GEOTECHNICAL INVESTIGATION REPORT

Nobleton Wells 2 and 5 Upgrades, The Regional Municipality of York, Ontario.

EnVision Project #: 23-0358
Prepared for: ETO Solutions Corp o/a ETO Engineering
Date: March 12, 2025

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March 12, 2025

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Attention: Johnny Pang, P.Eng., PMP

SUBJECT: GEOTECHNICAL INVESTIGATION REPORT, NOBLETON WELLS 2 AND 5 UPGRADES, THE REGIONAL MUNICIPALITY OF YORK, ONTARIO.

EnVision Consultants Ltd. is pleased to present the enclosed revised draft Geotechnical Investigation Report in support of the proposed facility upgrades at Nobleton Wells 2 and 5, in the Regional Municipality of York, Ontario.

We thank you for utilizing EnVision for this assignment. If there are any questions regarding the enclosed report, please do not hesitate to contact us.

Yours sincerely,

DRAFT

Meagan Fullerton
Project Manager
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QUALITY MANAGEMENT

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1. INTRODUCTION

EnVision Consultants Ltd. (EnVision) was retained by ETO Solutions Corp o/a ETO Engineering (the 'Client') to provide geotechnical engineering consulting services in support of proposed facility upgrades at Nobleton Wells 2 and 5, in the Regional Municipality of York, Ontario. (the 'Site').

The scope of work for the geotechnical engineering services provided herein is outlined in The Regional Municipality of York's request for proposal entitled "Preliminary Design, Detailed Design, Contract Administration and Site Inspection Services for The Nobleton Wells 2 and 5 Upgrades", Reference No. RFPC-738-22, and EnVision's proposal entitled "Geotechnical, Hydrogeology, Excess Soil, Air Emission, and Natural Heritage/Environmental Screening Services, Nobleton Wells 2 and 5 Upgrades", dated August 02, 2022. The scope of field investigations was further amended in collaboration with the Client as documented in email communications between September 15th and October 13th, 2023.

Geo-environmental soil characterization studies and hydrogeological studies were also performed for this project and those findings are provided in separate reports. This report addresses only the geotechnical aspects of the project.

Review of the design drawings provided by the Client indicates that the proposed upgrades at the two sites consist of the following:

- ***Nobleton Well 2 -*** Construction of a generator pad.
- ***Nobleton Well 5 -*** Construction of a treatment plant building and a generator pad, as well as watermain and sanitary sewer installations.

The purpose of this geotechnical investigation was to explore the subsurface soil and groundwater conditions at the borehole locations and from the findings in the boreholes, to provide geotechnical recommendations for the proposed upgrades.

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, EnVision should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client-specific needs and economics and do not conform to generalized standards for services. Laboratory testing for the most part follows ASTM or CSA Standards.

This report has been prepared for the ETO Solutions Corp o/a ETO Engineering and the Regional Municipality of York. Third party use of this report without EnVision's consent is prohibited. The limitation conditions presented in this report form an integral part of the report and must be considered in conjunction with this report.

2. FIELD INVESTIGATION AND TESTING

2.1. FIELDWORK

Nobleton Well 2

- The field investigation at this Site was carried out on December 6, 2023 and consisted of drilling a total of three (3) boreholes, (designated as BH2-1 to BH2-3) to depths ranging from 5.2 m to 6.1 m below the existing ground surface as listed in Table 2-1.
- All three boreholes were instrumented with a monitoring well, consisting of 50mm diameter, environmental-grade PVC pipe and screened sections.
- The driveway asphaltic concrete pavement was cored at two (2) locations. Photographs of the asphalt cores are presented in Appendix A.
- The approximate locations of the boreholes and asphaltic concrete cores are shown on Drawing No. 1, Borehole and Corehole Location Plan – Nobleton Well 2, and the geological profiles at the borehole locations are shown on Drawing No. 2, Generalized Subsurface Profile – Nobleton Well 2.

Nobleton Well 5

- The field investigation at this Site was carried out on October 19 and October 20, 2023, and consisted of drilling a total of six (6) boreholes, (designated as BH5-1 to BH5-6) to depths ranging from 1.5 m to 9.7 m below the existing ground surface.
- Three (3) monitoring wells, consisting of 50mm diameter, environmental-grade PVC pipe and screened sections were installed in select boreholes as listed in Table 2-2.
- The approximate locations of the boreholes are shown on Drawing No. 3, Borehole Location Plan – Nobleton Well 5 and the geological profiles at the borehole locations are shown on Drawing No. 4, Generalized Subsurface Profile – Nobleton Well 5.

The as-drilled borehole locations were surveyed by EnVision personnel using differential GPS. The borehole coordinates and geodetic elevations are summarized in Table 2-1 and Table 2-2 below, and are presented on Log of Borehole sheets in Appendix A.

Table 2-1: Summary of Borehole/Monitoring Well Information – Nobleton Well 2

BOREHOLE ID	GROUND SURFACE ELEVATION (m)	BOREHOLE COORDINATES UTM NAD83, ZONE 17		DEPTH OF BOREHOLE (m)	MONITORING WELL
		NORTHING (m)	EASTING (m)		
BH2-1	265.6	4861733.5	608018.3	5.2	50mm MW
BH2-2	266.0	4861751.0	608012.9	6.1	50mm MW
BH2-3	264.6	4861701.0	608028.4	5.2	50mm MW

Table 2-2: Summary of Borehole/Monitoring Well Information – Nobleton Well 5

BOREHOLE ID	GROUND SURFACE ELEVATION (m)	BOREHOLE COORDINATES UTM NAD83, ZONE 17		DEPTH OF BOREHOLE (m)	MONITORING WELL
		NORTHING (m)	EASTING (m)		
BH5-1	261.2	4861432.5	608166.9	9.6	50mm MW
BH5-2	260.7	4861419.8	608183.3	9.7	50mm MW
BH5-3	260.6	4861412.2	608192.4	3.5	-
BH5-4	260.4	4861454.7	608228.7	6.5	50mm MW
BH5-5	260.4	4861453.4	608254.3	1.5	-
BH5-6	260.2	4861412.1	608158.5	6.5	-

Boreholes BH2-1 to BH2-3, BH5-1 to BH5-4 and BH5-6 were advanced using a track mounted drilling rig supplied and operated by a specialist drilling contractor. Borehole BH5-5 was advanced using a hand drilling auger supplied and operated by EnVision staff. The field work was observed by EnVision staff who arranged for the clearance of underground public and private utility locate services, supervised the sampling and in situ testing operations and logged the boreholes. The soil samples were identified in the field, placed in labelled containers, and transported to EnVision's laboratory for further examination and testing.

In boreholes BH2-1 to BH2-3, BH5-1 to BH5-4 and BH5-6, samples of the overburden soils were generally obtained at depth intervals of 0.75 m and 1.5 m using a 50 mm outer diameter (O.D.) split-spoon sampler, in conjunction with the Standard Penetration Testing (SPT) procedures as specified in ASTM Method D 1586. This sampling method recovers samples from the soil strata, and the number of blows required to drive the sampler 0.3 m depth into the undisturbed soil (SPT 'N'-value) gives an indication of the relative density (compactness condition) or consistency of the sampled soil material. The SPT 'N' values are indicated on the Log of Borehole sheets (Refer to Appendix A). In Borehole BH5-5, soil samples were collected from auger cuttings.

Groundwater conditions in the open boreholes were observed during the drilling operations. Monitoring wells were installed in selected boreholes to permit longer term ground water level monitoring.

2.2. GEOTECHNICAL LABORATORY TESTING

The geotechnical laboratory testing program consisted of natural moisture content measurements of all available soil samples and the results are presented on the respective Log of Borehole sheets.

Grain size analyses were conducted on a total of ten (10) selected samples and Atterberg Limits tests were conducted on five (5) selected soil samples. The gradation curves and Atterberg Limits tests results are presented in Appendix B and on the respective Log of Borehole sheets in Appendix A.

3. SUBSURFACE CONDITIONS

The subsurface soil and groundwater conditions encountered in the boreholes, along with the in situ and geotechnical laboratory testing results are presented on the Log of Borehole sheets provided in Appendix A. The terms used in the record of boreholes and general notes on soil descriptions are also presented on the fly pages preceding Appendix A.

The stratigraphic boundaries shown on the Log of Borehole sheets and Generalized Subsurface Profile drawings are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following subsections.

3.1. SUBSURFACE CONDITIONS - NOBLETON WELL 2

In summary, the subsurface conditions encountered in the boreholes consisted of topsoil or flexible pavement structure underlain by fill material, generally consisting of loose to compact sand and gravel to gravelly sand, and firm to very stiff silty clay to clayey silt. Native overburden deposits consist of very stiff to hard silty clay to clayey silt till and compact to dense silty sand.

3.1.1. TOPSOIL

A 205 mm thick layer of topsoil was encountered at borehole BH2-2. Topsoil thickness will vary between and beyond the borehole locations.

3.1.2. FLEXIBLE PAVEMENT

Boreholes BH2-1 and BH2-3 were advanced through the pavement structure of the driveway to the property located at 22 Faris Avenue. Two asphalt cores were also collected from the driveway pavement. A pavement structure consisting of 105mm to 130mm asphaltic concrete, underlain by 350mm to 355mm of sand and gravel to gravelly sand fill was encountered at the test hole locations.

Two Standard Penetration Tests carried out in sand and gravel to gravelly sand fill measured SPT N-values of 6 blows and 12 blows for 0.3m of penetration, indicating a loose to compact relative density. The natural moisture content of tested samples of the granular base/subbase material were 8% and 10% by weight.

Grain size analysis was conducted on one (1) selected sample of granular base/subbase material. The results were compared against the Ontario Provincial Standards (OPSS) gradation specifications for Granular A and Granular B Type I. The particle size distribution is summarized in Table 3-1 and the grain size distribution curve is presented in Figure B1, in Appendix B.

Table 3-1: Summary of Grain Size Distribution Tests on Granular Base/Subbase Samples

BOREHOLE NO.	SAMPLE NO.	AVERAGE SAMPLE DEPTH (m)	GRAIN SIZE DISTRIBUTION		
			GRAVEL (%)	SAND (%)	FINES (SILT +CLAY) (%)
BH2-3	AS1	0.4	26	52	22

The fines content of the tested sample of existing granular base/subbase greatly exceeds the recommended OPSS1010 maximum fines content of 8%.

3.1.3. FILL – SILTY CLAY TO CLAYEY SILT

Fill material, consisting of silty clay to clayey silt was encountered in all the boreholes at depths ranging from 0.2m to 0.5m below the ground surface which extended to depths ranging about from 0.6m to 1.2m below the existing ground surface.

The SPT 'N' values recorded in the silty clay to clayey silt fill ranged from 6 blows to 18 blows per 0.3m penetration, indicating a firm to very stiff consistency. The water content of the tested samples of silty clay to clayey silt fill ranged from about 15% to 20% by weight.

Grain size analysis was carried out on one (1) selected sample of the silty clay to clayey silt fill, and the grain size distribution curve is presented in Figure B2, in Appendix B. One (1) sample of the silty clay to clayey silt fill was also subjected to Atterberg Limits tests and the results are presented in Figure B3, in Appendix B. The results indicate that the silty clay to clayey silt fill is a cohesive soil of low plasticity (CL). The laboratory test results are summarized in Table 3-2.

Table 3-2: Summary of Grain Size Distribution and Atterberg Limits Tests on a Silty Clay Fill Sample

BH NO.	SAMPLE NO.	AVERAGE SAMPLE DEPTH (m)	GRAIN SIZE DISTRIBUTION				ATTERBERG LIMITS			SOIL TYPE
			GR (%)	SA (%)	SI (%)	CL (%)	LL (%)	PL (%)	PI (%)	
BH2-3	SS2	0.9	4	25	52	19	25	16	9	CL

3.1.4. SILTY CLAY TILL TO CLAYEY SILT TILL

Cohesive glacial till deposits ranging in texture from silty clay to clayey silt were encountered in all of the boreholes, at depths ranging from 0.6m to 1.2m below ground surface, which extended to borehole termination depths ranging from 5.2m to 6.1m below ground surface.

Standard Penetration tests carried out in silty clay till to clayey silt till measured SPT N-values ranging from 22 blows to 69 blows per 0.3 penetration, indicating a very stiff to hard consistency. The natural water content of silty clay till to clayey silt till samples ranged from 11% to 22% by weight.

Grain size analyses were carried out on two (2) selected samples of the silty clay till to clayey silt till deposits and the grain size distribution curves are presented in Figure B4, in Appendix B. Two (2) samples of the silty clay till to clayey silt till deposits were also subjected to Atterberg Limits tests and the results are presented in Figure B5, in Appendix B. These results indicate that the silty clay till to clayey silt till deposits are cohesive soils of low plasticity (CL-ML to CL). The laboratory test results are summarized in Table 3-3.

Table 3-3: Summary of Grain Size Distribution and Atterberg Limits Tests on Cohesive Till Samples

BH NO.	SAMPLE NO.	AVERAGE SAMPLE DEPTH (m)	GRAIN SIZE DISTRIBUTION				ATTERBERG LIMITS			SOIL TYPE
			GR (%)	SA (%)	SI (%)	CL (%)	LL (%)	PL (%)	PI (%)	
BH2-1	SS6	4.1	1	17	64	18	21	14	7	CL-ML to CL
BH2-2	SS2	0.9	2	13	60	25	29	17	12	CL

Glacial till deposits can be expected to contain cobbles and boulders. The slow rate of drilling experienced within these deposits can be attributed to the presence of cobbles and/or boulders.

3.1.5. SILTY SAND

Embedded within the cohesive glacial till, a 0.2m to 0.4m thick layer of wet silty sand was encountered in all of the boreholes, at depths ranging from 2.1m to 3.0m below ground surface, which extended to depths ranging from 2.5m to 3.3 m below the ground surface. The natural water content of samples of the silty sand deposit ranged from 16% to 19% by weight.

3.2. SUBSURFACE CONDITIONS - NOBLETON WELL 5

In summary, the subsurface conditions encountered in the boreholes consisted of topsoil or a flexible pavement structure underlain by fill material, generally consisting of firm to very stiff silty clay to clayey silt, loose to compact silty sand to sand and silt and, loose sand and gravel. Native overburden deposits consist of very dense cohesionless deposits ranging in composition from silt to sand and silt, stiff to hard silty clay to clayey silt and very dense silty sand till to sandy silt till.

3.2.1. TOPSOIL

A layer of topsoil, ranging in thickness from 80 mm to 130 mm was encountered at the ground surface at the borehole locations. Topsoil thickness will vary between and beyond the borehole locations.

3.2.2. FLEXIBLE PAVEMENT

Borehole BH5-3 was advanced through the pavement structure of the driveway to the property located at 12860 ON-12. A pavement structure consisting of 80mm asphaltic concrete, underlain by sand and gravel fill was encountered.

A Standard Penetration Test carried out in sand and gravel fill measured a SPT N-value of 9 blows for 0.3m of penetration, indicating a loose relative density. The natural moisture content of a sample of the sand and gravel fill was 5% by weight.

3.2.3. FILL – SILTY CLAY TO CLAYEY SILT

Fill material, consisting of silty clay to clayey silt was encountered at boreholes, BH5-1 to BH5-4 and BH5-6 at depths ranging from 0.1m to 0.7m below the ground surface which extended to depths ranging from 0.7m to 2.2m below the existing ground surface.

The SPT 'N' values measured in the silty clay to clayey silt fill ranged from 7 blows to 26 blows per 0.3m penetration, indicating a firm to very stiff consistency. The water content of the tested samples of silty clay to clayey silt fill ranged from about 8% to 19% by weight.

Grain size analysis was carried out on one (1) selected sample of the silty clay to clayey silt fill, and the grain size distribution curve is presented in Figure B6, in Appendix B. One (1) sample of the silty clay to clayey silt fill was also subjected to Atterberg Limits tests and the results are presented in Figure B7, in Appendix B. The results indicate that the tested sample of silty clay fill is a cohesive soil of medium (intermediate) plasticity (CI). The laboratory test results are summarized in Table 3-4.

Table 3-4: Summary of Grain Size Distribution and Atterberg Limits Tests on a Silty Clay Fill Samples

BH NO.	SAMPLE NO.	AVERAGE SAMPLE DEPTH (m)	GRAIN SIZE DISTRIBUTION				ATTERBERG LIMITS			SOIL TYPE
			GR (%)	SA (%)	SI (%)	CL (%)	LL (%)	PL (%)	PI (%)	
BH5-1	SS2	1.1	4	16	51	29	36	20	16	CI

3.2.4. FILL – SILTY SAND TO SANDY SILT

Silty sand to sandy silt fill material was encountered in boreholes, BH5-4 and BH5-5 at depths of 0.1m and 0.7m below ground surface which extended to depths of 1.5m and 1.8m below ground surface.

Two Standard Penetration Tests carried out in silty sand to sandy silt fill measured SPT N-values of 10 blows and 23 blows per 0.3m penetration, indicating a loose to compact relative density. The water contents of samples of the silty sand to sandy silt fill ranged from 9% to 15% by weight.

3.2.5. SILT

Silt deposits (non-plastic) were encountered in the boreholes, BH5-1, BH5-2, BH5-4 and BH5-6. The silt deposits were encountered at depths ranging from 2.2m to 4.8m below ground surface which extended to borehole termination depths ranging from 6.5m to 9.7m below ground surface.

Standard Penetration tests carried out in silt deposits measured SPT N-values ranging from 40 blows to 100 blows per 0.3m penetration indicating a dense to very dense relative density. The natural water content of samples of the silt deposits ranged from 12% to 24% by weight.

Grain size analyses were carried out on two (2) selected samples of the silt deposits. The grain size distribution curves are presented in Figure B8, in Appendix B and the results are summarized in Table 3-5.

Table 3-5: Summary of Grain Size Distribution Tests on Silt Samples

BOREHOLE NO.	SAMPLE NO.	AVERAGE SAMPLE DEPTH (m)	GRAIN SIZE DISTRIBUTION			
			GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)
BH5-1	SS7	4.8	2	7	84	7
BH5-6	SS7	4.9	1	18	76	5

3.2.6. SILTY CLAY TO CLAYEY SILT

Cohesive deposits of silty clay to clayey silt were encountered in boreholes, BH5-4 and BH5-6. The silty clay to clayey silt deposits were encountered at depths of 0.7m and 1.8m below ground surface which extended to depths of 2.2m and 4.8m below ground surface.

Standard Penetration tests carried out in the silty clay to clayey silt deposits measured SPT N-values which ranged from 26 blows to 95 blows per 0.3m penetration indicating a very stiff to hard consistency. The natural water content of samples of silty clay to clayey silt ranged from 12% to 25% by weight.

A grain size analysis was carried out on one (1) selected sample of the silty clay to clayey silt deposit and the grain size distribution curve is presented in Figure B9 in Appendix B. One (1) sample of the silty clay to clayey silt deposit was also subjected to Atterberg Limits test and result is presented in Figure B10, in Appendix B. This result indicates that the tested sample of silty clay to clayey silt is a cohesive soil of low plasticity (CL). The laboratory test results are summarized in Table 3-6.

Table 3-6: Summary of Grain Size Distribution and Atterberg Limits Tests on a Silty Clay to Clayey Silt Sample

BH NO.	SAMPLE NO.	AVERAGE SAMPLE DEPTH (m)	GRAIN SIZE DISTRIBUTION				ATTERBERG LIMITS			SOIL TYPE
			GR (%)	SA (%)	SI (%)	CL (%)	LL (%)	PL (%)	PI (%)	
BH5-4	SS5	2.6	3	17	60	20	25	15	10	CL

3.2.7. SANDY SILT AND SAND AND SILT

Cohesionless deposits of sandy silt and sand and silt were encountered in boreholes BH5-2 and BH5-3 at depths of 2.2m and 4.5m below ground surface which extended to depths of 3.5m and 5.6m below ground surface.

Standard Penetration tests carried out in sandy silt and sand and silt deposits measured SPT N-values which ranged from 73 blows to 80 blows per 0.3m penetration indicating a very dense relative density. The natural water content of sandy silt and sand and silt samples ranged from 10% to 17% by weight.

Grain size analyses were carried out on two (2) selected samples of sandy silt and sand and silt deposits. The grain size distribution curves are presented in Figure B11, in Appendix B and laboratory test results are summarized in Table 3-7.

Table 3-7: Summary of Grain Size Distribution on Sandy Silt / Sand and Silt Samples

BOREHOLE NO.	SAMPLE NO.	AVERAGE SAMPLE DEPTH (m)	GRAIN SIZE DISTRIBUTION			
			GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)
BH5-2	SS7	4.8	0	27	69	4
BH5-3	SS4	2.6	1	55	39	5

3.2.8. SILTY SAND TILL TO SANDY SILT TILL

A cohesionless glacial till deposit of silty sand to sandy silt texture was encountered in borehole BH5-6 at a depth of 2.2m below ground surface, which extended to a depth of 3.0m below ground surface.

A Standard Penetration test carried out in silty sand till to sandy silt till deposit measured a SPT N-value of 74 blows per 0.3 penetration indicating a very dense relative density. The natural water content of a sample of silty sand till to sandy silt till was 10% by weight.

Glacial till deposits can be expected to contain cobbles and boulders. The slow rate of drilling experienced within these deposits can be attributed to the presence of cobbles and/or boulders.

4. GROUNDWATER CONDITIONS

The groundwater levels measured in monitoring wells are summarized in Table 4-1 and are also shown on the Log of Borehole sheets attached in Appendix A.

Table 4-1: Summary of Groundwater Levels Observed in the Monitoring Wells

BH NO.	EXISTING GROUND SURFACE ELEVATION (m)	STRATIGRAPHY AT SCREEN DEPTH (m)	DATE OF OBSERVATION	DEPTH OF GROUNDWATER BELOW EXISTING GROUND SURFACE (m)	GROUNDWATER TABLE ELEVATION (m)
BH2-1	265.6	Silty Clay Till to Clayey Silt Till / Silty Sand (2.1 -5.2)	Dec 8, 2023 Sept. 11, 2024	2.4 2.6	263.2 263.0
BH2-2	266.0	Silty Clay Till to Clayey Silt Till / Silty Sand (3.1 – 6.1)	Dec 8, 2023 Sept. 11, 2024	Dry 3.2	- 262.8
BH2-3	264.6	Silty Clay Till to Clayey Silt Till / Silty Sand (2.1 – 5.2)	Dec 8, 2023 Sept. 11, 2024	1.8 1.9	262.8 262.7
BH5-1	261.2	Silt (6.1m – 9.1m)	Oct 25, 2023 Dec 12, 2023 Sept. 11, 2024	6.9 7.1 6.3	254.3 254.1 254.9
BH5-2	260.7	Silt (6.1m – 9.1)	Oct 25, 2023 Dec 12, 2023 Sept. 11, 2024	6.4 6.6 5.6	254.3 254.1 255.1
BH5-4	260.4	Silty Clay to Clayey Silt / Silt (4.6 – 6.1)	Oct 25, 2023 Dec 12, 2023 Sept. 11, 2024	Dry Dry 5.8	- - 254.6

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to weather events. Groundwater levels will typically mimic ground surface topography.

Longer term groundwater level monitoring will be required to confirm the groundwater table(s) and seasonal groundwater variations.

5. ANALYTICAL SOIL TESTING

5.1. CORROSIVITY PARAMETERS

Two (2) soil samples were submitted to ALS Environmental Laboratories in Mississauga, Ontario, for analysis of parameters used to assess corrosion potential towards buried ferrous metal as well as analysis for potential sulphate attack against buried Portland cement concrete.

A summary of the results is presented in Table 5-1 below. The Certificates of Analysis are provided in Appendix C.

Table 5-1: Summary of Corrosivity and Water-Soluble Soil Sulphate Content Tests Results

BH NO.	SAMPLE NO.	APPROXIMATE SAMPLE DEPTH (m) (ELEVATION) (m)	SOIL TYPE	TOTAL POINTS	WATER SOLUBLE SULPHATE (µg/g) [%]
BH5-2	SS7	4.6 -5.0 (255.7 – 256.1)	Sandy Silt	5.5	32 (0.0032%)
BH5-4	SS5	2.3 – 2.9 (257.5 – 258.1)	Silty Clay to Clayey Silt	5.5	91 (0.0091%)

The corrosivity results were compared to Table A.1 *(Soil-test evaluation)* of the American Water Works Association (AWWA) C105/A21.5-10 (2010) Standard to determine the total points for each corrosivity parameter. Scoring of less than 10 on the basis of these test results is indicative, of soil which is not unusually corrosive towards gray or ductile cast iron pipe.

There may be other over-riding factors that govern the need for corrosion protection, such as stray currents, application of de-icing salts to the roadway, etc. and these may play an important role in determining the protection measures needed.

The analytical test results for water-soluble soil sulphate content were compared to CSA A23.1 Table 3 (*Additional Requirements for Concrete Subjected to Sulphate Attack*) to assess the potential severity of sulphate attack on concrete during its service life. The sulphate concentration measured indicates the soil tested is less than 0.1%, which is below the moderate degree of exposure (i.e., below the Class S3 exposure limits).

The civil design engineer should review these results to make their own determination of the appropriate exposure class and potential aggressiveness of the soils, and to ensure that all aspects of CSA A23.1 Section 4.1.1 (Durability Requirements) and the project design requirements are satisfied.

6. DISCUSSION AND RECOMMENDATIONS

This section of the report presents an interpretation of the factual geotechnical data and provides geotechnical design recommendations. The subsurface conditions are interpreted as they relate to the design and construction of the proposed upgrades at the Sites. The conditions are known only at the borehole locations and in view of the generally wide spacing of the boreholes, conditions may vary significantly between boreholes. Comments concerning construction are intended for the guidance of the engineering designer to establish constructability.

The construction methods described in this report must not be considered as being specifications or direct recommendations to contractors, or as being the only suitable methods. Prospective contractors should evaluate all the factual information, obtain additional subsurface information as they deem necessary and should select their construction methods, sequencing and equipment based on their own experience in similar ground conditions.

Design recommendations provided herein are based on the design drawings provided by the Client as listed below. Recommendations in this report should be updated if designs are altered.

- Drawing entitled "Nobleton Wells 2 and 5 Upgrades, Discipline – Well 2 Existing Site Plan", Drawing No. C101, dated February 2023;
- Pdf file named "Nobleton Well 2 Preferred Option" and entitled "Figure 5 - Preferred Option (Option 1A)", provided via email on October 16, 2023;
- Drawing entitled "Nobleton Wells 2 and 5 Upgrades, Civil – Well 5 Proposed Site Plan", Drawing No. C202, dated February 2023; and
- Drawing entitled "Nobleton Wells 2 and 5 Upgrades, Architectural – Building Sections (1) & (2)", Drawings No. S104 and S105, provided via email on December 06, 2023.

The design recommendations in this report pertain to design and construction of the following project components.

Nobleton Well 2

- Construction of a generator pad.

Nobleton Well 5

- Construction of a water treatment plant comprising of multiple underground compartment tanks and a single-story above ground structure,
- Construction of a generator pad, and
- Watermain and sanitary sewer installations.

6.1. OVERVIEW OF SUBSURFACE CONDITIONS AND RECOMMENDATIONS

The subsurface conditions encountered at the borehole locations at the two sites are shown on Drawings No. 2 and 4, and are as detailed below:

- ***Nobleton Well 2*** - Fill material generally consisting of loose to compact sand and gravel to gravelly sand, and firm to very stiff silty clay to clayey silt. Native overburden deposits at this site consist of very stiff to hard silty clay to clayey silt till and compact to dense silty sand.
- ***Nobleton Well 5*** - Fill material generally consisting of firm to very stiff silty clay to clayey silt, loose to compact silty sand to sand and silt and, loose sand and gravel. Native overburden deposits at this site consist of very dense cohesionless deposits ranging in composition from silt to sand and silt, stiff to hard silty clay to clayey silt and very dense silty sand till to sandy silt till.

The groundwater levels measured in the monitoring wells, as well as the in-situ moisture content of the soil samples were used to estimate the groundwater table elevation as listed below:

- ***Nobleton Well 2*** **–** During the period of observation, the groundwater levels measured in the monitoring wells were found to be between elevations 262.8 m and 263.2 m.
- ***Nobleton Well 5*** - During the period of observation, the groundwater levels measured in the monitoring wells were found to be at depths ranging from 5.6 m to 5.8 m below ground surface, corresponding to elevations 254.6 m to 255.1 m.

Perched water should also be expected within shallow granular fill (as well as within existing utility trench backfill and bedding materials) and especially where relatively permeable soils are underlain by more impermeable silty clay and clayey silt deposits.

For design purposes, the groundwater level shall be taken as 1 m higher than the measured groundwater level in the nearest monitoring well installed within the overburden or the regional flood level, whichever is higher (provided that the site topography is not expected to affect the groundwater table elevation).

6.1.1. COBBLES AND BOULDERS

Glacial till soils were encountered at Nobleton Well 5. Till soils inherently contain cobbles and boulders given their nature of deposition. The method of borehole drilling used in the current investigation could not determine the size and frequency of any cobbles and boulders. However, the relatively slow rate of drilling advancement experienced during augering through these deposits, combined with auger grinding observations, can be attributed to the general presence of cobbles/boulders.

Cobbles are defined (under ASTM) as rock fragments that cannot pass through a screen with 75 mm square openings and are less than 300 mm in maximum dimension. Boulders are defined as rock fragments with their minimum dimension being equal to or greater than 300 mm. The Contract should include provisions for removal of boulders within the till deposits.

6.2. EARTHQUAKE CONSIDERATIONS

The Ontario Building Code (OBC) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration, and the site classification.

The parameters for determination of Site Classification for Seismic Site Response are set out in *Table 4.1.8.4 A* of the OBC. The classification is based on the determination of the average shear wave velocity in the top 30 metres of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated from the rational analysis of undrained shear strength (s_u) or penetration resistance (N-values) according to the OBC and National Building Code of Canada.

Based on the average N-values recorded in the boreholes and according to *Table 4.1.8.4.A* of OBC, a Class 'D' for seismic site response may be used for the designs at Nobleton Well 2 site, and a Class 'C' for seismic site response may be used for the designs at Nobleton Well 5 site.

6.3. FOUNDATIONS

6.3.1. RAFT FOUNDATIONS

The base of the tanks or foundations for supporting the loads imparted from machines such as generators can be designed as raft foundations. The raft design parameters provided herein, are based on assuming a uniform load at the base of the raft and conservatively assessed Young's Moduli for each of the load-bearing strata. Geotechnical reactions provided below can be used for preliminary design purposes:

Nobleton Well 2:

- An assumed 7m x 4m raft foundation founded on *an engineered granular fill pad* placed over undisturbed native soils (consisting of very stiff to hard silty clay till to clayey silt till) at the location of borehole BH2-2, and below elevation 265.0 m may be designed based on a factored geotechnical resistance of 375 kPa at the Ultimate Limit State (ULS) and a geotechnical reaction of 250 kPa at the Serviceability Limit State (SLS). A raft foundation designed for the specified SLS value is expected to undergo approximately 25 mm of total settlement. The engineered granular pad should consist of OPSS Gran. 'A' 19mm crusher run limestone compacted to 98% of its Standard Proctor Maximum dry density at a placement water content within 2% of its optimum.

Nobleton Well 5:

- An assumed 7m x 4m raft foundation founded on *an engineered granular fill pad* placed over undisturbed native soils (consisting of very dense sand and silt after removal of the upper fill of approximately 2.3m thickness) at the location of borehole BH5-3, and below elevation 258.1 m may be designed based on a factored geotechnical resistance of 375 kPa at ULS and a geotechnical reaction of 250 kPa at the SLS. A raft foundation designed for the specified SLS value is expected to undergo approximately 25 mm of total settlement. The engineered granular pad should consist of OPSS Gran. 'A' 19mm crusher run limestone compacted to 98% of its Standard Proctor Maximum dry density at a placement water content within 2% of its optimum.

- At the location of the proposed treatment plant, the base of a 20m x 26.8m tank founded on undisturbed native soils (consisting of very dense silt) between elevations 254.0 m and 254.5 m, may be designed based on a factored geotechnical resistance of 450 kPa at the ULS and a geotechnical reaction of 300 kPa SLS. A raft foundation designed for the specified SLS value is expected to undergo approximately 25 mm of total settlement. *The foregoing bearing resistances are predicated on effective site dewatering undertaken in advance of excavation such that the piezometric level is drawn down and maintained at least 1.0m below the excavation base level until such time as the tank is backfilled.*

The subgrade at the slab and tank base locations and the modulus of subgrade reaction appropriate for preliminary raft foundation designs are outlined in Table 6-1, below:

Table 6-1: Moduli of Subgrade Reaction for Raft Foundation Design

<table>
<tr><th>SITE</th><th>FOUNDATION SIZE (m)</th><th>APPROXIMATE BASE SLAB ELEVATION (m)</th><th>BOREHOLE</th><th>SUBGRADE SOIL</th><th>MODULUS OF SUBGRADE REACTION (MPa/m)</th></tr>
<tr><td>Nobleton Well 2</td><td>7 x 4</td><td>Below 265.0</td><td>BH 2-2</td><td>Very Stiff to Hard
Silty Clay Till to Clayey Silt Till</td><td>15</td></tr>
<tr><td rowspan="4">Nobleton Well 5</td><td>7 x 4</td><td>Below 258.1</td><td>BH 5-3</td><td>Very Dense Sand and Silt</td><td>15</td></tr>
<tr><td rowspan="3">20 x 26.8</td><td rowspan="3">254.0 to 254.5</td><td>BH 5-1</td><td>Very Dense Silt</td><td>30*</td></tr>
<tr><td>BH 5-2</td><td>Very Dense Silt</td><td>30*</td></tr>
<tr><td>BH 5-6</td><td>Very Dense Silt</td><td>30*</td></tr>
</table>

* Note that this silt is highly prone to disturbance if not dewatered in advance. Limit construction traffic, vibrations on the prepared silt surface or dilation and loss of bearing resistance will result.

Footings should be founded at a minimum depth of 1.6 m of earth cover below the lowest surrounding grade to provide adequate protection against frost penetration, as per OPSD 3090.101.

6.3.2. SITE WORK AND SUBGRADE PREPARATION

The effects of site work can have a profound impact on soil integrity unless care is taken to prevent and reduce this kind of damage. The subgrade soils can be protected from disturbance by constructing an adequate well-graded granular working surface or a sufficiently thick mud slab. Subgrade preparation works cannot be adequately accomplished during wet weather and the project schedule must account for these unpredictable events. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the founding subgrade must be provided and it may also be necessary to hoard/heat to prevent freezing. Construction of granular bases may be required for certain construction equipment to operate safely. A crane platform assessment as dictated by the OHSA would be required in such eventuality, customized to the specific equipment and loadings contemplated.

Any organic and deleterious materials, softened / loosened soils should be sub-excavated prior to construction of any foundation and the exposed subgrade should be proof-rolled with a heavy static roller. Do not use vibratory action directly on the prepared silt foundation material beneath the treatment plant footprint since this could disturb the soil and destroy the bearing resistance. Remedial work (i.e., sub excavation and replacement) should be carried out on any disturbed, softened / loosened, organic or deleterious zones as directed by qualified geotechnical personnel. The areas should then be brought to within about 150 mm of the underside of the proposed slab, if required, using OPSS.MUNI 1010 Granular A material, placed in maximum 200 mm (loose thickness) lifts and uniformly compacted to 98% of Standard Proctor Maximum Dry Density (SPMDD) at a placement water content within 2% of the materials optimum. The final lift directly beneath the base should consist of a minimum of 150 mm of OPSS.MUNI 1010 Granular A material, uniformly compacted to at least 100% SPMDD.

The founding elevations of the generator pads (Elev. 265.0 m at Nobleton Well 2, and Elev. 258.1 m at Nobleton Well 5) are sufficiently above the groundwater table. Hence, active dewatering is not anticipated to be required for the construction of generator pads. However, the subgrade materials at the founding levels are susceptible to disturbance during construction activities, especially during wet weather, and care should be taken to preserve the integrity of the materials at the excavation/founding subgrade.

Subgrade soils at the anticipated founding elevation of the proposed treatment plant underground level (tank base slab) at Nobleton Well 5 consist of silt and thus are very susceptible to dilation and disturbance upon relief of overburden pressure or in the presence of water. For these reasons, it is vital that the groundwater table be depressed in advance of excavation such that the piezometric level is drawn down to 1.0m below the intended excavation level until such time as the tank (underground level) is backfilled.

As previously mentioned, the raft foundation base must be inspected by the geotechnical engineer prior to placing reinforcing steel or concrete to ensure placement on suitably competent, undisturbed subgrade soils. A 100 mm thick mud slab should be placed immediately after inspection and cleaning of the excavated base, in order to avoid disturbance of the founding soil due to construction activities.

6.4. NOBLETON WELL 5 – TREATMENT PLANT BUILDING DESIGN CONSIDERATIONS

6.4.1. DRAINAGE

To assist in maintaining dry conditions below grade and to prevent seepage, it is recommended that exterior grades around the new treatment plant building be sloped away from building walls at a 2% gradient or more, for a distance of at least 1.2 m.

6.4.1.1 *Permanent Waterproofing of Underground Tanks (Building's Underground Level)*

The treatment plant underground level (proposed tanks) should be designed as a watertight structure, designed for hydrostatic pressure in general accordance with the concepts illustrated in Drawing No. 5. The waterproofing design shall also take into consideration tie-back heads (if present) and other projections into the wall plane that have the potential for creating drainage pathways into the structure.

6.4.1.2 *Underfloor* Drainage

Based on the design drawings, the floor slab of the proposed above ground structure directly adjoining the existing pump house building will be founded on undisturbed native soils above the ground water table. Perimeter and subfloor drainage are required to collect and remove any water that infiltrates into and around the building perimeter and under the floor.

A capillary break consisting of at least 200 mm of 19 mm clear crushed stone should be installed under the floor slab. Given the cohesionless nature of the subgrade, a nonwoven geotextile separator such as Terrafix 270R or equivalent should be placed on the subgrade before placing clear stone to mitigate the flow of fines from the subgrade into the crushed stone layer.

6.4.2. LATERAL EARTH PRESSURES ACTING AGAINST PERMANENT STRUCTURES

The lateral earth pressure coefficient will be a function of the stiffness / deflection of the treatment plant underground level (tank) wall. Earth pressures acting on structures are generally calculated using the following expression:

$$\sigma_z = [d\,\gamma + \gamma'(z-d) + q] \times K$$

Where:

σ_z= lateral earth pressure acting depth z, kPa
K = earth pressure coefficient: K = K_o = 0.5 for rigid tank walls;
γ = unit weight of retained soil/backfill, kN/m^3
γ'= effective unit weight if retained soil/backfill, kN/m^3
d = depth to water table below ground surface, m [Refer to Section 6.1]
z = depth to point of interest in soil, m
q = equivalent value of surcharge on the ground surface, kPa

Earth pressure coefficients are dependent on the material used as backfill and typical values are provided in Table 6-2, below.

Table 6-2: Lateral Earth Pressure Coefficient (K)

WALL CONDITION	BACKFILL MATERIAL	
	OPSS Granular A or OPSS Granular B Type II ϕ = 35°; γ = 22.8 kN/m^3	OPSS Granular B Type I ϕ = 32°; γ = 21.2 kN/m^3
At rest (Restrained Wall)	0.43	0.47
Passive (Movement Towards Soil Mass)	3.70	3.30

The lateral earth pressure coefficients provided in the table above are "ultimate" values that require certain movements of the wall for the respective conditions to be mobilized.

6.4.3. SHORING DESIGN

The proposed treatment plant building directly adjoins the existing pump house building to the east. The east and south walls of the excavation must be constructed as a rigid shoring system to preserve the integrity and support the soil beneath existing foundations of the adjacent building. Excavations above the water table can potentially be supported using conventional soldier pile and lagging walls on the north and west sides of the excavation. However, it is recommended that all walls be constructed as a rigid shoring system in a state approximating the at-rest condition, while at the same time preventing ground water flow through the shoring walls. This is to be achieved using continuous interlocking caisson wall (secant pile walls) on all sides of the excavation.

Special care in design and construction will be needed to orient tie back anchorages (if utilized) so as to avoid existing Water Well No. 6. along the west side of the excavation. Existing well casings/screens must also be protected from inadvertent entry of grout from tieback anchor pressurization.

6.4.3.1 Secant Pile Walls

A secant pile wall (or caisson wall) is constructed by drilling holes of approximately 0.9m to 1.2 m in diameter to the full depth of the wall, inserting steel reinforcement in the form of steel beams or reinforcing bars, and filling the holes with concrete. The secant pile wall is formed by having each pile overlap the adjacent pile. A permanent secant pile wall often has a permanent cast-in-place concrete facing attached to the front surface to fill any gaps between the piles and provide a smooth or architecturally appropriate surface finish.

The main advantages of a secant pile wall are increased wall stiffness compared to the more flexible soldier pile and lagging and, control of loss of ground and ground water seepage reduction because of the interlocking pile arrangement. The main drawbacks are maintaining good vertical pile alignment, they are relatively expensive to construct and, waterproofing may be difficult to achieve at the interlocking joints. Also, where submerged cohesionless soils are encountered temporary liners will be required during installation to maintain caisson sidewall support.

Secant pile walls will typically undergo a maximum horizontal and vertical displacement of about 0.1 percent of the total excavation depth provided that good design and construction procedures and good workmanship are adopted.

6.4.3.2 Passive Toe Restraint

The maximum factored passive resistance P_p that may be mobilized at any depth in front of the embedded depth of a secant pile wall may be calculated from the following equations.

Cohesionless Deposits:

Above the water table $P_p = \Phi \{K_p' \boldsymbol{\gamma} Z\}$
Below the water table $P_p = \Phi K_p' \{(\boldsymbol{\gamma} D_w + (\boldsymbol{\gamma}-\boldsymbol{\gamma}_w) (Z - D_w))\}$

Where:

P_p = factored resistance at any depth below excavation base, kN/m
Φ = a resistance factor of 0.6 for Limit State Design and 0.5 for Working Stress Design
$\boldsymbol{\gamma}$ = soil unit weight, kN/m^3
$\boldsymbol{\gamma}_w$ = unit weight of Water, 9.8 kN/m^3
D_w = depth of ground water table below excavation base, m
Z = depth below the excavation base in front of the wall, m
K_p' = passive earth pressure coefficient which takes into account friction on the embedded portion of the wall.

When dewatering is required to maintain the ground water level below the excavation base, assume that D_w is equal to zero.

Cohesive Deposits:

$$P_p = \Phi \{\gamma Z + 2 S_u\}$$

Where:

P_p = factored resistance at any depth below excavation base, kN/m
Φ = a resistance factor of 0.6 for Limit State Design and 0.5 for Working Stress Design
γ = soil unit weight, kN/m^3
Z = depth below the excavation base in front of the wall, m
S_u = undrained shear strength, kPa

6.4.3.3 Horizontal Restraint for Temporary Protection Systems – Tie Backs/Ground Anchors

Tie-backs, also called ground anchors, are constructed by drilling holes into the ground behind the wall as the excavation proceeds downward. After the hole is drilled, steel rods or high-strength steel strand are inserted into the hole and an "anchor zone" is then created by filling the annular space around the steel rods or strands with cement grout that is often injected under pressure. Behind the wall the anchor zone is typically located beyond the "active" earth zone i.e., the mass of earth that deforms and places load on the wall. After the grout is cured, the anchor is pre-stressed to its design load, structurally connected to the wall, and the remaining annular space between the anchor zone and the wall face, called the "free" length," is debonded.

Depending on the excavation depth, the bond length of ground anchors may be formed within the very dense sandy silt to silt, very dense silty sand till to sandy silt till and the hard silty clay to clayey silt. Typical ground anchor bond lengths range from 8 m to 10 m and nominal drill hole diameters range between 100 mm and 300 mm. The recommended tentative allowable soil to grout bond stresses to be used for post-grouted anchors subject to tensile loads are:

- Very dense sandy silt to silt / Very dense silty sand till to sandy silt till – 100 kPa; and
- Hard silty clay to clayey silt – 60 kPa.

When calculating anchor capacity, we recommend neglecting the 5 m of anchor extending beyond the face of the shoring system. This is typically an un-bonded anchor length that does not contribute significantly to force resistance. The allowable axial geotechnical capacity (P) of a single anchor can be calculated by the following expression:

$$P = \tau A_s L$$

Where:

τ = allowable soil to grout bond stress, kPa
A_s = surface area per metre of bond length, m^2/m
L = bond length, m

During construction anchors shall be performance and proof tested to confirm carrying capacities, in accordance with the requirements of the Post Tensioning institute and the Canadian Foundation Engineering Manual, 4th Edition. Any permanent anchors should be double corrosion protected.

Special care in design and construction will be needed to orient tie back anchorages (if utilized) so as to avoid existing Water Well No. 6. along the west side of the excavation. Existing well casings/screens must also be protected from inadvertent entry of grout from tieback anchor pressurization.

6.4.3.4 Earth Pressures Acting on Temporary Shoring

For the preliminary design of the temporary support system the geotechnical parameters provided in Table 6-3:, below, may be considered. The geo-structural designer/engineer should select the appropriate parameters to design a shoring system with the appropriate stiffness required to limit wall deflection such that there are no detrimental impacts to structures. The values provided below are guideline values and selection of the appropriate design parameters is the responsibility of the shoring designer.

Table 6-3: Soil Parameters for Temporary Support of Excavation Design

STRATIGRAPHIC UNIT	BULK UNIT WEIGHT[1] γ (kN/m^3)	FRICTION ANGLE ϕ' (degrees)	SHEAR STRENGTH[2] S_U (kPa)	COEFFICIENT OF LATERAL EARTH PRESSURE		
				AT REST K_o	ACTIVE K_a	PASSIVE K_p
Fill	19	28	-	0.53	0.36	2.77
Silt / Sand & Silt / Sandy Silt	20	30	-	0.50	0.33	3.00
Silty Sand Till to Sandy Silt Till	21	32	-	0.47	0.31	3.25
Silty Clay to Clayey Silt	20	28	150	0.53	0.36	2.77

Note: 1. Below the groundwater table, $\gamma_{submerged} = \gamma_{bulk} - \gamma_{water}$ should be used
2. Undrained shear strength is not to be used in combination with drained friction angle.

The lateral earth pressure coefficients provided above are calculated based on the assumption that the ground surface behind the temporary excavation support system is horizontal. Where the retained ground is sloping, the lateral earth pressure coefficients must be adjusted to account for the slope. Loads from adjacent structures and construction equipment as well as any material stockpiles located within a distance defined by a 1H:1V line drawn upward and outward from the bottom of the excavation to the existing ground surface shall be included as a surcharge.

The geotechnical engineering parameters provided in Table 6-3, are for the design of temporary ground support systems with respect to the ultimate conditions and may not account for control of ground displacements to desirable values. If control of ground displacements is critical it may be necessary to use values that result in higher design loads or, carry out an iterative evaluation of assumed ground and ground water pressures and structural displacements to design an appropriately stiff ground support system.

6.4.3.5 Global Stability of Temporary Shoring

For the preliminary design of the temporary support system for an excavation extending to elevation 254.0 m and vertically supported around the perimeter with a rectangular caisson wall. A minimum caisson wall tip elevation of 251.0 m is recommended. Further assessments will be required by the shoring designer to assess the stability of these excavations for the selected construction equipment that will be used in close proximity to the perimeter of excavations and to further verify the required minimum caisson wall tip elevation.

6.4.4. GROUNDWATER CONTROL

Surface water and groundwater control will be necessary to enable construction below the groundwater table. Where cohesionless deposits are encountered below the groundwater table, flowing soil conditions (with associated ground loss, base instability and surface settlement) will occur unless suitable groundwater control and active dewatering measures are implemented. The level of groundwater control will be dependent on the depth and size of excavation as such, further assessments related to dewatering requirements will need to be carried out during the detailed design stage.

While design, installation, operation, and maintenance of the dewatering system is the Contractor's responsibility, provided herein are general approaches to control the groundwater into excavations during construction.

Excavations into and through the cohesionless water bearing deposits will require active dewatering measures such as closely spaced vacuum well point systems to depress the piezometric level at least 1.0m below the excavation base. Depending on the base depth of the excavation, it may be necessary to use closely spaced eductors instead of well points. Groundwater seepage can also be controlled with cut-off walls designed with sufficient embedment depth to limit the influence of groundwater on construction as well as the effects of groundwater lowering on existing structures and settlement sensitive utilities, if present. Cut-off walls should also be designed with sufficient embedment depth below the excavation base to satisfy stability requirements and to mitigate the risk of basal instability/boiling.

To verify the functionality of the dewatering system, groundwater monitoring wells/piezometers will be required to monitor the groundwater level before, during and after construction. The excavation shall not be extended below groundwater level unless the groundwater monitoring data indicates that the piezometric level has been depressed at least 1.0 m below the targeted excavation base.

Around the perimeter of the excavation an interceptor trench should be installed to prevent water from storm events from entering the excavation. The dewatering system must also include appropriate filtration mechanisms to prevent the pumping of fines and loss of ground during the dewatering activities.

It should be noted that, the Ontario Ministry of Environment and Climate Change (MOECC) requires a Permit to Take Water (PTTW) for any combined groundwater and storm water taking in excess of 400 m^3/day. If the groundwater and storm water taking is between 50 m^3/day and 400 m^3/day, then the activity must be registered on the Environmental Activity and Sector Registry (EASR).

6.4.5. BASAL STABILITY

Basal stability of excavations should be reviewed and checked by the Contractor's licensed Professional Engineer. Excavations should also be designed such that the base is stable at each successive stage during excavation.

The type of base failure condition depends on the subsurface conditions beneath the excavation bottom and this type of failure can occur if one or all of the following conditions are encountered:

- Cohesionless soils below the ground water table at or near the excavation base resulting in piping failure;
- Relatively impermeable deposits at the excavation base that are underlain by water-bearing permeable deposits with a sufficiently high hydrostatic head resulting in basal uplift; and
- Weak cohesive soils below the excavation base resulting in base heave due to the stress imposed by the vertical height of the retained overburden.

The subsurface conditions encountered at Nobleton Well 5 site indicate that the excavations would be susceptible to piping failure. Therefore, groundwater conditions must be controlled prior to excavation in order to prevent basal instability (i.e., the piezometric levels must be lowered to at least 1.0m below the excavation base level).

6.4.6. UPLIFT PRESSURES

The ground water will impart hydrostatic pressure and uplift forces on the treatment plant underground level (tank) base slab. Resistance against uplift must be maintained at all stages during construction as well as after construction.

The uplift pressure that acts on the base slab of the tank can be calculated as the product of the vertical depth of the base slab below the design ground water table and the unit weight of water. It is generally recommended that resistance to uplift be provided by the combination of static gravity loads of the structure and the structural bending capacity of the base slab.

The treatment plant underground level (tank) base slab must also be designed to transfer loads due to uplift pressures to the tank walls. A static ground water elevation of 255.5± m i.e., approximately 1m higher than the highest ground water level recorded at the site should be used for uplift design and a unit weight of 9.81 kN/m^3 should be assumed for groundwater to derive submerged unit weights. The dead loads imposed by the treatment plant building structure can be considered in the design as a force resisting uplift pressure.

6.4.7. PROTECTION OF EXISTING STRUCTURES

Subsurface deformations will have to be controlled such that the structural integrity of the existing pump house building is not compromised. No excavation shall extend below a plane extending one vertical to one horizontal from foundations of existing adjacent structures without adequate alternative support being provided in advance of the excavation.

The zone of influence of the works should be evaluated and, pre and post construction surveys should be carried out for all structures that are located within the zone of influence. An integral part of any support of excavation system is the accompanying instrumentation and monitoring network that needs to be installed, baselined and read on a frequent basis as construction progresses. An instrumentation and monitoring programme including vibration, structure, and ground displacement (horizontal and vertical) monitoring should also be installed, baselined and read on a sufficiently adequate and frequent basis as construction progresses to ensure that the structural integrity of the existing pump house structure is not compromised.

6.5. NOBLETON WELL 5 – WATERMAIN & SANITARY SEWER INSTALLATIONS

It is anticipated that the proposed new watermains and sanitary sewers at Nobleton Well 5 will be installed in supported open cut excavations. Based on the expected excavation depths of about 3.0 m to 3.5 m for the open cut installations, trenches will primarily be through pavement structure, fill material of variable texture, and into the underlying native deposits of sand and silt to silt, and silty clay to clayey silt.

The anticipated subsurface conditions at the trench bottom are expected to provide adequate pipe support for a conventional OPSS Class 'B' bedding detail. Any fill or soft to firm/loose soils should be removed and replaced with compacted OPSS Granular "A" material under supervision of qualified geotechnical personnel. Length of the trench should be kept as short as practical at all times during construction.

Anomalous trenching conditions with greater potential for wall collapse will occur in instances where the new utility trench encroaches on existing utility trenches or existing structure backfill (such as culverts, etc.). Perched water is also to be encountered in such cases where existing trench backfill, structure backfill, and bedding are intercepted by the new trench.

6.5.1. EXCAVATIONS, TRENCH STABILITY AND DEWATERING

Although not anticipated at this site, if conditions are encountered where the servicing trenches extend into cohesionless deposits below groundwater, active dewatering will be required to control the groundwater flow into the excavations.

Where excavations are made through cohesive silty clay to clayey silt material, it is expected that much of the water seepage should be controllable by use of conventional pumping from filtered collection sumps for trenches. However, contractors should provide provisional bid pricing to employ more elaborate, advanced dewatering procedures such as well points if the flow from fill material or any native cohesionless deposit that may be encountered is not controlled by conventional methods. The groundwater table must be lowered to at least 0.5m below the deepest excavation base.

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

- Fill Soils – Type 4 Soils.
- Silt / Sand and Silt – Type 2 Soils above groundwater table and Type 4 Soils below groundwater table.
- Silty Clay to Clayey Silt– Type 3 Soils.

The foregoing OHSA Soil Types are intended for preliminary planning purposes only. During construction, the Contractor's nominated *Competent Person*, as defined under the OHSA, must re-classify the *Soil Types*, and determine the appropriate trench support or side slopes based on visual observations of the trench wall behaviour and groundwater ingress.

The side slopes of temporary excavations may be formed no steeper than 1H:1V for Type 2 and Type 3 Soils and no steeper than 3H:1V for Type 4 Soils. Below the groundwater table, unsupported excavations in Type 4 Soils cannot safely proceed until the groundwater table is lowered to a minimum depth of 0.5 m below the base of the excavation.

If an excavation contains more than one Type of Soil, the Soil should be classified as the Type with the highest number. Excavations should also be carried out in accordance with OPSS.MUNI 401 and OPSS.MUNI 402.

6.5.2. USE OF TRENCH BOX FOR TRENCH WALL SUPPORT

Where permissible under the OSHA, contractors often elect to utilize trench boxes for temporary trench support. While in many situations, the use of trench boxes can result in a high rate of productivity in trenching, it is not without some technical drawbacks. These include:

- Increased loss of ground relative to many other shoring methods; and
- Reduced ability to compact backfill between the trench wall and trench box.

Ground loss, raveling and/or loosening of soils will occur when using a trench box prior to its installation and while moving the box, particularly in pre-existing fill including the granular courses below existing pavements.

It is important that the trench not be over-excavated to ensure a tight fit between the box and the trench walls. Trench boxes need to be installed expediently. When moving the box, the void space between its outer walls and the trench must be backfilled and compacted. This may require raising the box sequentially prior to sliding it laterally. If this is not done, post-construction settlements will occur along the trench walls.

Where trench depths exceed 6.0 m and in Type 4 Soils of any trench depth, *Engineered Support Systems* are required as defined under the OHSA. This scenario is not expected on this project based on our understanding of the designs.

6.5.3. PIPE BEDDING

Pipe bedding should conform to the requirements of OPSD 802.030, OPSD 802.031, OPSD 802.032 (for rigid pipes), and OPSD 802.010 (for flexible pipes), as appropriate. Pipe bedding should also conform to the requirements specified in the Township of King and York Region’s Design Criteria and specifications for construction of watermains and sanitary sewers, including Township of King’s Drawing No. KS-180 and Drawing No. KS-801.

The subsurface conditions at this site are considered suitable to provide adequate pipe support and therefore Class “B” bedding will suffice. Additional embedment requirements that may be imposed by the pipe supplier or the York Region/Township of King must also be followed.

The subgrade condition must be inspected and approved by qualified geotechnical personnel prior to placing bedding. Prior to placing the bedding material, any accumulation of water at the base of the excavation should be removed and any firm to soft/loose soils should be subexcavated and replaced with compacted OPSS Granular “A” material. Placement of the pipe bedding must be carried out in the dry.

Granular “A” material conforming to OPSS.MUNI 1010 or 20 mm Crusher Run Limestone (CRL) material should be used as embedment material, as stipulated in the Township of King’s Design Criteria and Drawing No. KS-801. Alternate granular materials for pipe bedding may be specified, subject to the approval of the Township. The minimum bedding thickness should be 150 mm, but this should be increased as dictated by the pipe diameter and/or aforementioned specifications.

The embedment material should be placed in 150 mm thick loose lifts and uniformly compacted to 98% of the material’s Standard Proctor Maximum Dry Density (SPMDD) using suitable vibratory compaction equipment. Care should be exercised when compacting the cover material on top of the pipe as well as beside them to avoid damaging them. The use of light, hand operated compaction equipment is recommended in these areas.

6.5.4. TRENCH BACKFILL

The majority of the fill and native soils are deemed to be suitable for reuse as trench backfill provided that they are free of topsoil, organic material, frozen lumps and boulders or other deleterious material and provided that these soils are approved for use by qualified geotechnical personnel. Below the driveway and parking lots, use of OPSS 1010 Granular “A” material is recommended to minimize the post construction settlement. Trench backfill material should be placed in maximum 150 mm loose lifts and should be uniformly compacted in accordance with OPSS.MUNI 501. Trench backfill must be compacted to at least 95% of material’s SPMDD within the boulevard area and to 98% of the material’s SPMDD under the driveway and parking lots.

To achieve the specified compaction, soils must neither be too wet nor too dry of their optimum moisture content. Soils that are too wet cannot be used immediately because the material will have to be dried to about ± 2 % of the optimum moisture content. If the construction operations are time sensitive, the use of imported granular material should be considered. Soils that are dry of optimum can be used immediately provided that the material is moisture conditioned (i.e., water added) to achieve a moisture content of ±2% of optimum.

Since backfilling will be carried out in the narrow confines of trenches, achieving adequate compaction may be difficult given the space constraints. Also, the glacial till deposits (if encountered) will excavate in relatively large pieces that will require some form of pulverization before placing in the trenches. Therefore, it is recommended that the placing and compacting of backfill materials be done under close supervision of qualified geotechnical personnel.

6.5.5. TRENCHING ADJACENT TO EXISTING SERVICES

In areas where the new trenches impinge on existing utility trenches, structures, or passes through existing fill soils, unstable trench conditions can occur, particularly where granular backfill, clear stone, high performance backfill, or poorly compacted fill of any type are present. In such cases, raveling of the pre-existing fill and high rates of water infiltration through utility bedding can potentially occur which can, in severe cases, put the stability of the adjacent utility in jeopardy. As such, a higher standard of care in shoring is needed where the proposed utility trench is located closer than 0.75 H to an adjacent trench, where ‘H’ is the depth of the deeper cut. The use of trenching boxes is poorly suited in this instance, since they do not provide adequate intimate lateral support to the sides of the cut and considerable loss of ground or relaxation of the soil can occur prior to insertion of the box. Closed sheeting or other pre-installed shoring measures are more suitable.

6.5.6. FROST PROTECTION

As stipulated by the Township of King's Design Criteria and Standard Detail Drawings, the minimum depth of cover for watermains is 1.8 m. Where this requirement can not be met insulation should be provided in accordance with the Township of King's Drawing No. KS-804. The minimum depth of cover for sanitary sewers in residential, commercial and institutional areas is 2.75 m, and 2.15 m within industrial areas.

6.5.7. THRUST BLOCK BEARING RESISTANCE

An allowable (or SLS) bearing resistance of 75 kPa and factored bearing resistance of 115 kPa can be used in the design of thrust blocks constructed against native soils or against engineered fill. Where loose fill is encountered, the thrust blocks must be bear against a minimum of 1.0 m thick engineered fill. This will require re-excavation of existing fill and replacement with engineered fill placed in layers and compacted to 100% SPMDD.

6.5.8. TRENCH CLAY PLUGS AND CUT-OFF COLLARS

Where the invert of the trench is below the water table, clay plugs or cut-off collars are usually installed to minimize the extent of groundwater lowering due to the "French Drain" effect of the granular bedding and backfill material. This scenario is not expected on this project based on our understanding of the design.

6.6. PAVEMENT STRUCTURE FOR PARKING AND DRIVEWAYS

Pavement Structures for vehicular parking lots and internal access roads that will be subjected to medium duty traffic are provided in Table 6-4, below.

Table 6-4: Recommended Flexible Pavement Structure Thicknesses for Parking and Internal Roads

PAVEMENT STRUCTURE	LIGHT DUTY CAR PARKING (mm)	MEDIUM DUTY INTERNAL ROADS (mm)
HMA Surface Course HL3	40 mm	40 mm
HMA Binder Course HL8	50 mm	75 mm
Base Course - OPSS Granular A or 20mm CRL	150 mm	150 mm
Subbase Course - OPSS Granular B or 50mm CRL	300 mm*	400 mm*
Total Pavement Thickness	540mm	665 mm

* Adjust granular subbase thickness on the basis of proofrolling and the existing fill stiffness at the time of construction under the guidance of the Geotechnical Engineer.

6.7. DEWATERING INDUCED SETTLEMENTS

During the facility upgrades, several excavations are planned which will extend below the groundwater table. These excavations will require dewatering which will result in an increase in the effective stress within the underlying soils. This is expected to induce settlements within the vicinity of the dewatering zone.

The Hydrogeological Impact Assessment (HIA) Report prepared by EnVision, dated October 11, 2024, provides an estimate for the excavation depths, target groundwater elevation, anticipated drawdown on the basis of monitoring well data, and the radius of Zone of Influence (ZOI). These estimates have been utilized in estimating the dewatering-induced settlements provided herein for the existing structures/utilities within the vicinity of the proposed excavations. For more information regarding dewatering impact assessment, please refer to the HIA Report.

The settlement parameters for the encountered soils were estimated based on index properties and published relationships/parameters presented in Federal Highway Administration (FHWA) publications NHI-06-088 and NHI-132033, and are summarized in Table 6-5 below.

Table 6-5: Summary of Soil Compressibility Parameters Utilized in the Analysis

SITE	SOIL LAYER	e_0	C_c	C_r	C_v (m^2/yr)	OCR	E (MPa)	ν
Nobleton 2	Silty Clay Fill	0.6	0.12	0.02	16	6	Only consolidation settlements	
	Silty Clay Till	0.4	0.08	0.02	25	5		
Nobleton 5	Silty Clay Fill	No impact (above groundwater)						
	Silt	Immediate settlement only					30	0.3

RocScience software Settle3 has been utilized in combination with in-house spreadsheets to estimate the dewatering induced settlements. Please note that the settlement estimates provided herein are strictly from dewatering induced settlements and does not include construction impacts from support of excavations, trench movements, equipment tracking etc.

6.7.1. SETTLEMENT ESTIMATES

Table 6-6 below summarizes the estimated drawdown at the location of various structures and utilities that currently exist within the ZOI of the proposed excavations at the Site. The drawdown within the ZOI is conservatively assumed to vary linearly between the zone of excavation/dewatering and the limits of the ZOI.

Table 6-6: Summary of Dewatering Induced Settlement – Nobleton 2

EXCAVATION	TOTAL ESTIMATED DRAWDOWN (m)	RADIUS OF INFLUENCE (m)	ESTIMATED SETTLEMENT ADJ TO EXCAVATION (mm)	ADJACENT STRUCTURE	ESTIMATED SETTLEMENT AT THE STRUCTURE (mm)
Chlorine Tank	5.4	34	16	Existing Gas (Faris Ave) Existing Watermain (Faris Ave) Existing Bldg (16 Faris Ave) Existing Sanitary (Faris Ave)	15 12 11 10
200mm WM Removal	0.5 – 2.0	15	7	Nobleton Well 2	7
150mm SAN and Storm Removal	1.9	15	7	Nobleton Well 2 Existing Bldg (16 Faris Ave)	7 5
Valve Chamber	2.8	32	9	Existing Gas (Faris Ave) Existing Watermain (Faris Ave) Existing Bldg (16 Faris Ave) Existing Sanitary (Faris Ave)	8 6 6 5
250mm WM	1.0 – 1.4	19	5	Nobleton Well 2 Existing Gas (Faris Ave)	5 5
150mm SAN and MH	0.6 – 4.2	30	13	Nobleton Well 2	12

Notes:

1. Only dewatering induced settlement estimates are provided. Other construction impacts from support of excavations, trench movements, equipment tracking etc. are not included.
2. Settlement estimates are for the soil surrounding the existing structures and soil structure interactions effects are not considered.
3. Settlement values provided are estimates based on the available data, dewatering duration of about 4 weeks, and will be subject to change based on the groundwater conditions encountered at the time of the construction works, dewatering systems and duration adopted. Settlement monitoring will be required at all relevant structures to measure the actual settlements.
4. Settlement estimates at the relevant structure/utility identified in the drawings are included.
5. For any structure, if multiple settlement numbers are noted above, the highest value will be utilized.

At the Nobleton 5 location, only excavation for the Water Treatment Plant (WTP) is identified. The structures adjacent to the excavation are estimated to experience a settlement of 6mm.

Due to the competent ground conditions, the settlements expected within the existing structures and utilities are generally expected to be low. In general, the dewatering induced settlements of the existing structures/utilities at both Nobleton 2 and Nobleton 5 are expected to be less than 25mm (1 inch), and generally less than 12.5m (0.5 inch). It is expected that portions of the settlements will be elastic and reduce upon completion of dewatering activities. While the settlements estimated are within generally accepted values, it is recommended that settlement/tilt instrumentation and monitoring be undertaken to mitigate the risk of any potential settlement impacts. Pre-construction condition surveys will also be important in identifying whether existing infrastructure is already compromised or is in good condition.

6.7.2. INSTRUMENTATION & MONITORING

It is recommended that the structures and utilities within the ZOI of the dewatering area be instrumented and monitored. In addition, it is recommended that a pre-construction and post-construction survey be performed at the structures and monitoring of any existing damage, where applicable, be performed in order to limit liability resulting from potential claims. The instrumentation could include target points at the existing structures, ground settlement points, and crack meters. Review and alert thresholds as well as the actions to be taken if these levels are exceeded, are required prior to begin of construction works. EnVision is capable of performing Instrumentation and Monitoring works, should such services be required.

7. GENERAL COMMENTS AND LIMITATIONS OF REPORT

EnVision Consultants Ltd. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, EnVision will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the preliminary guidance of the Region's design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole and test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to EnVision at the time of preparation. Unless otherwise agreed in writing by EnVision Consultants Ltd. it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and preliminary recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The preliminary design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EnVision Consultants Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

7.1. SIGNATURES

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7.2. QUALIFIER

EnVision prepared this report solely for the use of the intended recipient in accordance with the professional services agreement. In the event a contract has not been executed, the parties agree that the EnVision General Terms and Conditions, which were provided prior to the preparation of this report, shall govern their business relationship.

The report is intended to be used in its entirety. No excerpts may be taken to be representative of the findings in the assessment. The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the report are based on the observations and/or information available to EnVision at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by EnVision and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

EnVision disclaims any obligation to update this report if, after the date of this report, any conditions appear to differ significantly from those presented in this report; however, EnVision reserves the right to amend or supplement this report based on additional information, documentation or evidence.

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In preparing this report, EnVision has relied in good faith on information provided by others, as noted in the report. EnVision has reasonably assumed that the information provided is correct and EnVision is not responsible for the accuracy or completeness of such information.

Unless otherwise agreed in writing by EnVision, the Report shall not be used to express or imply warranty as to the suitability of the site for a particular purpose. EnVision disclaims any responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions /or costs.

This limitations statement is considered an integral part of this report.

DRAWINGS

LEGEND

- Monitoring Well Location
- Corehole Location
- Site Boundary

0 4 8 12 16 METERS

TITLE	Borehole and Corehole Location Plan
PROJECT	Geotechnical and Environmental Investigations Nobleton Well 2 Upgrades
CLIENT	ETO Engineering

PROJECT NO.	DATE	PREPARED BY	APPROVED BY	DRAWING NO
23-0358	January 2024	MO	CS	1

LEGEND

Borehole Location

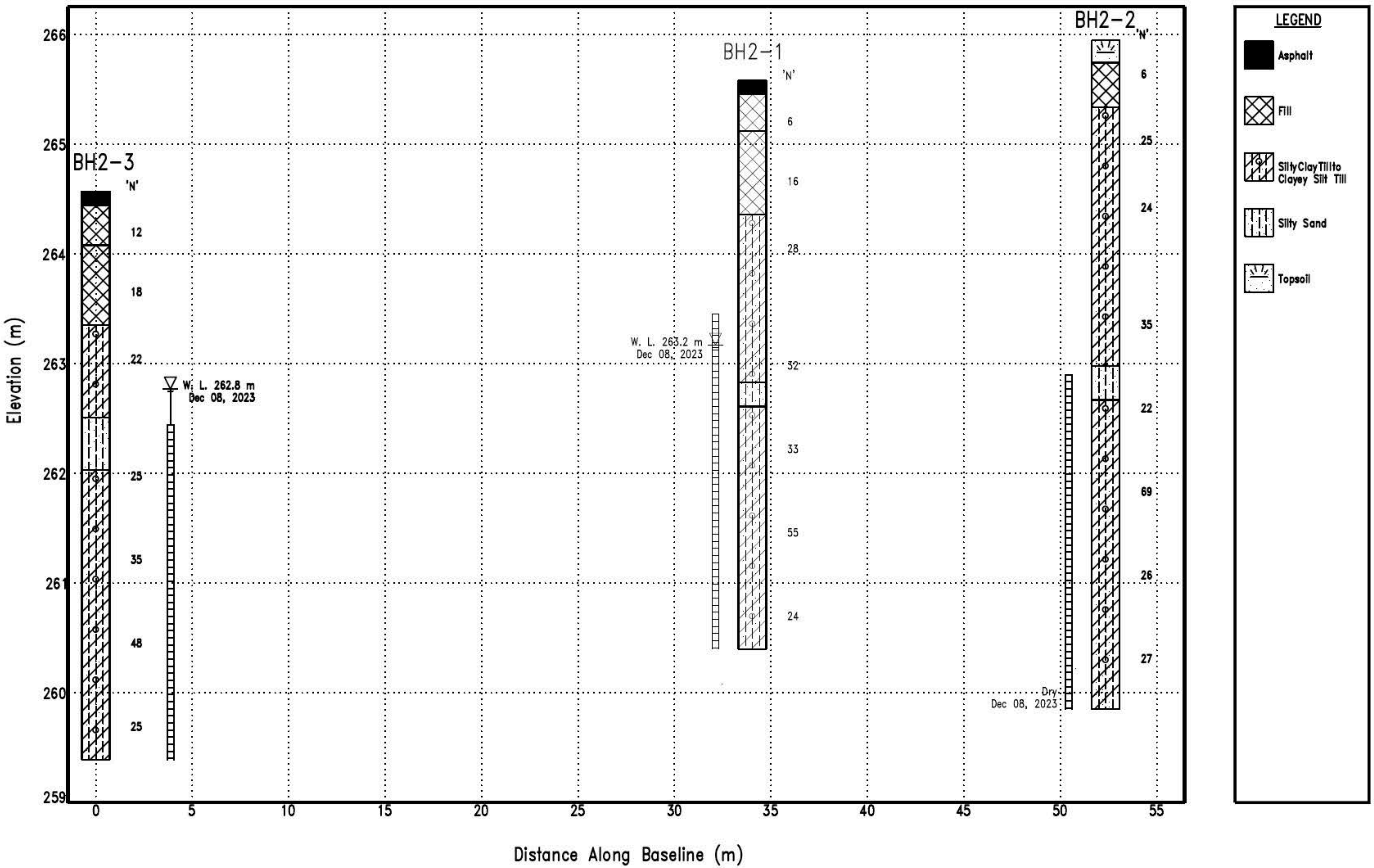
Monitoring Well Location

Site Boundary

0 5 10 15 20 METERS

TITLE	Borehole Location Plan
PROJECT	Geotechnical and Environmental Investigations Nobleton Well 5 Upgrades
CLIENT	ETO Engineering

PROJECT NO.	DATE	PREPARED BY	APPROVED BY	Drawing No.
23-0358	November 2023	MO	DW	2



C:\Users\MyoOo\OneDrive - EnVision Consultants\Documents - EnVision Consultants\02. Projects\06. 2023\23-0358 Nobleton Wells 2 and 5 Upgrades\04. Tech Services\05. Geotechnical\6 Drawings\Site Plan in CAD\Soil Profile.dwg

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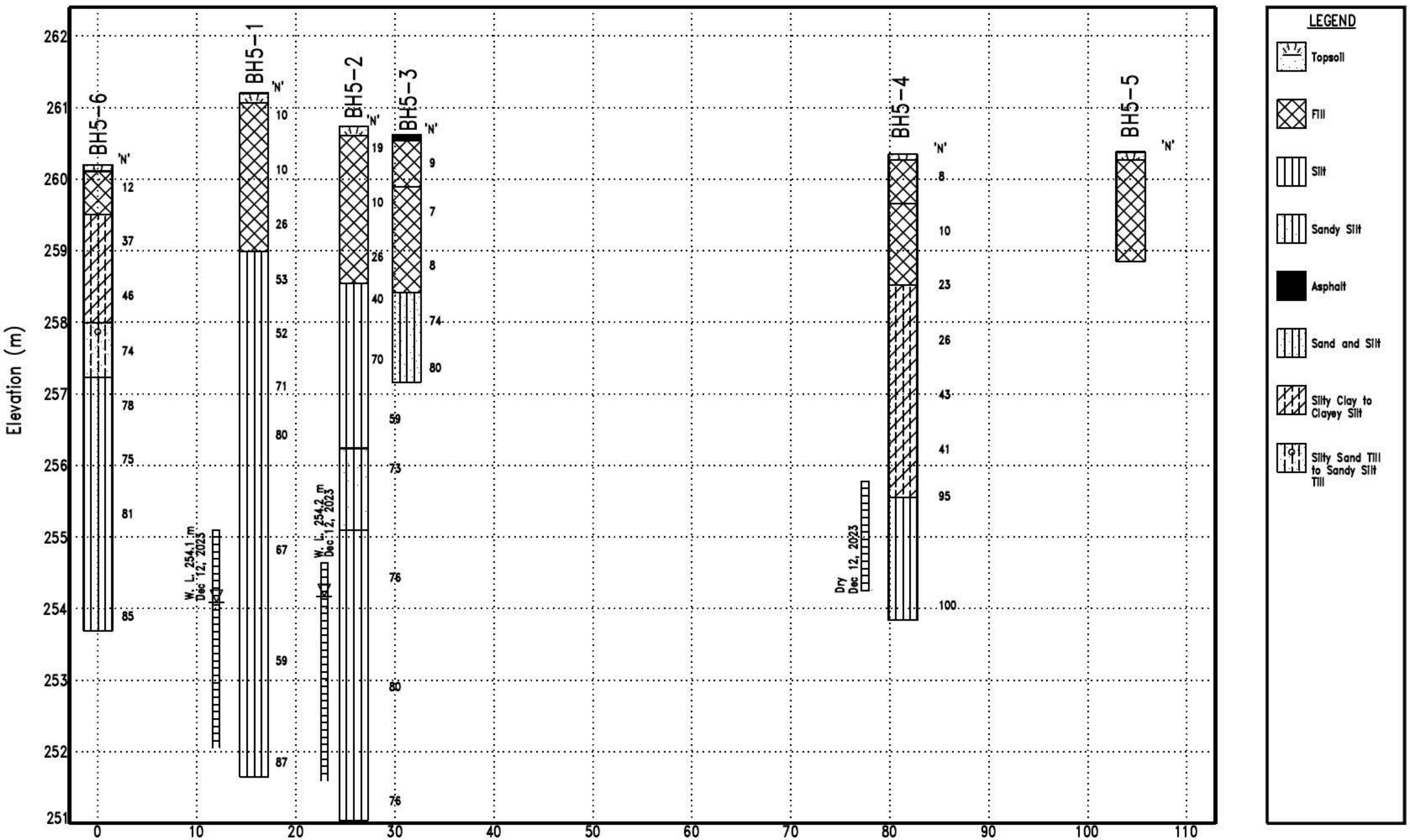
Generalized Subsurface Profile

DRAWING NO.	3
JOB NO.	23-0358
DATE	January 2024



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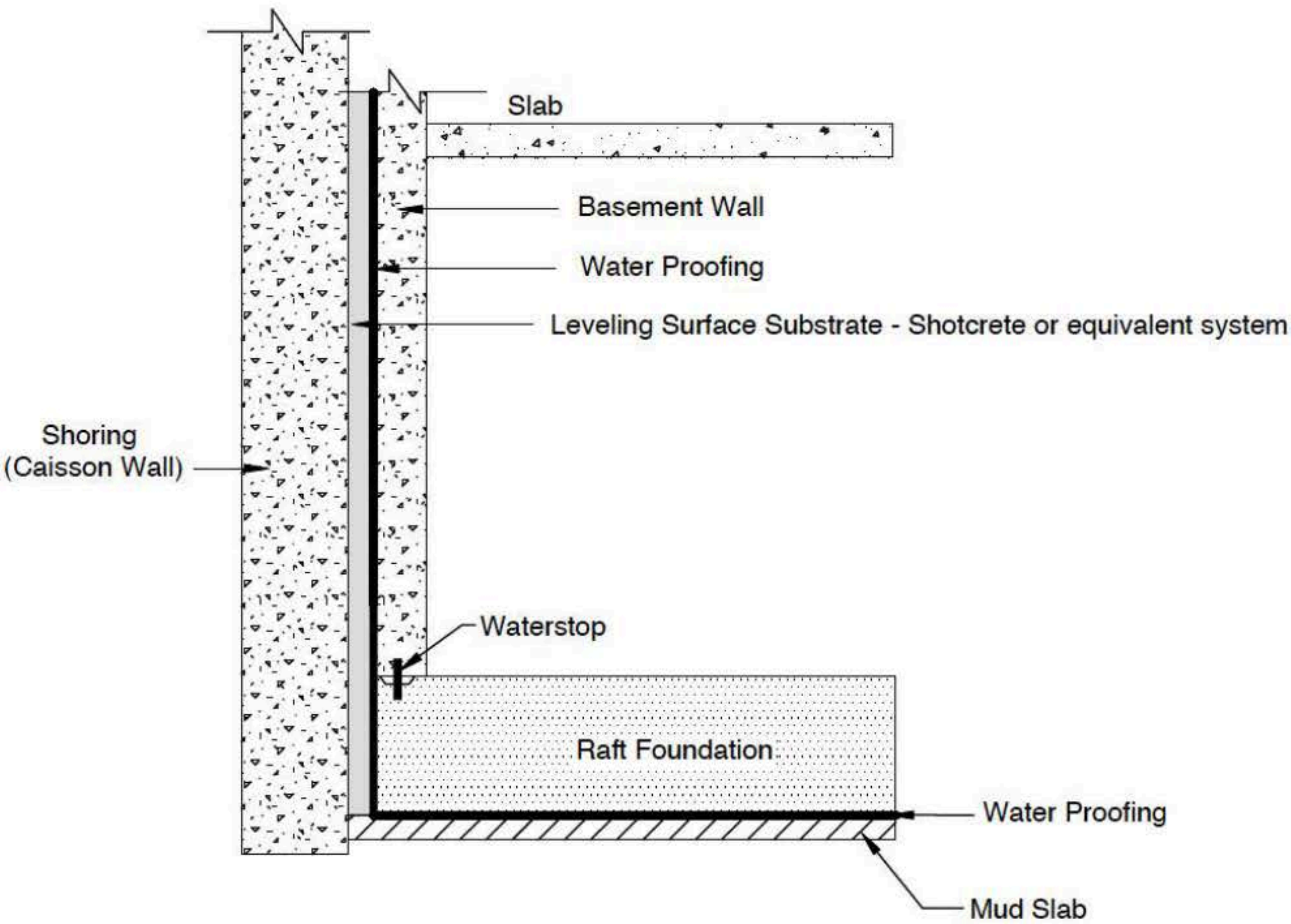
Generalized Subsurface Profile

DRAWING NO.	4
JOB NO.	23-0358
DATE	January 2024

C:\Users\MyoOo\OneDrive - EnVision Consultants\Documents - EnVision Consultants\02. Projects\06. 2023\23-0358 Nobleton Wells 2 and 5 Upgrades\04. Tech Services\05. Geotechnical\6 Drawings\Site Plan in CAD\Soil Profile.dwg



Notes

1. Detailing of the concepts shown on this drawing are to be completed by the Building Science Engineer or Architect.
2. Not for construction.

CONCEPTUAL RAFT SLAB SYSTEM

For Underground Structures Designed as a Watertight Structure

(not to scale)

APPENDIX A:

Log of Borehole Sheets & Asphalt Core Photos

Notes On Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by SPL also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that, with the exception of those samples where a grain size analysis and/or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

0.002 0.006 0.02 0.06 0.2 0.6 2.0 6.0 20 60 200

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

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Explanation of Terms Used in the Record of Borehole

Sample Type

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Dimension type sample
FS	Foil sample
NR	No recovery
RC	Rock core
SC	Soil core
SS	Spoon sample
SH	Shelby tube sample
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

Penetration Resistance

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) required to drive a 50 mm (2 in) drive open sampler for a distance of 300 mm (12 in).

WH – Samples sinks under "weight of hammer"

Dynamic Cone Penetration Resistance, N_d:
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) to drive uncased a 50 mm (2 in) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in).

Textural Classification of Soils (ASTM D2487-10)

Classification	Particle Size
Boulders	> 300 mm
Cobbles	75 mm - 300 mm
Gravel	4.75 mm - 75 mm
Sand	0.075 mm - 4.75 mm
Silt	0.002 mm - 0.075 mm
Clay	<0.002 mm(*)

(*) Canadian Foundation Engineering Manual (4th Edition)

Coarse Grain Soil Description (50% greater than 0.075 mm)

Terminology	Proportion (*)
Trace	0-10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. sand and gravel)	> 35%

(*) Canadian Foundation Engineering Manual (4th Edition)

Soil Description

a) Cohesive Soils(*)

Consistency	Undrained Shear Strength (kPa)	SPT "N" Value
Very soft	<12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very stiff	100-200	15-30
Hard	>200	>30

(*) Hierarchy of Shear Strength prediction

1. Lab triaxial test
2. Field vane shear test
3. Lab. vane shear test
4. SPT "N" value
5. Pocket penetrometer

b) Cohesionless Soils

Density Index (Relative Density)	SPT "N" Value
Very loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Soil Tests

w	Water content
w_p	Plastic limit
w_l	Liquid limit
C	Consolidation (oedometer) test
CID	Consolidated isotropically drained triaxial test
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement
D_R	Relative density (specific gravity, Gs)
DS	Direct shear test
ENV	Environmental/ chemical analysis
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified proctor compaction test
SPC	Standard proctor compaction test
OC	Organic content test
U	Unconsolidated Undrained Triaxial Test
V	Field vane (LV-laboratory vane test)
γ	Unit weight

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LOG OF BOREHOLE BH2-1

PROJECT: Nobleton Well 2 Upgrades	REF. NO.: 23-0358
CLIENT: ETO Engineering	Method: Solid Stem Auger
ENCL NO.:	
PROJECT LOCATION: 22 Faris Avenue, Nobleton	Diameter: 150mm
ORIGINATED BY GR	
DATUM: Geodetic	Date: Dec-06-2023 to Dec-06-2023
COMPILED BY CS	
BH LOCATION: N 4861733.5 E 608018.3	Equipment: Drill Tech M5T Trackmounted Rig
CHECKED BY SD	

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	POCKET PEN. (Cu) (kPa)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.6	Ground Surface						
265.6 / 0.1	**ASPHALT:** 125mm				Flushmount cover		
265.1 / 0.5	355mm **FILL**, sand and gravel, trace to some silt, trace to some clay, brown, moist, loose	1A	SS	6			
		1B					
264.4 / 1.2	**FILL:** silty clay to clayey silt, some sand to sandy, trace gravel, brown, wet, firm to very stiff	2	SS	16	Bentonite		
262.8 / 2.8	**SILTY CLAY TILL TO CLAYEY SILT TILL:** some sand, trace gravel, brown, moist, very stiff to hard	3	SS	28		>250	
					Sand		
		4A	SS	32	W. L. 263.2 m Dec 08, 2023	125	
262.6 / 3.0	**SILTY SAND:** some clay, trace gravel, brown, wet, inferred dense	4B					
260.4 / 5.2	**SILTY CLAY TILL TO CLAYEY SILT TILL:** some sand, trace gravel, grey, moist, very stiff to hard	5	SS	33		>250	
					Screen		
		6	SS	55		>250	1 17 64 18
		7	SS	24		>250	

Soil Head Space Vapors: PID (ppm) 10 20 30 40; CGD (ppm) 10 20 30 40

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30

NATURAL UNIT WT (kN/m^3)

ELEVATION: 265, 264, 263, 262, 261

END OF BOREHOLE:

Notes:

1) Borehole was open and unstabilized water measured at 4.0m below ground surface upon completion of drilling.

2) Borehole was straight augered from 4.6m to 5.2m for a monitoring well installation

3) Monitoring well was installed upon completion of drilling, screened from 2.1m to 5.2m.

Water Level Readings:

Date	W.L. Depth (m)
Dec 08, 2023	2.41

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

ENVISION-SOIL-ROCK-APRIL8-2022.GLB ENVIRO PID(PPM) AND CGD(PPM) 2016-R02 23-0358 NOBLETON 2 JAN 8 2023 GPJ 24-1-8

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LOG OF BOREHOLE BH2-2

PROJECT: Nobleton Well 2 Upgrades
CLIENT: ETO Engineering
PROJECT LOCATION: 22 Faris Avenue, Nobleton
DATUM: Geodetic
BH LOCATION: N 4861751 E 608012.9

Method: Solid Stem Auger
Diameter: 150mm
Date: Dec-06-2023 to Dec-06-2023
Equipment: Drill Tech M5T Trackmounted Rig

REF. NO.: 23-0358
ENCL NO.:
ORIGINATED BY GR
COMPILED BY CS
CHECKED BY SD

SOIL PROFILE

ELEV (m) / DEPTH	DESCRIPTION
266.0	Ground Surface
265.8 / 0.0	**TOPSOIL:** 205mm
0.2	**FILL:** silty clay to clayey silt, some sand to sandy, trace gravel, trace rootlets, brown, moist, firm
265.3 / 0.6	**SILTY CLAY TILL TO CLAYEY SILT TILL:** some sand, trace gravel, brown, moist, very stiff to hard
263.0 / 3.0	**SILTY SAND:** some clay, trace gravel, brown, wet, inferred compact
262.7 / 3.3	**SILTY CLAY TILL TO CLAYEY SILT TILL:** some sand, trace gravel, brown, moist to wet, very stiff to hard; grey
259.9 / 6.1	**END OF BOREHOLE:**

SAMPLES

NUMBER	TYPE	"N" BLOWS/0.3 m	POCKET PEN. (Cu) (kPa)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	6		
2	SS	25		2 13 60 25
3	SS	24	>250	
4	SS	35	>250	
5A	SS	22		
5B			188	
6	SS	69	>250	
7	SS	26	>250	
8	SS	27	>250	

GROUND WATER CONDITIONS: Flushmount cover; Bentonite; Sand; Screen

ELEVATION: 265, 264, 263, 262, 261, 260

Soil Head Space Vapors: PID (ppm) 10 20 30 40; CGD (ppm) 10 20 30 40

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30

NATURAL UNIT WT (kN/m^3)

Notes:
1) Borehole was open and unstabilized water measured at 5.8m below ground surface upon completion of drilling.
2) Borehole was straight augered from 5.3m to 6.1m for a monitoring well installation
3) Monitoring well was installed upon completion of drilling, screened from 3.1m to 6.1m.

Water Level Readings:

Date	W.L. Depth (m)
Dec 08, 2023	Dry

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

ENVISION
CONSULTANTS LTD

LOG OF BOREHOLE BH2-3

PROJECT: Nobleton Well 2 Upgrades
CLIENT: ETO Engineering
PROJECT LOCATION: 22 Faris Avenue, Nobleton
DATUM: Geodetic
BH LOCATION: N 4861701 E 608028.4

Method: Solid Stem Auger
Diameter: 150mm
Date: Dec-06-2023 to Dec-06-2023
Equipment: Drill Tech M5T Trackmounted Rig

REF. NO.: 23-0358
ENCL NO.:
ORIGINATED BY GR
COMPILED BY CS
CHECKED BY SD

(m) ELEV DEPTH	DESCRIPTION (SOIL PROFILE)	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	POCKET PEN. (Cu) (kPa)	GR	SA	SI	CL
264.6	Ground Surface				Flushmount cover					
0.1	**ASPHALT:** 130mm									
	350mm **FILL**, gravelly sand, some silt, trace clay, brown, moist, compact	1A	SS	12			26	52	(22)	
264.1 / 0.5	**FILL:** silty clay to clayey silt, some sand to sandy, trace gravel, brown, wet, stiff to very stiff	1B								
		2	SS	18	Bentonite		4	25	52	19
263.4 / 1.2	**SILTY CLAY TILL TO CLAYEY SILT TILL:** some sand, trace gravel, brown, moist, very stiff	3	SS	22		>250				
262.5 / 2.1	**SILTY SAND:** some clay, trace gravel, brown, wet, inferred compact	4A	SS	25	W. L. 262.8 m Dec 08, 2023					
262.0 / 2.5	**SILTY CLAY TILL TO CLAYEY SILT TILL:** some sand, trace gravel, brown, moist to wet, very stiff to hard	4B				125				
		5	SS	35	Screen	>225				
	grey	6	SS	48		175				
		7	SS	25		225				
259.4 / 5.2	**END OF BOREHOLE:**									

ELEVATION: 264, 263, 262, 261, 260

Soil Head Space Vapors: PID (ppm) 10 20 30 40; CGD (ppm) 10 20 30 40

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30

NATURAL UNIT WT (kN/m^3)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

Notes:
1) Borehole was open and unstabilized water measured at 3.0m below ground surface upon completion of drilling.
2) Borehole was straight augered from 4.6m to 5.2m for a monitoring well installation
3) Monitoring well was installed upon completion of drilling, screened from 2.1m to 5.2m.

Water Level Readings:

Date	W.L. Depth (m)
Dec 08, 2023	1.80

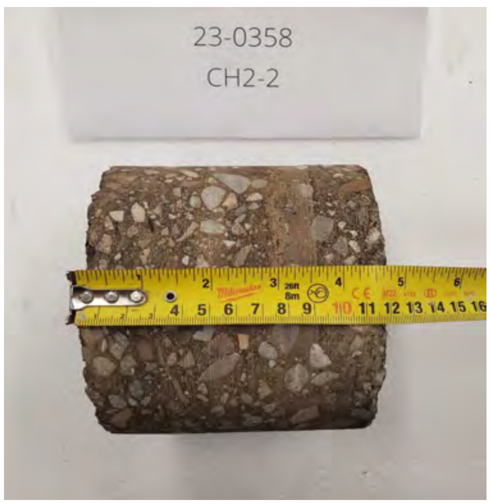
GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

ASPHALT CORE PHOTOGRAPHS AND DATA

22 Faris Avenue
Driveway
CH2-1

Lift No.	Thickness (mm)
1	50
2	55
Total	105



22 Faris Avenue
Driveway
CH2-2

Lift No.	Thickness (mm)
1	45
2	70
Total	115

Project No. : 23-0358
Date : December, 2023

Prepared by : CS
Checked by : SD

ENVISION CONSULTANTS LTD

LOG OF BOREHOLE BH5-1

PROJECT: Nobleton Well 5 Upgrades
CLIENT: ETO Engineering
PROJECT LOCATION: 12860 York Regional Road 27, Nobleton
DATUM: Geodetic
BH LOCATION: N 4861432.5 E 608166.9

Method: Solid Stem Auger
Diameter: 150 mm
Date: Oct-19-2023 to Oct-19-2023
Equipment: Drill Tech M5T Trackmounted Rig

REF. NO.: 23-0358
ENCL NO.:
ORIGINATED BY NL
COMPILED BY CS
CHECKED BY SD

ELEV (m) / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	CGD (ppm)	GR	SA	SI	CL
261.2	Ground Surface									
261.0 / 0.1	**TOPSOIL:** 130 mm									
	FILL: silty clay to clayey silt, some sand to sandy, trace gravel, trace rootlets, trace organics, brown, moist, stiff to very stiff	1	SS	10	Bentonite					
		2	SS	10			4	16	51	29
		3	SS	26						
259.0 / 2.2	**SILT:** trace clay, trace to some sand, trace gravel, brown, moist to wet, very dense	4	SS	53		70				
		5	SS	52		125				
		6	SS	71		100				
		7	SS	80		100	2	7	84	7
					Sand					
		8	SS	67		55				
					W. L. 254.3 m Oct 25, 2023					
					Screen					
		9	SS	59						
	containing silty clay layers	10	SS	87	Bentonite					
251.7 / 9.6	**END OF BOREHOLE:**									

Soil Head Space Vapors: PID (ppm), CGD (ppm). PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%). POCKET PEN. (Cu) (kPa). NATURAL UNIT WT (kN/m³). REMARKS AND GRAIN SIZE DISTRIBUTION (%).

Notes:
1) Borehole was open and unstabilized water measured at 7.6m below ground surface upon completion of drilling.
2) Monitoring well was installed upon completion of drilling, screened from 6.1m to 9.1m.

Water Level Readings:

Date	W.L. Depth (m)
Oct 25, 2023	6.94
Dec 12, 2023	7.11

ENVISION-SOIL-ROCK-APRIL-2022.GLB
ENVIRO PID(PPM) AND CGD(PPM) 2016-R02 23-0358_NOBLETON 5 DEC 8, 2023.GPJ 24-1-5

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

ENVISION
CONSULTANTS LTD

LOG OF BOREHOLE BH5-2

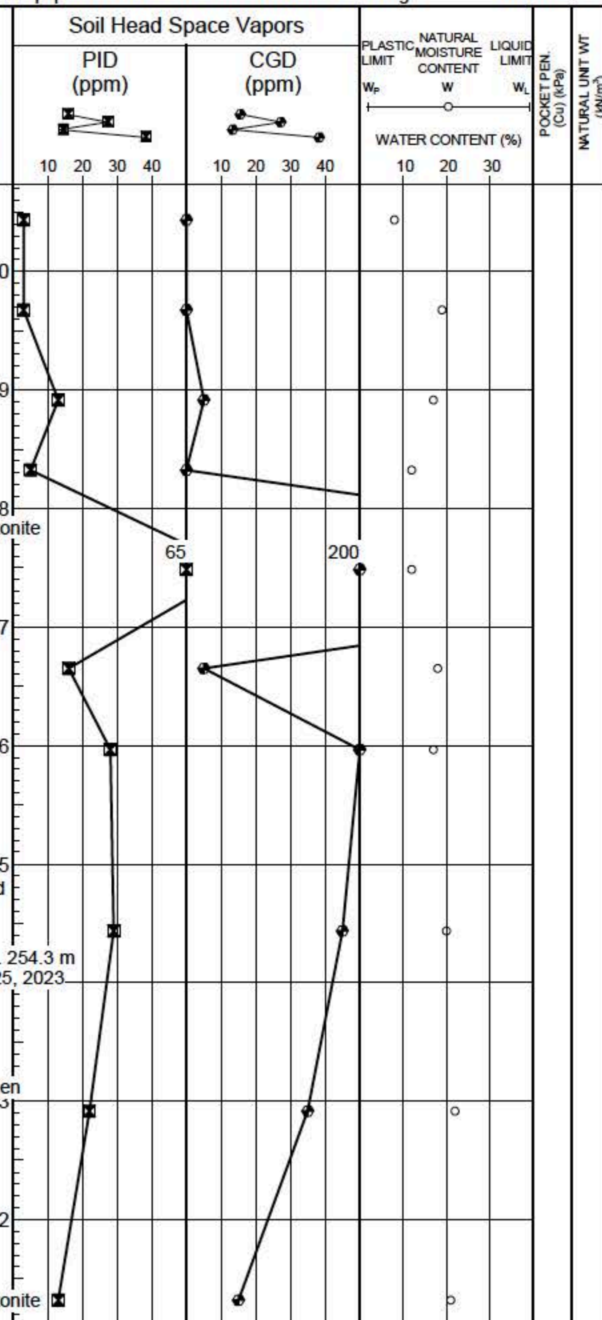
PROJECT: Nobleton Well 5 Upgrades
CLIENT: ETO Engineering
PROJECT LOCATION: 12860 York Regional Road 27, Nobleton
DATUM: Geodetic
BH LOCATION: N 4861419.8 E 608183.3

Method: Solid Stem Auger
Diameter: 150 mm
Date: Oct-19-2023 to Oct-19-2023
Equipment: Drill Tech M5T Trackmounted Rig

REF. NO.: 23-0358
ENCL NO.:
ORIGINATED BY NL
COMPILED BY CS
CHECKED BY SD

(m) ELEV DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.7	Ground Surface					
260.6 / 0.1	**TOPSOIL:** 130 mm					
	FILL: silty clay to clayey silt, some sand to sandy, trace gravel, trace rootlets, trace organics, brown, moist, stiff to very stiff	1	SS	19		
		2	SS	10		
		3	SS	26		
258.5 / 2.2	**SILT:** some sand to sandy, trace to some clay, brown, moist to wet, very dense	4	SS	40	Bentonite	
		5	SS	70		
		6	SS	59		
256.2 / 4.5	**SANDY SILT:** trace clay, brown, wet, very dense	7	SS	73		0 27 69 4
255.1 / 5.6	**SILT:** some clay, some sand, trace gravel, brown, wet, very dense				Sand	
		8	SS	76	W. L. 254.3 m Oct 25, 2023	
		9	SS	80	Screen	
		10	SS	76	Bentonite	
251.0 / 9.7	**END OF BOREHOLE:**					

Soil Head Space Vapors



Notes:
1) Borehole was open and unstabilized water measured at 7.9m below ground surface upon completion of drilling.
2) Monitoring well was installed upon completion of drilling, screened from 6.1m to 9.1m.

Water Level Readings:

Date	W.L. Depth (m)
Oct 25, 2023	6.42
Dec 12, 2023	6.57

ENVISION-SOIL-ROCK-APRIL5-2022.GLB ENVIRO PID(PPM) AND CGD(PPM) 2016-R02 23-0358 NOBLETON 5 DEC 8 2023.GPJ 24-1-5

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ $^{\varepsilon=3\%}$ Strain at Failure

ENVISION
CONSULTANTS LTD

LOG OF BOREHOLE BH5-3

PROJECT: Nobleton Well 5 Upgrades
CLIENT: ETO Engineering
PROJECT LOCATION: 12860 York Regional Road 27, Nobleton
DATUM: Geodetic
BH LOCATION: N 4861412.2 E 608192.4

Method: Solid Stem Auger
Diameter: 150 mm
Date: Oct-19-2023 to Oct-19-2023
Equipment: Drill Tech M5T Trackmounted Rig

REF. NO.: 23-0358
ENCL NO.:
ORIGINATED BY NL
COMPILED BY CS
CHECKED BY SD

(m) ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	Soil Head Space Vapors PID (ppm)	CGD (ppm)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.6	Ground Surface							
260.5 / 0.1	**ASPHALT:** 80 mm							
	FILL: sand and gravel, trace silt, brown, moist, loose	1	SS	9			280	
259.9 / 0.7	**FILL:** silty clay to clayey silt, some sand to sandy, trace gravel, trace rootlets, trace organics, brown, moist, firm to stiff	2	SS	7			80	
		3	SS	8		65	230	
258.4 / 2.2	**SAND AND SILT:** trace clay, trace gravel, brown, moist, very dense	4	SS	74		58	170	1 55 39 5
		5	SS	80		64	200	
257.2 / 3.5	**END OF BOREHOLE**							

ELEVATION: 260, 259, 258

Soil Head Space Vapors: PID (ppm) 10 20 30 40; CGD (ppm) 10 20 30 40

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30

POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m^3)

ENVISION-SOIL-ROCK-APRIL5-2022.GLB
ENVIRO PID(PPM) AND CGD(PPM)-2016-R02 23-0358_NOBLETON 5 DEC 8, 2023.GPJ 24-1-5

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

ENVISION
CONSULTANTS LTD

LOG OF BOREHOLE BH5-4

PROJECT: Nobleton Well 5 Upgrades | REF. NO.: 23-0358
CLIENT: ETO Engineering | Method: Solid Stem Auger | ENCL NO.:
PROJECT LOCATION: 12860 York Regional Road 27, Nobleton | Diameter: 150 mm | ORIGINATED BY NL
DATUM: Geodetic | Date: Oct-20-2023 to Oct-20-2023 | COMPILED BY CS
BH LOCATION: N 4861454.7 E 608228.7 | Equipment: Drill Tech M5T Trackmounted Rig | CHECKED BY SD

ELEV (m) / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	PID (ppm)	CGD (ppm)	POCKET PEN. (Cu) (kPa)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.4	Ground Surface									
260.3 / 0.1	**TOPSOIL:** 80 mm									
	FILL: silty clay to clayey silt, some sand to sandy, trace gravel, trace rootlets, trace organics, brown, moist, firm to stiff	1	SS	8		260				
259.7 / 0.7	**FILL:** silty sand, trace gravel, trace clay, brown, moist, loose to compact	2	SS	10				115		
						259				
258.5 / 1.8	**SILTY CLAY TO CLAYEY SILT:** some sand to sandy, trace gravel, brown, moist, very stiff to hard	3	SS	23	Bentonite					
		4	SS	26		258		105	250	
	containing silty sand seams	5	SS	43		257		90	250	3 17 60 20
		6	SS	41	Sand		64	190	250	
255.6 / 4.8	**SILT:** trace clay, some sand to sandy, trace gravel, brown, moist, very dense	7	SS	95	Screen			430	188	
		8	SS	100	Bentonite			300		Split spoon sampler wet.
253.8 / 6.5	**END OF BOREHOLE:**									

Notes:
1) Borehole was open and unstabilized water measured at 5.8m below ground surface upon completion of drilling.
2) Monitoring well was installed upon completion of drilling, screened from 4.6m to 6.1m.

Water Level Readings:

Date	W.L. Depth (m)
Oct 25, 2023	Dry
Dec 12, 2023	Dry

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ○ ^{8}=3% Strain at Failure

ENVISION CONSULTANTS LTD

LOG OF BOREHOLE BH5-5

PROJECT: Nobleton Well 5 Upgrades
REF. NO.: 23-0358
CLIENT: ETO Engineering
Method: Hand Auger
ENCL NO.:
PROJECT LOCATION: 12860 York Regional Road 27, Nobleton
Diameter: 75 mm
ORIGINATED BY KS
DATUM: Geodetic
Date: Oct-19-2023 to Oct-19-2023
COMPILED BY CS
BH LOCATION: N 4861453.4 E 608254.3
CHECKED BY SD

(m) ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	PID (ppm)	CGD (ppm)	WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.4	Ground Surface												
260.3 / 0.1	**TOPSOIL:** 115 mm												
	FILL: silty sand to sandy silt, trace to some clay, trace gravel, trace organics, brown, moist		1	GS			260						
			2	GS									
258.9			3	GS			259						
1.5	**END OF BOREHOLE**												

Soil Head Space Vapors: PID (ppm) scale 10 20 30 40; CGD (ppm) scale 10 20 30 40

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

ENVISION CONSULTANTS LTD

LOG OF BOREHOLE BH5-6

PROJECT: Nobleton Well 5 Upgrades
REF. NO.: 23-0358
CLIENT: ETO Engineering
Method: Solid Stem Auger
ENCL NO.:
PROJECT LOCATION: 12860 York Regional Road 27, Nobleton
Diameter: 150 mm
ORIGINATED BY NL
DATUM: Geodetic
Date: Oct-20-2023 to Oct-20-2023
COMPILED BY CS
BH LOCATION: N 4861412.1 E 608158.5
Equipment: Drill Tech M5T Trackmounted Rig
CHECKED BY SD

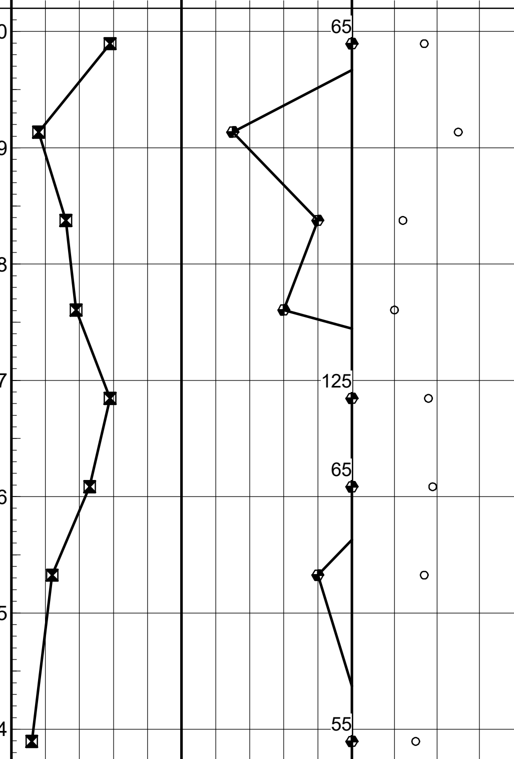
SOIL PROFILE

(m) ELEV / DEPTH	DESCRIPTION
260.2	Ground Surface
260.0 / 0.1	**TOPSOIL:** 90 mm
259.5 / 0.7	**FILL:** silty clay to clayey silt, some sand to sandy, trace gravel, trace organics, trace rootlets, brown, moist, stiff
258.0 / 2.2	**SILTY CLAY TO CLAYEY SILT:** some sand, trace gravel, brown, moist to wet, hard
257.2 / 3.0	**SILTY SAND TILL TO SANDY SILT TILL:** some clay, trace gravel, brown, moist, very dense
253.7 / 6.5	**SILT:** some sand to sandy, trace clay, trace gravel, brown, moist to wet, very dense
	END OF BOREHOLE

SAMPLES

NUMBER	TYPE	"N" BLOWS/0.3 m	POCKET PEN. (Cu) (kPa)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	12		
2	SS	37	250	
3	SS	46	250	
4	SS	74		
5	SS	78		
6	SS	75		
7	SS	81		1 18 76 5
8	SS	85		

Soil Head Space Vapors: PID (ppm), CGD (ppm); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%); NATURAL UNIT WT (kN/m^3); GROUND WATER CONDITIONS; ELEVATION



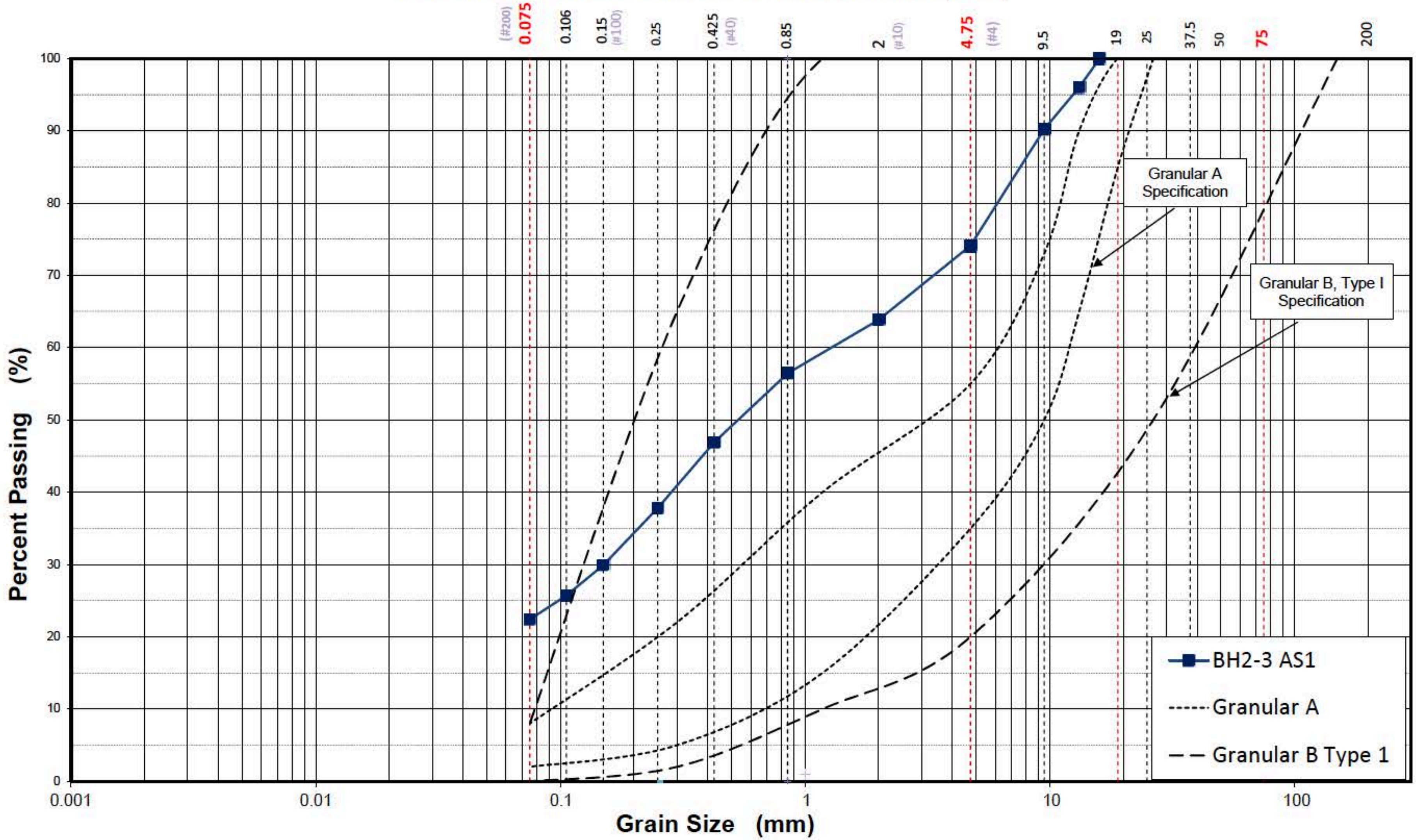
GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

APPENDIX B:

Laboratory Test Results

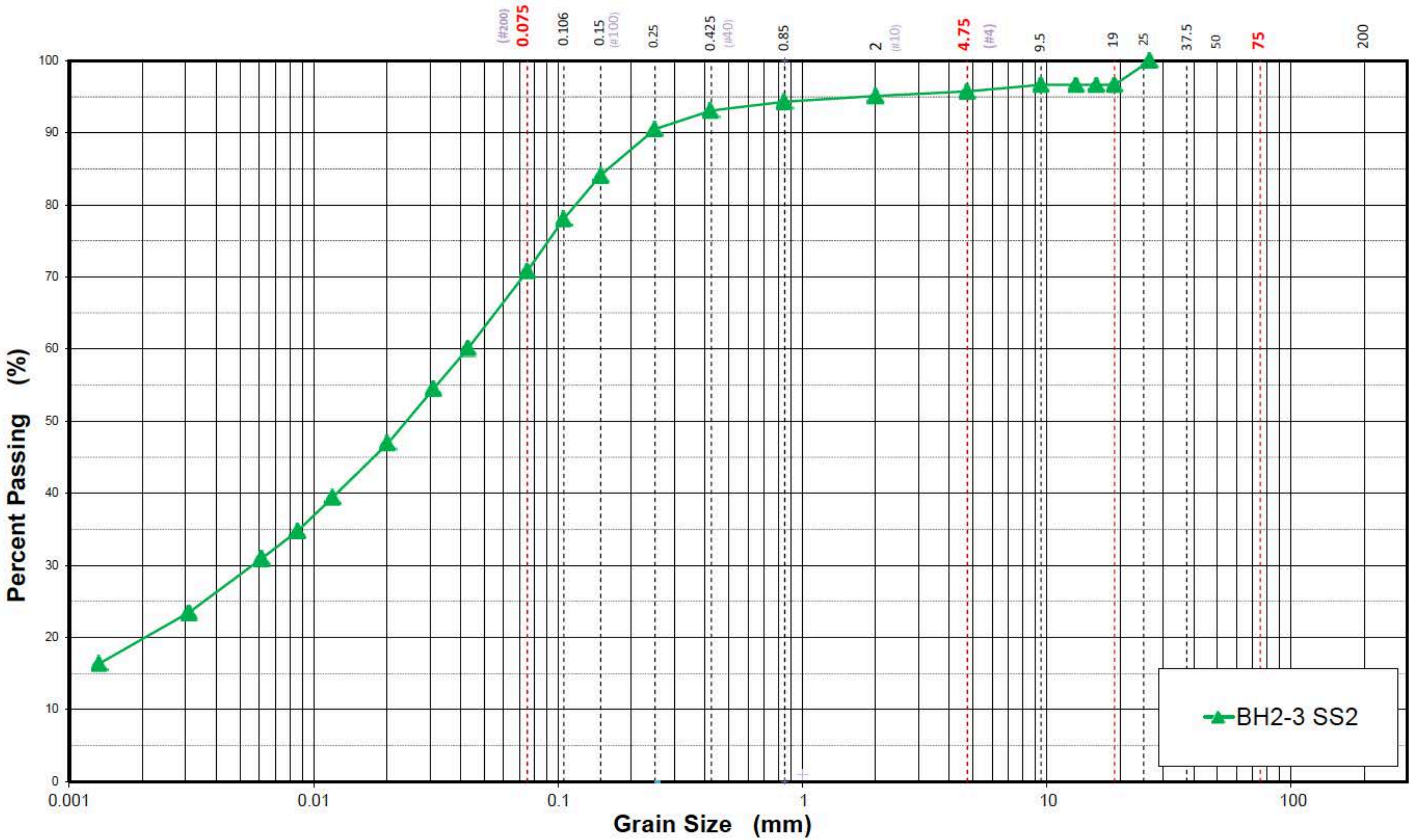
Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

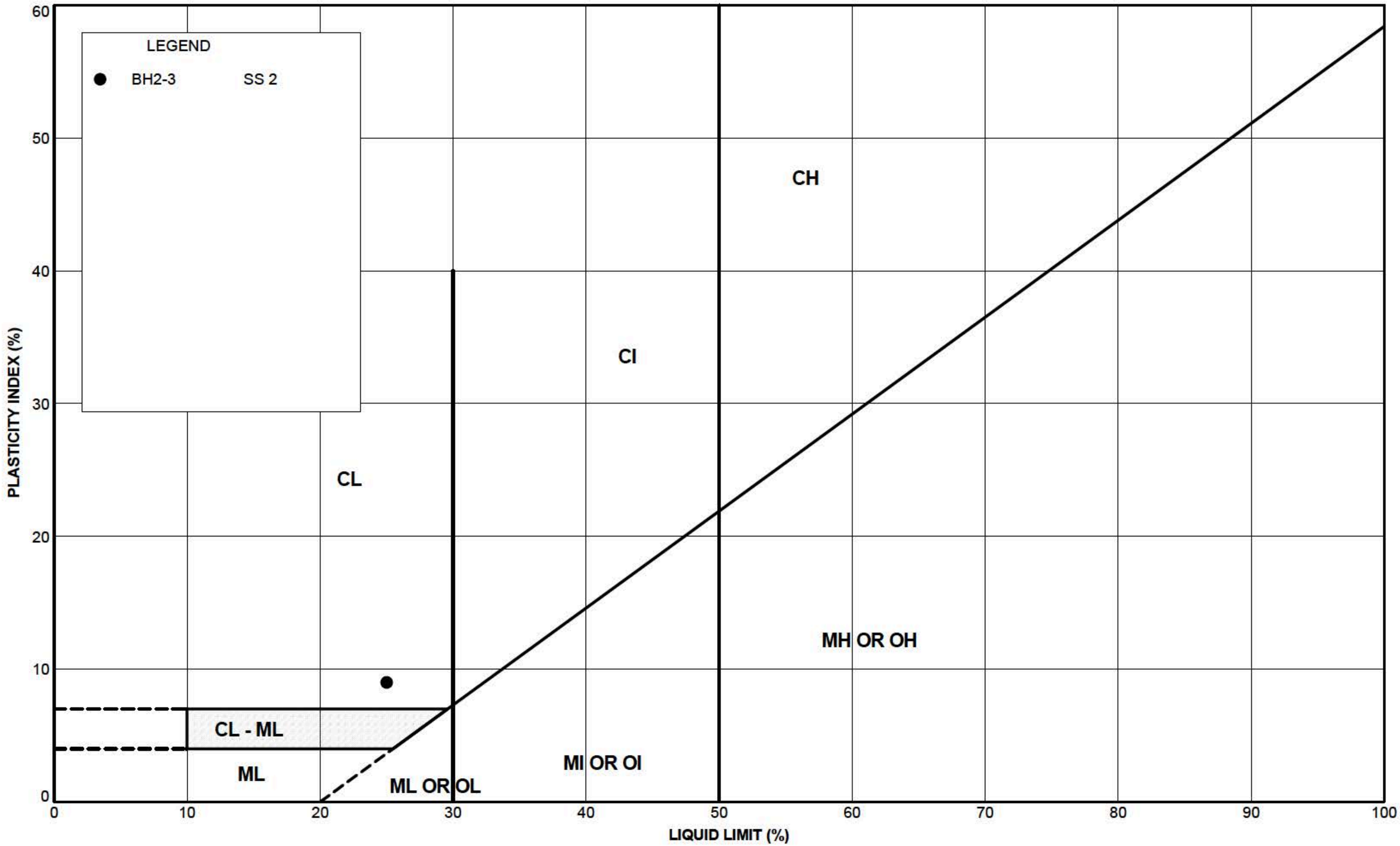
ENVISION CONSULTANTS LTD	Nobleton Well 2 GRAIN SIZE DISTRIBUTION Fill: gravelly sand	Figure No	B1
		Project No	23-0358
		Date	Dec 20/2023

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

ENVISION CONSULTANTS LTD	Nobleton Well 2 GRAIN SIZE DISTRIBUTION FILL: silty clay to clayey silt	Figure No	B2
		Project No	23-0358
		Date	Dec. 20/2023



ENVISION CONSULTANTS LTD

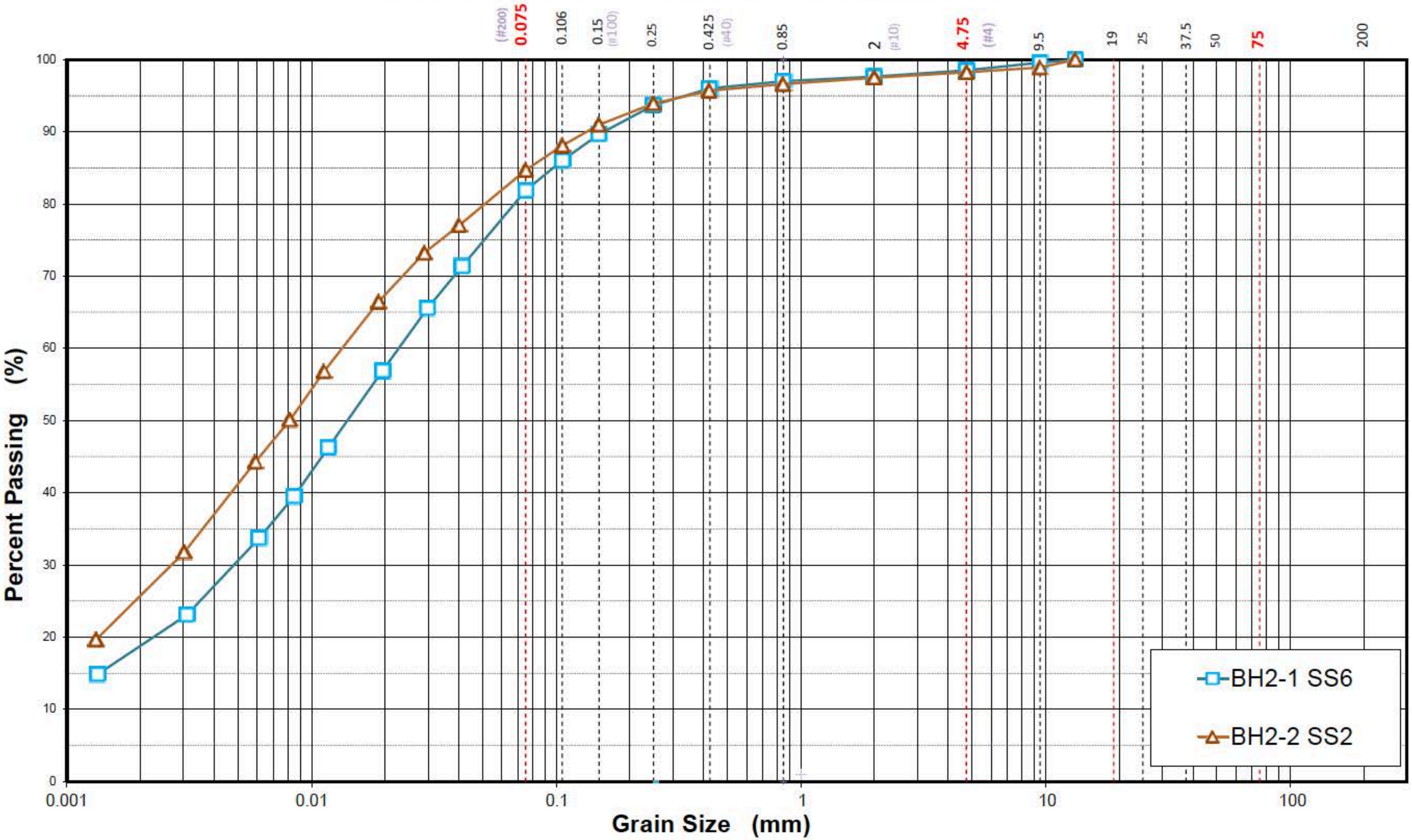
Nobleton Well 2

PLASTICITY CHART

FILL: silty clay to clayey silt

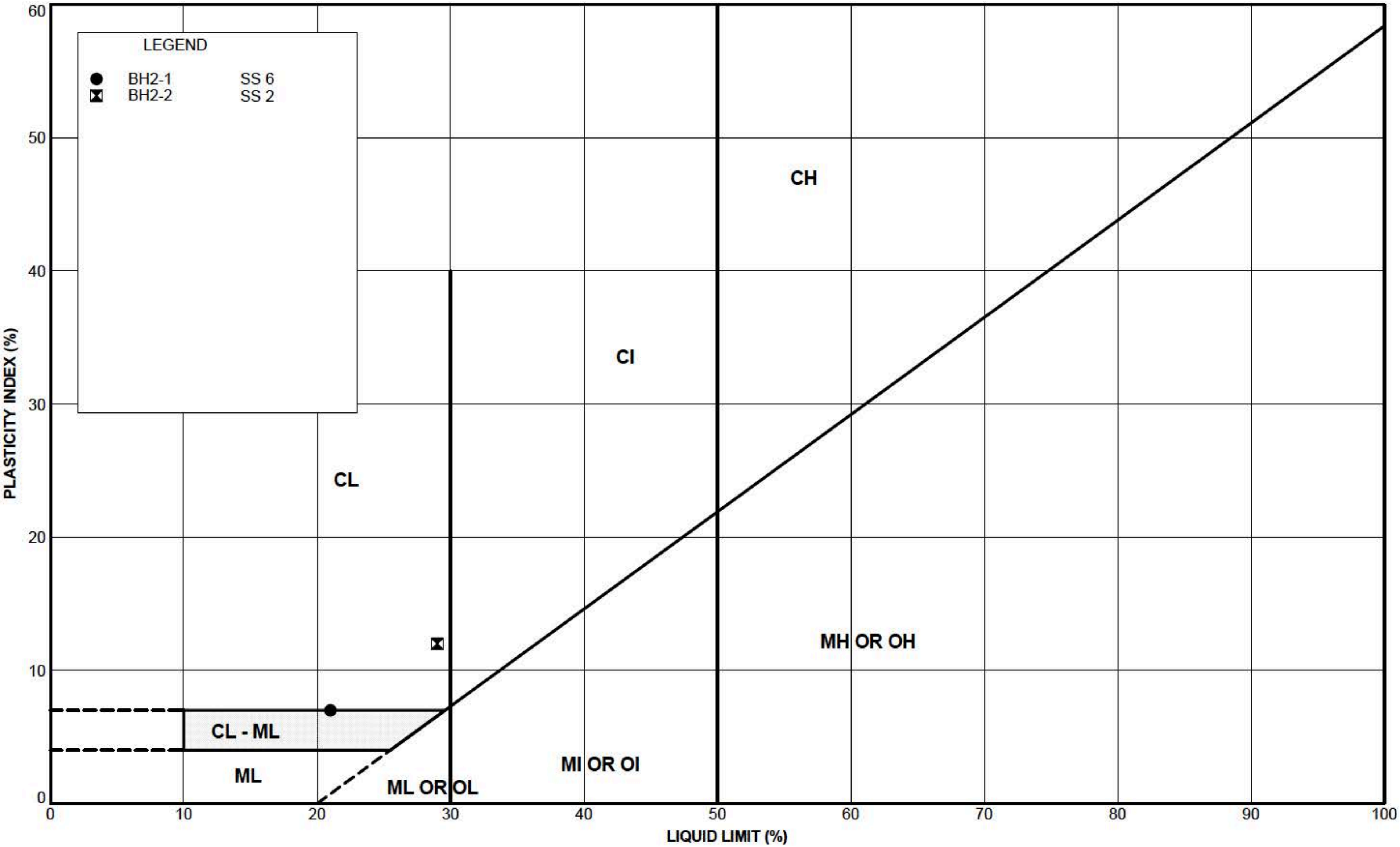
FIGURE NO.	B3
JOB NO.	23-0358
DATE	Dec. 20, 2023

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

ENVISION CONSULTANTS LTD	Nobleton Well 2 GRAIN SIZE DISTRIBUTION SILTY CLAY TILL TO CLAYEY SILT TILL	Figure No	B4
		Project No	23-0358
		Date	Dec. 20/2023

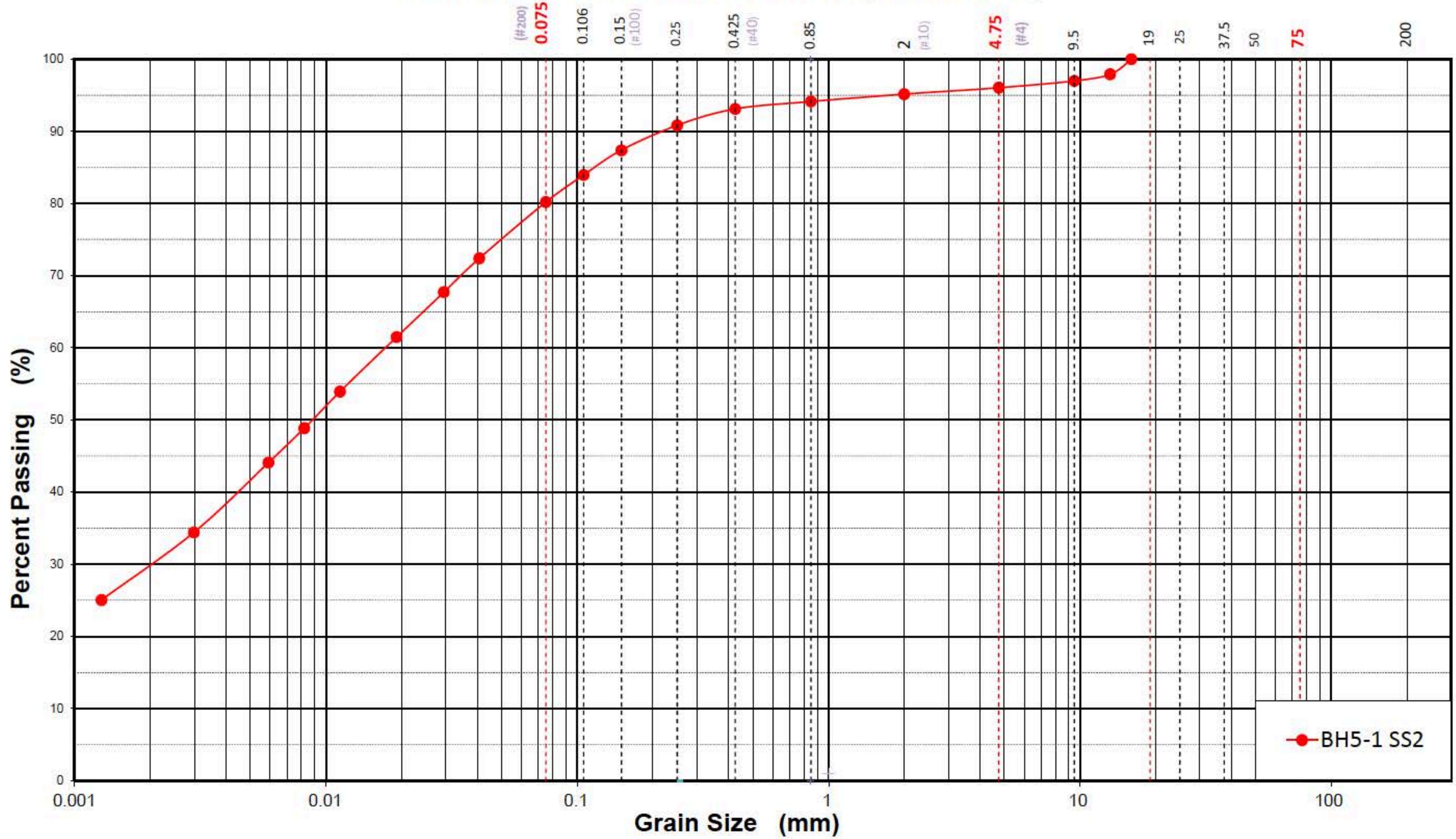


ENVISION CONSULTANTS LTD

Nobleton Well 2
PLASTICITY CHART
Silty Clay Till to Clayey Silt Till

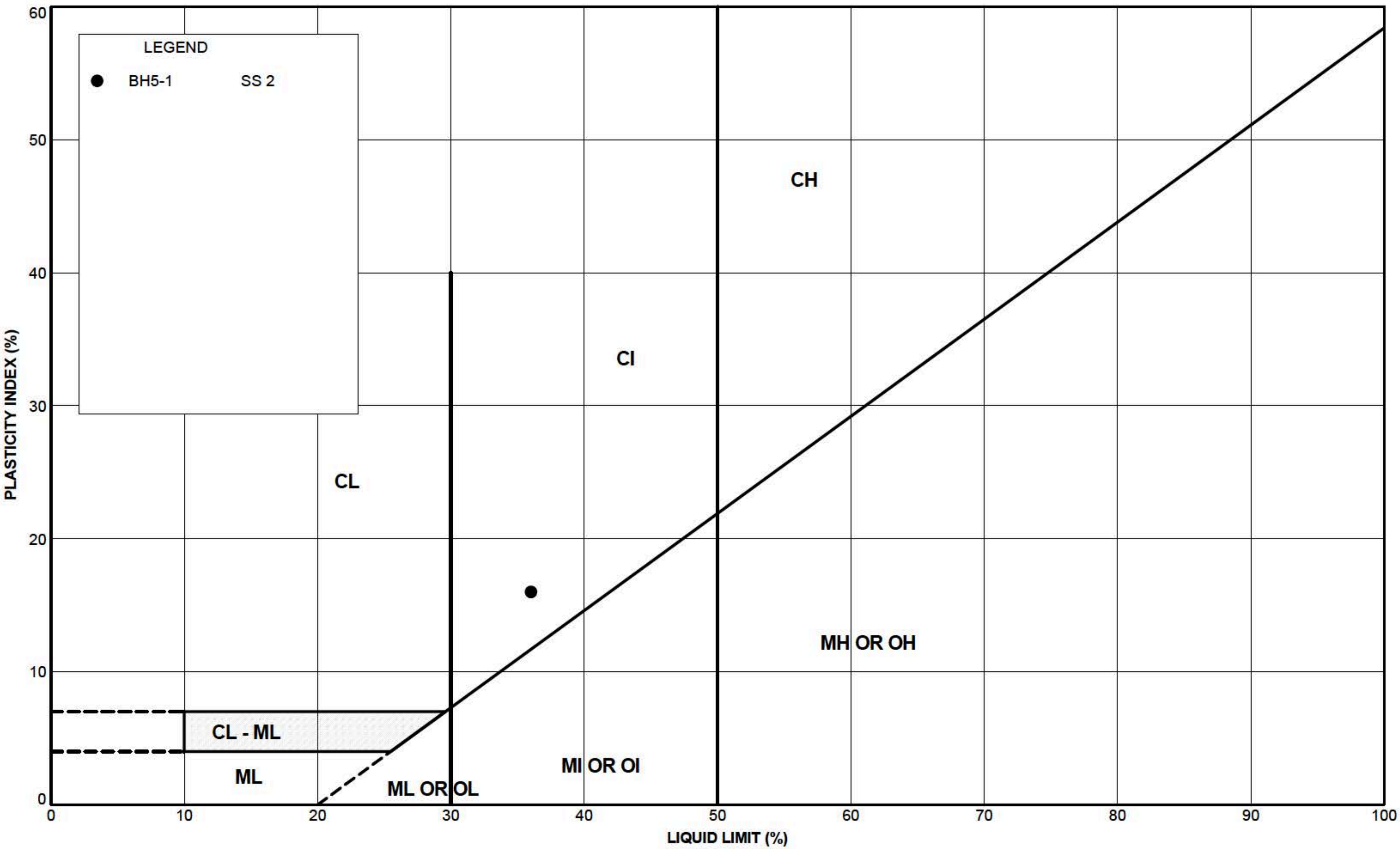
FIGURE NO.	B5
JOB NO.	23-0358
DATE	Dec. 20, 2023

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

ENVISION CONSULTANTS LTD	Nobleton Well 5 GRAIN SIZE DISTRIBUTION FILL: silty clay to clayey silt	Figure No	B6
		Project No	23-0358
		Date	Nov. 15/2023

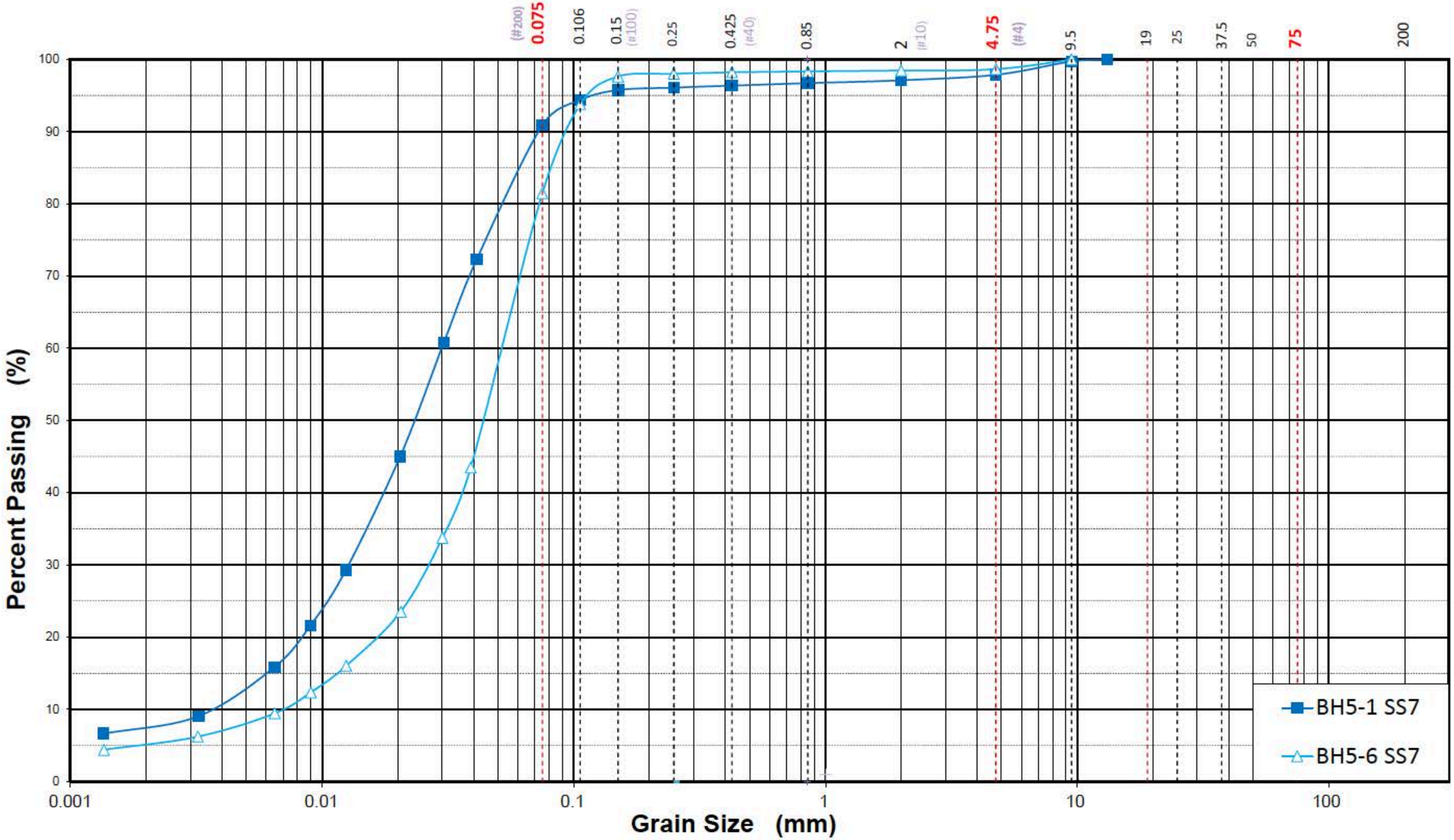


ENVISION CONSULTANTS LTD

Nobleton Well 5
PLASTICITY CHART
FILL: silty clay to clayey silt

FIGURE NO.	B7
JOB NO.	23-0358
DATE	Nov. 24, 2023

Particle Size Distribution (ASTM-D421/D422)



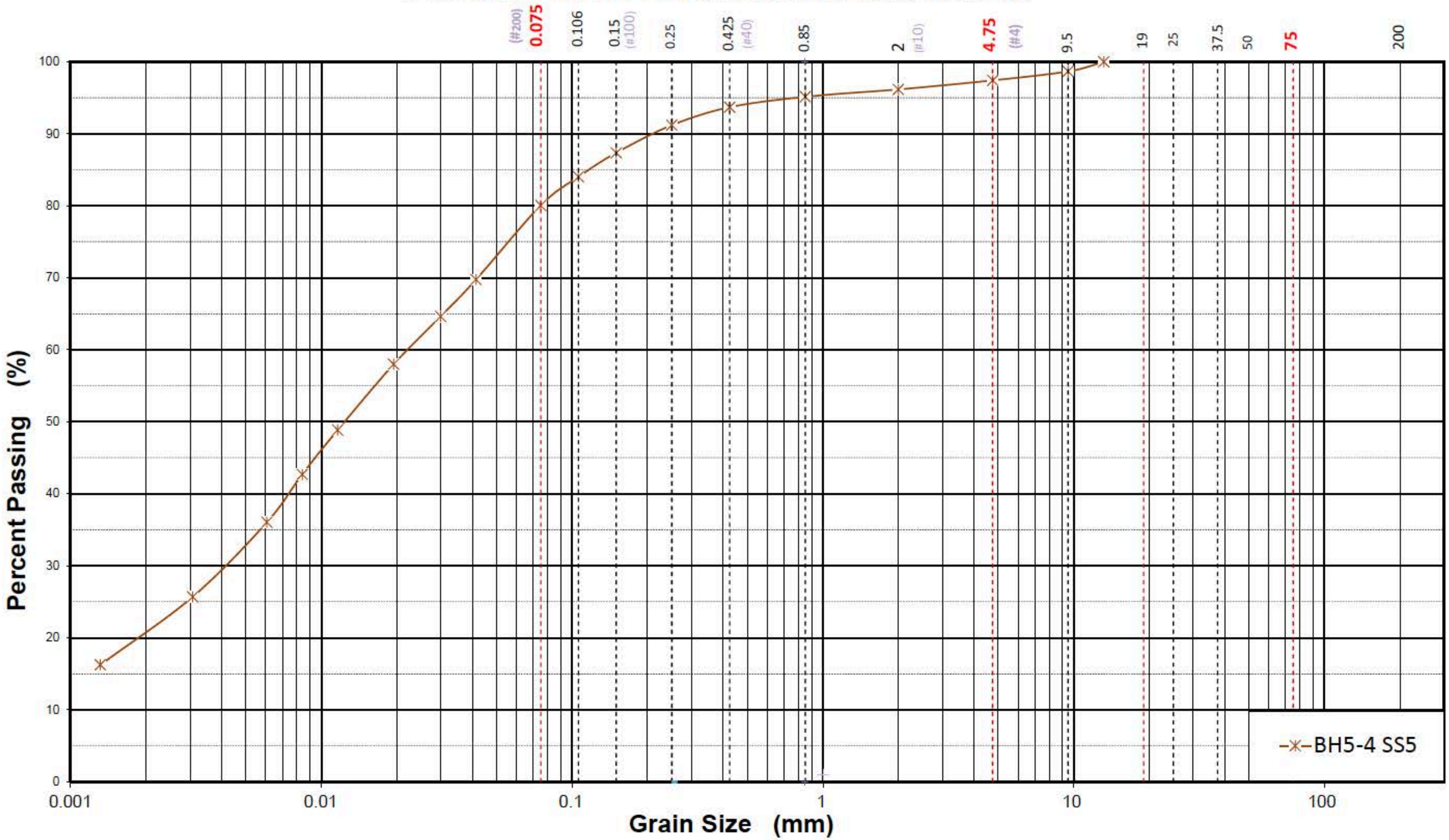
Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

ENVISION CONSULTANTS LTD

Nobleton Well 5
GRAIN SIZE DISTRIBUTION
SILT

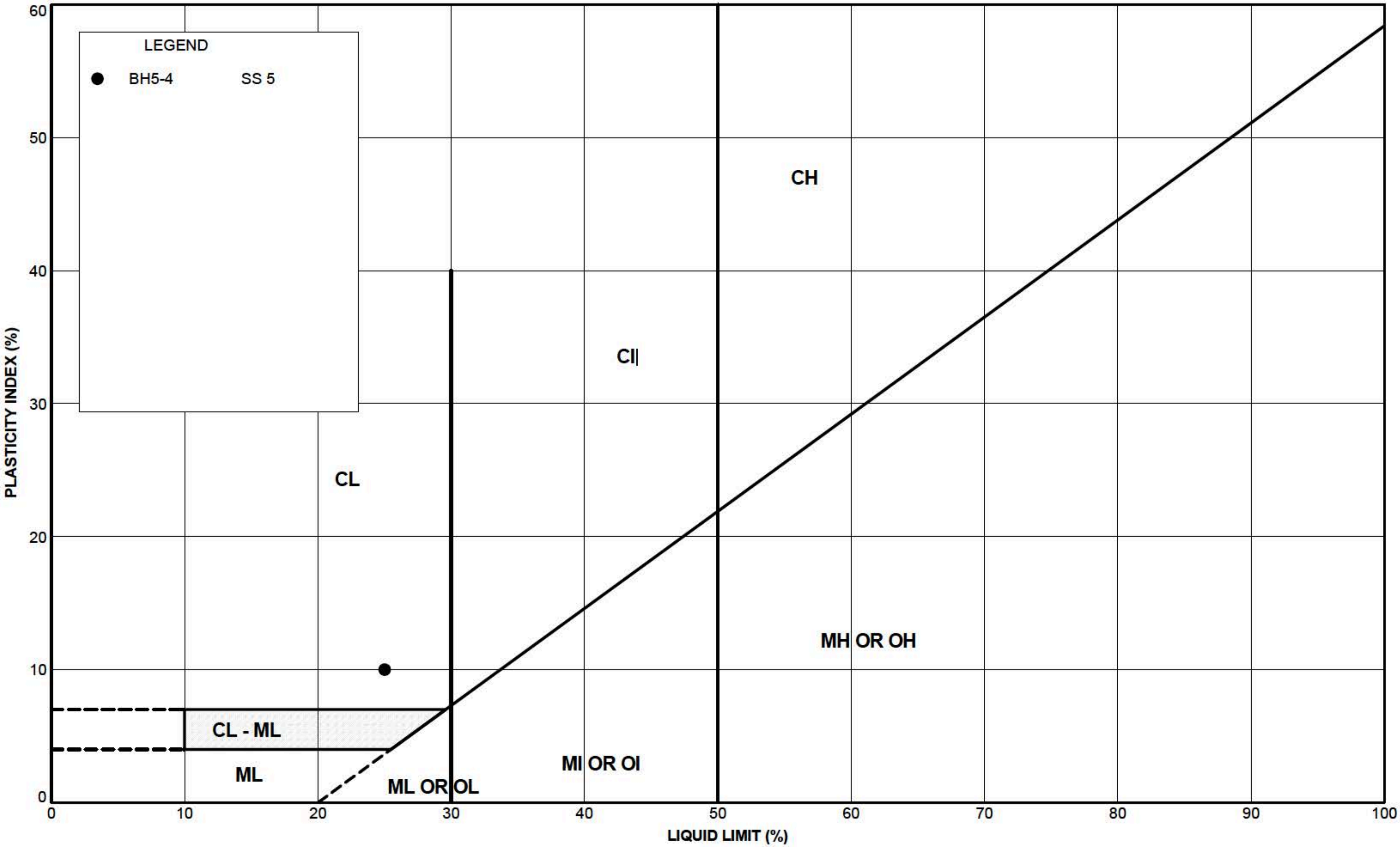
Figure No	B8
Project No	23-0358
Date	Nov. 15/2023

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

ENVISION CONSULTANTS LTD	Nobleton Well 5 GRAIN SIZE DISTRIBUTION SILTY CLAY TO CLAYEY SILT	Figure No	B9
		Project No	23-0358
		Date	Nov. 15/2023

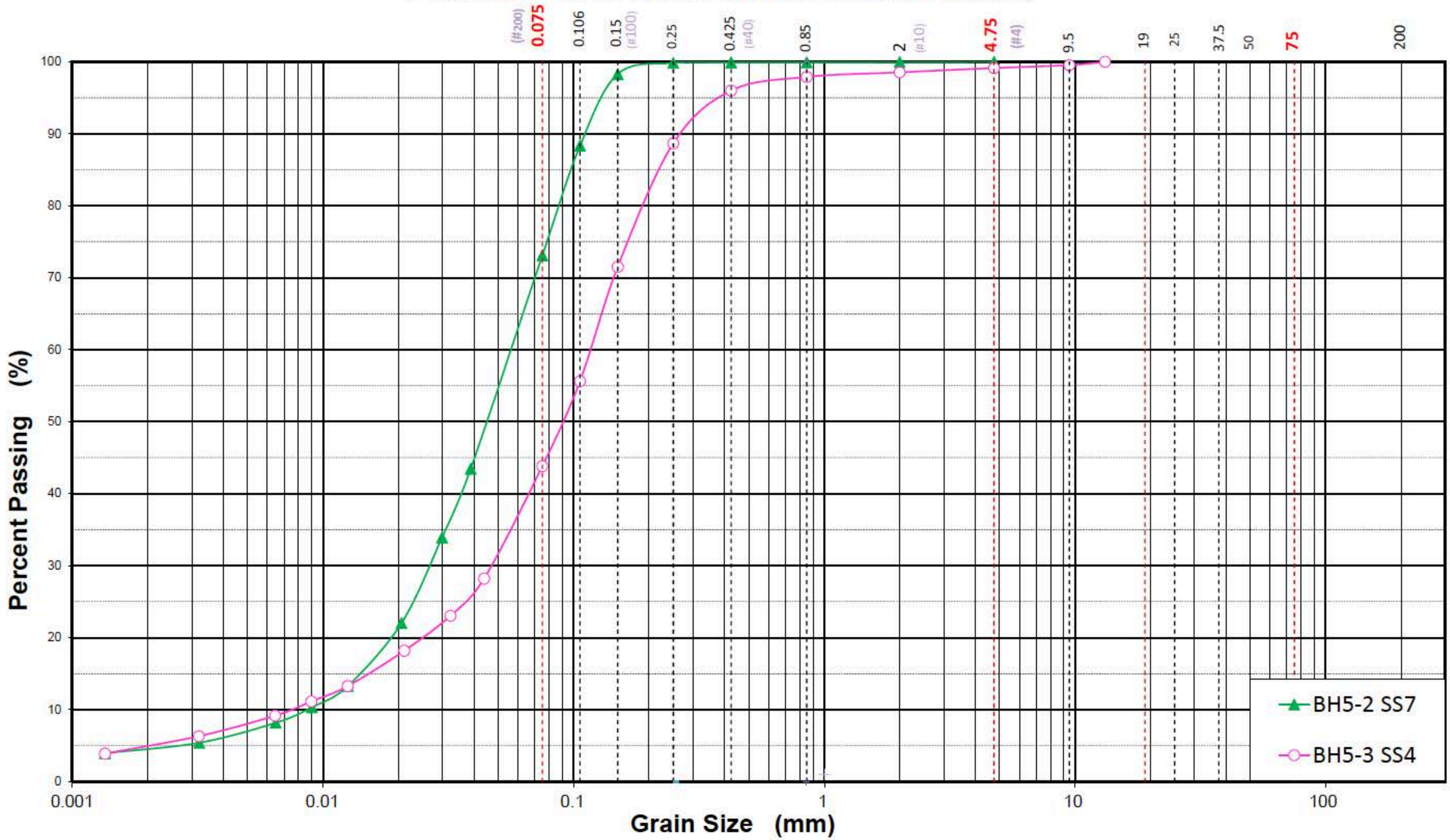


ENVISION CONSULTANTS LTD

Nobleton Well 5
PLASTICITY CHART
SILTY CLAY TO CLAYEY SILT

FIGURE NO.	B10
JOB NO.	23-0358
DATE	Nov. 24, 2023

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

ENVISION CONSULTANTS LTD	Nobleton Well 5 GRAIN SIZE DISTRIBUTION SANDY SILT and SAND AND SILT	Figure No	B11
		Project No	23-0358
		Date	Nov. 15/2023

APPENDIX C:

Laboratory Certificate of Analyses

ALS Canada Ltd.

right solutions. right partner.

CERTIFICATE OF ANALYSIS

Work Order	: **WT2335766**	Page	: 1 of 3
Client	: **EnVision Consultants Ltd.**	Laboratory	: ALS Environmental - Waterloo
Contact	: Chris Song	Account Manager	: Emily Hansen
Address	: 6415 Northwest Drive U37-40 MIssissauga ON Canada L4V 1X1	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: ----	Telephone	: +1 519 886 6910
Project	: 23-0358.315	Date Samples Received	: 01-Nov-2023 17:00
PO	: ----	Date Analysis Commenced	: 02-Nov-2023
C-O-C number	: ----	Issue Date	: 07-Nov-2023 22:24
Sampler	: ----		
Site	: ----		
Quote number	: 2022 Standing Offer		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Josphin Masihi	Analyst	Centralized Prep, Waterloo, Ontario
Nik Perkio	Inorganics Analyst	Inorganics, Waterloo, Ontario

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.
Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
%	percent
µS/cm	microsiemens per centimetre
mg/kg	milligrams per kilogram
mV	millivolts
ohm cm	ohm centimetres (resistivity)
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical Results

Sub-Matrix: **Soil**

(Matrix: **Soil/Solid)**

				Client sample ID	BH5-4 SS5	BH5-2 SS7	----	----	----
				Client sampling date / time	20-Oct-2023 00:00	19-Oct-2023 00:00	----	----	----
Analyte	CAS Number	Method/Lab	LOR	Unit	WT2335766-001	WT2335766-002	--------	--------	--------
					Result	Result	----	----	----
Physical Tests									
Conductivity (1:2 leachate)	----	E100-L/WT	5.00	µS/cm	269	194	----	----	----
Moisture	----	E144/WT	0.25	%	11.6	14.3	----	----	----
Oxidation-reduction potential [ORP]	----	E125/WT	0.10	mV	235	231	----	----	----
pH (1:2 soil:CaCl2-aq)	----	E108A/WT	0.10	pH units	7.81	8.00	----	----	----
Resistivity	----	EC100R/WT	100	ohm cm	3720	5150	----	----	----
Inorganics									
Sulfides, acid volatile	----	E396-L/WT	0.20	mg/kg	0.78	0.60	----	----	----
Leachable Anions & Nutrients									
Chloride, soluble ion content	16887-00-6	E236.Cl/WT	5.0	mg/kg	29.4	36.9	----	----	----
Sulfate, soluble ion content	14808-79-8	E236.SO4/WT	20	mg/kg	91	32	----	----	----

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Please refer to the Accreditation section for an explanation of analyte accreditations.

ALS Canada Ltd.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WT2335766**	Page	: 1 of 7
Client	: **EnVision Consultants Ltd.**	Laboratory	: ALS Environmental - Waterloo
Contact	: Chris Song	Account Manager	: Emily Hansen
Address	: 6415 Northwest Drive U37-40 MIssissauga ON Canada L4V 1X1	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: +1 519 886 6910
Project	: 23-0358.315	Date Samples Received	: 01-Nov-2023 17:00
PO	: ----	Issue Date	: 07-Nov-2023 22:24
C-O-C number	: ----		
Sampler	: ----		
Site	: ----		
Quote number	: 2022 Standing Offer		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.

CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.

DQO: Data Quality Objective.

LOR: Limit of Reporting (detection limit).

RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Soil/Solid**

Evaluation: ✗ = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method	Method	Sampling Date	Extraction / Preparation				Analysis			
Container / Client Sample ID(s)			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap [ON MECP] BH5-4 SS5	E396-L	20-Oct-2023	07-Nov-2023	14 days	18 days	✗ EHT	07-Nov-2023	7 days	0 days	✓
Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap [ON MECP] BH5-2 SS7	E396-L	19-Oct-2023	07-Nov-2023	14 days	19 days	✗ EHT	07-Nov-2023	7 days	0 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH5-4 SS5	E236.Cl	20-Oct-2023	03-Nov-2023	30 days	15 days	✓	03-Nov-2023	28 days	0 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH5-2 SS7	E236.Cl	19-Oct-2023	03-Nov-2023	30 days	16 days	✓	03-Nov-2023	28 days	0 days	✓
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH5-4 SS5	E236.SO4	20-Oct-2023	03-Nov-2023	30 days	15 days	✓	03-Nov-2023	28 days	0 days	✓
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH5-2 SS7	E236.SO4	19-Oct-2023	03-Nov-2023	30 days	16 days	✓	03-Nov-2023	28 days	0 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] BH5-4 SS5	E100-L	20-Oct-2023	03-Nov-2023	30 days	15 days	✓	07-Nov-2023	30 days	19 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation: Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis: Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] BH5-2 SS7	E100-L	19-Oct-2023	03-Nov-2023	30 days	16 days	✓	07-Nov-2023	30 days	20 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] BH5-4 SS5	E144	20-Oct-2023	----	----	----		02-Nov-2023	----	14 days	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] BH5-2 SS7	E144	19-Oct-2023	----	----	----		02-Nov-2023	----	15 days	
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap [ON MECP] BH5-4 SS5	E125	20-Oct-2023	02-Nov-2023	180 days	14 days	✓	06-Nov-2023	180 days	18 days	✓
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap [ON MECP] BH5-2 SS7	E125	19-Oct-2023	02-Nov-2023	180 days	15 days	✓	06-Nov-2023	180 days	19 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap [ON MECP] BH5-4 SS5	E108A	20-Oct-2023	02-Nov-2023	30 days	14 days	✓	06-Nov-2023	30 days	18 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap [ON MECP] BH5-2 SS7	E108A	19-Oct-2023	02-Nov-2023	30 days	15 days	✓	06-Nov-2023	30 days	19 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: × = QC frequency outside specification; ✓ = QC frequency within specification.

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1226345	1	11	9.0	4.7	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1220735	1	18	5.5	5.0	✓
Moisture Content by Gravimetry	E144	1219929	1	19	5.2	5.0	✓
ORP by Electrode	E125	1219761	1	14	7.1	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	1219802	1	18	5.5	5.0	✓
Water Extractable Chloride by IC	E236.Cl	1221529	1	6	16.6	5.0	✓
Water Extractable Sulfate by IC	E236.SO4	1221528	1	6	16.6	5.0	✓
Laboratory Control Samples (LCS)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1226345	1	11	9.0	4.7	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1220735	2	18	11.1	10.0	✓
Moisture Content by Gravimetry	E144	1219929	1	19	5.2	5.0	✓
ORP by Electrode	E125	1219761	1	14	7.1	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	1219802	1	18	5.5	5.0	✓
Water Extractable Chloride by IC	E236.Cl	1221529	2	6	33.3	10.0	✓
Water Extractable Sulfate by IC	E236.SO4	1221528	2	6	33.3	10.0	✓
Method Blanks (MB)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1226345	1	11	9.0	4.7	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1220735	1	18	5.5	5.0	✓
Moisture Content by Gravimetry	E144	1219929	1	19	5.2	5.0	✓
Water Extractable Chloride by IC	E236.Cl	1221529	1	6	16.6	5.0	✓
Water Extractable Sulfate by IC	E236.SO4	1221528	1	6	16.6	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by “mod”).

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L ALS Environmental - Waterloo	Soil/Solid	CSSS Ch. 15 (mod)/APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Conductance is measured in the fluid that is observed in the upper layer.
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A ALS Environmental - Waterloo	Soil/Solid	MECP E3530	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C) and is carried out in accordance with procedures described in the Analytical Protocol (prescriptive method). A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling, or decanting and then analyzed using a pH meter and electrode.
ORP by Electrode	E125 ALS Environmental - Waterloo	Soil/Solid	APHA 2580 (mod)	Oxidation Redution Potential (ORP) is reported as the oxidation-reduction potential of the platinum metal-reference electrode employed in the analysis, measured in mV.
Moisture Content by Gravimetry	E144 ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1	Moisture is measured gravimetrically by drying the sample at 105°C. Moisture content is calculated as the weight loss (due to water) divided by the wet weight of the sample, expressed as a percentage.
Water Extractable Chloride by IC	E236.Cl ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer.
Water Extractable Sulfate by IC	E236.SO4 ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer.
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L ALS Environmental - Waterloo	Soil/Solid	APHA 4500S2J	This analysis is carried out in accordance with the method described in APHA 4500 S2-J. After extraction the Acid Volatile Sulphide is determined colourimetrically.
Resistivity Calculation for Soil Using E100-L	EC100R ALS Environmental - Waterloo	Soil/Solid	APHA 2510 B	Soil Resistivity (calculated) is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil:Water for pH/EC	EP108 ALS Environmental - Waterloo	Soil/Solid	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water.
Leach 1:2 Soil : 0.01CaCl2 - As Received for pH	EP108A ALS Environmental - Waterloo	Soil/Solid	MOEE E3137A	A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling or decanting and then analyzed using a pH meter and electrode.
Preparation of ORP by Electrode	EP125 ALS Environmental - Waterloo	Soil/Solid	APHA 2580 (mod)	Field-moist sample is extracted in a 1:2 ratio with DI water and then analyzed by ORP meter.
Anions Leach 1:10 Soil:Water (Dry)	EP236 ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	5 grams of dried soil is mixed with 50 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.
Distillation for Acid Volatile Sulfide in Soil	EP396-L ALS Environmental - Waterloo	Soil/Solid	APHA 4500S2J	Acid Volatile Sulfide is determined by colourimetric measurement on a sediment sample that has been treated with hydrochloric acid within a purge and trap system, where the evolved hydrogen sulfide gas is carried into a basic solution by argon gas for analysis.

ALS Canada Ltd.

QUALITY CONTROL REPORT

Work Order	: **WT2335766**	Page	: 1 of 5
Client	: EnVision Consultants Ltd.	Laboratory	: ALS Environmental - Waterloo
Contact	: Chris Song	Account Manager	: Emily Hansen
Address	: 6415 Northwest Drive U37-40 MIssissauga ON Canada L4V 1X1	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	:	Telephone	: +1 519 886 6910
Project	: 23-0358.315	Date Samples Received	: 01-Nov-2023 17:00
PO	: ----	Date Analysis Commenced	: 02-Nov-2023
C-O-C number	: ----	Issue Date	: 07-Nov-2023 22:24
Sampler	: ---- ----		
Site	: ----		
Quote number	: 2022 Standing Offer		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Josphin Masihi	Analyst	Waterloo Centralized Prep, Waterloo, Ontario
Nik Perkio	Inorganics Analyst	Waterloo Inorganics, Waterloo, Ontario

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	LOR	Unit	Original Result	Duplicate Result	RPD(%) or Difference	Duplicate Limits	Qualifier
Physical Tests (QC Lot: 1219761)											
WT2335452-001	Anonymous	Oxidation-reduction potential [ORP]	----	E125	0.10	mV	322	315	2.20%	25%	----
Physical Tests (QC Lot: 1219802)											
TY2310567-004	Anonymous	pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units	7.42	7.49	0.939%	5%	----
Physical Tests (QC Lot: 1219929)											
HA2300975-021	Anonymous	Moisture	----	E144	0.25	%	3.98	4.12	3.49%	20%	----
Physical Tests (QC Lot: 1220735)											
WT2335679-001	Anonymous	Conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm	0.476 mS/cm	480	0.837%	20%	----
Inorganics (QC Lot: 1226345)											
WT2335452-001	Anonymous	Sulfides, acid volatile	----	E396-L	0.26	mg/kg	<0.26	<0.26	0.0003	Diff <2x LOR	----
Leachable Anions & Nutrients (QC Lot: 1221528)											
WT2335452-001	Anonymous	Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	69	69	0.2	Diff <2x LOR	----
Leachable Anions & Nutrients (QC Lot: 1221529)											
WT2335452-001	Anonymous	Chloride, soluble ion content	16887-00-6	E236.Cl	5.0	mg/kg	356	358	0.577%	30%	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Soil/Solid**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 1219929)						
Moisture	----	E144	0.25	%	<0.25	----
Physical Tests (QCLot: 1220735)						
Conductivity (1:2 leachate)	----	E100-L	5	µS/cm	<5.00	----
Inorganics (QCLot: 1226345)						
Sulfides, acid volatile	----	E396-L	0.2	mg/kg	<0.20	----
Leachable Anions & Nutrients (QCLot: 1221528)						
Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	<20	----
Leachable Anions & Nutrients (QCLot: 1221529)						
Chloride, soluble ion content	16887-00-6	E236.Cl	5	mg/kg	<5.0	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Soil/Solid**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 1219802)									
pH (1:2 soil:CaCl2-aq)	----	E108A	----	pH units	7 pH units	100	98.0	102	----
Physical Tests (QCLot: 1219929)									
Moisture	----	E144	0.25	%	50 %	97.6	90.0	110	----
Physical Tests (QCLot: 1220735)									
Conductivity (1:2 leachate)	----	E100-L	5	µS/cm	1409 µS/cm	98.2	90.0	110	----
Inorganics (QCLot: 1226345)									
Sulfides, acid volatile	----	E396-L	0.2	mg/kg	2.506 mg/kg	81.4	70.0	130	----
Leachable Anions & Nutrients (QCLot: 1221528)									
Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	5000 mg/kg	99.4	80.0	120	----
Leachable Anions & Nutrients (QCLot: 1221529)									
Chloride, soluble ion content	16887-00-6	E236.Cl	5	mg/kg	5000 mg/kg	100	80.0	120	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix:

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Physical Tests (QCLot: 1219761)									
	RM	Oxidation-reduction potential [ORP]	----	E125	475 mV	99.4	90.0	110	----
Physical Tests (QCLot: 1220735)									
	RM	Conductivity (1:2 leachate)	----	E100-L	1970.3 µS/cm	107	70.0	130	----
Leachable Anions & Nutrients (QCLot: 1221528)									
	RM	Sulfate, soluble ion content	14808-79-8	E236.SO4	1070 mg/kg	96.0	70.0	130	----
Leachable Anions & Nutrients (QCLot: 1221529)									
	RM	Chloride, soluble ion content	16887-00-6	E236.Cl	432 mg/kg	94.1	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

Affix ALS barcode label here (lab use only)

CC

Environmental Division
Waterloo
Work Order Reference
WT2335766

Telephone : +1 519 886 6910

Report To		Report Format / Distribution		Select Service Level Below (Rush Tur
Company:	Envision Consultants	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	R ☑ Regular (Standard TAT if received by 3
Contact:	Chris Song	Quality Control (QC) Report with Report	☐ Yes ☐ No	P ☐ Priority (2-4 bus. days if received by 3p
Address:	6415 Northwest [illegible] 40, Mississauga, ON L4V 1X1	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 bus. days if received by
		Select Distribution:	☐ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency - con
Phone:	647 679 8664	Email 1 or Fax	smonfared@envisionconsultants.ca	Specify Date Required for E2,E or P:
		Email 2	csong@envisionconsultants.ca	Analy

Invoice To		Invoice Distribution	
Same as Report To	☑ Yes ☐ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Copy of Invoice with Report	☑ Yes ☐ No	Email 1 or Fax	Payables@envisionconsultants.ca
Company:	Envision Consultants	Email 2	csong@envisionconsultants.ca
Contact:	Accounts Payables		

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:		Approver ID:	Cost Center:
Job #:	23-0358.315	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only)	WT2335766 FH.	ALS Contact:	Sampler:

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Corrosivity Test Package with Redox	Number of Containers
	BH5-4 SS5	20-Oct-23	AM	Soil	R	1
	BH5-2 SS7	19-Oct-23	AM	Soil	R	1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ Yes ☑ No

Are samples for human drinking water use? ☐ Yes ☑ No

Special Instructions / Specify Criteria to add on report (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐ No ☐
Ice packs	Yes ☑ No ☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated	☐		

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
8.9	3.7

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Song	Date: 01-NOV-23	Time: 4:55PM	Received by: AM	Date: 11/01/2023	Time: 17:00	Received by:	Date: 11/02/23	Time: 10:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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SOL-S24 ES

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.