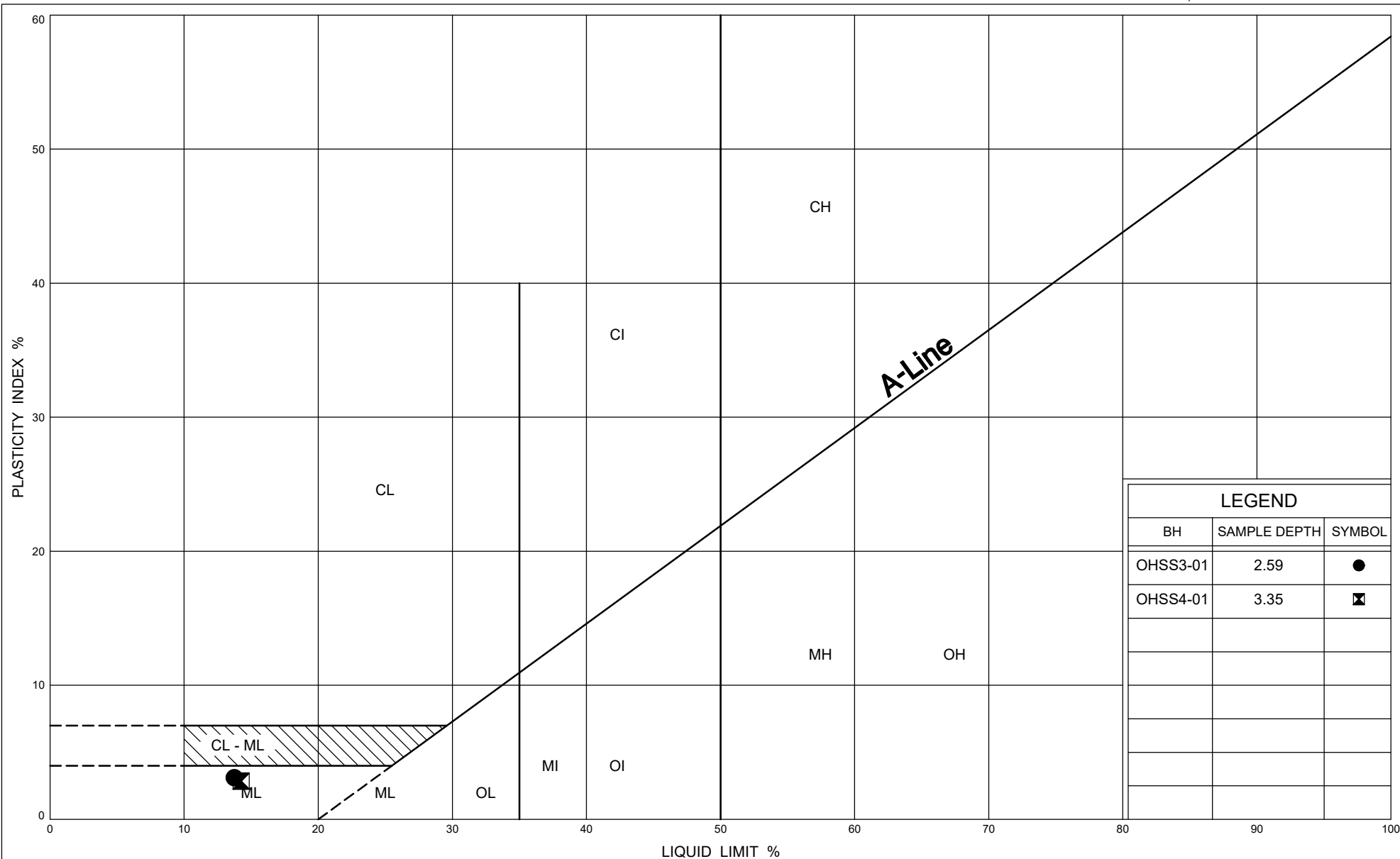






LEGEND		
BH	SAMPLE DEPTH	SYMBOL
HMLP-01	7.92	●
OHSS2-01	6.40	⊠
OHSS4-01	2.59	▲
OHSS4-02	2.59	★





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