



Revised Foundation Investigation Report

TEMPORARY PROTECTION SYSTEM, HIGHWAY 402 (EASTBOUND AND WESTBOUND) AND HOWARD WATSON NATURE TRAIL (FORMER CN) OVERHEAD STRUCTURES, CITY OF SARNIA, ONTARIO, MINISTRY OF TRANSPORTATION, ONTARIO GWP 3105-18-00

SITE NO.: 14X-0337/B1 AND 14X-0337/B2

Site NO.	Latitude	Longitude
14X-0337/B1	42.987606°	-82.358487°
14X-0337/B2	42.987774°	-82.358483°

27 January 2023

GEOCRES NO.: 40J16-94

Distribution:

- 1 PDF & 1 Copy – Ministry of Transportation, Ontario (Central Region)
- 1 PDF & 1 Copy - Ministry of Transportation, Ontario (Foundation Section)
- 1 PDF – GHD Limited

➔ **The Power of Commitment**



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1. Introduction

GHD Limited (GHD) was retained by the Ministry of Transportation, Ontario (MTO), to provide foundation investigation and engineering services for the temporary protection systems associated with the proposed rehabilitation and conversion to semi-integral abutments of two CNR overhead structures on Highway 402 (eastbound and westbound) at Howard Watson Nature Trail (former CNR), located in the City of Sarnia, Ontario (see the Key Plan on Drawing 1).

The purpose of this investigation is to establish the subsurface soil and groundwater conditions at the locations of proposed temporary protection system by means of borehole drilling and geotechnical laboratory testing on selected soil samples.

The Terms of Reference (TOR) and the scope of work for this project are identified within the agreement of services as amended between MTO and GHD for Consultant's Assignment Number 3020-E-0014. The work has been carried out in accordance with the requirements of *Guideline for Foundation Engineering Services, Version 3.0, April 2022*, prepared by the MTO.

2. Site Description

The CNR overhead structures are located along Highway 402, about 1.3 km west of Highway 402 and Highway 40 interchange, and 0.7 km east of Murphy Road, in the City of Sarnia, Ontario.

The existing three span CNR overhead structures were constructed in 1976. Howard Watson Nature Trail (former CNR) passes under the CNR overhead structures and is generally aligned in north-south direction. The eastbound and westbound CNR overhead structures of Highway 402 consist of two lanes each, separated by a grass median and noise barrier walls along the perimeter of the structures.

The CNR overhead structures are situated in an urban-setting environment with generally a flat landscape. The areas surrounding the CNR overhead structures are a mix of residential and commercial land uses with vacant farm fields mostly towards the northeast side of the CNR overhead structures. West of the existing east abutment there are two buried power utilities that are operated by Bluewater Power and there is also a buried cable operated by Eastlink.

The embankment slopes between the CNR overhead structures are covered by grass or other vegetation (a grass median) and observed to be stable, with no signs of erosion. General site conditions are shown in Photographs 1 to 4 presented in Appendix A.

3. Investigation Procedures

3.1 Previous Investigation

A geotechnical investigation was completed for the Highway 402 overhead structure at the former CNR tracks on July 17, 1970, during which time a total of fourteen boreholes were advanced near the overhead structure. The boreholes were advanced from the original ground surface and prior to construction of the overhead structure to depths of between 6.4 m and 35.3 m below ground surface and geotechnical laboratory testing was carried out on selected soil samples. The results of the investigation are contained in a report titled, "*Foundation Investigation Report for The Proposed C.N.R. Overhead of Highway 402, near Sarnia, District No. 1 (Chatham)*", WP 346-65-01 & 02, prepared by the Department of Highways Ontario, dated July 17, 1970

(GEOCREs No. 40J16-039). The location of the boreholes are shown on Drawing 1 and on the borehole location drawing included in Appendix B.

3.2 Current Investigation

The geotechnical fieldwork for this investigation was carried out between September 6 and 12, 2022, during which time four boreholes designated as BH1-22 to BH4-22 (two boreholes at each structure) were advanced to a depth of about 12.8 m below ground surface (existing Highway 402 road level). The borehole depths were advanced to a minimum depth of 10 m below the base of the excavation for the proposed rehabilitation and in accordance with the MTO “*Guidelines for Foundation Engineering Services*”, dated April 2022. The boreholes were advanced through the right lanes of eastbound and westbound as shown on Drawing 1.

Prior to the start of fieldwork, utility clearance procedures were carried out through Ontario One Call, and fieldwork notification was sent to MTO West Region. A project specific Health and Safety as well as Traffic Protection Plans were prepared before commencement of the fieldwork. In addition, the borehole locations were marked by GHD staff prior to drilling. All drilling activity, soil sampling and logging, and backfilling of boreholes were conducted under the full-time supervision of an experienced GHD geotechnical engineer.

The boreholes were advanced using a B57 track-mounted drill rig, equipped with continuous flight, hollow stem augers, supplied and operated by Landshark Drilling of Brantford, Ontario. The asphalt and underlying concrete were cored using concrete coring equipment and municipal water supplied by the drilling subcontractor. Soil samples were obtained at 0.75 m intervals of depth, using a 50 mm outer-diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedures described in ASTM D1586¹. Where firm to stiff cohesive deposits were encountered, in-situ field vane shear tests were carried out using an MTO 'N'-size vane to assess the strength characteristics of these soils in accordance with ASTM D2573². Soil samples obtained from the boreholes were inspected in the field immediately upon retrieval for type, texture, and color. All retrieved samples from the investigation were sealed in clean plastic bags and transported to the GHD laboratory in Waterloo for further visual examination, and geotechnical laboratory tests.

No monitoring wells were installed in any of the boreholes; however, groundwater conditions and water levels were observed/measured in the open boreholes during drilling by visual examination of soil samples and drill rods as well as immediately following the drilling operations. The boreholes were backfilled with bentonite and sealed at the top with compacted auger cuttings, in accordance with Ontario Regulation 903, (as amended).

Surveying of the as-drilled borehole locations was conducted by Callon Dietz Inc. (Callon Dietz) of London, Ontario, subcontracted to GHD. Callon Dietz provided northing and easting in MTM NAD 83 (Zone 11) coordinates. The ground surface elevations are referenced to Geodetic datum. The coordinates and ground surface elevation are presented below, on the borehole records and on Drawing 1.

Structure Number	Borehole Number	Location	Location (MTM NAD 83, ZONE 11)		Borehole Depth (m)	Ground Surface Elevation (m)	End of Borehole Elevation (m)
			Northing (m) (Latitude, °)	Easting (m) (Longitude, °)			
14X-0337/B1 (Eastbound Lanes)	BH2-22	Right lane of EB of Highway 402	4,760,863.7 (42.987490)	316,314.3 (-82.358806)	12.8	189.9	177.1
	BH4-22	Right lane of EB of Highway 402	4,760,879.4 (42.987631)	316,364.0 (-82.358196)	12.8	190.1	177.3
14X-0337/B2	BH1-22	Right lane of WB of Highway 402	4,760,893.2 (42.987756)	316,314.3 (-82.358805)	12.8	190.0	177.2

¹ ASTM D1586-08a – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the soil.

² ASTM D2573-15 Standard Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils

Structure Number	Borehole Number	Location	Location (MTM NAD 83, ZONE 11)		Borehole Depth (m)	Ground Surface Elevation (m)	End of Borehole Elevation (m)
			Northing (m) (Latitude, °)	Easting (m) (Longitude, °)			
(Westbound Lanes)	BH3-22	Right lane of WB of Highway 402	4,760,911.6 (42.987921)	316,369.7 (-82.358125)	12.8	189.9	177.1

Classification testing (i.e., water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. All laboratory tests were conducted in accordance with MTO and/or American Society for Testing Materials (ASTM) standards, as appropriate.

4. Site Geology and Subsurface Conditions

4.1 Regional Geology

The CNR overhead structures are located within physiographic region known as Huron Fringe, which is a subdivision of the St. Clair Clay Plain, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)³. The surficial soils of the Huron Fringe region in proximity to the site generally consist of sand, gravel, silt and clay, and littoral deposits derived from coarse-textured lacustrine deposits. The majority of the region is characterized by Sand Plains and tributary valleys to Lake St. Clair. The depth to the bedrock in the area is in excess of 30 m below ground surface and consists of shale of the Kettle Point Formation.

4.2 Subsurface Conditions – Previous Investigation

As discussed in Section 3.1 previously a geotechnical investigation was carried out from the original ground surface prior to the construction of the overhead structure. The results of previous investigation from GEOCREs No. 40J16-039 are presented in Appendix B.

The subsurface conditions encountered in boreholes advanced from the original ground surface (approximately Elevation 180 m) consist of sandy silt to silty sand and organics that extended to a depth of between about 1.5 m and 3 m below the original ground surface. The SPT “N” values presented on the borehole records range from 2 blows to 7 blows per 0.3 m of penetration, suggesting a very loose to loose compactness condition.

The surficial deposit was underlain by a 32 m thick deposit of clayey silt to silty clay, with trace sand and gravel. Within the deposit the upper approximately 3 m can be characterized as an “upper weathered crust” encountered at depths of between 1.5 m and 3 m below the original ground surface (between Elevation 179.2 m and 177.0 m). The SPT “N” values within the upper weathered crust range from about 9 blows to 43 blows per 0.3 of penetration, suggesting a stiff to hard consistency. The upper weathered crust has slight plasticity with the plastic limit averaging about 16% and the liquid limits at about 30%.

Underlying the upper weathered crust the deposit consists of silty clay, with trace sand and gravel and extended to the bedrock surface at about a depth of 33.8 m below ground surface (approximate Elevation of 146.6 m). In-situ vane shear testing was carried out in the boreholes and the undrained shear strength of the silty clay deposit varied from about 38 kPa to greater than 105 kPa, indicating that the cohesive deposit has a firm to very stiff consistency. The silty clay deposit has medium plasticity with the plastic limit averaging about 19% and the liquid limits at about 38%.

Shale bedrock of the Kettle Point Formation was encountered at a depth of 33.5 m below the original ground surface (Elevation 246.6 m).

³ Chapman, L.J. and Putman, D.F., 1984, *The Physiography of Southern Ontario*, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.)

The previous report indicates that the groundwater level measured in the completed boreholes was at depths of about 0.6 m below the original ground surface and that it was likely lower during drier seasons.

4.3 Subsurface Conditions

Details of the subsurface soil and groundwater conditions as encountered in the boreholes advanced during the geotechnical investigation and the results of the laboratory tests carried out on selected soil samples are presented on the borehole records provided in Appendix C. The *Notes on Borehole and Test Pit Reports* are also included in Appendix C to assist in the interpretation of the borehole records. The results of the geotechnical laboratory testing are contained in Appendix D. The results of in-situ field tests (i.e., SPT “N” values), as presented on the borehole records and in the sub-sections of Section 4 are uncorrected.

The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress, the results of the Standard Penetration Tests and in-situ vane shear tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations; however, the factual data presented in the borehole records governs any interpretation of the site conditions.

In summary, the subsurface conditions at boreholes completed in the vicinity of the existing CNR overhead structures consists of a layer of asphalt underlain by a layer of concrete. The concrete is further underlain by granular fill consisting of gravelly sand to sand and gravel, which in turn is underlain by fill material consisting of sandy clayey silt. In places beneath the cohesive fill material is a thin layer of fill material consisting of sand to gravelly sand. The fill material is underlain by a deposit consisting of sandy clayey silt. Detailed descriptions of subsurface conditions are provided in the following sections of this report. The subsurface conditions are described in accordance with the Ontario Ministry of Transportation (MTO) Guideline for Foundation Engineering Services Version 3.0 (April 2022).

4.3.1 Asphalt

Boreholes BH1-22 to BH4-22 were advanced through the eastbound and westbound lanes of Highway 402 and encountered an asphalt layer ranging in thickness from 150 mm to 310 mm.

4.3.2 Approach Slab Concrete

Underlying the asphalt in all four boreholes (BH1-22 to BH4-22), a layer of reinforced concrete was encountered, ranging in thickness from about 300 mm to 490 mm.

4.3.3 Fill

Underlying the concrete in all four boreholes (BH1-22 to BH4-22), fill material consisting of gravelly sand to sand and gravel with some fines was encountered and extended to depths of between about 1.2 m to 2.3 m below ground surface (Elevations 188.7 m and 187.8 m).

The Standard Penetration Test (SPT) “N” values recorded within the fill material range from 17 blows to 38 blows per 0.3 m of penetration, indicating a compact to dense compactness condition.

Grain size distribution testing was conducted on three representative samples of the granular fill and the results are presented on Figure D-1 in Appendix D). The water content measured on samples of the granular fill range from approximately 5% to 11%.

The granular fill is underlain by embankment fill consisting of sandy clayey silt, trace gravel. The cohesive fill extends to depths of between about 10.7 m and 11.3 m (Elevations 179.2 m and 178.6). In Borehole BH2-22 a 0.1 m thick layer of gravelly sand fill was encountered at 10.2 m depth (Elevation 179.7 m). Underlying the cohesive fill in Borehole BH2-22 at a depth of 10.7 m (Elevation 179.2 m) a 0.7 m thick layer of fill material consisting of sand, some silt, trace gravel and clay was encountered.

The Standard Penetration Test (SPT) “N” values recorded within the cohesive fill material range from 4 blows to 23 blows per 0.3 m of penetration. In-situ vane tests carried out within the cohesive fill material measured undrained shear strength of greater than 100 kPa. The in-situ field vane tests together with the SPT “N” values indicate that the cohesive encountered in the boreholes has a soft to very stiff consistency. The SPT “N” values recorded in the granular fill were 25 blows and 30 blows per 0.3 m of penetration, suggesting a compact compactness condition.

Grain size distribution testing was conducted on eight representative samples of the cohesive fill and the results are shown on Figure D-2 in Appendix D. Atterberg limits testing was carried out on fifteen samples of the cohesive fill and the results had liquid limits ranging from about 23% to 33%, plastic limits ranging from about 12% to 16%, and resulting plasticity indices of between about 9% to 17%. These results, which are plotted on a plasticity chart on Figures D-3A&B in Appendix D, indicate that the cohesive fill consist of sandy clayey silt of low to medium plasticity. Further, grain size distribution testing was conducted on two representative samples of the gravelly sand to sand fill material and the results are shown on Figure D-4 in Appendix D).

The water content measured on samples of the granular fill range from approximately 5% to 11% and water content measured on samples of the cohesive fill range from approximately 12% to 21%. The water content measured on a sample of the lower granular fill in Borehole BH2-22 was 17%.

4.3.4 Sandy Clayey Silt

A cohesive deposit consisting of sandy clayey silt with trace of gravel was encountered beneath the cohesive fill in Boreholes BH3-22 and 4-22 and below the granular fill in Boreholes BH1-22 and 2-22, at depths of about 11.3 m and 11.4 m below ground surface (Elevations 178.8 m and 178.5 m). All boreholes terminated within the sandy clayey silt at a depth of 12.8 m below ground surface (between Elevations 177.3 m and 177.1 m).

The SPT “N” values recorded within the sandy clayey silt deposit range from 11 blows to 18 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency.

The water content measured on samples of the sandy clayey silt deposit were 14% and 16%.

4.3.5 Groundwater

The groundwater level in the open boreholes was measure upon completion of drilling each borehole. The water levels measured in the open boreholes are summarized below.

Structure Number	Borehole Number	Water Level Depth (m)	Water Level Elevation (m)	Date of Observation (Measurement)	Remark
14X-0337/B1 (Eastbound Lanes)	BH2-22	12.7	177.2	September 08, 2022	Open boreholes upon completion of drilling
	BH4-22	Dry	--	September 07, 2022	
14X-0337/B2 (Westbound Lanes)	BH1-22	11.3	178.7	September 12, 2022	
	BH3-22	Dry	--	September 12, 2022	

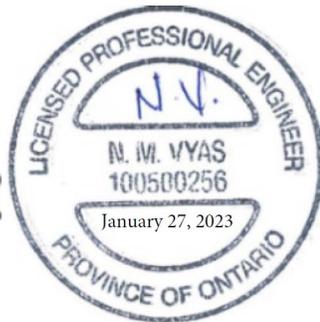
It should be noted that the groundwater level at the site will fluctuate with seasonal changes, periods of precipitation, and temperature and should be expected to be higher during wet periods of the year.

5. Closure

The fieldwork was supervised by Mr. Madlool Alsabak, E.I.T. under the direction of Mr. Nirjar Vyas, M.Eng., P.Eng., and Ms. Sandra McGaghran M.Eng., P.Eng. This report was prepared by Mr. Nirjar Vyas, M.Eng., P.Eng., a Geotechnical Engineer with GHD. Ms. Sandra McGaghran, M.Eng., P.Eng., a Senior Geotechnical Engineer with GHD and MTO Foundations Designated Contact conducted an independent review of the report.

Sincerely,

GHD Limited



Nirjar Vyas, M.Eng., P.Eng.
Geotechnical Engineer



Sandra McGaghran, M.Eng., P.Eng.
MTO Foundations Designated Contact, Senior Geotechnical Engineer

References

Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual (CFEM), 4th Edition. The Canadian Geotechnical Society, BiTech Publisher Ltd., British Columbia.

Canadian Highway Bridge Design Code (CHBDC (2019)) and Commentary on CAN/CSA-S6-19. Canadian Standard Association. (CSA) Group.

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

Kulhawy, F.H. and Mayne, P.W. 1990. Manual on Estimating Soil Properties for Foundation Design. EL6800, Research Project 14936. Prepared for Electric Power Research Institute, Palo Alto, California, U.S

ASTM International:

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

ASTM D2573-15 Standard Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils

Ontario Provincial Standard Specification:

OPSS.PROV 539 Construction Specification for Temporary Protection Systems

SP 105S09 Special Provision – Amendment to OPSS 539, November 2014

Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)

Ontario Occupational Health and Safety Act:

Ontario Regulation 213/91 Construction Projects (as amended)

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

CONT No.
 GWP No. 3105-18-00



HWY 402/FORMER CN OVERHEAD
 (RAPIDS PARKWAY) REHABILITATION
 BOREHOLE LOCATIONS

SHEET



KEY PLAN
 SCALE 0 750 1500 3000 m

LEGEND

- Borehole Location
- Borehole Location Geocres no. 40J16-039

BOREHOLE CO-ORDINATES
 (MTM ZONE 11)

NO	Elevation	Northing	Easting
BH1-22	190.0	4760893.2	316314.3
BH2-22	189.9	4760863.7	316314.3
BH3-22	189.9	4760911.6	316369.7
BH4-22	190.1	4760879.4	316364.0
1	180.6	4760882.5	316319.8
2	180.6	4760904.2	316322.7
3	180.4	4760870.9	316355.4
4	-	4760880.1	316347.8
5	-	4760896.3	316334.4
6	-	4760904.3	316331.5
7	-	4760863.7	316330.0
8	180.7	4760871.1	316321.5
9	180.4	4760897.1	316347.5
10	-	4760912.2	316348.2
11	-	4760883.9	316359.6
12	180.2	4760910.5	316360.6
14	180.3	4760920.9	316357.8

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.
 The boreholes shown in plan from GEOCREs 40J16-039 are approximate.

REFERENCE

Base plans provide in digital format by CALLON DIETZ, drawing file: 402SAR.dwg, received on October 31, 2022.

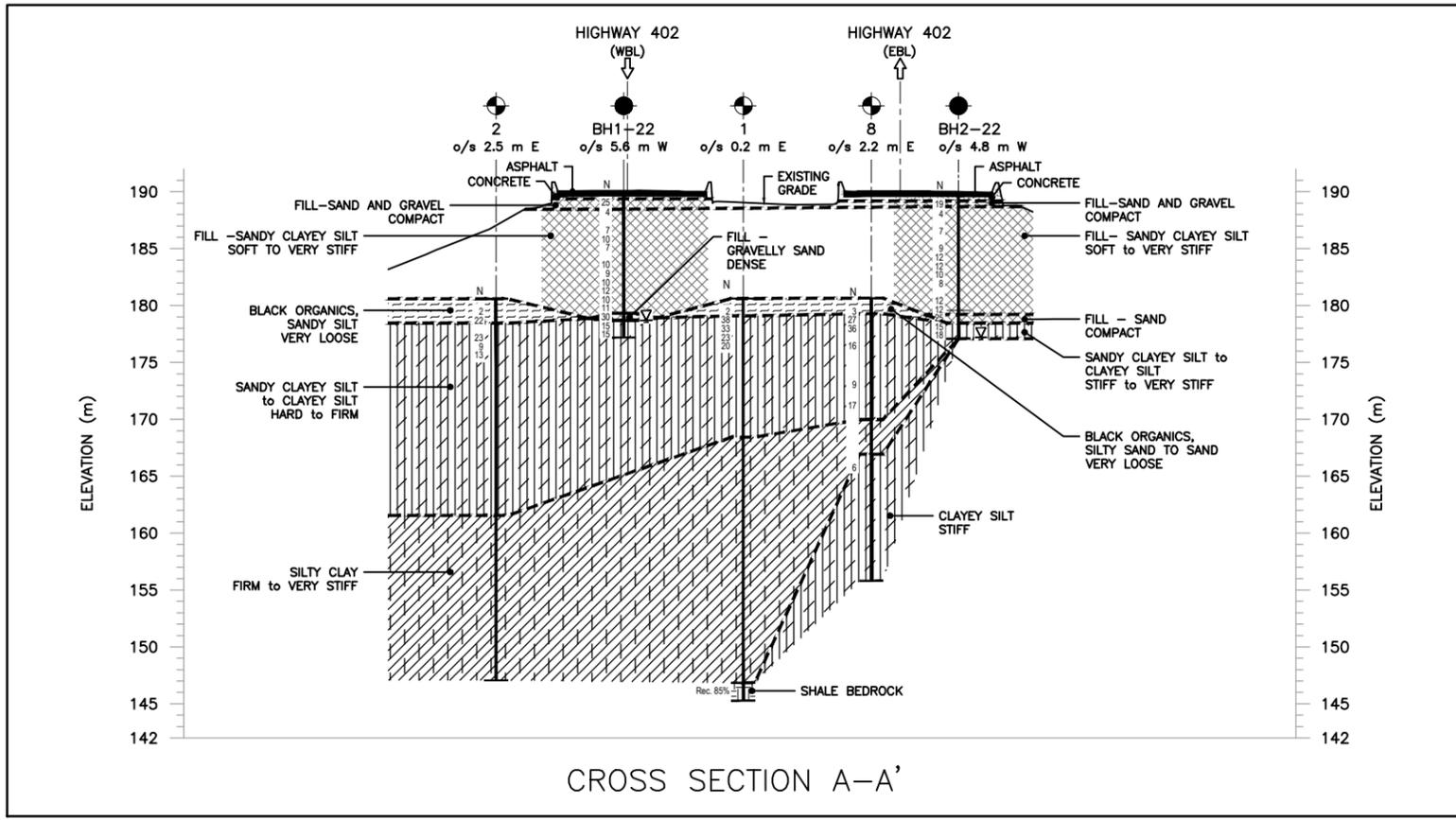


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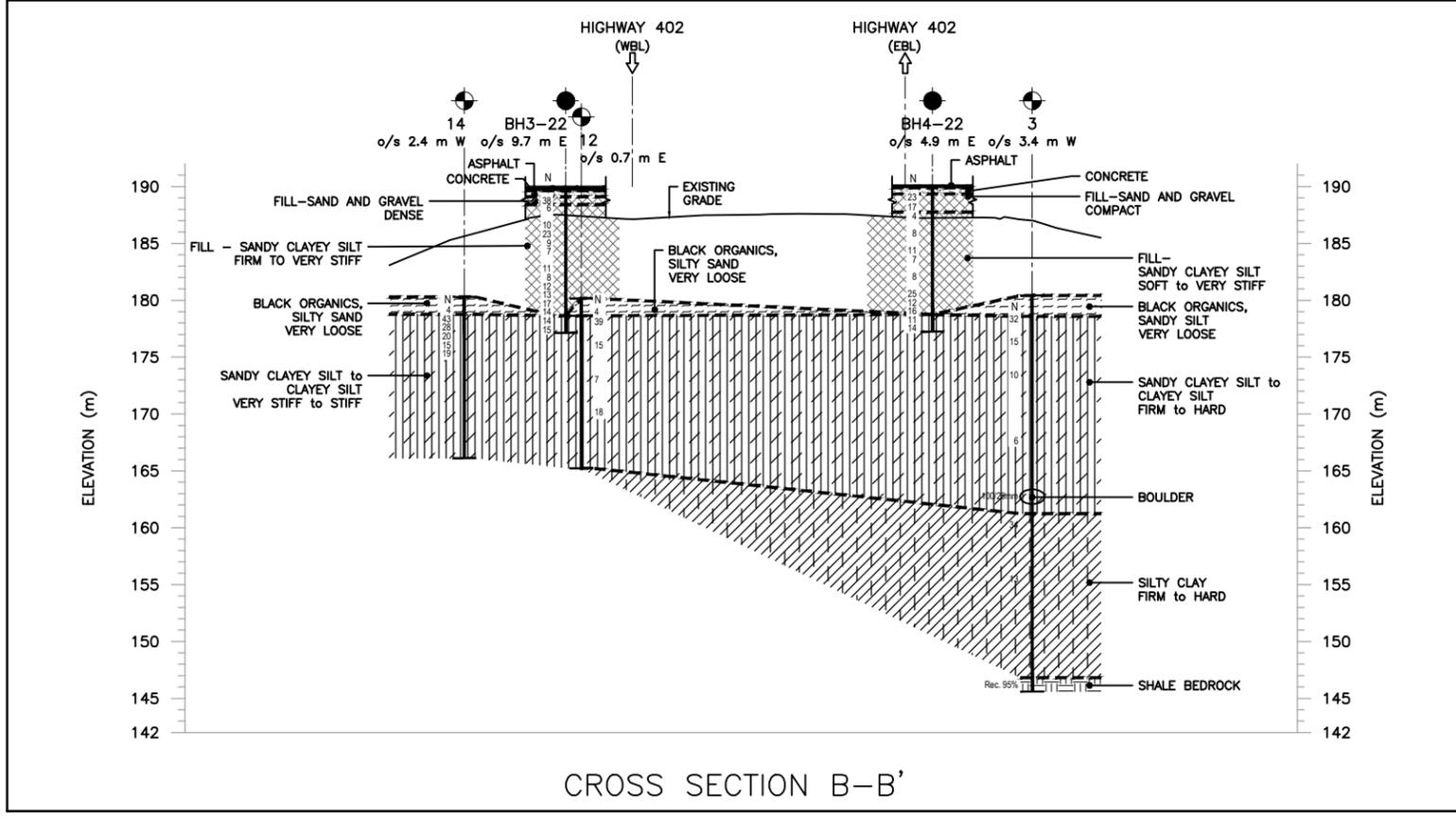
NO.	DATE	BY	REVISION

Geocres No.: 40J16-94

HWY. 402	PROJECT NO. 12566052	DIST. SOUTHWEST
SUBMD. MA	CHKD. AC	DATE: 1.23.2023
DRAWN: AW	CHKD. NV	APPD. SMM



CROSS SECTION A-A'



CROSS SECTION B-B'



LEGEND

- Borehole Location
- Borehole Location
Geocres no. 40J16-039
- Standard Penetration Test Value
- Blows/0.3 m unless otherwise stated
(Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling
- Recovery

BOREHOLE CO-ORDINATES
 (MTM ZONE 11)

NO	Elevation	Northing	Easting
BH1-22	190.0	4760893.2	316314.3
BH2-22	189.9	4760863.7	316314.3
BH3-22	189.9	4760911.6	316369.7
BH4-22	190.1	4760879.4	316364.0
1	180.6	4760882.5	316319.8
2	180.6	4760904.2	316322.7
3	180.4	4760870.9	316355.4
8	180.7	4760871.1	316321.5
12	180.2	4760910.5	316360.6
14	180.3	4760920.9	316357.8

NOTES

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The boundaries between soil strata has been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

Boreholes from GEOCRES 40J16-039 were advanced prior to construction of the overpass.

REFERENCE

Base plans provide in digital format by CALLON DIETZ, drawing file: 402SAR.dwg, received on October 31, 2022.

NO.	DATE	BY	REVISION

Geocres No.: 40J16-94

HWY. 402	PROJECT NO. 12566052	DIST. SOUTHWEST
SUBM.D. MA	CHKD. AC	DATE: 1.24.2023
DRAWN: AW	CHKD. NV	SITE: 14X-0337/B1 AND 14X-0337/B2
	APPD. SMM	DWG. 2



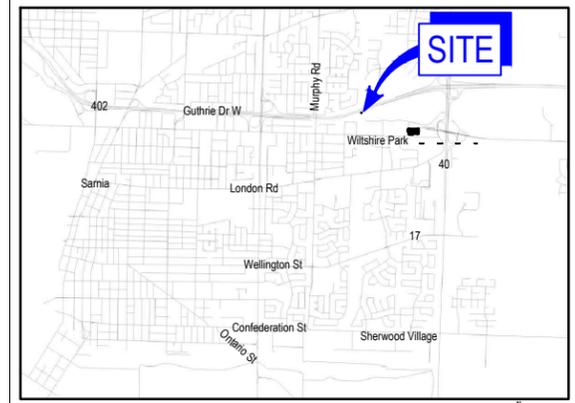
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 STATIONS IN KILOMETRES + METRES

CONT No.
 GWP No. 3105-18-00

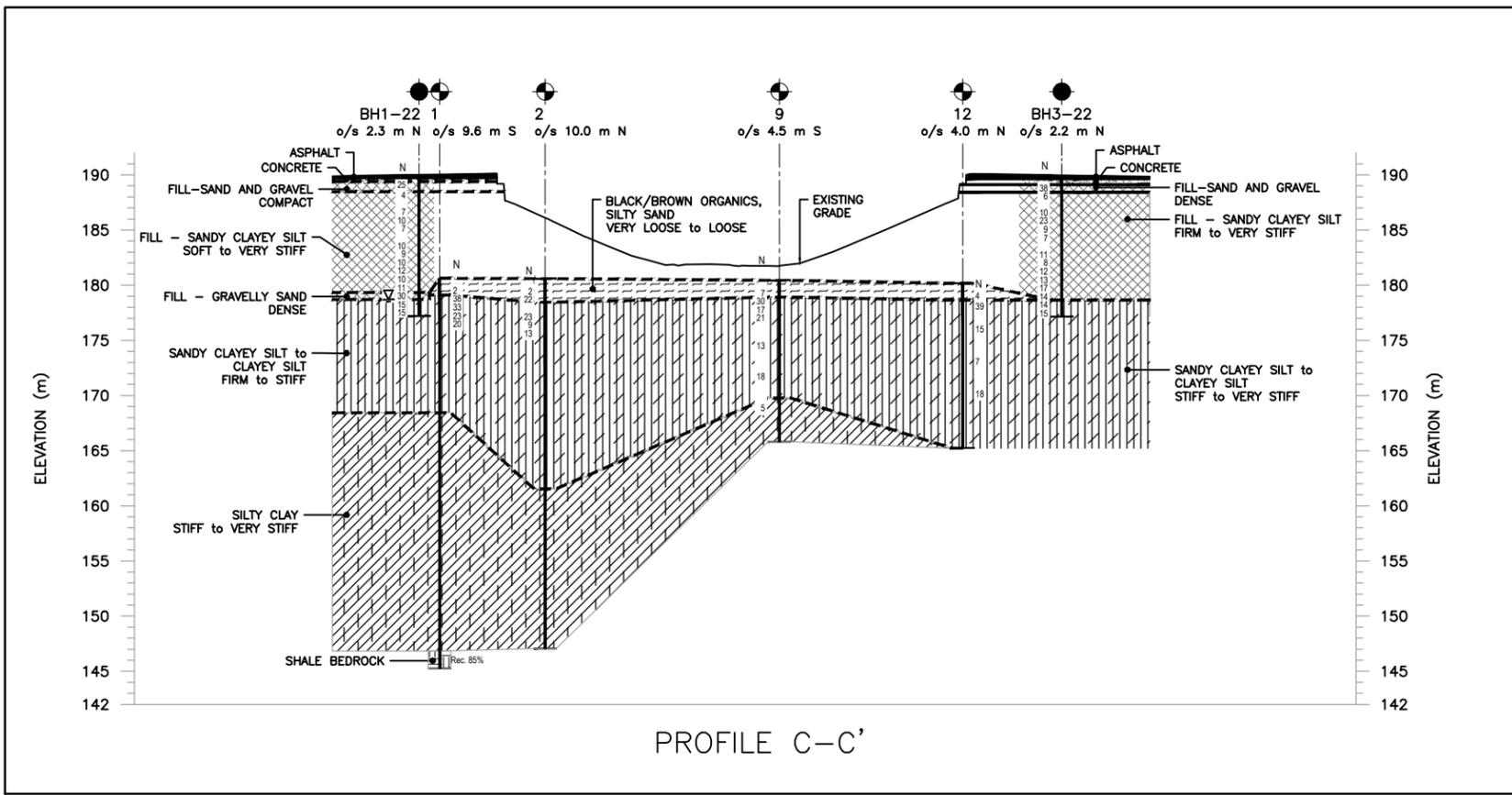


HWY 402/FORMER CN OVERHEAD
 (RAPIDS PARKWAY) REHABILITATION
 SOIL STRATA

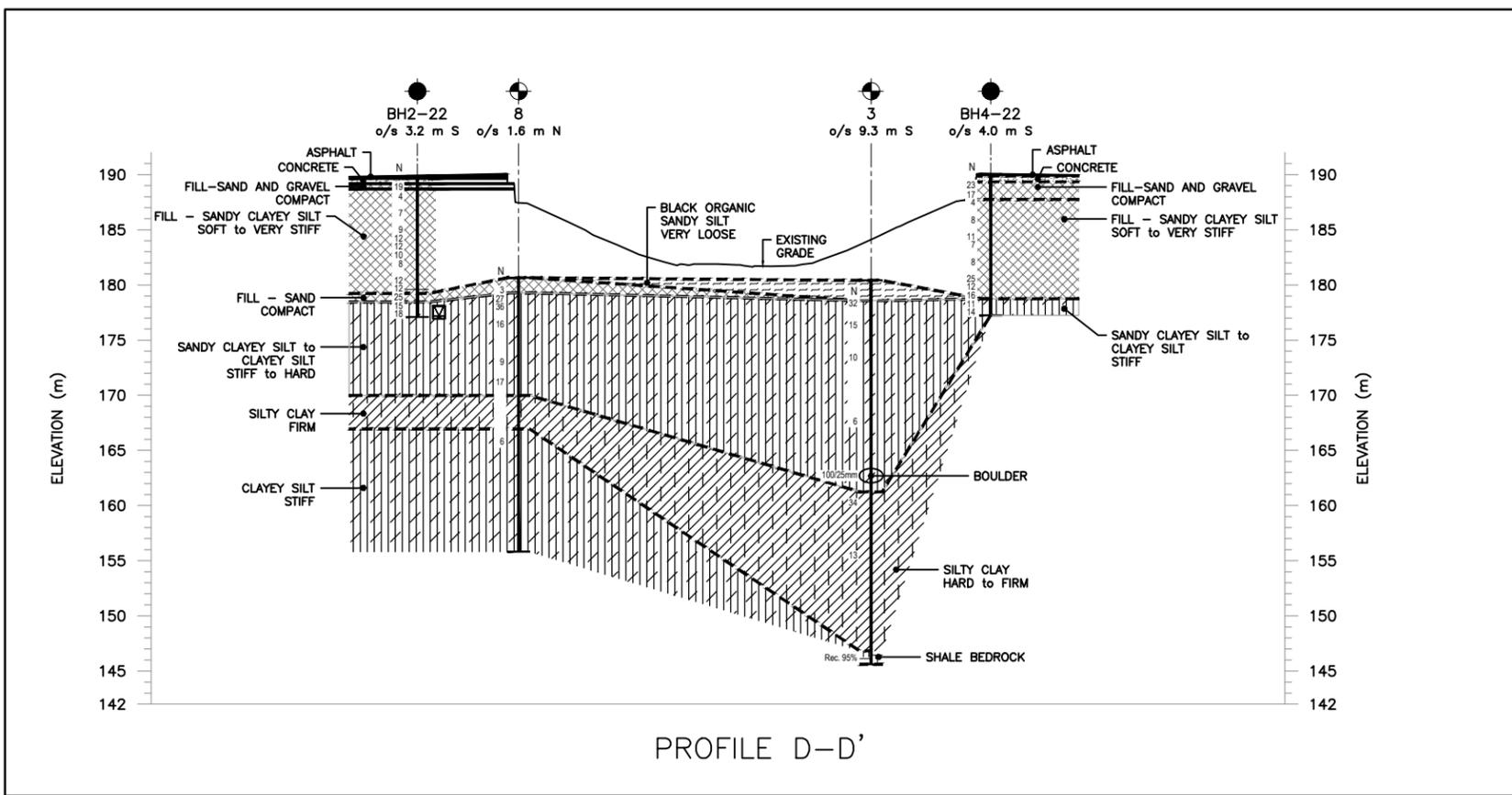
SHEET



KEY PLAN
 SCALE 0 750 1500 3000 m



PROFILE C-C'



PROFILE D-D'



LEGEND

- Borehole Location
- Borehole Location
Geocres no. 40J16-039
- Standard Penetration Test Value
- Blows/0.3 m unless otherwise stated
(Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling
- Recovery

BOREHOLE CO-ORDINATES
 (MTM ZONE 11)

NO	Elevation	Northing	Eastng
BH1-22	190.0	4760893.2	316314.3
BH2-22	189.9	4760863.7	316314.3
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BH4-22	190.1	4760879.4	316364.0
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3	180.4	4760870.9	316355.4
8	180.7	4760871.1	316321.5
9	180.4	4760897.1	316347.5
12	180.2	4760910.5	316360.6

NOTES

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The boundaries between soil strata has been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

Boreholes from GEOCREs 40J16-039 were advanced prior to construction of the overpass.

REFERENCE

Base plans provide in digital format by CALLON DIETZ, drawing file: 402SAR.dwg, received on October 31, 2022.

NO.	DATE	BY	REVISION

Geocres No.: 40J16-94

HWY. 402	PROJECT NO. 12566052	DIST. SOUTHWEST
SUBM.D. MA	CHKD. AC	DATE: 1.23.2023
DRAWN: AW	CHKD. NV	SITE: 14X-0337/B1 AND 14X-0337/B2
	APPD. SMM	DWG. 3



Appendices

Appendix A

Site Photographs



Photograph 1 – Drilling operations at Borehole, BH2-22 – Highway 402 Eastbound Lane



Photograph 2 – Highway 402 at CNR overhead structure - Eastbound Lanes



Photograph 3 – CNR Overhead structures at Highway 402, westbound and eastbound lanes – Looking southeast



Photograph 4 – Drilling set up at Borehole, BH1-22 – Highway 402 Westbound Lane

Appendix B

Previous Investigation

Geocres No. 40J16-039

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H.		SAMPLE ADVANCED HYDRAULICALLY
	P.M.		SAMPLE ADVANCED MANUALLY

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 70 - 11045

LOCATION Sta. 20 + 39 Offset 3 Lt.

ORIGINATED BY H.S.

W.P. 346-65-01802

BORING DATE Nov. 26, 27, Dec. 1 & 2, 1969

COMPILED BY G.A.

DATUM Geodetic

BOREHOLE TYPE Washboring, NX, BX casing, BXL core

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w				BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WATER CONTENT % w_p — w — w_L					
592.6	Ground Level															
0.0	Silty sand-- V. loose	1	SS	2	590											
587.6	Clayey silt with traces of sand & gravel firm to stiff grey	2	SS	38												
5.0		3	SS	33												
		4	SS	23	580											
		5	SS	20												
		6	TW	PH											130.5	
		7	TW	PH		570										
		8	TW	PH											130.0	
		9	TW	PH		560										
		10	TW	PH		550									116.0	
552.6		Silty clay with traces of sand & gravel stiff to very stiff	11	TW	PH	540										
40.0	12		TW	PH	530										2 8 44 46	
	13		TW	PH	520										123.5	
	14		TW	PH	510										122.0	
481.8	Shale Bedrock	15	RC	Rec. 85%	480											
110.8																
476.6																
116.0	End of borehole															

20
15 — 5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 70-11045 LOCATION STA. 20 + 71, 69.5 Ft. Lt. of ϕ ORIGINATED BY T.P.
 W.P. 346-65-01 & 02 BORING DATE June 24, 1970 COMPILED BY A.K.B.
 DATUM Geodetic BOREHOLE TYPE C.M.E. Auger CHECKED BY [Signature]

SOIL PROFILE		STRAT. PLOT	SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE		BLOWS/FOOT	1000	2000	10	20			30
592.5	Ground Level												
0.0	Black organics & sandy silt--V. loose		1	SS	2								
685.5			2	SS	22								
7.0	Clayey silt with traces of sand & gravel hard to firm		3	TW	PH						136		
			4	SS	23	580							
			5	SS	9								
			6	SS	13								
			7	TW	PH	570						130	
			8	TW	PH	560						134	
												134.5	
			9	TW	PH	550						120	
			10	TW	PH	540						130	
530.0						530							
62.5	Silty clay with traces of sand & gravel firm to stiff		11	TW	PH						120.5		
			12	TW	PH	520							
					490								
481.5	Probable Bedrock												
110.0	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No.3

FOUNDATION SECTION

JOB 70-11045

LOCATION STA 21 + 37, 69.5 Ft. Rt. of ϕ

ORIGINATED BY T.P.

W.P. 346-65-01 & 02

BORING DATE June 11-15, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger & Washboring, BX casing

CHECKED BY *[Signature]*

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			BULK DENSITY γ	REMARKS			
			NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	W _L	W _P	W			P.C.F.	GR.	SA.
591.9	Ground Level																		
0.0	Black organics & sandy silt		1	TW	PM	590													
585.9	V. Loose		2	SS	32														
6.0	Clayey silt with traces of sand & gravel Hard to Firm		3	TW	PH														
			4	SS	15	580													
			5	TW	PH														
			6	SS	10														
			7	TW	PH														
			8	SS	6														
			9	TW	PH														
			10	SS	100/1"														
529.0		Boulder					530												
62.9		Silty clay with traces of sand & gravel Hard to firm		11	SS	34													
			12	SS	13														
			13	TW	PM														
481.7	Shale Bedrock		14	RC	Rec. 95%	480													
477.7																			
114.2	End of borehole																		

20
15-5 % STRAIN AT FAILURE
10

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6

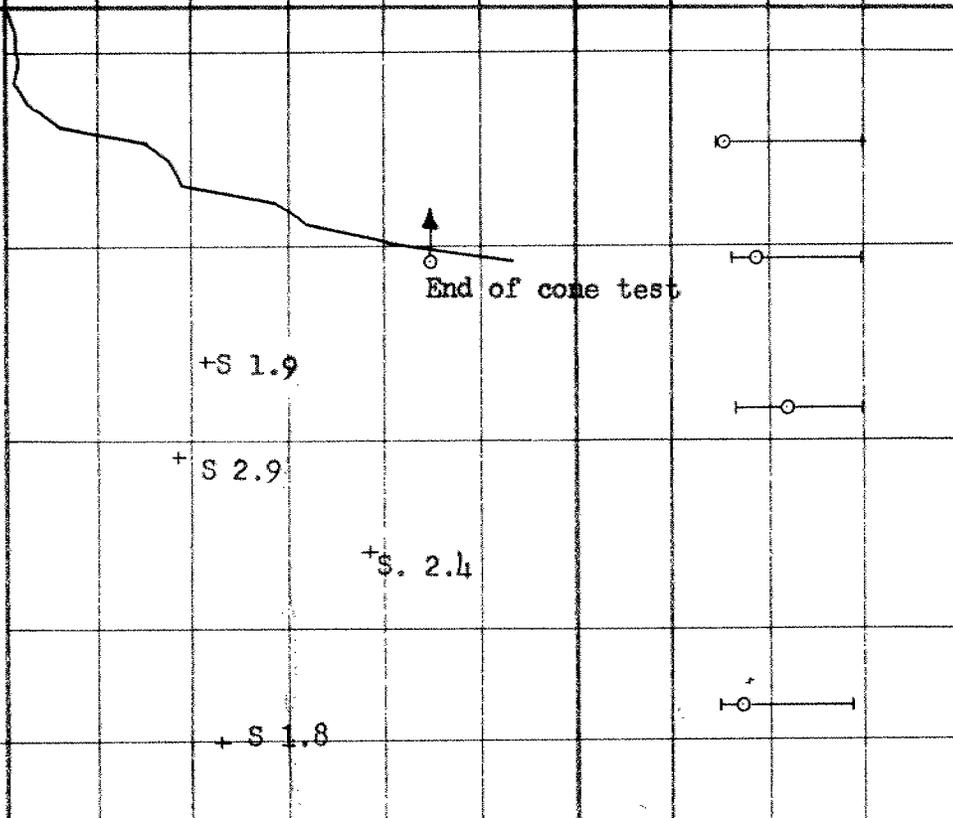
FOUNDATION SECTION

JOB 70-11045 LOCATION STA 20 + 98 Offset 60 Lt. ORIGINATED BY G.A.
 W.P. 346-65-01 & 02 BORING DATE Dec. 4/69 COMPILED BY _____
 DATUM Geodetic BOREHOLE TYPE Washboring CHECKED BY [Signature]

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— W _L PLASTIC LIMIT ——— W _P WATER CONTENT ——— W			BULK DENSITY γ P.C.F.	REMARKS
			NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	W _P	W	W _L		
592.0	ground level															
0.0	organics & silty sand loose		1	SS	4	590										
587.0			2	SS	24											
5.0			3	SS	31											
	Clayey silt with traces of sand & gravel		4	TW	PH	580										132.0
			5	SS	12											
			6	TW	PH	570										228.0
	very stiff to stiff		7	SS	11											
			8			560										
554.0			9	SS	30											n.q.
38.0	End of borehole					550										

SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB. VANE
 1000 2000

WATER CONTENT %
 10 20 30



DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 70-11045 LOCATION STA 20 + 34 32.5 Ft. Rt of C ORIGINATED BY T.P.
 W.P. 346-65-01 & 02 BORING DATE June 22-23, 1970 COMPILED BY A.K.B.
 DATUM Geodetic BOREHOLE TYPE C.M.E. Auger CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— W _L PLASTIC LIMIT ——— W _P WATER CONTENT ——— W			BULK DENSITY γ	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %					P.C.F.
							1000	2000	10	20	30			
592.7	Ground Level													
0.0	Black organics & very					590								
588.2	loose sand		1	SS	3							0 = 81		
4.5	Clayey silt with traces of sand and gravel; Hard to stiff		2	SS	27									
			3	SS	36									
			4	TW	PH		580						135	
			5	SS	16									
			6	TW	PH		570						130	
			7	SS	9									
			8	SS	17		560							
557.7		Silty clay, traces of sand & gravel--firm												
35.0			9	TW	PM		550						116.5	
517.7	Clayey silt with traces of sand & gravel; stiff													
45.0			10	SS	6		540							
			11	TW	PM		530						124	
511.2	End of boreholes													
81.5			12	TW	PH		520						121.5	

DEPARTMENT OF HIGHWAYS- ONTARIO
 MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

JOB 70-11045

LOCATION STA 21 + 40 Offset 20' LT.

ORIGINATED BY G.A.

W.P. 346-65-01 & 02

BORING DATE Dec. 2, 1969

COMPILED BY G.A.

DATUM Geodetic

BOREHOLE TYPE Cont. Flt. Auger

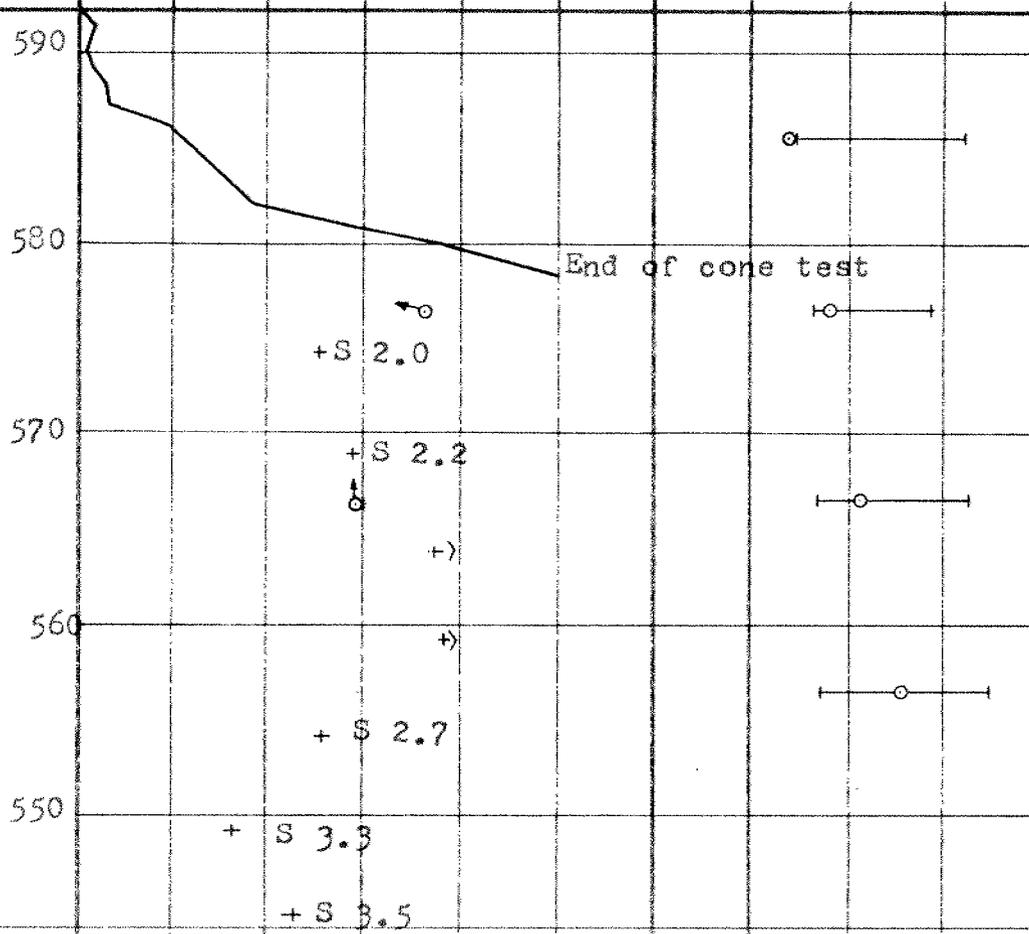
CHECKED BY *LR*

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w	BULK DENSITY γ P.C.F.	REMARKS	
			NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100				SHEAR STRENGTH P.S.F.
592.0	Ground Level														
0.0	Silty sand--firm	1	SS	7	590									
587.0			2	SS	30										
5.0	Clayey silt with traces of sand & gravel very stiff to stiff		3	SS	17	580									
			4	SS	21										
			5	TW	PH										
			6	SS	13										
			7	TW	PH										
			8	SS	18										
557.0	Silty clay with traces of sand & gravel stiff		9	TW	PH	560									
35.0			10	SS	5										
			11	TW	PH										
544.0						550									
48.0	End of borehole														

DYNAMIC PENETRATION RESISTANCE
 BLOWS/FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB. VANE
 1000 2000

LIQUID LIMIT w_L
 PLASTIC LIMIT w_p
 WATER CONTENT w
 w_p — w — w_L
 WATER CONTENT %
 10 20 30



0 16 4638

132.0
129.0
124.5

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 10

FOUNDATION SECTION

JOB 70-11045 LOCATION STA 21+57 offset 69' LT. ORIGINATED BY G.A.
 W.P. 346-65-01 & 02 BORING DATE Dec 1967 COMPILED BY G.A.
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT — w_L	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	BLOWS / FOOT		
592.1	Ground Level								
0.0	Cone Penetration Only								
578.1									
14.0	End of cone test								

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT

SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB. VANE

LIQUID LIMIT — w_L
 PLASTIC LIMIT — w_p
 WATER CONTENT — w
 w_p — w — w_L
 WATER CONTENT %

P.C.F. GR. SA. SI. CL.

End of cone test

Appendix C

Borehole Records

RECORD OF BOREHOLE No BH2-22

2 OF 2

METRIC

G.W.P. NO. 3105-18-00 LOCATION Hwy 402 / Former CNR (Northing: 4760863.7, Easting: 316314.3, MTM Zone 11) ORIGINATED BY M.A
 DIST West HWY 402/CNR BOREHOLE TYPE Hollow Stem Auger DRILLING RIG TYPE Track Mounted Drill Rig COMPILED BY N.V
 DATUM Geodetic DATE 2022.09.08 - 2022.09.08 LATITUDE 42.987490 LONGITUDE -82.358806 CHECKED BY SMM

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
179.2	0.1 m gravelly sand layer at 10.2 m	X	10A	SS	12													
10.7	FILL - SAND, some silt, trace gravel, trace clay Compact Brown Moist	X	11	SS	25							17			9	68	18	5
178.5		X																
11.4	SANDY CLAYEY SILT, trace gravel Stiff to very stiff Grey Moist to wet	X	12	SS	15													
177.1		X										16						
12.8	END OF BOREHOLE NOTE: 1. Groundwater at a depth of 12.7 m (Elev. 177.2 m) upon completion of drilling.	X																

File: \\GHDNET\GHD\CA\WATER\LO\PROJECTS\66212566052\TECH\12 FOUNDATIONS\04\FIELDWORK\06-FIELD NOTES AND LOGS\GINT LOGS\12566052 LOGS.GPJ
 Library File: 12566052\ITD\LIBRARY_GLB_Report: 12566052 BOREHOLE LOG_V01 Date: 23/1/23

+ 3 Numbers refer to Sensitivity

RECORD OF BOREHOLE No BH3-22

1 OF 2

METRIC

G.W.P. NO. 3105-18-00 LOCATION Hwy 402 / Former CNR (Northing: 4760911.6, Easting: 316369.7, MTM Zone 11) ORIGINATED BY M.A
 DIST West HWY 402/CNR BOREHOLE TYPE Hollow Stem Auger DRILLING RIG TYPE Track Mounted Drill Rig COMPILED BY N.V
 DATUM Geodetic DATE 2022.09.12 - 2022.09.12 LATITUDE 42.987921 LONGITUDE -82.358125 CHECKED BY SMM

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60	80	100	20
189.9	0.0 ASPHALT (310 mm)																	
189.6	0.3 CONCRETE (490 mm)																	
189.1	0.8 FILL - SAND and GRAVEL, some fines Dense Brown Moist		1	SS	38							50						36 49 (16)
188.4	1.5 FILL - SANDY CLAYEY SILT, trace gravel, contains trace rootlets at the depth of 1.5 m below ground surface Firm to very stiff Brown to grey Moist		2	SS	6													
				VANE														
			3	SS	10								13					LL=29% PL=14% PI=15%
			4	SS	23													
			5	SS	9								13					2 28 41 29 LL=28% PL=14% PI=14%
			6	SS	7													2 28 44 26 LL=28% PL=13% PI=15%
				VANE														
			7	SS	11								130					
			8	SS	8													
			9	SS	12													
			10	SS	13								12					LL=26% PL=13% PI=13%
				VANE														
				VANE														

File: \\GHDNET\GHD\CA\WATER\LOI\PROJECTS\66212566052\TECH\12 FOUNDATIONS\04\FIELDWORK\06-FIELD NOTES AND LOGS\GINT LOGS\12566052 LOGS.GPJ
 Library File: 12566052\ITD\LIBRARY_GLB Report: 12566052 BOREHOLE LOG -V01 Date: 23/1/23

Continued Next Page

+ 3 Numbers refer to Sensitivity

RECORD OF BOREHOLE No BH3-22

2 OF 2

METRIC

G.W.P. NO. 3105-18-00 LOCATION Hwy 402 / Former CNR (Northing: 4760911.6, Easting: 316369.7, MTM Zone 11) ORIGINATED BY M.A
 DIST West HWY 402/CNR BOREHOLE TYPE Hollow Stem Auger DRILLING RIG TYPE Track Mounted Drill Rig COMPILED BY N.V
 DATUM Geodetic DATE 2022.09.12 - 2022.09.12 LATITUDE 42.987921 LONGITUDE -82.358125 CHECKED BY SMM

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
178.6	contains trace rootlets, hydrocarbon odour at depths of 9.9 m and 12.0 m.	[Cross-hatched pattern]	11	SS	17													
			12	SS	14		179											
11.3	SANDY CLAYEY SILT, trace gravel Stiff Grey Moist	[Diagonal hatched pattern]	13	SS	14		178											
177.1			14	SS	15													
12.8	END OF BOREHOLE NOTE: 1. Borehole open and dry upon completion of drilling.																	

File: \\GHDNET\GHD\CA\WATER\LOO\PROJECTS\66212566052\TECH\12 FOUNDATIONS\04-FIELDWORK\06-FIELD NOTES AND LOGS\GINT LOGS\12566052 LOGS.GPJ
 Library File: 12566052 INTD LIBRARY.GLB Report: 12566052 BOREHOLE LOG_V01 Date: 23/1/23

+ 3 Numbers refer to Sensitivity

RECORD OF BOREHOLE No BH4-22

1 OF 2

METRIC

G.W.P. NO. 3105-18-00 LOCATION Hwy 402 / Former CNR (Northing: 4760879.4, Easting: 316364.0, MTM Zone 11) ORIGINATED BY M.A
 DIST West HWY 402/CNR BOREHOLE TYPE Hollow Stem Auger DRILLING RIG TYPE Track Mounted Drill Rig COMPILED BY N.V
 DATUM Geodetic DATE 2022.09.06 - 2022.09.07 LATITUDE 42.987631 LONGITUDE -82.358196 CHECKED BY SMM

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
190.1																		
190.0	0.0 ASPHALT (150 mm)																	
	0.2 CONCRETE (350 mm)																	
189.4																		
	0.7 FILL - SAND and GRAVEL, some fines Compact Brown Moist		1	SS	23							11						35 50 (15)
			2	SS	17													
187.8																		
	2.3 FILL - SANDY CLAYEY SILT, trace gravel Soft to very stiff Brown to grey Moist to wet		3	SS	4							18						6 26 43 25 LL=23% PL=12% PI=11%
				VANE						>100 kPa								
			4	SS	8							17						LL=28% PL=14% PI=14%
				VANE						>100 kPa								
			5	SS	11							20						3 26 44 28 LL=28% PL=15% PI=13%
			6	SS	7							15						
				VANE						>100 kPa								
			7	SS	8													
				VANE						>100 kPa								
			8	SS	25							15						2 27 (72)
180.2																		

File: \\GHD\NET\GHD\CA\WATER\LOI\PROJECTS\66212566052\TECH\12 FOUNDATIONS\04-FIELDWORK\06-FIELD NOTES AND LOGS\GINT LOGS\12566052 LOGS.GPJ
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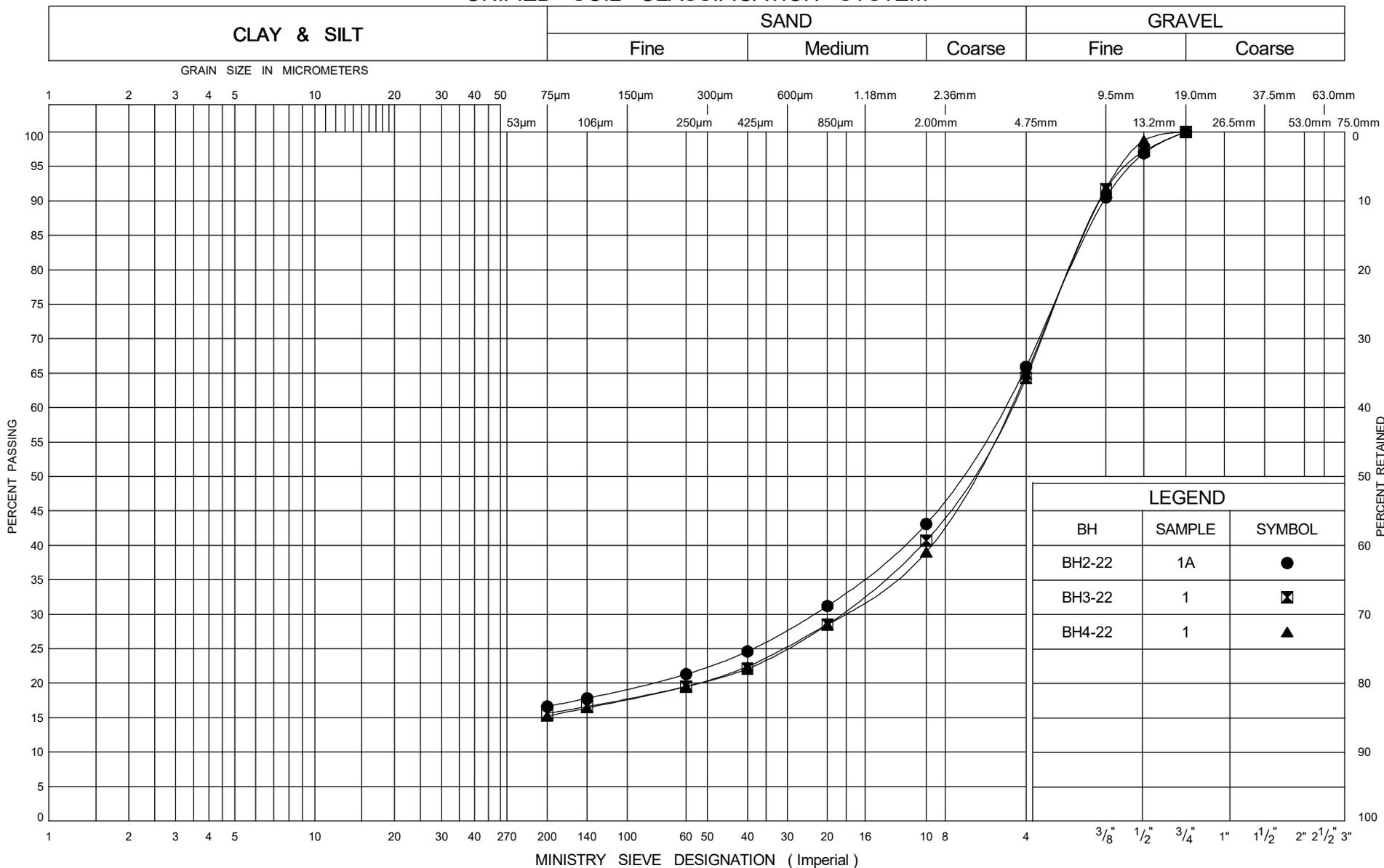
Continued Next Page

+ 3 Numbers refer to Sensitivity

Appendix D

Geotechnical Laboratory Test

UNIFIED SOIL CLASSIFICATION SYSTEM

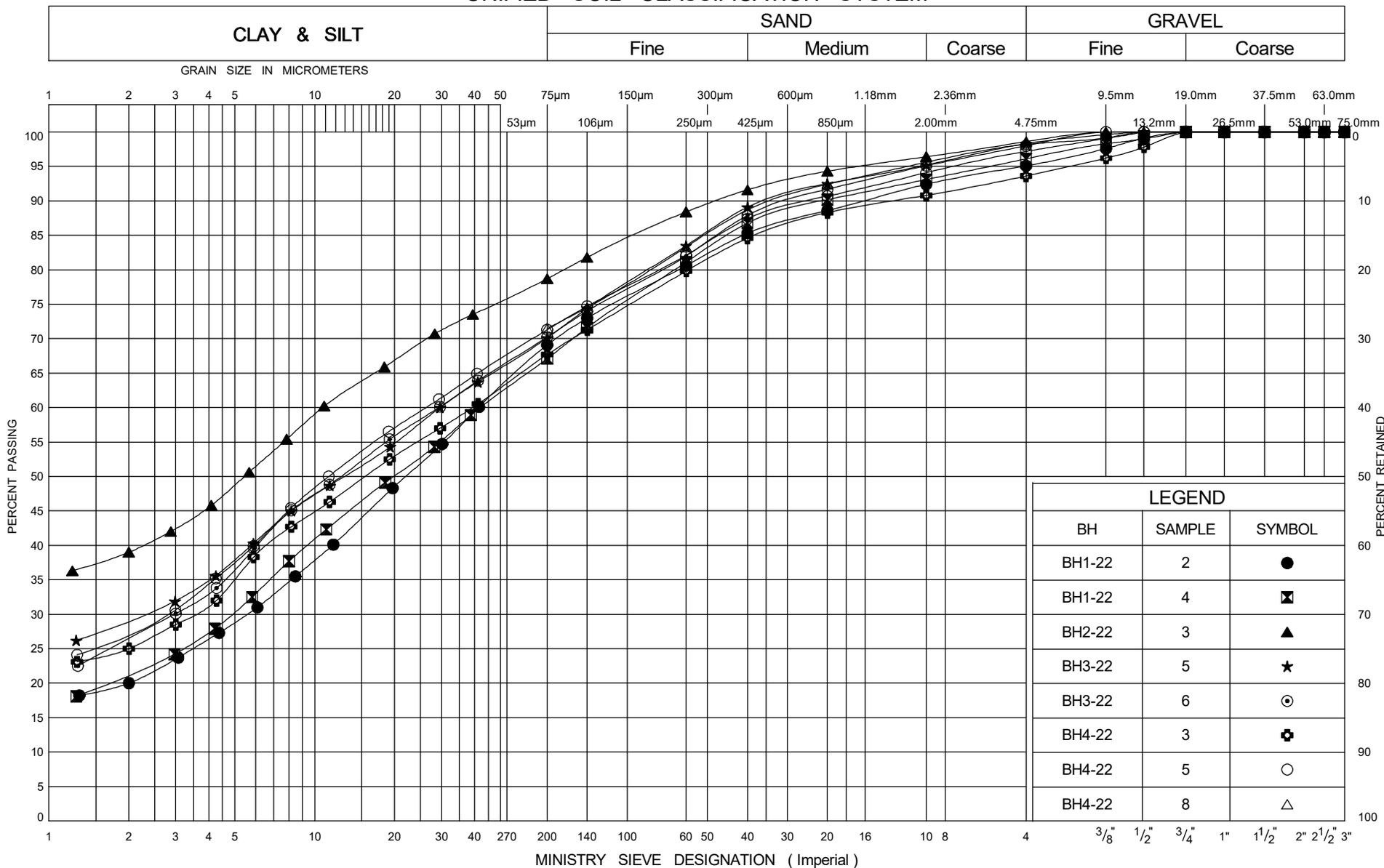


GRAIN SIZE DISTRIBUTION

Granular Fill - Sand and Gravel

Figure:	D-1
Project Name:	Highway 402/CNR
G.W.P. No.:	3105-18-00
GHD Project No.:	12566052

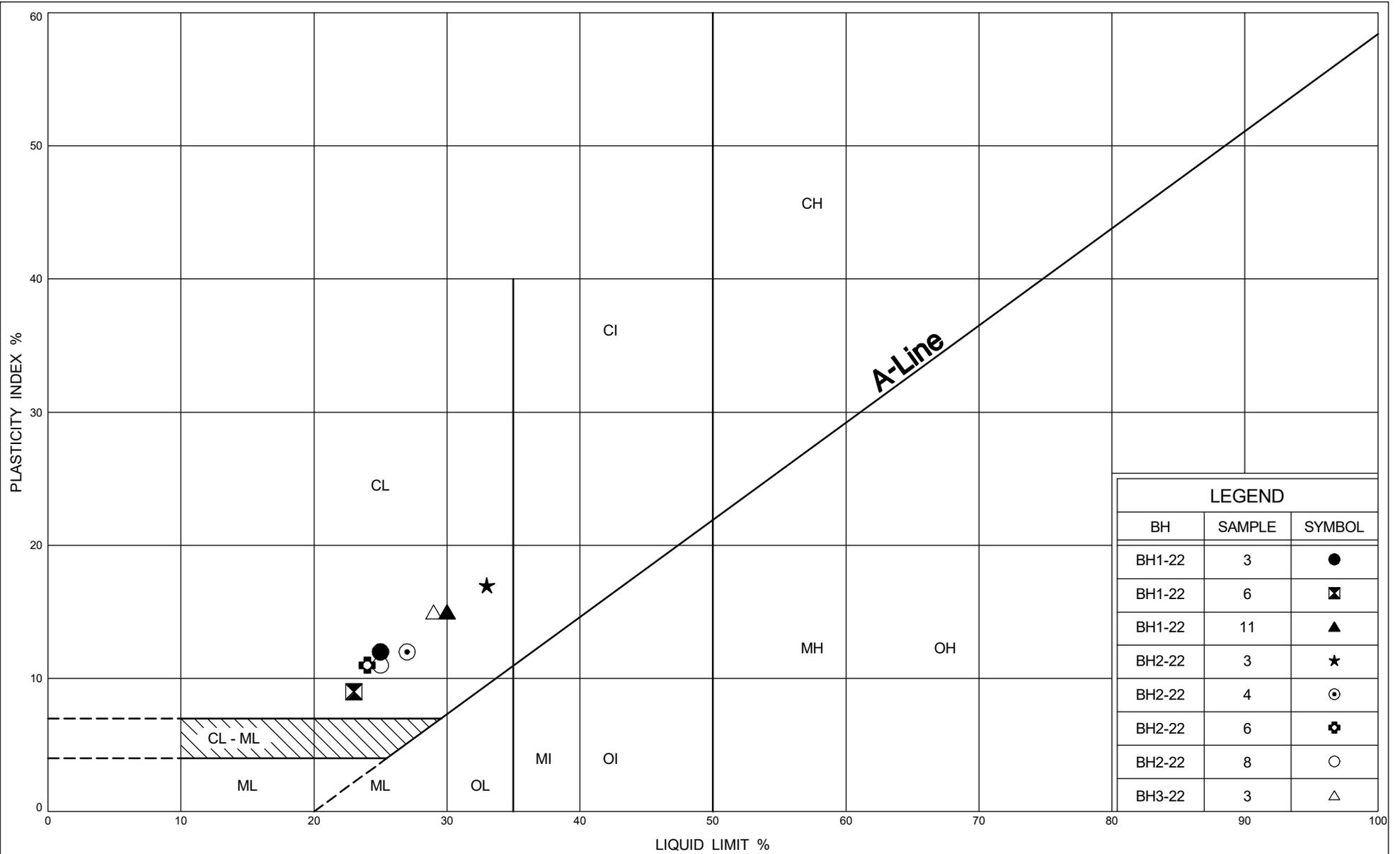
UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

FILL - Sandy Clayey Silt

Figure:	D-2
Project Name:	Highway 402/CNR
G.W.P. No.:	3105-18-00
GHD Project No.:	12566052

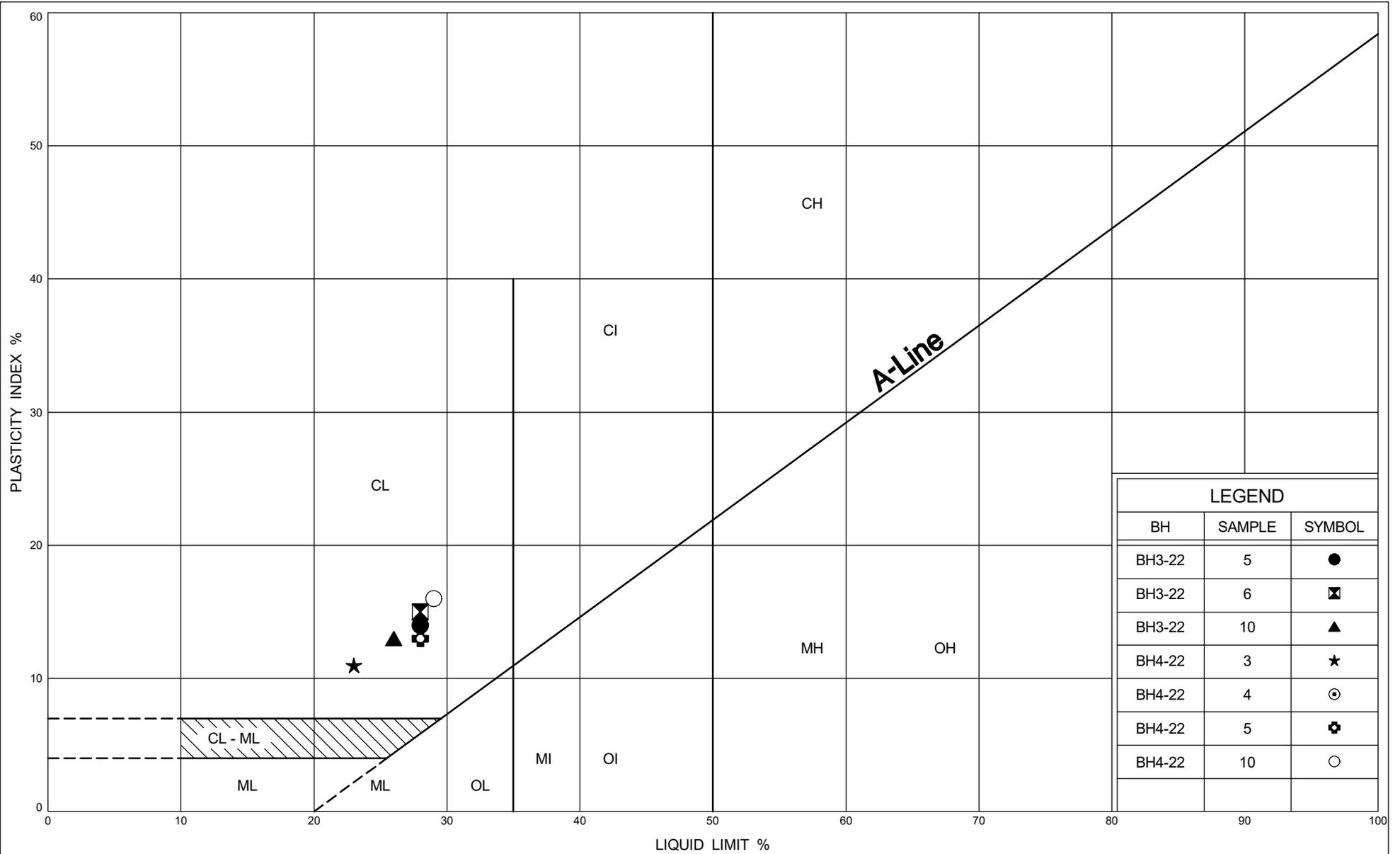


LEGEND		
BH	SAMPLE	SYMBOL
BH1-22	3	●
BH1-22	6	⊠
BH1-22	11	▲
BH2-22	3	★
BH2-22	4	⊙
BH2-22	6	⊕
BH2-22	8	○
BH3-22	3	△



PLASTICITY CHART
FILL - Sandy Clayey Silt

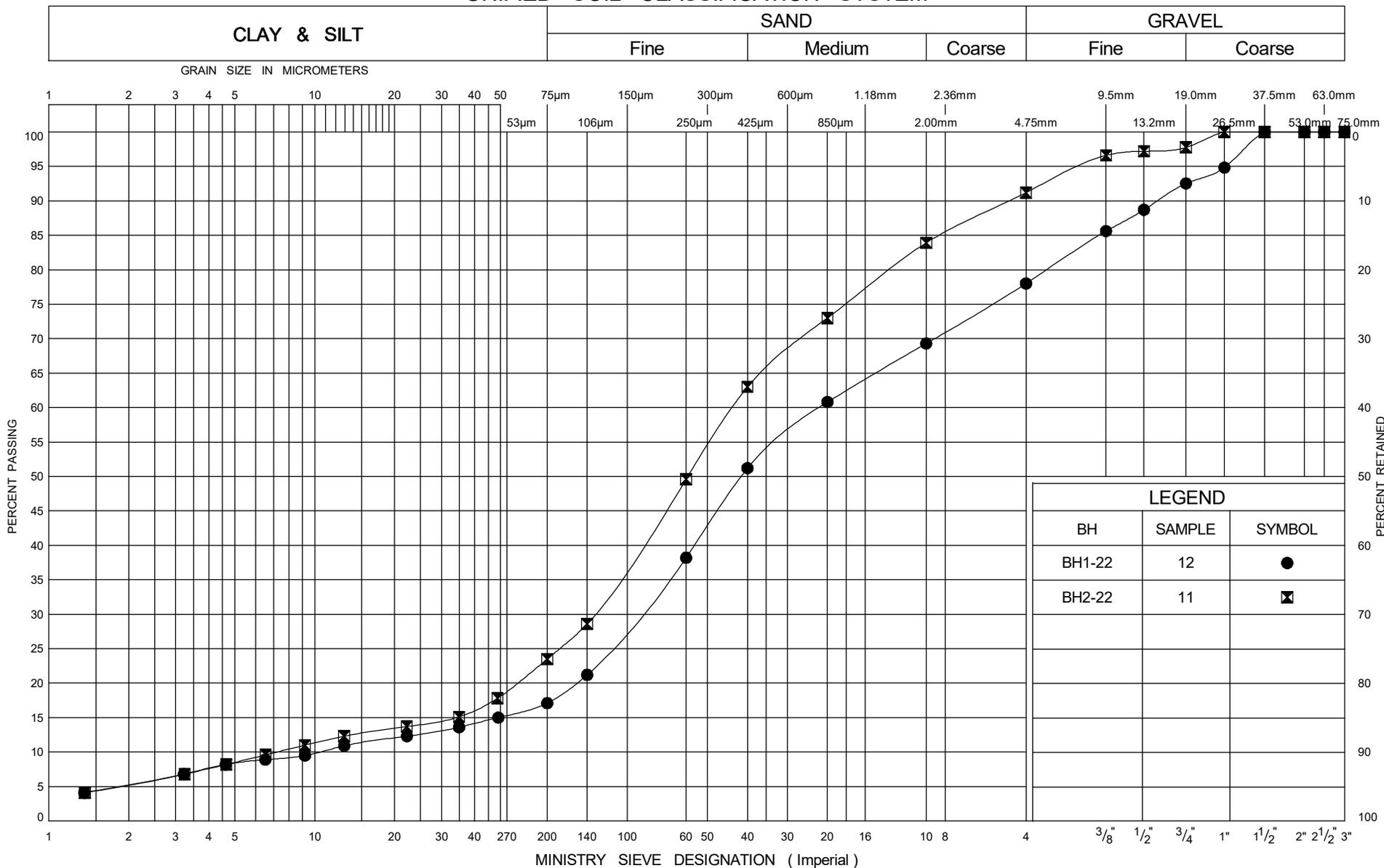
Figure:	D-3A
Project Name:	Highway 402/CNR
G.W.P. No.:	3105-18-00
GHD Project No.:	12566052



PLASTICITY CHART
FILL - Sandy Clayey Silt

Figure:	D-3B
Project Name:	Highway 402/CNR
G.W.P. No.:	3105-18-00
GHD Project No.:	12566052

UNIFIED SOIL CLASSIFICATION SYSTEM



PERCENT PASSING

PERCENT RETAINED

GRAIN SIZE DISTRIBUTION

FILL - Gravelly Sand to Sand



Figure:	D-4
Project Name:	Highway 402/CNR
G.W.P. No.:	3105-18-00
GHD Project No.:	12566052