Klohn Crippen Berger

BC Hydro
Power smart

Willoughby Substation Preliminary Geotechnical Investigation



Geotechnical Data Report

Rev. 0

CANADA BEST MANAGED COMPANIES Platinum member

ISO 9001 14001 45001

P10600A140

February 2025

February 28, 2025

BC Hydro
6911 Southpoint Dr.
7th Floor
Burnaby, BC
V3N 4X8

Dylan Lee, P.Eng.
Senior Geotechnical Engineer, Transmission Lines Engineering

Dear Mr. Lee:

Willoughby Substation Preliminary Geotechnical Investigation
Geotechnical Data Report
Rev. 0

Klohn Crippen Berger Ltd. (KCB) is pleased to submit our Geotechnical Data Report for the preliminary site investigation carried out for the proposed Willoughby Substation located in the City of Surrey.

This report presents the results from the site investigation carried out from February 5th to 6th, 2025.

Yours truly,

KLOHN CRIPPEN BERGER LTD.
B.C. Permit to Practice No. 1000171

Matthew Cormier, P.Eng.
Geological Engineer

MC/JM

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CLARIFICATIONS REGARDING THIS REPORT

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of BC Hydro (Client) for the specific application to the Willoughby Substation Preliminary Geotechnical Investigation Project, and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time. KCB should be consulted regarding the interpretation or application of the findings in the report. The report contains information provided to KCB by the Client or by other parties on behalf of the client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.

The test hole data indicate subsurface conditions at the specific locations where samples were obtained or where in-situ tests were conducted, and only at the time they were obtained and to the depths penetrated. The samples and tests cannot be relied upon to accurately reflect the nature and extent of variations in strata and material parameters that may exist between sampling or testing locations.

1 INTRODUCTION

BC Hydro (BCH) has retained Klohn Crippen Berger Ltd. (KCB) to provide geotechnical consulting services as part of the Willoughby Substation – Phase 1 Geotechnical Investigation Project under KCB's Master Services Agreement (MSA) for Geotechnical Engineering and Geohazard Services (Reference #: RFP 17635) with BC Hydro (effective March 4th, 2024).

BCH wished to undertake a geotechnical investigation at a greenfield site, located within 76 Avenue, 74 Avenue, 194 Street, and 196 Street in the City of Surrey in the Bosa and Kool properties, to perform a screening level assessment prior to completing property acquisition for the proposed new substation. The project locations and proposed property acquisition is shown in Figure 1.1.

This report summarises the preliminary geotechnical information collected during the investigation program and geotechnical conditions expected to be encountered throughout the project site.

Figure 1.1 Phase 1 Geotechnical Investigation Project Location (Land Title and Survey Authority of BC 2025)



2 REVIEW OF AVAILABLE GEOTECHNICAL DATA

BCH carried out a preliminary desktop geotechnical assessment of the site location in 2019. The assessment consisted of reviewing information from the BCH, City of Surrey and the Township of Langley, Geological Survey of Canada, Google Earth, Province of British Columbia, and information from nearby building structures. Lithology review of wells installed within the site location indicated the presence of clays, gravel, sand, and till soils.

3 SITE INVESTIGATION

3.1 Scope of Work

An initial site visit was completed on January 10th, 2025 with representatives from BCH and KCB to identify the requirements for the geotechnical investigation and access constraints. KCB's site investigation program consisted of three (3) proposed auger holes advanced using an auger drill rig and twelve (12) hand auger holes conducted from February 5th to 6th, 2025.

The locations of the test holes are indicated on a Site Investigation Plan and can be found in Appendix I.

3.2 Utility Locates

KCB conducted a BC One Call (Ticket Number: 20250211803) prior to the site investigation. The ticket response indicated asset owners, BCH, FortisBC, Telus, and Rogers. There were no conflicts with the asset holders identified in the working area. KCB engaged a utility locating sub-contractor, Quadra Utility Locating, of Port Coquitlam, BC, to conduct utility locating services prior to drilling. An anomalous signature was identified at AH25-B, which ran adjacent to a large extent of the southbound gravel shoulder of 196 Street (see Appendix II for photos). AH25-B could not be relocated further west into the wooded area as it was inaccessible by the truck mounted drill rig. After discussion with BCH, AH25-B was removed from the drilling program.

The properties of Kool and Bosa contained local electrical, gas, and water connections to City services on 194 Street. Each property also contained their own septic system located within the property. The Bosa property's septic system is located about 10 m east of the edge of the gravel driveway. The Kool property's septic system is located directly to the east of the house, below the concrete patio.

3.3 Traffic Control

Inline Traffic Services Ltd. of Coquitlam, BC, prepared the traffic management plan prior to the drilling investigation and provided traffic control services during the auger drilling program.

3.4 Auger Drilling

Geotech Drilling Services Ltd., of Delta, BC, was retained by KCB to perform the geotechnical auger drilling work on February 5th, 2025 for the purpose of investigating the subsurface conditions prior to property acquisition by BCH. Three drill holes were attempted within the Bosa and Kool properties with only one drill hole successfully being drilled to the target depth. Auger hole AH25-01 was completed to a depth of 13.56 m in the Kool property near the southern property line. Auger hole AH25-B, located along 196 Street near the eastern Bosa property line, was eliminated in the field due to a located potential utility. Auger hole AH25-02, located in the Bosa property near 194 Street, was terminated at a depth of 0.15 m due to repeated refusal within the granular driveway surface as there was suspected random concrete fill within the driveway.

The auger drill holes were carried out using a B54 truck mounted drill rig. The auger flights used in the investigation were a hollow stem auger in 1.52 m (5') length with an inside diameter (I.D.) of 108 mm (4.25"). Depth measurements were taken from the ground surface, and the stratigraphy was logged by KCB's field engineer. Drilling was advanced in 1.52 m (5') runs.

Soil sampling was conducted by KCB at approximate 1.52 m (5') intervals from soils recovered by the Standard Penetration (SPT) split spoon sampler. SPT's were conducted in accordance with ASTM D1586. The SPT consists of driving a standard 51 mm (2") outside diameter (O.D.), 610 mm (2') long split spoon sampler into the soil using and automatic trip hammer with a mass of 6.5 kg (140 lbs) and a drop height of 762 mm (2.5'). The number of hammer blows are recorded for each 0.15 m (0.5') of sampler penetration. The number of hammer blows required to advance the sampler every 0.15 m (0.5') was recorded up to 0.6 m (24") depth of advancement.

SPTs were carried out every 1.52 m (5') for AH25-01, except for SPT-07, which was carried out at an auger refusal depth of 13.41 m (44"). The soils recovered in the SPT split spoon sampler were visually classified and subsequently sampled by KCB for further classification and laboratory testing. Disturbed soil samples were placed in plastic bags, sealed, and transported to KCB's Vancouver laboratory for index testing. The completed drill hole was backfilled with auger cuttings from 13.56 m to 0.65 m, bentonite chips from 0.65 m to 0.15 m, and additional auger cuttings from 0.15 m to surface. in accordance with the BC Groundwater Protection Regulation.

Drill rig information is summarised in Table 3.1, and the SPT hammer calibration information is presented in Appendix III. Coordinates were collected using a cellphone GPS. Drill hole locations are summarised in Table 3.2 and drill hole logs are presented in Appendix IV.

Table 3.1 Summary of Drill Rig Information

Drill Rig Model	Drill Rig ID	Hammer ID	Calibration Date
B54	DR002	SPT015	September 10, 2024

Table 3.2 Summary of Auger Drill Hole Locations

Auger Hole ID	Corresponding Property	Northing (m)	Easting (m)	Termination Depth (m)
AH25-01	Kool	5442872.58	523037.31	13.56
AH25-02	Bosa	5442990.20	522984.31	0.15
AH25-B	Bosa	5442991.84	523375.25	Eliminated due to potential utility locates.

3.5 Hand Augering

KCB field engineers carried out hand augering on February 6th, 2025 using an Edelman hand auger rented from Hoskin Scientific. Hand augering was chosen in these locations due to the limited access in a moderately wooded area which would not be accessible to a drill rig without significant clearing and grubbing. Hand augering was advanced in runs of about 0.18 m up to refusal depth. The soils recovered by the hand auger were only visually classified.

Coordinates were collected using a cellphone GPS. Hand auger hole locations are summarised in Table 3.3, and hand auger logs are presented in Appendix IV.

Table 3.3 Summary of Hand Auger Hole Locations

Auger Hole ID	Northing (m)	Easting (m)	Termination Depth (m)
HA25-01	5442933.86	523069.15	0.72
HA25-02	5442889.52	523098.51	0.90
HA25-03	5442927.32	523101.27	0.72
HA25-04	5442982.58	523022.27	0.90
HA25-05	5442993.84	523056.5	0.72
HA25-06	5442975.16	523109.1	0.72
HA25-07	5443011.87	523114.05	0.90
HA25-08	5443056.79	523222.54	0.90
HA25-09	5443030.05	523208.79	0.72
HA25-10	5443035.96	523291.19	0.90
HA25-11	5443022.52	523269.36	0.72
HA25-12	5443008.32	523327.77	0.72

3.6 Laboratory Testing

Collected soil samples from the auger drilling investigation were transported to the KCB laboratory in Vancouver, BC. The soil laboratory tests carried out by KCB are summarised in Table 3.4. Laboratory test results can be found in Appendix IV.

Table 3.4 Summary of Laboratory Tests

Test Name	Number of Tests	ASTM Standard
Moisture Content	5	ASTM D2216
Washed Sieve	1	ASTM D6913 and ASTM D1140
Atterberg Limits	3	ASTM D4318
Hydrometer	2	ASTM D7928

1. Hydrometer tests include a washed sieve on soils greater than 0.075 mm.

4 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The soil descriptions provided in this report are based on commonly accepted methods of classification, more specifically, Modified Unified Soil Classification System (USCS) from ASTM D2487 and identification employed in geotechnical practice. Classification and identification of soil involves judgment, and KCB does not guarantee descriptions as exact but infers accuracy to the extent that is common in current geotechnical practice. The locations of stratigraphic boundaries indicated in the test hole logs are inferred from the limited data; the location of these boundaries may not be exact. These boundaries may also represent transitions from one soil type to another and should not necessarily be regarded as the location of a precise or planar contact between different geological materials.

The surficial soils at the site consist primarily of low to intermediate plasticity silty clays and low plasticity silts mixed with small amounts of sands and gravels. These fine grained soils were typically stiff to very stiff, although very soft silty clay was encountered from the depths of 6.10 m to 10.67 m at AH25-01 where the split spoon sampler was able to penetrate 0.6 m under the weight of the steel rods and sample without requiring blows from the hammer. Silty sand was then encountered from 12.19 m at AH25-01 up to the termination depth of 13.56 m where the auger encountered refusal on a suspected cobble or boulder. Table 4.1 summarises the typical conditions encountered during the investigation.

Table 4.1 Typical Ground Conditions Encountered During Geotechnical Investigation

Soil Type	USCS Classification	Properties	Comments
Topsoil	-	▪ Clayey and occasional sandy with grass, rootlets, and roots. ▪ Brown to dark brown.	▪ Up to 0.36 m thick.
Clay	CL to CI	▪ Clay to silty clay, trace sand, trace gravel, trace organic soil. ▪ Stiff to very stiff from 0.30 m to 6.10 m. Very soft from 6.10 m to 10.7 m. ▪ Ranges from brown, grey, and tan.	▪ Up to 12.01 m thick. ▪ Encountered from 0.18 m to 12.19 m depth.
Silt	ML	▪ Some clay to clayey, trace sand to sandy, and trace to some gravel. ▪ Very soft to very stiff, moist. ▪ Ranges from brown, grey, and tan.	▪ Up to 0.72 m thick. ▪ Encountered from 0.18 m up to 0.90 m depth.
Sand	SM	▪ Silty, some gravel and trace cobbles. ▪ Poorly graded. ▪ Grey to greyish tan.	▪ Encountered at 12.19 m to the termination depth at 13.56 m in AH25-01.

4.2 Water Level Observations

Water was visually observed and measured in several hand auger holes with depths ranging from about 0.05 m to 0.60 m. Within the vicinity of HA25-04, frozen standing water was visible at the ground surface. Water was also observed during auger drilling at AH25-01 below a depth of about 1.52 m, but the depth was not confirmed due to time limitations with the drilling program. Measured water depths from ground surface are summarised in Table 4.2

Table 4.2 Measured Water Levels

Auger Hole ID	Northing (m)	Easting (m)	Water Depth (m)
HA25-01	5442933.86	523069.15	0.30
HA25-03	5442927.32	523101.27	0.36
HA25-04	5442982.58	523022.27	0.05
HA25-05	5442993.84	523056.5	0.05
HA25-06	5442975.16	523109.1	0.29
HA25-08	5443056.79	523222.54	0.15
HA25-10	5443035.96	523291.19	0.60
HA25-11	5443022.52	523269.36	0.14
HA25-12	5443008.32	523327.77	0.18

5 CLOSING

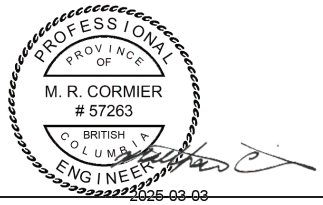
We trust this geotechnical Data report meets your requirements. Should you have any questions or concerns, regarding this report, please do not hesitate to contact the undersigned.

KLOHN CRIPPEN BERGER LTD.
B.C. Permit to Practice No. 1000171

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REFERENCES

BC Hydro. (BCH). 2019. Proposed Willoughby Substation Preliminary Desktop Geotechnical Assessment TM0592.

Land Title and Survey Authority of BC. 2025. “ParcelMap BC” Accessed January 13, 2025.

APPENDIX I

Site Investigation Plan



APPENDIX II

ConeTec SPT Hammer Calibration Information

Job No: 24-02-28326
Client: Geotech Drilling Services Ltd
Project: Geotech SPTe Calibration
Start Date: 2024-09-10
End Date: 2024-09-10

Borehole ID: BH24-01
Rig: DR002
Hammer: SPT015

STANDARD PENETRATION TEST ENERGY MEASUREMENT RESULTS

Test Start Depth (ft)	Date	Instrumented Rod Type	Instrumented Rod Area (cm^2)	Rod String Type	Strain Gauge #1 Serial No.[1]	Strain Gauge #2 Serial No.[1]	Accelerometer #1 Serial No.[1]	Accelerometer #2 Serial No.[1]	Recorded Blow Counts 0"-6"	Recorded Blow Counts 6"-12"	Recorded Blow Counts 12"-18"	Recorded Blow Counts 18"-24"	N (Blow Counts)[2]	Number of Blows Analyzed[2]	Average Max Force (kN)	Average Max Energy (kN-m)	Average Energy Transfer Ratio (FV) (%)	Standard Deviation of ETR (%)	Refer to Notation Number
0.0	2024-09-10	AWJ	7.61	AWJ	505AWJ1	505AWJ2	K5741	K11801	4	9	11	14	20	20	132.4	0.399	84.1	1.9	
0.0	2024-09-10	AWJ	7.61	AWJ	505AWJ1	505AWJ2	K5741	K11801	4	12	12	21	24	24	129.6	0.406	85.5	2.4	
0.0	2024-09-10	AWJ	7.61	AWJ	505AWJ1	505AWJ2	K5741	K11801	5	10	12	24	22	22	125.2	0.411	86.5	2.1	
Average[3]:															**129.1**	**0.405**	**85.4**		
Standard Deviation[3]:															**3.0**	**0.005**	**1.0**		

1. Strain gauge and accelerometer calibration records are provided in the data release folder.
2. Blow counts from the first and last 6" were not included.
3. Average and standard deviation are calculated using averaged data from SPT hammer blows from the 6" to 18" interval (ie. N value) from all sampling depths tested.

APPENDIX III

Photograph Summary

Appendix III
Photograph Summary

Photo 1: AH25-B, Anomalous Signature Detected During Utility Locates



Photo 2: Auger Drilling at AH25-01



Photo 3: AH25-01 SPT-01 (1.52 m to 2.13 m)



Photo 4: AH25-01 SPT-02 (3.05 m to 3.66 m)



Photo 5: AH25-01 SPT-03 (4.57 m to 5.18 m)



Photo 6: AH25-01 SPT-04 (6.10 m to 6.71 m)



Photo 7: AH25-01 SPT-05 (7.62 m to 8.23 m)



Photo 8: AH25-01 SPT-06 (10.67 m to 11.28 m)



Photo 9: AH25-01 SPT-07 (13.41 m to 14.02 m)



Photo 10: AH25-02 Drilling Location

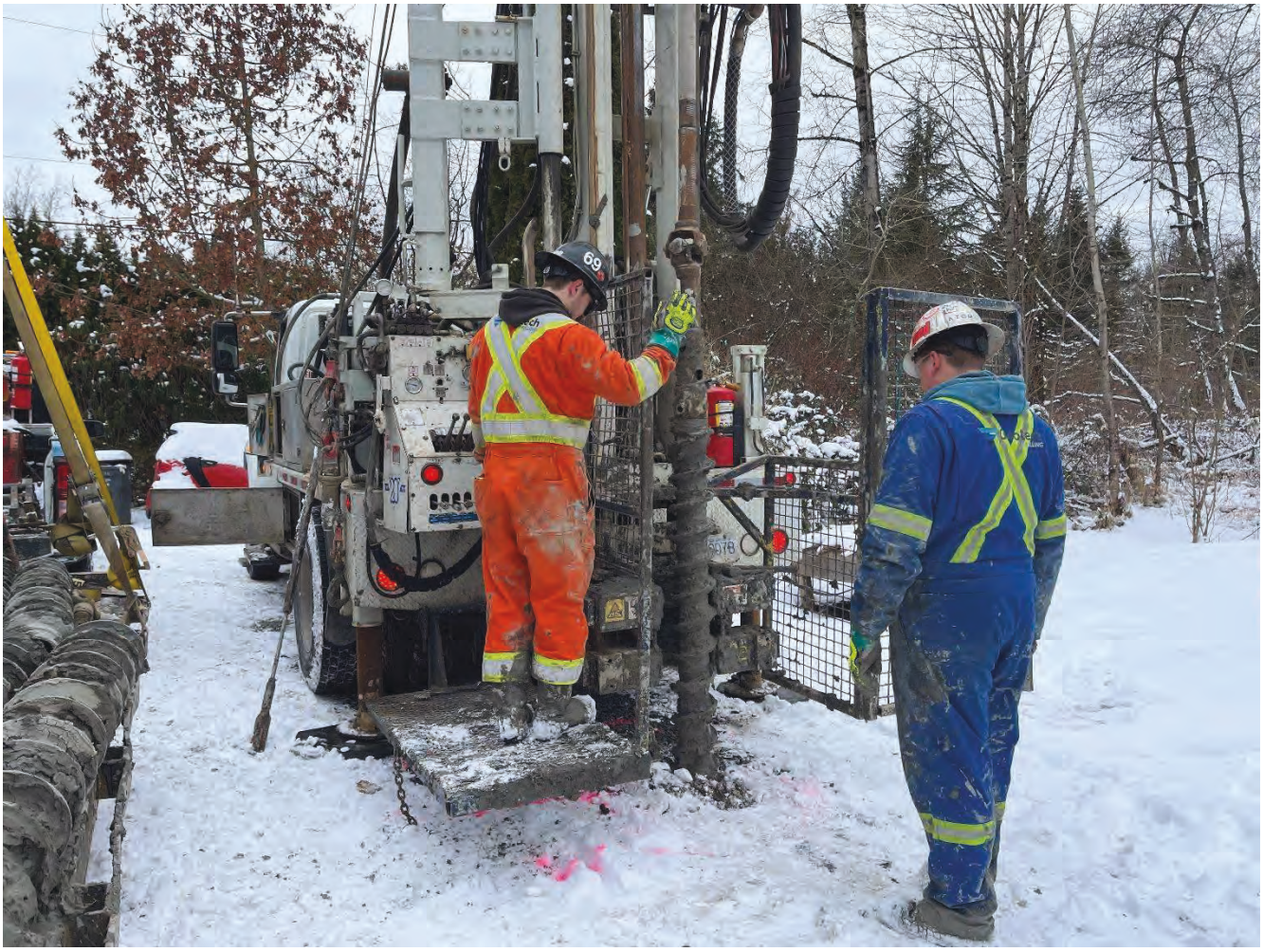


Photo 11: AH25-02 Concrete Fragments Recovered During Drilling



Photo 12: HA25-01 Run 1 (0 m to 0.18 m)



Photo 13: HA25-01 Run 2 (0.18 m to 0.36 m)



Photo 14: HA25-01 Run 3 (0.36 m to 0.54 m)



Photo 15: HA25-01 Run 4 (0.54 m to 0.72 m)



Photo 16: HA25-02 Run 1 (0 m to 0.18 m)



Photo 17: HA25-02 Run 2 (0.18 m to 0.36 m)



Photo 18: HA25-02 Run 3 (0.36 m to 0.54 m)



Photo 19: HA25-02 Run 4 (0.54 m to 0.72 m)



Photo 20: HA25-02 Run 5 (0.72 m to 0.90 m)



Photo 21: HA25-03 Run 1 (0 m to 0.18 m)



Photo 22: HA25-03 Run 2 (0.18 m to 0.36 m)



Photo 23: HA25-03 Run 3 (0.36 m to 0.54 m)



Photo 24: HA25-03 Run 4 (0.54 m to 0.72 m)



Photo 25: HA25-04 Run 1 (0 m to 0.18 m)



Photo 26: HA25-04 Run 2 (0.18 m to 0.36 m)



Photo 27: HA25-04 Run 3 (0.36 m to 0.54 m)



Photo 28: HA25-04 Run 4 (0.54 m to 0.72 m)



Photo 29: HA25-04 Run 5 (0.72 m to 0.90 m)



Photo 30: HA25-05 Run 1 (0 m to 0.18 m)



Photo 31: HA25-05 Run 2 (0.18 m to 0.36 m)



Photo 32: HA25-05 Run 3 (0.36 m to 0.54 m)



Photo 33: HA25-05 Run 4 (0.54 m to 0.72 m)



Photo 34: HA25-06 Run 1 (0 m to 0.18 m)



Photo 35: HA25-06 Run 2 (0.18 m to 0.36 m)



Photo 36: HA25-06 Run 3 (0.36 m to 0.54 m)



Photo 37: HA25-06 Run 4 (0.54 m to 0.72 m)



Photo 38: HA25-07 Run 1 (0 m to 0.18 m)



Photo 39: HA25-07 Run 2 (0.18 m to 0.36 m)



Photo 40: HA25-07 Run 3 (0.36 m to 0.54 m)



Photo 41: HA25-07 Run 4 (0.54 m to 0.72 m)



Photo 42: HA25-07 Run 5 (0.72 m to 0.90 m)



Photo 43: HA25-08 Run 1 (0 m to 0.18 m)



Photo 44: HA25-08 Run 2 (0.18 m to 0.36 m)



Photo 45: HA25-08 Run 3 (0.36 m to 0.54 m)



Photo 46: HA25-08 Run 4 (0.54 m to 0.72 m)



Photo 47: HA25-08 Run 5 (0.72 m to 0.90 m)



Photo 48: HA25-09 Run 1 (0 m to 0.18 m)



Photo 49: HA25-09 Run 2 (0.18 m to 0.36 m)



Photo 50: HA25-09 Run 3 (0.36 m to 0.54 m)



Photo 51: HA25-09 Run 4 (0.54 m to 0.72 m)



Photo 52: HA25-10 Run 1 (0 m to 0.18 m)



Photo 53: HA25-10 Run 2 (0.18 m to 0.36 m)



Photo 54: HA25-10 Run 3 (0.36 m to 0.54 m)



Photo 55: HA25-10 Run 4 (0.54 m to 0.72 m)



Photo 56: HA25-10 Run 5 (0.72 m to 0.90 m)



Photo 57: HA25-11 Run 1 (0 m to 0.18 m)



Photo 58: HA25-11 Run 2 (0.18 m to 0.36 m)



Photo 59: HA25-11 Run 3 (0.36 m to 0.54 m)



Photo 60: HA25-11 Run 4 (0.54 m to 0.72 m)



Photo 61: HA25-12 Run 1 (0 m to 0.18 m)



Photo 62: HA25-12 Run 2 (0.18 m to 0.36 m)



Photo 63: HA25-12 Run 3 (0.36 m to 0.54 m)



Photo 64: HA25-12 Run 4 (0.54 m to 0.54 m)



APPENDIX IV

Drill Hole and Hand Auger Logs

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DRILL HOLE LOG

AH25-01

Project Number:	P10600A140	Northing:	5442872.6 m	Easting:	523037.3 m
Project:	Willoughby Substation Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 05, 2025	Date Finished:	Feb 05, 2025

Drilling Company:	Geotech Drilling Services Ltd.
Drilling Method:	Auger, Hollow Stem

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
1					0.3	TOPSOIL, clayey, grass, brown, moist.	
						CLAY (CI), silty (low plasticity), some fine to medium sand, intermediate plasticity, stiff to very stiff, greyish brown, WC > PL.	
2	SPT-01		2-12-19 (31) 100%				
3	SPT-02		2-4-19 (23) 100%				
4						From 4.57 m to 6.10 m: trace fine to coarse sand, trace fine gravel.	
5	SPT-03		2-3-12 (15) 100%				
6					6.1		
	SPT-04		0-0-0 (0) 100%			From 6.10 m to 6.71 m: SPT-04 self-weight penetration.	
7						CLAY (CI), silty (low plasticity), intermediate plasticity, very soft, grey, WC > PL.	
	SPT-05		0-0-0 (0) 100%			From 7.62 m to 8.23 m: SPT-05 self-weight penetration.	
8						From 7.62 m to 10.67 m: trace fine to medium sand.	
9							
10							

Su (kPa)

VANE PEAK ◆ FIELD ◆ LAB ■ (top scale) ▲ UC/2

REMOLD ◊ FIELD ◊ LAB □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X--------O-------X

50 100 150

25 50 75

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DRILL HOLE LOG

AH25-01

Project Number:	P10600A140	Northing:	5442872.6 m	Easting:	523037.3 m
Project:	Willoughby Substation Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 05, 2025	Date Finished:	Feb 05, 2025

Drilling Company: Geotech Drilling Services Ltd.

Drilling Method: Auger, Hollow Stem

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					10.7	From 7.62 m to 10.67 m: trace fine to medium sand.	
11	SPT-06		6-7-8 (15) 75%		10.7	CLAY (CL), low plasticity, stiff, grey, WC ~ PL.	
12					12.2	SAND (SM), fine to coarse, silty, some fine to coarse gravel (subrounded to subangular), poorly graded, grey to greyish tan, moist.	
13	SPT-07		50 25%		13.6	At 13.56 m: SPT refusal - likely on boulder or cobble. Drill hole terminated at 13.6 m. 1) Terminated due to auger refusal on boulder or cobble. 2) SPT blow counts for the last 150 mm (6") were not recorded. 3) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 4) Auger drilling was carried out by Geotech Drilling Services Ltd. of Delta, BC using a B54 truck mounted drill rig. 5) Auger drill hole was backfilled with auger cuttings and bentonite chips.	
14							
15							
16							
17							
18							
19							
20							

Su (kPa)

	FIELD	LAB	
VANE PEAK	◆	■	▲ UC/2 (top scale)
REMOLD	◊	□	△ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50	100	150
25	50	75

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DRILL HOLE LOG

AH25-02

Project Number:	P10600A140 Willoughby Substation	Northing:	5442990.2 m	Easting:	522984.3 m
Project:	Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 05, 2025	Date Finished:	Feb 05, 2025

Drilling Company:	Geotech Drilling Services Ltd.
Drilling Method:	Auger, Hollow Stem

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
0					0.2	GRAVEL and SAND (GP/SP), fine to coarse, poorly graded, subrounded, greyish brown, moist, large pieces of concrete. [FILL]	
						Drill hole terminated at 0.2 m.	
						1) Terminated due to repeated auger refusal at the surface.	
						2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m.	
						3) Auger drilling was carried out by Geotech Drilling Services Ltd. of Delta, BC using a B54 truck mounted drill rig.	

Su (kPa)

VANE FIELD LAB (top scale)

PEAK ◆ ■ ▲ UC/2

REMOLD ◊ □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50 100 150

25 50 75

Klohn Crippen Berger

DRILL HOLE LOG

HA25-01

Project Number:	P10600A140 Willoughby Substation	Northing:	5442933.9 m	Easting:	523069.2 m
Project:	Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025
Drilling Company:	N/A				
Drilling Method:	Hand Auger				

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.2	TOPSOIL, clayey, grass, rootlets, brown, moist.	
						SILT (ML), sandy (fine to coarse), low plasticity, tan to grey, moist, some rootlets.	
					0.7	Drill hole terminated at 0.7 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	

Su (kPa)

VANE FIELD LAB (top scale)

PEAK ◆ ■ ▲ UC/2

REMOLD ◊ □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X--------O-------X

50 100 150

25 50 75

1 2 3 4 5

Klohn Crippen Berger

DRILL HOLE LOG

HA25-02

Project Number:	P10600A140 Willoughby Substation	Northing:	5442889.5 m	Easting:	523098.5 m
Project:	Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025
Drilling Company:	N/A				
Drilling Method:	Hand Auger				

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.2	TOPSOIL, clayey, grass, rootlets, brown, moist.	
					0.5	CLAY (CL-ML), silty, trace fine to coarse sand, low plasticity, brown, WC > PL, trace organic soil.	
					0.9	SILT (ML), sandy (fine to coarse), some clay, low plasticity, light brown, moist.	
1						Drill hole terminated at 0.9 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	
2							
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4							
5							

Su (kPa)

	FIELD	LAB	
VANE PEAK	◆	■	(top scale) ▲ UC/2
REMOLD	◊	□	△ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X--------O-------X

50	100	150
25	50	75

Klohn Crippen Berger

DRILL HOLE LOG

HA25-03

Project Number:	P10600A140	Northing:	5442927.3 m	Easting:	523101.3 m
Project:	Willoughby Substation Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025

Drilling Company: N/A

Drilling Method: Hand Auger

Su (kPa)
VANE FIELD LAB (top scale)
PEAK ◆ ■ ▲ UC/2
REMOLD ◊ □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)
Wp % W % WL %
X--------O-------X

50 100 150
25 50 75

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.2	TOPSOIL, clayey, grass, rootlets, brown, moist.	
						SILT (ML), sandy (fine to coarse), low plasticity, tan to grey/brown, moist, some organic soil.	
					0.7	From 0.54 m to 0.72 m: colour transitions to tan to grey.	
						Drill hole terminated at 0.7 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	

1
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Klohn Crippen Berger

DRILL HOLE LOG

HA25-04

Project Number:	P10600A140	Northing:	5442982.6 m	Easting:	523022.3 m
Project:	Willoughby Substation Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025

Drilling Company: N/A

Drilling Method: Hand Auger

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
						TOPSOIL, clayey, grass, rootlets, dark brown, moist to wet.	
					0.4	SILT (ML), sandy (fine to coarse), low plasticity, tan to brown, wet.	
					0.5	SILT (ML), clayey, some fine to coarse sand, low plasticity, light to dark brown, wet.	
					0.9	From 0.72 m to 0.90 m: colour transitions to grey to tan.	
1						Drill hole terminated at 0.9 m.	
						1) Terminated due to auger refusal.	
						2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m.	
2						3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm.	
						4) Hand auger hole was backfilled with auger cuttings.	
3							
4							
5							

Su (kPa)

VANE FIELD LAB (top scale)

PEAK ◆ ■ ▲ UC/2

REMOLD ◊ □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50 100 150

25 50 75

Klohn Crippen Berger

DRILL HOLE LOG

HA25-05

Project Number:	P10600A140 Willoughby Substation	Northing:	5442993.8 m	Easting:	523056.5 m
Project:	Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025
Drilling Company:	N/A				
Drilling Method:	Hand Auger				

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.2	TOPSOIL, clayey, grass, roots, rootlets, brown, wet.	
					0.4	SILT (ML), sandy (fine to coarse), low plasticity, brown, wet, rootlets.	
						SILT (ML), clayey, low plasticity, grey to tan, wet.	
					0.7	Drill hole terminated at 0.7 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	
1							
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5							

Su (kPa)

VANE FIELD LAB (top scale)

PEAK ◆ ■ ▲ UC/2

REMOLD ◊ □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X--------O-------X

50 100 150

25 50 75

Klohn Crippen Berger

DRILL HOLE LOG

HA25-06

Project Number:	P10600A140	Northing:	5442975.2 m	Easting:	523109.1 m
Project:	Willoughby Substation Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025

Drilling Company: N/A

Drilling Method: Hand Auger

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.2	TOPSOIL, sandy, some clay, some silt, grass, roots, brown, moist.	
					0.4	SILT (ML), sandy (fine to coarse), trace gravel, low plasticity, brown, wet, trace organic soil.	
						SILT (ML), clayey, trace sand, low plasticity, grey to tan, wet.	
					0.7	From 0.54 m to 0.72 m: trace gravel.	
						Drill hole terminated at 0.7 m.	
						1) Terminated due to auger refusal.	
						2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m.	
						3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm.	
						4) Hand auger hole was backfilled with auger cuttings.	

Su (kPa)

VANE FIELD LAB (top scale)

PEAK ◆ ■ ▲ UC/2

REMOLD ◊ □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50 100 150

25 50 75

1

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Klohn Crippen Berger

DRILL HOLE LOG

HA25-07

Project Number:	P10600A140 Willoughby Substation	Northing:	5443011.9 m	Easting:	523114.0 m
Project:	Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025

Drilling Company: N/A

Drilling Method: Hand Auger

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.2	TOPSOIL, clayey, grass, rootlets, light brown to brown, moist.	
						SILT (ML), sandy (fine to coarse), low plasticity, light brown, moist, some organic soil.	
						From 0.36 m to 0.54 m: clayey.	
						From 0.54 m to 0.72 m: some fine to coarse gravel.	
					0.9	Drill hole terminated at 0.9 m.	
						1) Terminated due to auger refusal.	
						2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m.	
						3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm.	
						4) Hand auger hole was backfilled with auger cuttings.	
1							
2							
3							
4							
5							

Su (kPa)

	FIELD	LAB	
VANE			(top scale)
PEAK	◆	■	▲ UC/2
REMOLD	◊	□	△ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50	100	150
25	50	75

Klohn Crippen Berger

DRILL HOLE LOG

HA25-08

Project Number:	P10600A140 Willoughby Substation	Northing:	5443056.8 m	Easting:	523222.5 m
Project:	Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025

Drilling Company: N/A

Drilling Method: Hand Auger

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.2	TOPSOIL, clayey, grass, rootlets, darkbrown, wet.	
						CLAY (CL-ML), silty, trace fine to coarse sand, low plasticity, grey to tan, WC > PL.	
						From 0.54 m to 0.90 m: trace silt.	
					0.9	Drill hole terminated at 0.9 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	

Su (kPa)

VANE FIELD LAB (top scale)

PEAK ◆ ■ ▲ UC/2

REMOLD ◊ □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50 100 150

25 50 75

1

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4

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Klohn Crippen Berger

DRILL HOLE LOG

HA25-09

Project Number:	P10600A140 Willoughby Substation	Northing:	5443030.0 m	Easting:	523208.8 m
Project:	Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025
Drilling Company:	N/A				
Drilling Method:	Hand Auger				

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.4	TOPSOIL, clayey, grass, rootlets, brown, moist.	
					0.7	SILT (ML) and SAND (SM), low plasticity, fine to coarse sand, some fine to coarse gravel, light brown, moist.	
1						Drill hole terminated at 0.7 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	
2							
3							
4							
5							

Su (kPa)

	FIELD	LAB	
VANE PEAK	◆	■	(top scale) ▲ UC/2
REMOLD	◊	□	△ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50	100	150
25	50	75

Klohn Crippen Berger

DRILL HOLE LOG

HA25-10

Project Number:	P10600A140	Northing:	5443036.0 m	Easting:	523291.2 m
Project:	Willoughby Substation Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025

Drilling Company: N/A

Drilling Method: Hand Auger

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.4	TOPSOIL, grass, rootlets, reddish brown, moist.	
					0.9	CLAY (CL-ML), silty, trace fine to coarse sand, low plasticity, grey to tan, WC > PL.	
1						Drill hole terminated at 0.9 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	
2							
3							
4							
5							

Su (kPa)

	FIELD	LAB	
VANE PEAK	◆	■	▲ UC/2 (top scale)
REMOLD	◊	□	△ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50	100	150
25	50	75

Klohn Crippen Berger

DRILL HOLE LOG

HA25-11

Project Number:	P10600A140	Northing:	5443022.5 m	Easting:	523269.4 m
Project:	Willoughby Substation Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025

Drilling Company: N/A

Drilling Method: Hand Auger

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.0	TOPSOIL, clayey, grass, rootlets, brown, moist.	
					0.2	SAND and SILT (SM), fine to coarse, low plasticity silt, poorly graded, light brown, moist.	
						SILT (ML), sandy (fine to coarse), low plasticity, tan to grey, moist.	
					0.7	Drill hole terminated at 0.7 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	

Su (kPa)

VANE FIELD LAB (top scale)

PEAK ◆ ■ ▲ UC/2

REMOLD ◊ □ △ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

X- - - - - - - -O- - - - - - -X

50 100 150

25 50 75

1 2 3 4 5

Klohn Crippen Berger

DRILL HOLE LOG

HA25-12

Project Number:	P10600A140 Willoughby Substation	Northing:	5443008.3 m	Easting:	523327.8 m
Project:	Preliminary Geotechnical Investigation	Ground Elevation:	m	Logged By:	JM/NL
Location:	Surrey, BC	Datum:	NAD83 UTM Zone 10N	Reviewed by:	MC
Client:	BC Hydro	Date Started:	Feb 06, 2025	Date Finished:	Feb 06, 2025
Drilling Company:	N/A				
Drilling Method:	Hand Auger				

DEPTH (m)	SAMPLE NUMBER	TOTAL CORE RECOVERY (%)	SPT BLOWS PER 0.15 m / RECOVERY (%)	LITHOLOGY SYMBOL	DEPTH / ELEVATION	DESCRIPTION OF MATERIALS	INSTRUMENT/ BACKFILL DETAILS
					0.2	TOPSOIL, clayey, grass, rootlets, dark brown, moist.	
						CLAY (CL-ML), silty, trace fine to coarse sand, low plasticity, grey to tan, WC > PL.	
						From 0.54 m to 0.72 m: trace coarse gravel.	
					0.7	Drill hole terminated at 0.7 m. 1) Terminated due to auger refusal. 2) Coordinates were collected using a cell phone GPS with an accuracy of +/- 5 m. 3) Hand augering was carried out using an Edelman hand auger. Sample spoon size = 50 mm. 4) Hand auger hole was backfilled with auger cuttings.	

Su (kPa)

	FIELD	LAB	
VANE PEAK	◆	■	(top scale) ▲ UC/2
REMOLD	◊	□	△ P.PEN/2

⊕ % Fines ● SPT N (bottom scale)

Wp % W % WL %

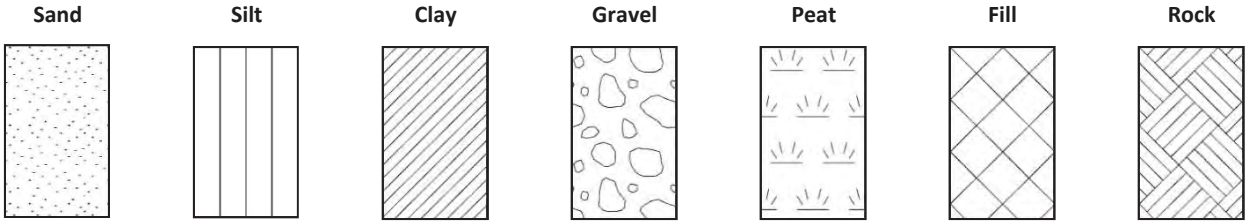
X--------O-------X

50	100	150
25	50	75

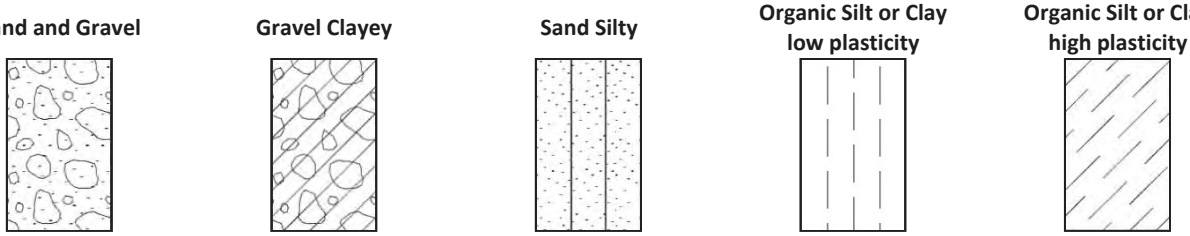
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SYMBOLS AND TERMS FOR SOIL DESCRIPTION AND TEST HOLE LOGS

Basic Symbols



Symbol Variations – Examples [1]



Classification by Particle Size

Name		Size Range (mm) [2]	U.S. Standard Sieve Size Retained	U.S. Standard Sieve Size Passing
Boulders		> 300	12 inch	-
Cobbles		75 – 300	3 inch	12 inch
Gravel:	coarse	19 – 75	0.75 inch	3 inch
	fine	4.75 - 19	No. 4	0.75 inch
Sand:	coarse	2 – 4.75	No. 10	No. 4
	medium	0.425 - 2	No. 40	No. 10
	fine	0.075 - 0.425	No. 200	No. 40
Fines (Silt or Clay) [3]		< 0.075	-	No. 200

Proportion of Minor Components by Weight [4]

and	35-50%
y / ey	20-35%
some	10-20%
trace	0-10%

Particle Shape

Flat	Width/thickness >3
Elongated	Length/width >3

Density of Granular Soils

Description	SPT N [5]	SPT $(N_1)_{60}$ [6]
Very Loose	0-4	0-3
Loose	4-10	3-8
Compact	10-30	8-25
Dense	30-50	25-42
Very Dense	>50	<42

Consistency of Cohesive Soils

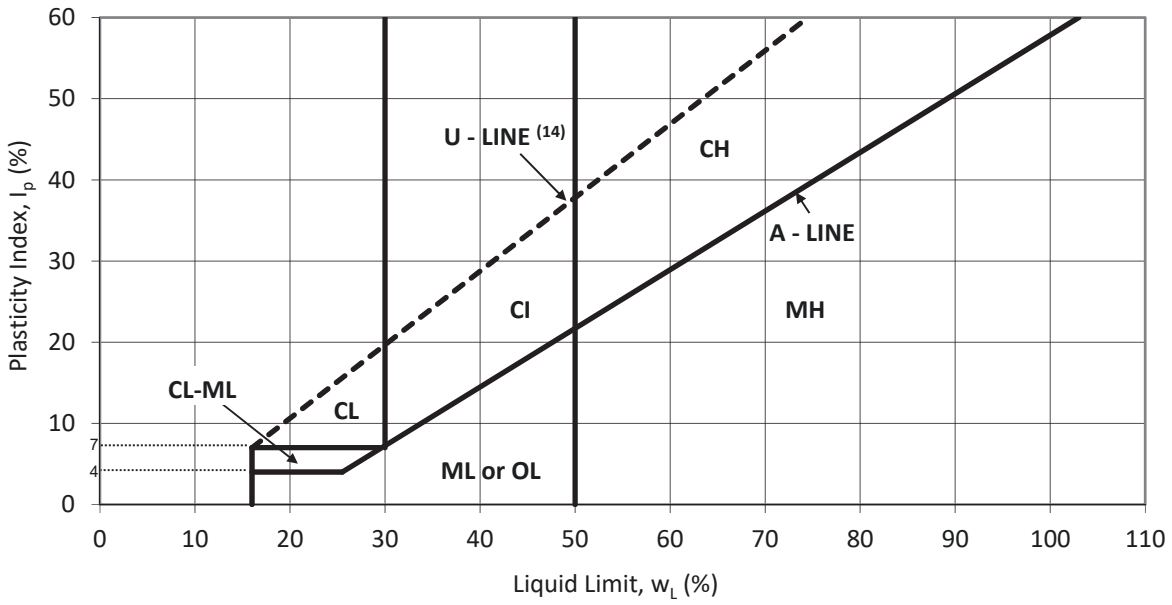
Description	S_U [7] (kPa) [3]	S_U [7] (ksf) [8]	SPT N [9]
Very Soft	< 12	< 0.25	< 2
Soft	12 - 25	0.25 - 0.5	2 - 4
Firm	25 - 50	0.5 - 1	4 - 8
Stiff	50 - 100	1 - 2	8 - 15
Very Stiff	100 - 200	2 - 4	15 - 30
Hard	> 200	>4	> 30

[1] Only selected examples of the possible variations or combinations of the basic symbols are illustrated.
[2] Approximate SI conversion.
[3] Fines are classified as silt or clay on the basis of Atterberg limits (refer to plasticity chart).
[4] Example: SAND, silty, trace of gravel = sand with 20% to 35% silt and up to 10% gravel by weight.
[5] Standard Penetration Test (SPT) blow count (uncorrected) after Terzaghi and Peck, 1948.
[6] SPT blow count, based on above N value corrected to 60% hammer efficiency and 96 kPa (1.0 ton/ft^2) effective overburden pressure, after Skempton, 1986.
[7] Undrained shear strength can be estimated by vane (gives S_u), pocket penetrometer (gives unconfined compressive strength, i.e. 2 S_u), or unconfined compression test (gives 2 S_u).
[8] ksf = 1000 pounds per square foot = 0.5 tsf (ton/ft^2) = approximately 0.5 kg/cm^2.
[9] Very approximate correlation with SPT blow counts after Terzaghi and Peck, 1948.

Plasticity of Cohesive Soils [10]		
Description	Silt	Clay
High	w_L [11] > 50	w_L > 50
Medium	-	30 < w_L < 50
Low	w_L < 50	w_L < 30
Non-Plastic	NP [12]	-

Sensitivity of Cohesive Soils [13]	
Description	Undisturbed Strength / Remoulded Strength
High	> 8
Medium	4 to 8
Low	< 4

Plasticity Chart



Classification of Ground Ice [15]			
Group		Subgroup	
Symbol	Description	Symbol	Description
N	Ice not visible by unaided eye	Nf	Poorly bonded or friable
		Nbn	Well bonded, no excess ice
		Nbe	Well bonded, excess ice
V	Visible ice less than 25 mm thick	Vx	Individual ice crystals or inclusions
		Vc	Ice coatings on soil particles
		Vr	Random of irregularly oriented ice
		Vs	Stratified or distinctly oriented ice
ICE	Visible ice greater than 25 mm thick	ICE + (soil type)	Ice with soil inclusions
		ICE	Ice without soil inclusions

[10] This plasticity classification conforms to the Unified Soil Classification System (USCS) and the ASTM D-2487 plasticity chart, except for the addition of an intermediate category for clay, where the liquid limit is between 30% and 50% (CI). Under ASTM and USCS, all clays with a liquid limit less than 50% are classified as low plasticity (CL).
[11] W_L = Liquid Limit (%)
[12] NP = Non-Plastic (silts only)
[13] Dimensionless ratio
[14] "U" Line marks typical upper limit. "A" Line divides clay from silts and organic silts.
[15] For soil descriptions, estimate percentage of ground ice based on volume after National Research Council of Canada, 1963.

Test Types [16]

AH	Auger hole - machine or hand auger, no SPT or thin-walled tube samples taken.	DH	Drill Hole - typical drilling methods include tricone, percussion, wash boring, machine auger with SPT or thin-walled tube samples and coring.
BK	Becker hammer drill hole pair - both open and closed test at the same location.	SCPT	Seismic cone penetration test with pore pressure measurements.
BOC	Becker hammer drill hole - open casing, sampled.	TP	Test pit - machine or hand dug.
BPT	Becker penetration test - closed casing.	VST	Vane shear test.
CPT	Cone penetration test with pore pressure measurements.		
DCT	Dynamic cone penetration test.		

In Situ Tests or Downhole Instrumentation [17]

BM	Benchmark	PT	Permeability test
DMT	Dilatometer test	PZ	Piezometer
IN	Inclinometer	SW	Shear wave velocity test
PMT	Pressuremeter test		

Laboratory and/or Field Tests [18]

S_u	Undrained shear strength, measured by: [19]	●	Standard Penetration Test (SPT) blow count, uncorrected (N)
♦	Field Vane (peak)	○	W (%) In situ moisture content
◊	Field Vane (remoulded)	X – –	w_P (%)Plastic Limit
■	Lab Vane (peak)	– – X	w_L (%) Liquid Limit
□	Lab Vane (remoulded)		Becker penetration test blow counts, closed casing
▲	Unconfined Compression		Becker penetration test blow counts, open casing
Δ	Pocket Penetrometer	▼ or ▽	Water level, measured on date and from piezometer indicated on log

Other Laboratory Tests [20]

CD	Consolidated, drained triaxial test	GSD	Grain size distribution (by sieve or hydrometer)
CUP	Consolidated, undrained triaxial test with pore pressure measurements	MDR	Moisture-density relationship (i.e. standard or modified Proctor test)
CUCY	Consolidated, undrained triaxial test with cyclic loading	ORG	Organic content
UU	Unconsolidated, undrained triaxial test	OED	Oedometer consolidation test
UC	Unconfined (uniaxial) compression test	RD	Relative density (also known as density index)
DS	Direct shear test	GS	Specific gravity
DSS	Direct simple shear test	K	Permeability
		UW	Unit weight

[16] Test type abbreviation is typically followed by a two-part number indicating year and chronological sequence of test. *Example: CPT15-1 indicates the first cone penetration test at a particular site in 2015.*
[17] In situ test or downhole instrumentation abbreviations are typically shown in brackets following the appropriate test type designation. *Example: DH15-1(PZ) indicates a piezometer was installed in drill hole 15-1.*
[18] These symbols are for laboratory and/or field test results shown on the test hole log.
[19] Vane gives S_u, pocket penetrometer and unconfined compression tests give $2S_u$, so results are divided by 2 for plotting on log.
[20] Where other laboratory test results are available but not shown on the test hole log, the applicable abbreviation appears under the heading *"Other Tests"* on the log.

APPENDIX V

Laboratory Test Results