



# Foundation Investigation Report

**VARIOUS CREEK CULVERT EXTENSIONS, HIGHWAY 3 WIDENING AND SAFETY ENHANCEMENTS 1.2 KM EAST OF ESSEX COUNTY ROAD 23 TO 1.1 KM EAST OF ESSEX COUNTY ROAD 34, TOWNSHIPS OF GOSFIELD NORTH / GOSFIELD SOUTH, DISTRICT OF CHATHAM, TOWN OF KINGSVILLE, ESSEX COUNTY, ONTARIO, MINISTRY OF TRANSPORTATION, ONTARIO, GWP 3021-18-00**

**SITE NO.: 06X-0420/C0, 06X-0421/C0, 06X-0422/C0, 06X-0423/C0  
06X-0426/C0, 06X-0427/C0, 06X-0429/C0, 06X-0432/C0**

Site NO.	Latitude	Longitude
06X-0420/C0	42.141773	-82.789997
06X-0421/C0	42.129369	-82.770415
06X-0422/C0	42.128920	-82.770742
06X-0423/C0	42.127865	-82.768205
06X-0426/C0	42.119725	-82.756535
06X-0427/C0	42.114946	-82.751028
06X-0429/C0	42.101778	-82.736576
06X-0432/C0	42.090308	-82.723864

13 January 2021

**GEOCRES NO.: 40J2-147**



→ **The Power of Commitment**

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# 1. Introduction

GHD Limited (GHD) was retained by the Ministry of Transportation, Ontario (MTO) to provide preliminary and design-build ready foundation engineering services for extension/replacement of eight culverts between Essex Road 23 and Essex Road 34 in the Town of Kingsville, County of Essex, Ontario. The location of the culverts is shown on the Key Plan on Drawing 1. The list of culverts with the corresponding site numbers, and the approximate culvert location and stationing are summarized in Table 1.

**Table 1**      *List of Culvert Structures*

Culvert No.	Approximate Station (m)	Road/Highway
06X-0420/C0	12+500	Concession Road 9
06X-0421/C0	14+625	Highway 3
06X-0422/C0	14+650	Concession Road 8
06X-0423/C0	14+870	Highway 3
06X-0426/C0	16+170	Highway 3
06X-0427/C0	16+900	Highway 3
06X-0429/C0	10+015	Highway 3
06X-0432/C0	11+661	Highway 3

Note: \* Culvert No. 06X-0426/C0 will be relocated 25 m to the east, with a replacement length of 63.2 m.

The purpose of this investigation is to establish the subsurface soil and groundwater conditions at the proposed culvert extensions/replacement by borehole drilling and geotechnical and analytical laboratory testing on selected soil samples.

The Terms of Reference (TOR) and the scope of work for this project are identified within the agreement of services as amended between MTO and GHD for Consultant's Assignment Number 3017-E-0012. The work has been carried out in accordance with the requirements of *Guideline for Foundation Engineering Services, Version 2.0, October 2020*, prepared by the MTO.

## 2. Site Description

The culvert sites addressed in this report are located from about Concession Road 9 to about 1,200 m east of Essex Road 29 (Division Road) along either Highway 3 or intersecting Concession Roads 8 and 9, in the Township of Gosfield North, Ontario. Detailed below is a general description of the location of each culvert:

- Culvert No. 06X-0420/C0 is located on Concession Road 9, about 50 m south of the intersection with Highway 3.
- Culvert No. 06X-0421/C0 is located just west of the intersection between Highway 3 and Concession Road 8.
- Culvert No. 06X-0422/C0 is located on Concession Road 8, about 80 m south of the intersection between Highway 3 and Concession Road 8.
- Culvert No. 06X-0423/C0 is located approximately 220 m east of the intersection between Highway 3 and Concession Road 8.
- Culverts Nos. 06X-0426/C0, 06X-0427/C0 and 06X-0429/C0 are located between Essex Road 27 (Belle River Road) and Essex Road 29 (Division Road); and,



- Culvert No. 06X-0432/C0 is located about 600 m east of the intersection between Highway 3 and Essex Road 29 (Division Road).

The water in the culvert flows from north to south, with the exception of Culvert Nos. 06X-0427/C0 and 06X-0429/C0 where the water in the culvert flows to the west.

Highway 3 in the area serves as a regional corridor and major collector, connecting small rural and urban communities with Windsor and the United States. It is a two-lane road aligned mostly in the northwest-southeast direction. The culverts are situated in a rural-setting environment with generally a flat landscape. Land in the surroundings of the structures is used mainly for agricultural purposes and related farm facilities. There are few residential buildings immediately south of Culvert No. 06X-0429/C0 along Concession Road 6 and further north along Essex Road 29 (Division Road). A greenhouse structure and associated facilities also exist immediately south of the Culvert No. 06X-0432/C0.

The embankment slopes on culverts were covered by grass or other vegetation and observed to be stable, with no signs of erosion at most culvert locations. Signs of minor erosion at the toe of the embankment slopes was observed at the location of Culvert Nos. 06X-0422/C0 and 06X-0426/C0. General site and culvert conditions are shown in photographs (i.e., Photographs 1 to 16) presented in Appendix A.

### 3. Investigation Procedures

The geotechnical fieldwork for this investigation was carried out in two phases. Between April 27 and May 19, 2020 sixteen boreholes numbered as BH-20-01 to BH-16-20 (two boreholes at each structure), were advanced to depths between 9.8 m and 11.3 m below existing grade. The boreholes were advanced either, near or at the shoulder of the road and near the proposed south culvert extensions. The boreholes were advanced using a Diedrich D-50 track-mounted drill rig, equipped with continuous flight, solid stem augers supplied and operated by Altech Drilling and Investigative Services of Cambridge, Ontario.

Between October 4 and November 11, 2021, six boreholes (numbered BH-21-01 to BH-21-06, inclusive) were advanced at the location of Culvert Nos. 06X-0423/C0, 06X-0426/C0, 06X-0427/C0, 06X-0429/C0, 06X-0432/C0 to depths of between 11.3 m and 15.8 m below existing grade, near the end of the proposed north extensions. The boreholes were advanced using either a Diedrich D-50 track-mounted drill rig (for Boreholes BH-21-01, BH-21-03, and BH-21-06) or a truck-mounted drilling rig (for the remaining boreholes), equipped with hollow stem augers, supplied and operated by Direct Environmental Drilling Inc. of London, Ontario.

A summary of the field program including the borehole location, depth and termination elevation of the borehole is presented in Table 2. The location of the boreholes advanced at the culvert sites are shown on Drawings 2 to 9.

**Table 2** Summary of the Borehole Program

Culvert Number	Borehole Number	Location	Location (MTM NAD 83, ZONE 11)		Borehole Depth (m)	Ground Surface Elevation (m)
			Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
06X-0420/C0	BH-20-01	NBL Shoulder of Concession Rd 9	4,666,959.4 (42.141783)	280,836.9 (-82.789905)	9.8	194.8
	BH-20-02	Near the east end of proposed culvert	4,666,946.7 (42.141670)	280,856.9 (-82.789663)	9.8	194.3
06X-0421/C0	BH-20-03	EBL Shoulder	4,665,573.4 (42.129352)	282,433.8 (-82.770533)	9.8	195.3

Culvert Number	Borehole Number	Location	Location (MTM NAD 83, ZONE 11)		Borehole Depth (m)	Ground Surface Elevation (m)
			Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
	BH-20-04	Near the south end of proposed culvert	4,665,539.7 (42.129048)	282,422.5 (-82.770669)	9.8	194.9
06X-0422/C0	BH-20-05	NBL Shoulder of Concession Rd 5	4,665,516.3 (42.128837)	282,413.7 (-82.770774)	9.8	194.5
	BH-20-06	Near the east end of proposed culvert	4,665,505.6 (42.128742)	282,445.9 (-82.770385)	9.8	194.4
06X-0423/C0	BH-20-07	EBL shoulder	4,665,404.5 (42.127837)	282,622.8 (-82.768241)	9.8	195.5
	BH-20-08	Near the south end of proposed culvert	4,665,399.6 (42.127792)	282,581.1 (-82.768745)	9.8	194.3
	BH- 21-01	Near the north end of proposed culvert	4,665,407.5 (42.127864)	282,642.3 (-82.768005)	13.6	194.9
06X-0426/C0	BH-20-09	EBL shoulder/original culvert location	4,664,521.8 (42.119915)	283,565.9 (-82.756802)	9.8	195.1
	BH-20-10	Near the south end of original culvert location	4,664,494.3 (42.119667)	283,549.3 (-82.757001)	11.3	193.3
	BH-21-02	Near the north end of proposed culvert	4,664,509.0 (42.119801)	283,607.0 (-82.756304)	15.8	195.7
06X-0427/C0	BH-20-11	EBL shoulder	4,663,965.9 (42.114922)	284,035.9 (-82.751097)	9.8	195.1
	BH-20-12	Near the south end of proposed culvert	4,663,975.9 (42.115011)	283,998.7 (-82.751668)	9.8	194.6
	BH-21-03	Near the north end of proposed culvert	4,663,959.4 (42.114864)	284,063.5 (-82.750763)	15.7	194.8
06X-0429/C0	BH-20-13	EBL shoulder	4,662,508.6 (42.101832)	285,219.3 (-82.736739)	9.8	195.3
	BH-20-14	Near the south end of proposed culvert	4,662,500.5 (42.101758)	285,185.7 (-82.737144)	11.3	194.7
	BH-21-04	Near the north end of proposed culvert	4,662,509.5 (42.101840)	285,243.3 (-82.736448)	15.8	195.0
	BH-21-05	Near the north end of proposed culvert	4,662,493.4 (42.101695)	285,254.3 (-82.736315)	15.8	195.3
06X-0432/C0	BH-20-15	EBL shoulder	4,661,218.0 (42.090237)	286,277.2 (-82.723907)	9.8	195.9
	BH-20-16	Near the south end of proposed culvert	4,661,205.3 (42.090123)	286,250.4 (-82.724231)	9.8	194.6
	BH-21-06	Near the north end of proposed culvert	4,661,226.8 (42.090317)	286,296.1 (-82.723679)	11.3	196.0

Prior to the start of the fieldwork, utility clearance procedures were implemented through Ontario One Call protocol, and fieldwork notification was sent to MTO West Region. Culvert No. 06X-0422/C0 is located on

Concession Road 8 and a road occupancy permit was obtained from the Town of Kingsville as the culvert is located beyond the limits of the MTO Right of Way (ROW). A project specific Health and Safety as well as Traffic Protection Plans were prepared before commencement of the fieldwork. In addition, the borehole locations were marked by GHD staff prior to drilling. All drilling activity, soil sampling and logging, and backfilling of boreholes were conducted under the full-time supervision of an experienced GHD geotechnical engineer.

Soil samples were obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm outer-diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedures described in ASTM D1586<sup>1</sup>. Where firm to stiff cohesive deposits were encountered, in-situ field vane shear tests were carried out using an MTO 'N'-size vane to assess the strength characteristics of these soils in accordance with ASTM D2573<sup>2</sup>. In addition, relatively undisturbed samples were obtained using 76 mm outer diameter thin-walled Shelby tube (ASTM D1587)<sup>3</sup>. Soil samples obtained from the boreholes were inspected in the field immediately upon retrieval for type, texture, and color. All retrieved samples from the first phase of investigation were sealed in clean plastic bags and transported to the GHD laboratory in Whitby and Waterloo for further visual examination, and geotechnical laboratory tests.

Groundwater condition and water levels in the open boreholes were observed during drilling by visual examination of soil samples and drill rods as well as immediately following drill operations. Three monitoring wells were installed in Boreholes BH-21-01, BH-21-03 and BH-21-06 to permit monitoring of the groundwater level at the location of Culvert Nos. 06X-0423/C0, 06X-0427/C0, and 806X-0432/C0, respectively. The monitoring wells consist of 50 mm diameter PVC pipe with a slotted screen that was sealed above the screen. The borehole annulus surrounding the monitoring well was backfilled with sand and the remainder of the borehole was then backfilled with bentonite to or near the ground surface. Details of the monitoring well installation and water level readings are presented on the borehole records in Appendix B. The boreholes without monitoring wells were backfilled with bentonite and sealed at the top with compacted auger cuttings, in accordance with Ontario Regulation 903, (as amended).

Classification testing (i.e., water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. In addition, two one-dimensional consolidation (oedometer) tests were carried out in GHD Waterloo laboratory on selected samples of the cohesive deposit from the Shelby tube samples. All laboratory tests were conducted in accordance with MTO and/or American Society for Testing Materials (ASTM) standards, as appropriate.

In addition, one soil sample collected during the first phase of investigation from each culvert site and five samples from the second phase of investigation were submitted for analysis of a suite of parameters, including conductivity, resistivity, soluble chloride concentration, soluble sulphate concentration and pH. These samples were sent to Caduceon Environmental Laboratories (Caduceon) of Richmond Hill, Ontario for the first phase of investigation and to ALS Environmental Laboratory of Waterloo, Ontario for the second phase of investigation.

Surveying of the as-drilled borehole locations was conducted by Callon Dietz Inc. (Callon Dietz) of London, Ontario, subcontracted to GHD. Callon Dietz provided northing and easting in MTM NAD 83 (Zone 11) coordinates. The coordinates shown on borehole logs and any part of this report correspond to these northings and eastings. The ground surface elevations are referenced to Geodetic datum. The coordinates and ground surface elevation are presented in Table 2, on the borehole records and on Drawings 2 to 9.

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

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

<sup>3</sup> ASTM D1587 - Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes

## 4. Physiography and Regional Geology

The culvert structures are located within the Essex Clay Plain region, which is a subdivision of the St. Clair Clay Plain, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)<sup>4</sup>. The plain is a broad area of low relief and poor natural drainage. It comprised of silt-clay soils and extends on both sides of the St. Clair/Detroit River system from Lake Huron to Lake Erie, and encompasses nearly all of Essex County. The Essex County area underwent at least four cycles of glaciations during the Quaternary Period, although only deposits of the most recent Wisconsinan age are recognized in Essex County (Chapman and Putnam, 1984). The surface geology is characterized by a clay plain with localized veneers of fine sand. This clay plain consists of a glaciolacustrine deposit made up of silty clay to clayey silt materials of less than 10 m in thickness. The glaciolacustrine deposits are underlain by a thicker glacial till. A thin layer of discontinuous sand and silt locally separates the glaciolacustrine deposit from the glacial till. Sand layers also occur sporadically within the till deposit. Throughout the Essex Clay Plain, the sand and clay soils together extend to a depth of 30 m to 60 m before encountering a bedrock (Chapman and Putnam, 1984).

The rock units in the area are sedimentary rocks consisting of limestone, dolostone and shale of the Michigan Basin sequence belonging to the Dundee Formation and Detroit River Group.

## 5. Subsurface Conditions

Details of the subsurface and groundwater conditions at each culvert location as encountered in the boreholes advanced during the investigation, the details of the monitoring well installations and the summary of the geotechnical laboratory testing are presented on the Records of Borehole provided in Appendix B. The *Notes on Borehole and Test Pit Reports* are also included in Appendix B to assist in the interpretation of the borehole records. The results of the geotechnical laboratory testing are contained in Appendix C. The results of in-situ field tests (i.e., SPT “N” values), as presented on the borehole records and in the sub-sections of Section 5 are uncorrected.

The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress and the results of the Standard Penetration Tests and in-situ vane shear tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations; however, the factual data presented in the borehole records governs any interpretation of the site conditions. It should be noted that the interpreted stratigraphy shown on Drawings 2 to 8 is a simplification of the subsurface conditions.

A more detailed description of the subsurface conditions encountered in the boreholes advanced near each culvert location is provided in the following subsections.

### 5.1 Culvert No. 06X-0420/C0

The fieldwork for the foundation investigation at Culvert No. 06X-0420/C0 consisted of Boreholes BH-20-01 and BH-20-02 advanced at the shoulder of Concession Road 9 and near the end of the proposed culvert extension, respectively (see Drawing 2).

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<sup>4</sup> Chapman, L.J. and Putman, D.F., 1984, *The Physiography of Southern Ontario*, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.)

In summary, the subsurface conditions at borehole locations consist of a surficial layer of topsoil or fill material underlain by a cohesive till deposit extending to the maximum depth of investigation at 9.8 m below ground surface (Elevation 184.5 m).

### 5.1.1 Topsoil

A 0.3 m thick layer of topsoil was encountered in Borehole BH-20-02. The topsoil was dark brown to black in color, moist to wet, and was generally clayey silt in texture and contains traces of sand, gravel and rootlets.

### 5.1.2 Fill

A 0.7 m thick layer of granular fill consisting of sand and gravel, some silt was encountered in Borehole BH-20-01, immediately below the ground surface.

The Standard Penetration Test (SPT) “N” value recorded within the fill was 23 blows per 0.3 m of penetration, indicating a compact compactness condition.

The water content measured on a sample of the fill was 9 per cent.

### 5.1.3 Clayey Silt to Silty Clay (Till)

A cohesive till deposit consisting of an upper silty clay layer underlain by clayey silt, some sand and trace gravel, was encountered beneath the fill material in Borehole BH-20-01 and beneath the topsoil in Borehole BH-20-02 at depths of 0.3 m and 0.7 m below ground surface, respectively. Boreholes BH-20-01 and BH-20-02 terminated in the till deposit at a depth of 9.8 m below ground surface (Elevations 185.0 m and 184.5 m), respectively. Within samples of the cohesive till deposit discontinuous 0.1 m thick layers of fine sand and silt were observed.

The SPT “N” values recorded within the cohesive till deposit range from 7 blows to 30 blows per 0.3 m of penetration, suggesting a firm to hard consistency.

Atterberg limits tests were carried out on five samples of cohesive till deposit and measured liquid limits between about 31 per cent and 46 per cent, plastic limits between about 16 per cent and 20 per cent, and plasticity indices between about 15 per cent and 26 per cent. The higher plasticity results were measured in the silty clay till deposit and the lower plasticity values were measured in the clayey silt till deposit. Based on these values, the upper portion of the till deposit may be classified as silty clay of medium to high plasticity and beneath the silty clay till deposit the till is classified as clayey silt with medium plasticity below depths of 1.5 m and 2.2 m below ground surface in Boreholes BH-20-2 and BH-20201, respectively. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C1-1 in Appendix C.

Grain size distribution testing was carried out on five samples of cohesive till and the results are shown on Figure C1-2 in Appendix C.

The water content measured on of samples of the cohesive till range between 15 per cent and 26 per cent.

## 5.2 Culvert No. 06X-0421/C0

The fieldwork at Culvert No. 06X-0421/C0 consisted of the completion of Boreholes BH-20-03 and BH-20-04 advanced at the shoulders of Highway 3 and Concession Road 8 (near to the end of the proposed culvert), respectively (see Drawing 3).

In summary, the subsurface conditions at borehole locations consist of a layer of fill material underlain by a cohesive till deposit extending to the maximum depth of investigation of 9.8 m below ground surface (Elevation 185.1 m).



## 5.2.1 Fill

At ground surface granular fill material consisting of sand and gravel with trace to some amounts of fines was encountered in Boreholes BH-20-03 and BH-20-04 and extended to depths of 1.4 m and 1.1 m below ground surface (Elevations 193.9 m and 193.8 m), respectively.

The SPT “N” values within the fill range from 8 blows to 16 blows per 0.3 m of penetration, indicating loose to compact compactness condition.

Grain size distribution test was carried out on a sample of the granular fill material and the results are shown on Figure C2-1 in Appendix C.

The water content measured on four samples of the granular fill range from 2 per cent to 4 per cent.

## 5.2.2 Clayey Silt to Silty Clay (Till)

Underlying the fill material, a cohesive till deposit consisting of silty clay underlain by clayey silt, some sand and trace gravel, was encountered in Boreholes BH-20-03 and BH-20-04 at depths of 1.4 m and 1.1 m below ground surface (Elevations 193.9 m and 193.8 m), respectively. Boreholes BH-20-03 and BH-20-04 terminated in the till deposit at a depth of 9.8 m below ground surface (Elevation 185.5 m and 185.1 m), respectively. Within samples of the cohesive till deposit discontinuous 0.1 m thick layers of fine sand and silt were observed.

The SPT “N” values recorded within the cohesive till range from 8 blows to 28 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency.

Atterberg limits tests were carried out on four samples of cohesive till and measured liquid limits between about 34 per cent and 38 per cent, plastic limits between about 14 per cent and 19 per cent, and plasticity indices between about 18 per cent and 20 per cent. Based on these values, the upper portion of the till deposit may be classified as silty clay of medium to high plasticity and beneath the silty clay till deposit the till is classified as clayey silt with medium plasticity below depths of 2.8 m and 2.2 m below ground surface in Boreholes BH-20-03 and BH-20-04, respectively. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C2-2 in Appendix C.

Grain size distribution test was carried out on four samples of the cohesive till and the results are provided on Figure C2-3 in Appendix C.

The water content measured on of samples of the cohesive till range between 17 per cent and 25 per cent.

## 5.3 Culvert No. 06X-0422/C0

The fieldwork at Culvert No. 06X-0422/C0 consisted of Boreholes BH-20-05 and BH-20-06 advanced at the shoulders of Concession Road 8 and near the end of the proposed culvert, respectively (see Drawing 4).

In summary, the subsurface conditions at borehole locations consist of topsoil/fill material underlain by a cohesive and granular till deposit extending to the maximum depth of investigation of 9.8 m below ground surface (Elevation 184.6 m).

### 5.3.1 Topsoil

A 0.4 m thick layer of topsoil was encountered in Borehole BH-20-06 at ground surface. The topsoil consists of clayey silt, trace sand and gravel and rootlets.

### 5.3.2 Fill

At ground surface in Borehole BH-20-05 a 0.3 m thick granular fill layer consisting of sand and gravel with trace to some fines was encountered.

The SPT “N” value recorded within the granular fill material was 10 blows per 0.3 m of penetration, indicating a compact compactness condition.

The water content measured on a sample of the granular fill was 5 per cent.

### 5.3.3 Clayey Silt to Silty Clay (Till)

Underlying the fill material, a cohesive till deposit consisting of silty clay underlain by clayey silt, some sand and trace gravel, was encountered in Boreholes BH-20-05 and BH-20-06 at depths of 0.3 m and 0.4 m below ground surface (Elevations 194.2 m and 194.0 m), respectively. Boreholes BH-20-05 and BH-20-06 terminated in the till deposit at a depth of 9.8 m below ground surface (Elevation 184.7 m and 184.6 m), respectively. The till deposit in Borehole BH-20-06 between depths of 5.6 m and 7.2 m below ground surface (Elevation 188.8 m and 187.2 m) was described as silt and sand, trace to some clay. Within samples of the cohesive till deposit discontinuous 0.1 m thick layers of fine sand and silt were observed.

The SPT “N” values recorded within the till deposit range from 5 blows to 18 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency.

Atterberg limits tests were carried out on four samples of cohesive till deposit and measured liquid limits between about 35 per cent and 51 per cent, plastic limits between about 18 per cent and 21 per cent, and plasticity indices between about 16 per cent and 30 per cent. Based on these values, the upper portion of the till deposit may be classified as silty clay of medium to high plasticity and beneath the silty clay till deposit the till is classified as clayey silt with medium plasticity below depths of 2.1 m and 2.9 m below ground surface in Boreholes BH-20-05 and BH-20-06, respectively. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C3-1 in Appendix C.

Grain size distribution tests carried out on four samples of cohesive till deposit and the results are provided on Figure C3-2 in Appendix C. Grain size distribution tests carried out on one sample of silt and sand till deposit and the results are provided on Figure C3-3 in Appendix C.

The water content measured on samples of the cohesive till deposit range between about 17 per cent to 24 per cent and the water content measured on a sample of the silt and sand till deposit was about 23 per cent.

## 5.4 Culvert No. 06X-0423/C0

The fieldwork for the foundation investigation at Culvert No. 06X-0423/C0 consisted of Boreholes BH-20-07, BH-20-08 and BH-21-01 advanced at the shoulder of Highway 3, near the proposed south and north end of the culvert extension (see Drawing 5).

In summary, the subsurface conditions at borehole locations consist of topsoil/fill material underlain by a cohesive till deposit extending to depths of between 9.8 m and 13.6 m below ground surface (Elevation 185.7 m and 181.3 m).

### 5.4.1 Topsoil

A 0.3 m thick layer of topsoil was encountered in Borehole BH-20-08 at ground surface. The topsoil consisted of clayey silt, trace sand and gravel and rootlets.

## 5.4.2 Fill

At ground surface in Boreholes BH-20-07 and BH-21-01 fill material consisting of sand to sand and gravel, some fines was encountered and extended to depths of 1.1 and 0.8 m below ground surface (Elevations 194.4 m and 194.1 m), respectively. Underlying the granular fill material, a layer of cohesive fill consisting of silty clay with sand to silty clay was encountered in Boreholes BH-20-07 and BH-21-01 and extended to depths of 3.0 m and 2.3 m below ground surface (Elevations 192.5 m and 192.6 m), respectively.

The SPT “N” values recorded within the granular fill material were 5 blows and 9 blows per 0.3 m of penetration, indicating a loose compactness condition. The SPT “N” values within the silty clay fill material range from 3 blows to 8 blows, per 0.3 m of penetration, suggesting a soft to stiff consistency.

Atterberg limits test were carried out on a sample of cohesive fill material and measured a liquid limit of 45 per cent, a plastic limit of 19 per cent, and a plasticity index of 26 per cent, indicating a silty clay of medium plasticity. These results of the Atterberg limits test are shown on the plasticity chart on Figure C4-1 in Appendix C.

Grain size distribution tests carried out on one sample of granular fill material and one sample of the cohesive fill material are shown on Figures C4-2 and C4-3 in Appendix C, respectively.

The water content measured on samples of the granular fill material range between about 3 per cent to 15 per cent and the water content measured on samples of the cohesive fill material range between about 16 per cent and 24 per cent.

## 5.4.3 Clayey Silt (Till)

Underlying the fill material in Boreholes BH-20-07 and BH 21-01, and underlying the topsoil in Borehole BH 20-08, a cohesive till deposit consisting of clayey silt, some sand and trace gravel, was encountered at depths of between 0.3 m and 3.0 m below ground surface (between Elevations 194.0 m and 192.5 m). Boreholes BH-20-07, BH-20-08 and BH-21-01 terminated in the till deposit at depths of between 9.8 m and 13.6 m below ground surface (Elevation 185.7 m and 181.3 m). Within samples of the cohesive till deposit discontinuous 0.1 m thick layers of fine sand and silt were observed.

The SPT “N” values recorded within the cohesive till deposit range from 4 blows to 31 blows per 0.3 m of penetration. The SPT “N” values generally decrease with depth within the till deposit. In-situ vane tests were carried out within this deposit measured undrained shear strengths ranging from about 80 kPa to greater than 100 kPa and the sensitivity ranges from about 1.7 to 2.3. The in-situ field vane test results together with the SPT “N” values indicate that the clayey silt till deposit predominately has a firm to hard consistency.

Atterberg limits tests were carried out on six samples of cohesive till deposit and measured liquid limits between about 31 per cent and 34 per cent, plastic limits between about 13 per cent and 18 per cent, and plasticity indices between about 13 per cent and 20 per cent. The results of the Atterberg limits tests shown on the plasticity chart on Figure C4-4 in Appendix C indicate that the cohesive deposit can be classified as clayey silt of low plasticity.

Grain size distribution tests carried out on three samples of cohesive till deposit and the results are provided on Figure C4-5 in Appendix C.

The water content measured on samples of the cohesive till deposit range between about 14 per cent to 24 per cent.

## 5.5 Culvert No. 06X-0426/C0

The fieldwork for the foundation investigation at Culvert No. 06X-0426/C0 consisted of Boreholes BH-20-09, BH-20-10 and BH-21-02, advanced at the shoulder of Highway 3, near the proposed south and north end of the culvert extension (see Drawing 6).

In summary, the subsurface conditions encountered at borehole locations consist of granular fill material underlain by cohesive till deposit extending to the maximum depth of investigation of 15.8 m (Elevation 179.8).

### 5.5.1 Fill

A 0.7 m to 1.5 m thick granular fill consisting of gravelly sand to sand and gravel, some silt was encountered in Boreholes BH-20-09 and BH-21-02, immediately below the ground surface.

The SPT “N” values recorded within the fill ranges between 11 blows and 53 blows per 0.3 m of penetration, indicating compact to very dense compactness condition.

The water content measured on samples of the granular fill ranged between 5 per cent and 9 per cent.

### 5.5.2 Clayey Silt to Silty Clay (Till)

A cohesive till deposit consisting of silty clay underlain by clayey silt, some sand and trace gravel, was encountered in Borehole BH-20-10 at ground surface and in Boreholes BH-20-09, and BH-21-02 underlying the fill material at depths of 0.7 m and 1.5 m below ground surface (Elevations 194.4 m and 194.2 m), respectively. Boreholes BH-20-09, BH-20-10 and BH-21-02 terminated in the till deposit at a depth of between 9.8 m and 15.8 m below ground surface (Elevation 185.3 m and 179.9 m), respectively. Within samples of the cohesive till deposit discontinuous 0.1 m thick layers of fine sand and silt were observed.

The SPT “N” values recorded within the cohesive till ranged from 5 blows to 29 blows per 0.3 m of penetration. In-situ vane tests were carried out within this deposit measured undrained shear strengths ranging from about 82 kPa to greater than 100 kPa and the sensitivity ranges from about 1.6 to 1.8. The in-situ field vane test results together with the SPT “N” values indicate that the clayey silt till deposit predominately has a firm to very stiff consistency.

Atterberg limits tests were carried out on ten samples of cohesive till deposit and measured liquid limits between about 31 per cent and 46 per cent, plastic limits between about 15 per cent and 30 per cent, and plasticity indices between about 13 per cent and 23 per cent. The results of the Atterberg limits tests shown on the plasticity chart on Figure C5-1 in Appendix C indicate that the cohesive deposit consists of low plasticity clayey silt to medium plasticity silty clay.

Grain size distribution tests carried out on seven samples of cohesive till deposit and the results are provided on Figure C5-2 in Appendix C.

The water content measured on samples of the cohesive till deposit range between about 17 per cent to 28 per cent.

In addition, a consolidation test carried out on a sample of the clayey silt till from a Shelby tube obtained from Borehole BH-21-02, and the results are summarized in Table 6. The results of the consolidation test are presented on Figure C5-3 in Appendix C.

**Table 3 Consolidation Parameters – Borehole BH-21-02**

Borehole No. and Sample No.	Sample Depth / Elevation (m)	$\sigma_{vo}'$	$\sigma_p'$	Void Ratio ( $e_0$ )	Compression Indices		OCR	Average $C_v$
					Cr	Cc		
BH 21-02 TW-1	7.6 – 8.2 (188.1 – 187.5)	141.7	153	0.57	0.010	0.116	1.1	4.5

Where:  $\sigma_{vo}'$  is the in-situ vertical effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
OCR is the overconsolidation ratio  
 $e_0$  is the initial void ratio  
Cc is the compression index  
Cr is the recompression index  
 $C_v$  is the coefficient of consolidation in  $m^2/\text{year}$

## 5.6 Culvert No. 06X-0427/C0

The fieldwork for the foundation investigation at Culvert No. 06X-0427/C0 consisted of Boreholes BH-20-11, BH-20-12 and BH-21-03 advanced at the shoulder of Highway 3, near the proposed south and north end of the culvert extension (see Drawing 7).

In summary, the subsurface conditions at borehole locations consist of fill and topsoil underlain by a cohesive till extending to the maximum depth of investigation of 15.7 m (Elevation 179.1).

### 5.6.1 Topsoil

A 0.3 m thick layer of topsoil was encountered in Borehole BH-20-12 at ground surface. The topsoil consisted of clayey silt, trace of sand and gravel and rootlets.

### 5.6.2 Fill

At ground surface in Boreholes BH-20-11 and BH-21-03 fill material consisting of sand to sand and gravel, some fines was encountered and extended to depths of 1.4 and 0.8 m below ground surface (Elevations 193.7 m and 194.0 m), respectively. Underlying the granular fill material, a layer of cohesive fill consisting of silty clay trace to some sand was encountered in Boreholes BH-20-11 and BH-21-03 and extended to depths of 3.0 m and 2.3 m below ground surface (Elevations 192.15 m and 192.5 m), respectively.

The SPT “N” values recorded within the granular fill material ranged from 10 blows to 29 blows per 0.3 m of penetration, indicating a compact compactness condition. The SPT “N” values recorded within the cohesive fill material ranged from 3 blows to 9 blows per 0.3 m of penetration, suggesting a soft to stiff consistency.

Atterberg limits test were carried out on a sample of cohesive fill material and measured a liquid limit of 55 per cent, a plastic limit of 22 per cent, and a plasticity index of 33 per cent, indicating a silty clay of high plasticity. The results of the Atterberg limits test are shown on the plasticity chart on Figure C6-1 in Appendix C.

Grain size distribution tests carried out on one sample of granular fill material and one sample of the cohesive fill material are shown on Figures C6-2 and C6-3 in Appendix C, respectively.

The water content measured on samples of the granular fill material range between about 7 per cent to 24 per cent and the water content measured on samples of the cohesive fill material range between about 18 per cent and 30 per cent.



### 5.6.3 Clayey Silt to Silty Clay (Till)

A cohesive till deposit consisting of silty clay underlain by clayey silt, some sand and trace gravel, was encountered underlying the cohesive fill material in Boreholes BH-20-11 and BH-21-03 and underlying the topsoil in Borehole BH-20-12 at depths of 0.3 m and 3.0 m below ground surface (Elevations 194.3 m and 192.1 m). Boreholes BH-20-11, BH-20-12 and BH-21-03 terminated in the cohesive till deposit at depths of between 9.8 m and 15.7 m below ground surface (Elevation 185.3 m and 179.1 m). Within samples of the cohesive till deposit discontinuous 0.1 m thick layers of fine sand and silt were observed.

The SPT “N” values recorded within the cohesive till deposit ranged from 2 blows to 32 blows per 0.3 m of penetration. In-situ vane tests were carried out within this deposit measured undrained shear strengths ranging from about 73 kPa to greater than 100 kPa and the sensitivity ranges from about 1.7 to 2.8. The in-situ field vane test results together with the SPT “N” values indicate that the cohesive till deposit predominately has a firm to hard consistency.

Atterberg limits tests were carried out on six samples of cohesive till deposit and measured liquid limits between about 25 per cent and 41 per cent, plastic limits between about 13 per cent and 20 per cent, and plasticity indices between about 12 per cent and 21 per cent. The results of the Atterberg limits tests shown on the plasticity chart on Figure C6-4 in Appendix C indicate that the cohesive deposit consists of low plasticity clayey silt to medium plasticity silty clay.

Grain size distribution tests carried out on five samples of cohesive till deposit and the results are provided on Figure C6-5 in Appendix C.

The water content measured on samples of the cohesive till deposit range between about 17 per cent to 27 per cent.

## 5.7 Culvert No. 06X-0429/C0

The fieldwork for the foundation investigation at Culvert No. 06X-0429/C0 consisted of Boreholes BH-20-13, BH-20-14, BH-21-04 and BH-21-05. These boreholes were advanced at the shoulder of Highway 3 (BH-20-13), near the end of the proposed south extension (BH-20-14), and near the end of proposed north extension (BH-21-04 and BH-21-05) (see Drawing 8).

In summary, the subsurface conditions at borehole locations consists of topsoil or fill underlain by a cohesive and granular till deposit extending to the maximum depth of investigation of 15.8 m (Elevation 179.2).

### 5.7.1 Topsoil

Topsoil was encountered in Boreholes BH-20-14 and BH-21-04 at ground surface and extended to a depth of 0.4 m and 0.2 m below ground surface. The topsoil consists of clayey silt, trace of sand and gravel and rootlets.

### 5.7.2 Fill

A 0.7 m thick layer of granular fill material consisting of sand and gravel, some clay, trace silt was encountered in Borehole BH-20-13 at ground surface. Underlying the topsoil in Borehole 21-04 and at ground surface in Borehole BH-21-05 a 0.7 m thick layer of silty clay fill material, some sand, trace to some gravel was encountered.

The SPT “N” values recorded within the granular fill material was 6 blows per 0.3 m of penetration, indicating a loose compactness condition. The SPT “N” recorded values within the silty clay fill material was 2 blows and 10 blows per 0.3 m of penetration, suggesting a soft to stiff consistency.

The water content measured on a sample of the granular fill material was about 10 per cent and the water content measured on samples of the cohesive fill material was about 22 per cent.

### 5.7.3 Clayey Silt and Sand to Silty Clay (Till)

Underlying the topsoil and/or fill material, a cohesive till deposit consisting of silty clay underlain by clayey silt, some sand and trace gravel to clayey silt and sand, was encountered at depths of 0.4 m and 0.8 m below ground surface (Elevations 194.6 m and 193.2 m). Within the till deposit in Borehole BH-21-05 the till consists of sand and gravel and was encountered at depths of between 6.1 m to 7.6 m below ground surface (between Elevation 189.2 m and 187.7 m). Granular till consisting of sandy silt to sand was encountered in Boreholes BH-21-04 and BH-21-05 at a depth of 13.7 m below ground surface (between Elevation 181.6 m and 181.3 m). Boreholes BH-21-04 and BH-21-05 terminated within this granular till deposit at a depth of 15.8 m below ground surface (between Elevations 179.5 m and 179.2 m). Boreholes BH-20-13 and BH-20-14 terminated in the cohesive till deposit at depths of between 9.8 m and 11.3 m below ground surface (Elevation 185.5 m and 183.4 m). Within samples of the cohesive till deposit discontinuous 0.15 m thick layers of fine sand and silt were observed.

The SPT “N” values recorded within the cohesive till deposit range from 4 blows to 58 blows per 0.3 m of penetration. In-situ vane tests were carried out within this deposit measured undrained shear strengths ranging from about 47 kPa to greater than 100 kPa and the sensitivity ranges from about 1.3 to 1.8. The in-situ field vane test results together with the SPT “N” values indicate that the cohesive till deposit predominately has a firm to hard consistency. The SPT “N” values recorded within the granular till deposit range from 7 blows to 80 blows per 0.3 m of penetration, suggesting a loose to very dense compactness condition.

The Atterberg Limit testing carried out on 13 samples of cohesive till gave liquid limit values ranging from 23% to 45%, plastic limit values ranging from 14% to 20%, resulting in plasticity index values ranging from 9% to 23%. Based on these values, the soil may be classified as clayey silt of low plasticity (CL) or silty clay of intermediate plasticity (CI) in the Unified Soil Classification System (USCS). The plasticity chart is provided on Figure C7-1 in Appendix C.

Atterberg limits tests were carried out on thirteen samples of cohesive till and measured liquid limits between about 23 per cent and 45 per cent, plastic limits between about 14 per cent and 20 per cent, and plasticity indices between about 9 per cent and 23 per cent. Based on these values, the upper portion of the till deposit may be classified as silty clay of medium plasticity and beneath the silty clay till deposit the till is classified as clayey silt with low plasticity. The results of the Atterberg limits tests are shown on the plasticity chart on Figures C7-1A and C7-1B in Appendix C.

Grain size distribution tests carried out on eight samples of cohesive till deposit and the results are provided on Figure C7-2 in Appendix C. Grain size distribution tests carried out on two samples of the granular till deposit and the results are provided on Figure C7-3 in Appendix C.

The water content measured on samples of the cohesive till deposit range between about 15 per cent to 37 per cent and the water content measured on samples of the silty sand to sand and gravel till deposit range between about 8 per cent to 26 per cent.

In addition, a consolidation test carried out on a clayey silt sample from Borehole BH-21-04, and the results are summarized in Table 10. The results of the consolidation test are presented on Figure C7-4 in Appendix C.

**Table 4 Consolidation Test results - BH-21-04**

Borehole No. and Sample No.	Sample Depth / Elevation (m)	$\sigma_{vo}'$	$\sigma_p'$	Void Ratio ( $e_0$ )	Compression Indices		OCR	Average $C_v$
					Cr	Cc		
BH-21-04 TW-2	6.1 – 6.7 188.9 – 188.4	125.5	145	0.64	0.010	0.116	1.16	3.7

Where:  $\sigma_{vo}'$  is the in-situ vertical effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
OCR is the overconsolidation ratio  
 $e_0$  is the initial void ratio  
Cc is the compression index  
Cr is the recompression index  
 $C_v$  is the coefficient of consolidation in  $m^2/\text{year}$

## 5.8 Culvert No. 06X-0432/C0

The fieldwork for the foundation investigation at Culvert No. 06X-0432/C0 consisted of Boreholes BH-20-15, BH-20-16 and BH-21-06. These boreholes were advanced at the shoulder of Highway 3 (BH-20-11), near the end of the proposed south extension (BH-20-12), and near the end of proposed north extension (BH-21-03) (see Drawing 9).

In summary, the subsurface conditions at borehole locations consists of topsoil or fill underlain by a cohesive and granular till deposit extending to the maximum depth of investigation of 11.3 m (Elevation 184.7).

### 5.8.1 Topsoil

A 0.2 m thick layer of topsoil was encountered in Borehole BH-20-16 at ground surface. The topsoil consists of clayey silt, trace of sand and gravel.

### 5.8.2 Fill

A 0.7 m to 0.8 m thick layer of granular fill consisting of gravelly sand to sand and gravel was encountered at ground surface in Boreholes BH-20-15 and BH-21-06. The granular fill material is underlain by a layer of silty clay with sand fill material that extends to depths of 2.2 m and 2.3 m below ground surface (Elevation 193.7 m).

The SPT “N” values recorded within the granular fill were 9 blows and 15 blows per 0.3 m of penetration, suggesting a loose to compact compactness condition. The SPT “N” values recorded within the cohesive fill range from 3 blows to 14 blows per 0.3 m of penetration, suggesting a soft to stiff consistency.

Atterberg limits test were carried out on two samples of cohesive fill material and measured liquid limits of 32 per cent and 39 per cent, plastic limits of 15 per cent and 18 per cent, and plasticity indices of 13 per cent and 18 per cent, indicating a silty clay of medium plasticity. The results of the Atterberg limits test are shown on the plasticity chart on Figure C8-1 in Appendix C.

Grain size distribution tests carried out on two samples of granular fill material are shown on Figure C8-2 in Appendix C.

The water content measured on samples of the granular fill material were about 10 per cent and 12 per cent and the water content measured on samples of the cohesive fill material range from 12 per cent to 28 per cent.

### 5.8.3 Clayey Silt to Silty Clay (Till)

Underlying the fill material in Boreholes BH-20-15 and BH-21-06 and underlying the topsoil in Borehole BH-20-16 a cohesive till deposit consisting of clayey silt with sand to clayey silt, some sand, trace gravel was encountered at depths of between 0.2 m and 2.3 m below ground surface (between Elevations 194.2 m and 193.7 m). The cohesive till deposit in Borehole BH-20-16 contains granular till layers consisting of silt and sand, trace clay to silty sand, trace gravel, trace clay between depths of 2.1 m to 5.6 m below ground surface (between Elevations 192.5 m and 189.0 m). In Borehole BH-21-06 a granular till consisting of silty sand, trace to some gravel was encountered underlying the cohesive till at a depth of 9.1 m below ground surface (Elevation 186.9 m). Borehole BH-21-06 terminated within the granular till deposit at a depth of 11.3 m below ground surface (Elevation 184.7 m). Boreholes BH-20-15 and BH-20-16 terminated within the cohesive till deposit at a depth of 9.8 m below ground surface (between Elevation 186.1 m and 184.8 m). Silty sand lenses with thicknesses of less than 0.1 m were also detected through the cohesive till layer.

The SPT “N” values recorded within the cohesive till deposit range from 10 blows to 33 blows per 0.3 m of penetration, suggesting a stiff to hard consistency. The SPT “N” values recorded within the granular till deposit ranged from 15 blows to 29 blows per 0.3 m of penetration, suggesting a compact compactness condition.

Atterberg limits tests were carried out on five samples of cohesive till deposit and measured liquid limits between about 25 per cent and 33 per cent, plastic limits between about 13 per cent and 18 per cent, and plasticity indices between about 10 per cent and 15 per cent. The results of the Atterberg limits tests shown on the plasticity chart on Figure C8-3 in Appendix C indicate that the cohesive deposit consists of low to medium plasticity clayey silt.

Grain size distribution tests carried out on three samples of cohesive till deposit and the results are provided on Figure C8-4 in Appendix C. Grain size distribution tests carried out on three samples of the granular till deposit and the results are provided on Figure C8-5 in Appendix C.

The water content measured on samples of the cohesive till deposit range between about 12 per cent to 27 per cent and the water content measured on samples of the granular till deposit range between about 10 per cent to 66 per cent.

## 5.9 Groundwater

Groundwater observations and measurements were obtained from the open boreholes during and upon completion of drilling each borehole. A monitoring well was installed in Boreholes BH-21-01, BH-21-03 and BH-21-06 to monitor the groundwater levels at the borehole locations. The water levels measured in the open boreholes and the monitoring wells are summarized in Table 3 below.

**Table 5** Summary of Groundwater Level Measurements

Culvert Number	Borehole Number	Water Level Depth (m)	Water Level Elevation (m)	Date of Observation (Measurement)	Remark
06X-0420/C0	BH-20-01	Dry	--	April 27, 2020	Upon completion of drilling
	BH-20-02	Dry	--	April 27, 2020	
06X-0421/C0	BH-20-03	2.2	193.1	April 28, 2020	
	BH-20-04	Dry	--	April 28, 2020	
06X-0422/C0	BH-20-05	Dry	--	April 28, 2020	
	BH-20-06	6.1	188.3	April 28, 2020	
06X-0423/C0	BH-20-07	Dry	--	April 30, 2020	

Culvert Number	Borehole Number	Water Level Depth (m)	Water Level Elevation (m)	Date of Observation (Measurement)	Remark
	BH-20-08	Dry	--	April 30, 2020	Monitoring well
	BH-21-01	Dry	--	April 10, 2021	
		0.9	193.9	November 24, 2021	
06X-0426/C0	BH-20-09	Dry	--	April 30, 2020	Upon completion of drilling
	BH-20-10	10.7	182.6	May 1, 2020	
	BH-21-02	Dry	--	November 10, 2021	
06X-0427/C0	BH-20-11	1.2	193.9	May 1, 2020	
	BH-20-12	4.9	189.7	May 1, 2020	
	BH-21-03	Dry	--	May 10, 2021	
		5.1	189.6	November 24, 2021	Monitoring well
06X-0429/C0	BH-20-13	0.8	194.5	May 4, 2020	Upon Completion of Drilling
	BH-20-14	6.1	188.6	May 4, 2020	
	BH-21-04	10.4	184.6	November 11, 2021	
	BH-21-05	11.5	183.8	November 10, 2021	
06X-0432/C0	BH-20-15	1.8	194.1	May 19, 2020	
	BH-20-16	2.4	192.2	May 19, 2020	
	BH-21-06	7.6	188.4	October 5, 2021	
		8.4	187.6	November 24, 2021	Monitoring well

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

## 5.10 Analytical Testing Results

Soil corrosivity chemical test consisting of pH, water soluble sulphate, sulphide, chloride and resistivity was conducted on a total of twelve samples. A summary of the test results is provided in Table 4. The test methods and test results are provided in Appendix D.

**Table 6** Soil Corrosivity Test Results

Culvert Number	Borehole No.	Sample No.	Depth (Elevation) (m)	Sulphate (µg/g)	Sulphide (µg/g)	Chloride (µg/g)	pH	Resistivity (Ohm-cm)
06X-0420/C0	BH-20-02	SS-6	4.8 (189.5)	510	< 5	13	7.78	1870
06X-0421/C0	BH-20-03	SS-6	3.0 (191.3)	980	< 5	129	7.80	1240
06X-0422/C0	BH-20-05	SS-6	4.8 (189.7)	800	< 5	71	7.69	1410
06X-0423/C0	BH-20-08	SS-5	3.2 (192.3)	510	< 5	12	7.68	1880
	BH-21-01	SS-4	2.6 (192.3)	729	<0.2	80.3	7.48	1180
06X-0426/C0	BH-20-10	SS-6	4.9 (189.8)	580	< 5	16	7.70	1730
	BH-21-02	SS-5	3.3 (192.4)	166	0.23	133	7.89	2070
06X-0427/C0	BH-20-11	SS-5	3.3 (191.8)	130	< 5	230	7.75	2060



Culvert Number	Borehole No.	Sample No.	Depth (Elevation) (m)	Sulphate (µg/g)	Sulphide (µg/g)	Chloride (µg/g)	pH	Resistivity (Ohm-cm)
	BH-21-03	SS-4	2.6 (192.2)	840	<0.2	263	7.46	857
06X-0429/C0	BH-20-13	SS-5	3.3 (192.0)	30	< 5	171	7.71	2880
	BH-21-04	SS-5	3.5 (191.5)	84	<0.2	133	7.61	1600
06X-0432/C0	BH-20-16	SS-5	3.3 (191.3)	280	< 5	30	7.70	2420

## 6. Closure

The fieldwork was supervised by Mr. Moe Nasir, E.I.T. and Mr. Manvit Reddy Mettupalli, E.I.T. under the direction of Mr. Nirjar Vyas, M.Eng., P.Eng., and Ms. Sandra McGaghran M.Eng., P.Eng.

This report was prepared by Ms. Sahar Soleimani, Ph.D., P.Eng, a Senior Geotechnical Engineer with GHD. Ms. Sandra McGaghran, M.Eng., P.Eng., a Senior Geotechnical Engineer with GHD and MTO Foundations Designated Contact conducted an independent review of the report.

Sincerely,

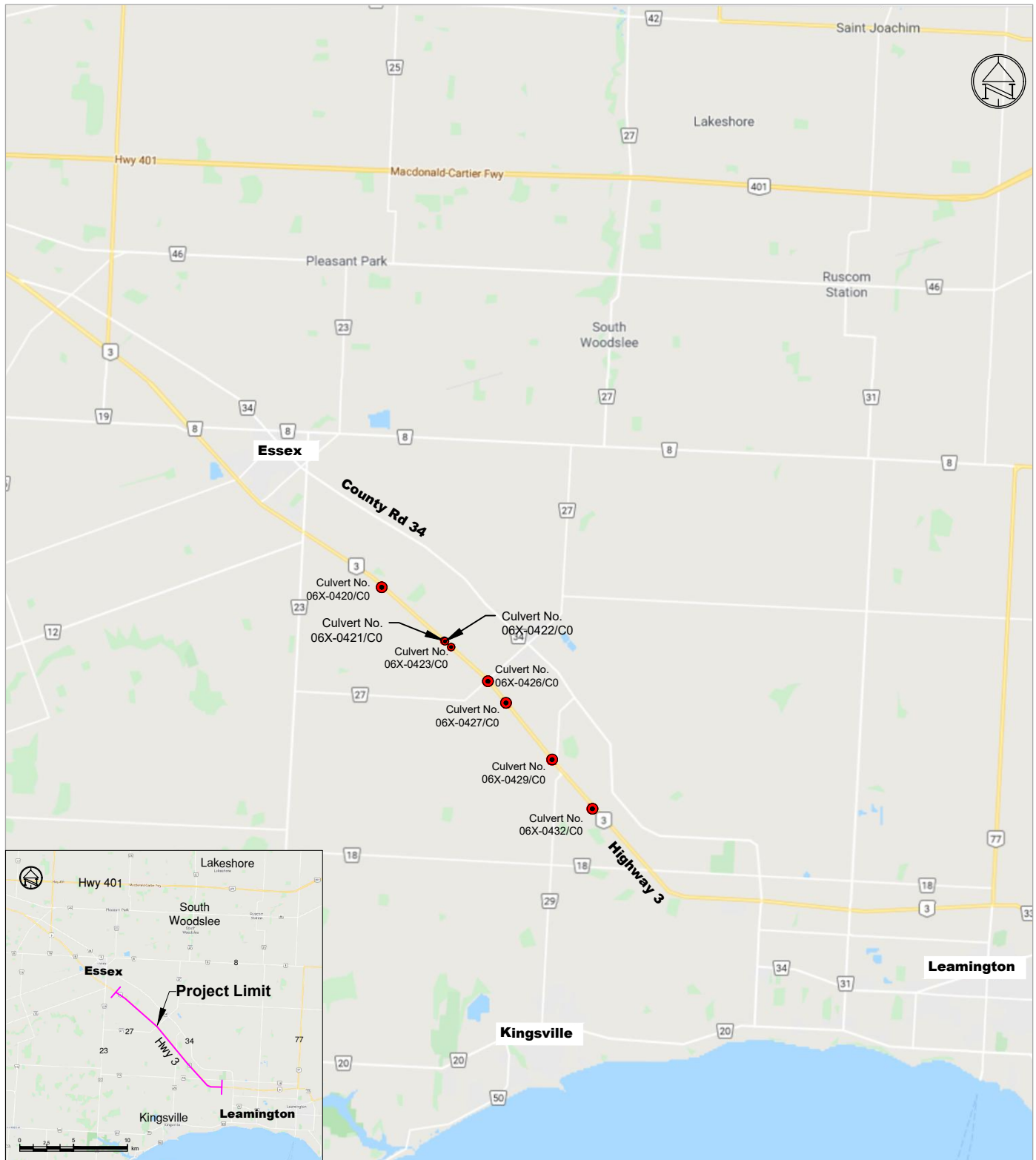
GHD Limited




Sahar Soleimani, Ph.D., P.Eng.  
Senior Geotechnical Engineer



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



LEGEND:  Culvert Location



REFERENCE: Google Map Data

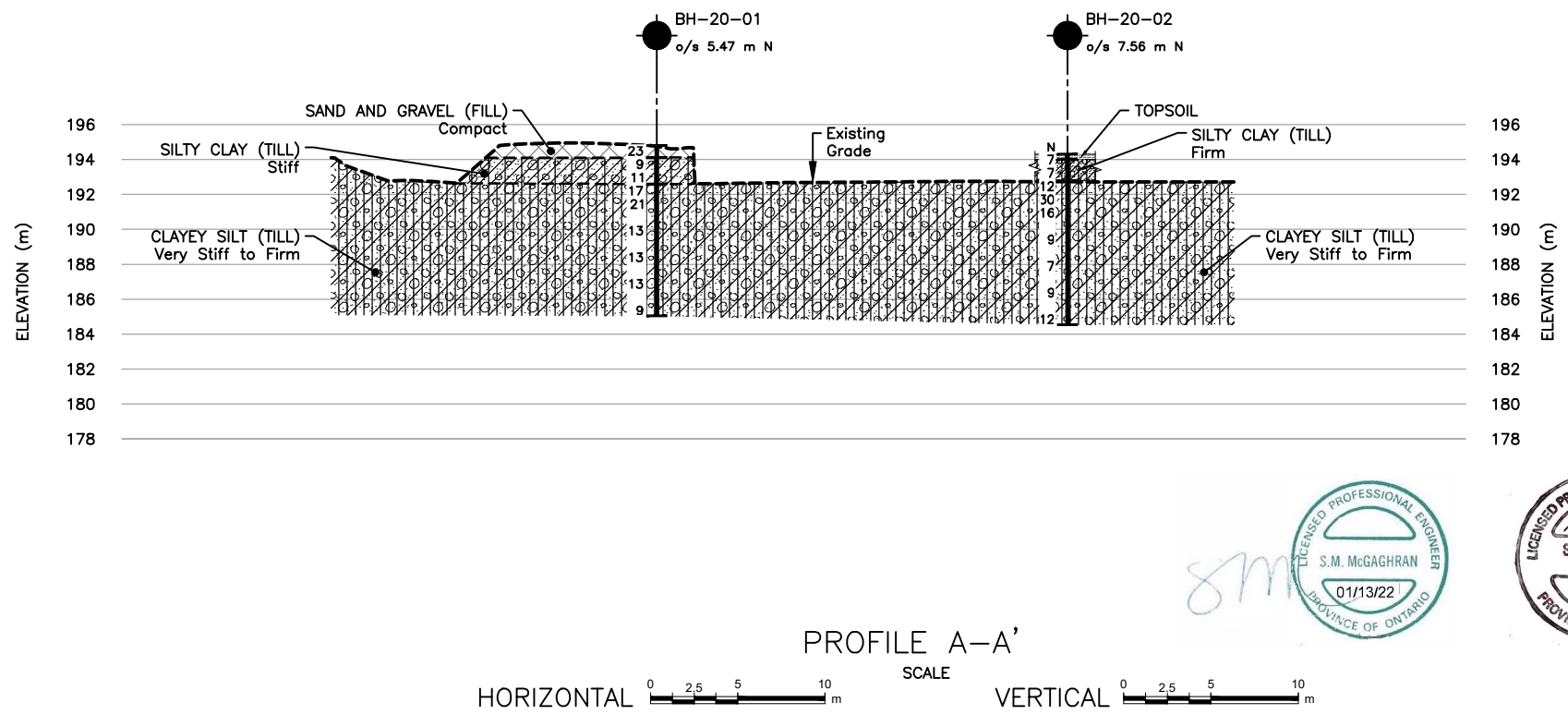
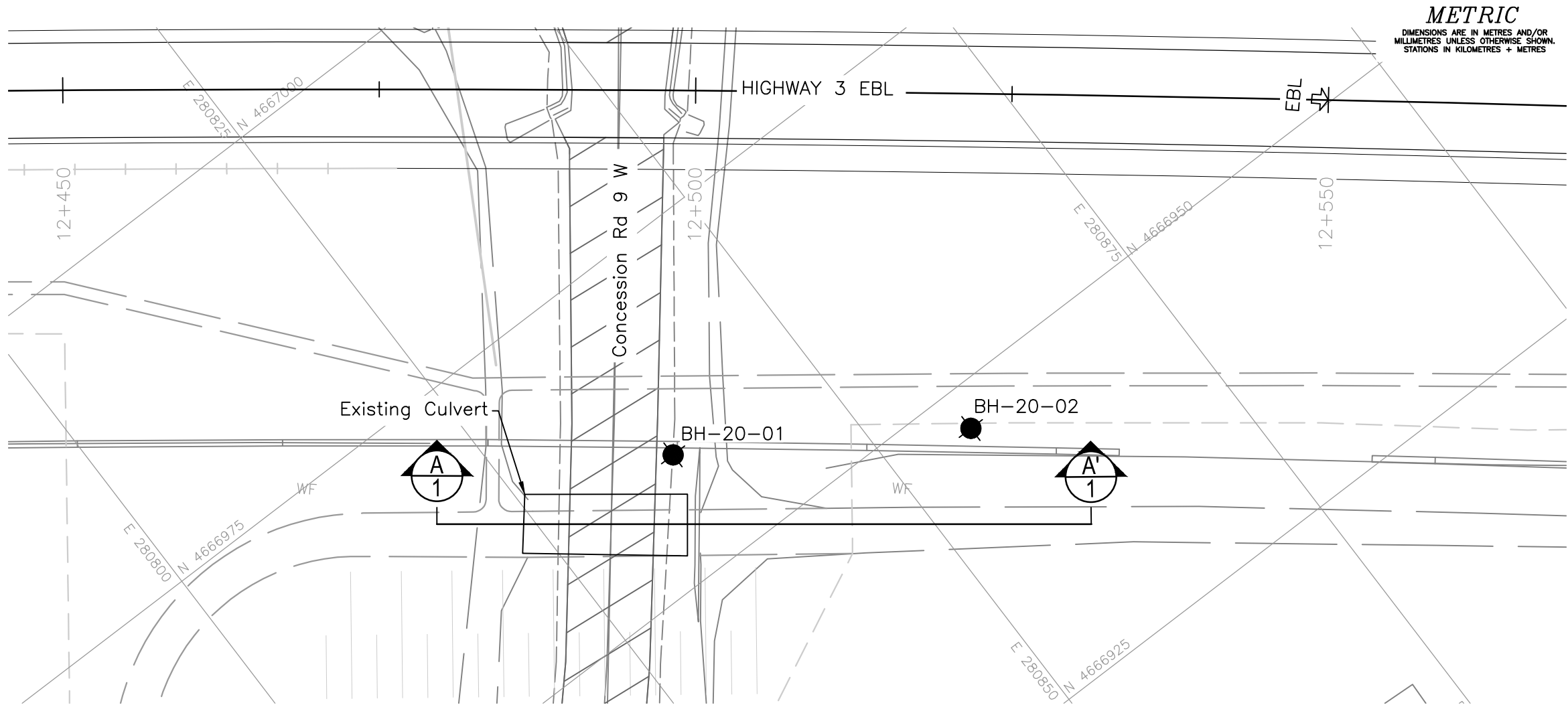
Assignment No.:	3017-E-0012	Geocres No.:	40J2-147
GWP:	3021-18-00	Hwy No.:	3
Township:	Gosfield North and Gosfield South		
District:	Chatham		
Drawn:	AW	Project No.:	11202866
Checked:	SS	Date:	1.10.2022
Reviewed:	SS	Revision:	
Approved:	SMM	Drawing:	1



## Key Plan

Foundation Investigation and Design

Hwy 3 Widening, Windsor to Leamington, Phase 3 - Contract 2



CONT No.  
GWP No. 3021-18-00

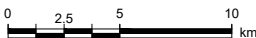


CULVERT No. 06X-0420/C0  
HIGHWAY 3  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEY PLAN  
SCALE



### LEGEND

- Borehole
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test. 475 j/blow)

### BOREHOLE CO-ORDINATES (MTM ZONE 11)

NO	ELEVATION	NORTHING	EASTING
BH-20-01	194.8	4666959.4	280836.9
BH-20-02	194.3	4666946.7	280856.9

### NOTES

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### REFERENCE

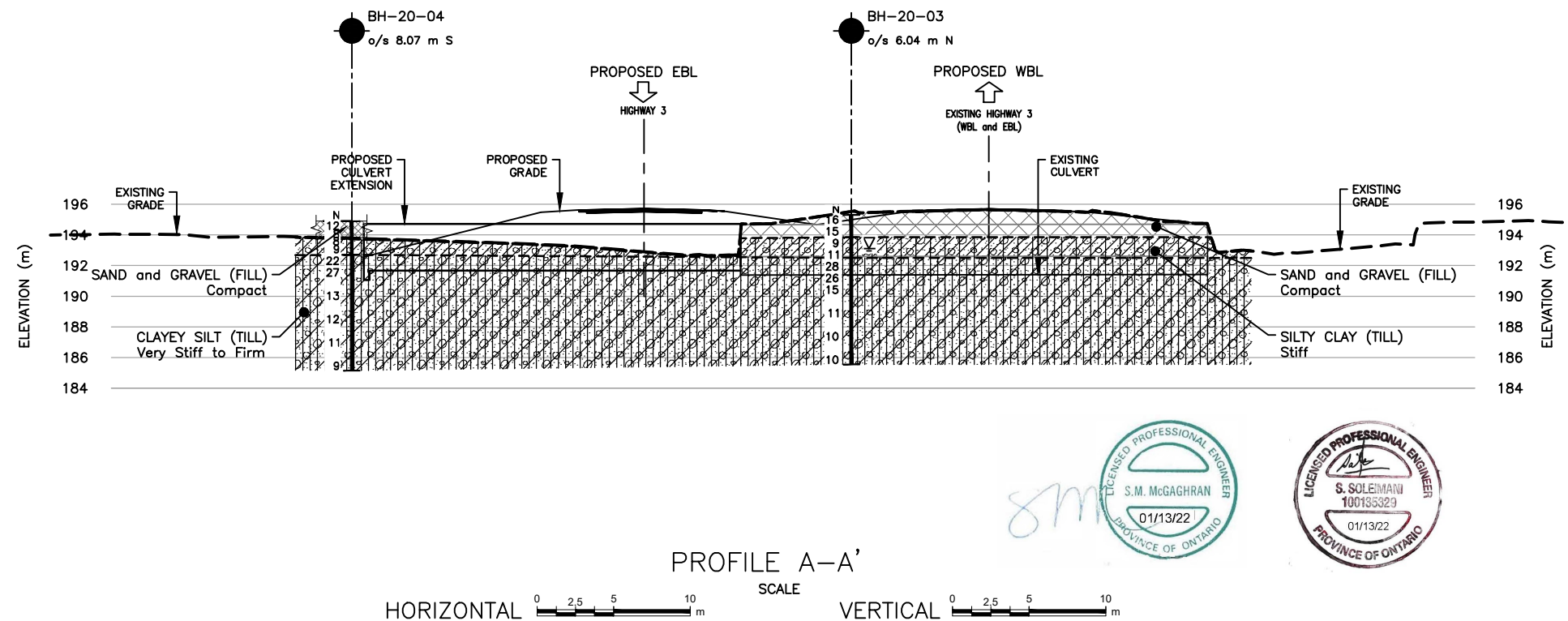
Base plans provide in digital format by Callon Dietz, drawing file: B-117-003-1 DB, B-116-003-1 DB, received March 5, 2021.

NO.	DATE	BY	REVISION

Geocres No.: 40J2-147

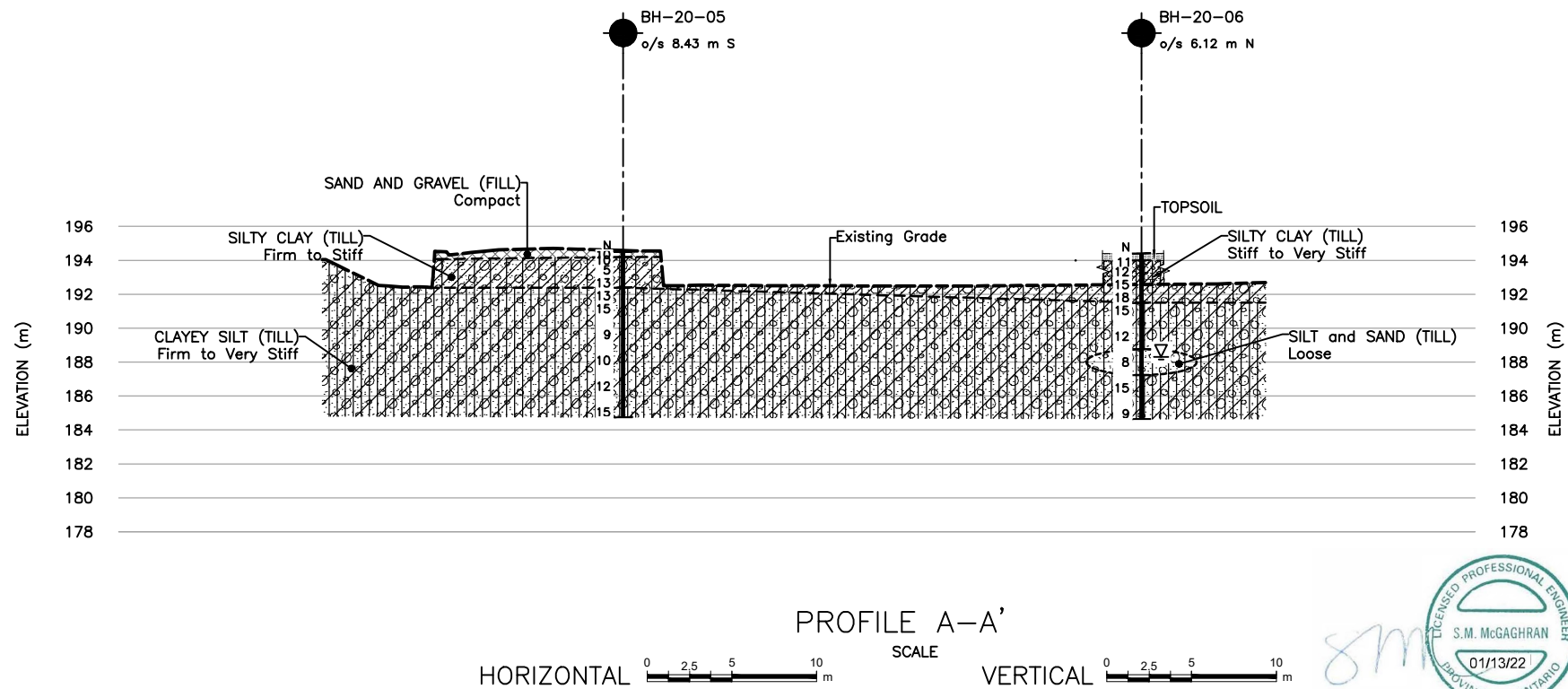
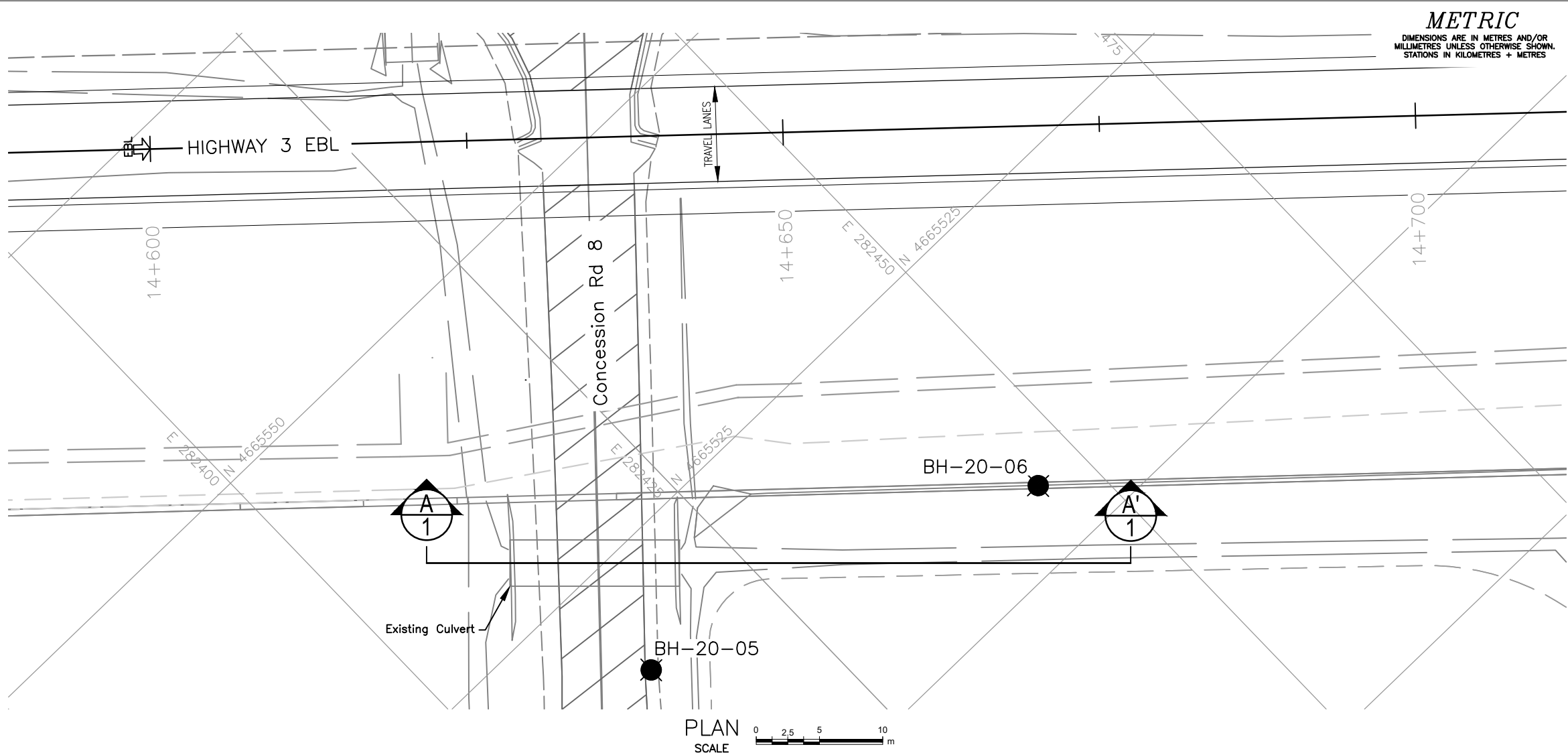
HWY. 3	PROJECT NO. 11202886	DIST. CHATHAM
SUBM'D. MN	CHKD. SS	DATE: 1.10.2022
DRAWN: AW	CHKD. SS	APPD. SMM

SITE: 06X-0420/C0  
DWG. 2



NO.	DATE	BY	REVISION	
Geocres No.: 40J2-147				
HWY. 3		PROJECT NO. 11202886		DIST. CHATHAM
SUBM'D. MN	CHKD. SS	DATE:1.10.2022		SITE: 06X--0421/co
DRAWN: AW	CHKD. SS	APPD. SMM		DWG. 3





CONT No.  
GWP No. 3021-18-00

CULVERT No. 06X-0422/C0  
HIGHWAY 3  
BOREHOLE LOCATIONS AND SOIL STRATA

GHD

KEY PLAN  
SCALE

0 2.5 5 10 km

**LEGEND**

- Borehole
- N Standard Penetration Test Value  
Blows/0.3m unless otherwise stated  
(Std. Pen. Test. 475 j/blow)
- Water Level in open borehole upon completion of drilling

BOREHOLE CO-ORDINATES (MTM ZONE 11)			
NO	ELEVATION	NORTHING	EASTING
BH-20-05	194.5	4665516.3	282413.7
BH-20-06	194.4	4665505.6	282445.9

**NOTES**

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**REFERENCE**

Base plans provide in digital format by Callon Dietz, drawing file: B-117-003-1 DB, B-116-003-1 DB, received March 5, 2021.

NO.	DATE	BY	REVISION

Geocres No.: 40J2-147

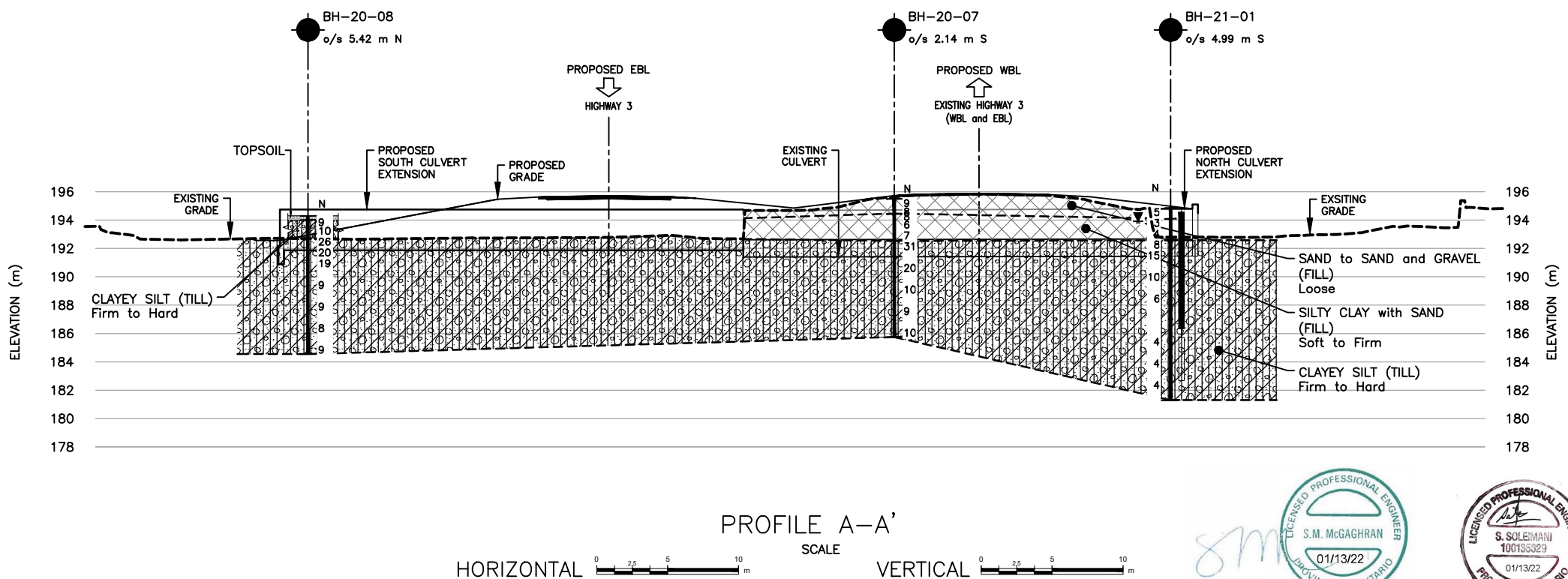
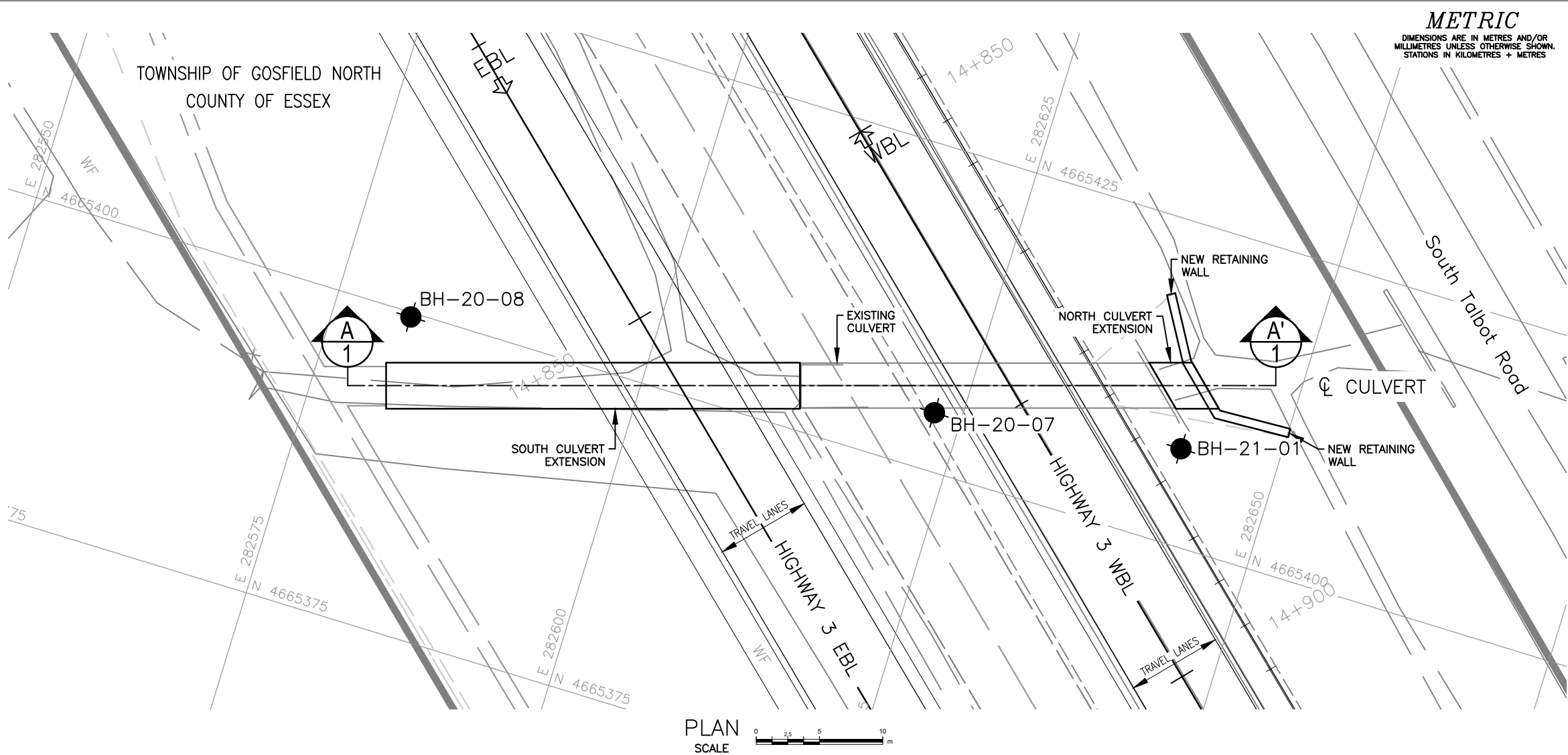
HWY. 3	PROJECT NO. 11202886	DIST. CHATHAM
SUBM'D. MN	CHKD. SS	DATE: 1.10.2022
DRAWN: AW	CHKD. SS	APPD. SMM

SITE: 06X-0422/C0  
DWG. 4

S.M. McGAGHRAN  
01/13/22  
PROVINCE OF ONTARIO

S. SOLEIMANI  
180135329  
01/13/22  
PROVINCE OF ONTARIO





CONT No.  
GWP No. 3021-18-00

CULVERT No. 06X-0423/C0  
HIGHWAY 3  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

**LEGEND**

- Borehole
- Seal
- Piezometer
- N Standard Penetration Test Value  
Blows/0.3m unless otherwise stated  
(Std. Pen. Test. 475 j/blow)
- Water Level in open borehole upon completion of drilling
- Water Level measured in piezometer (Nov. 24/2021)

BOREHOLE CO-ORDINATES (MTM ZONE 11)			
NO	ELEVATION	NORTHING	EASTING
BH-20-07	195.5	4665404.5	282622.8
BH-20-08	194.3	4665399.6	282581.1
BH21-01	194.9	4665407.5	282642.3

**NOTES**

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**REFERENCE**

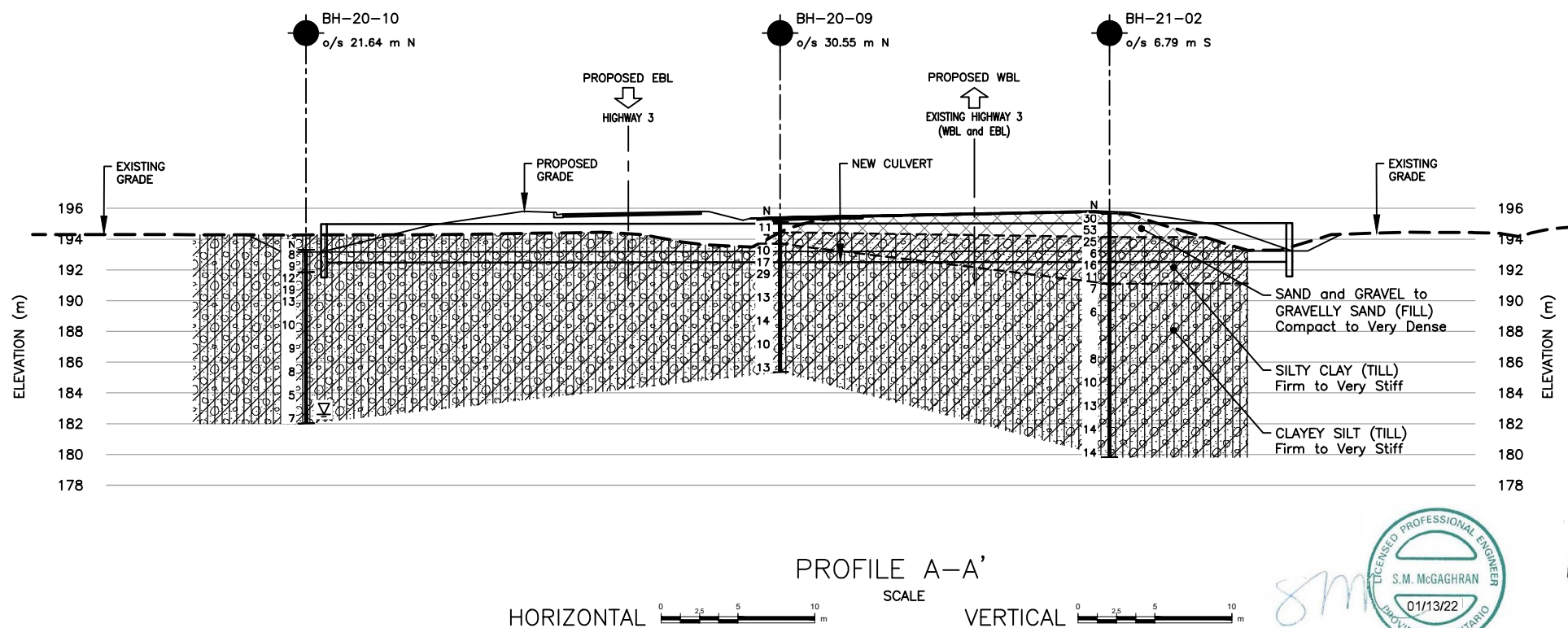
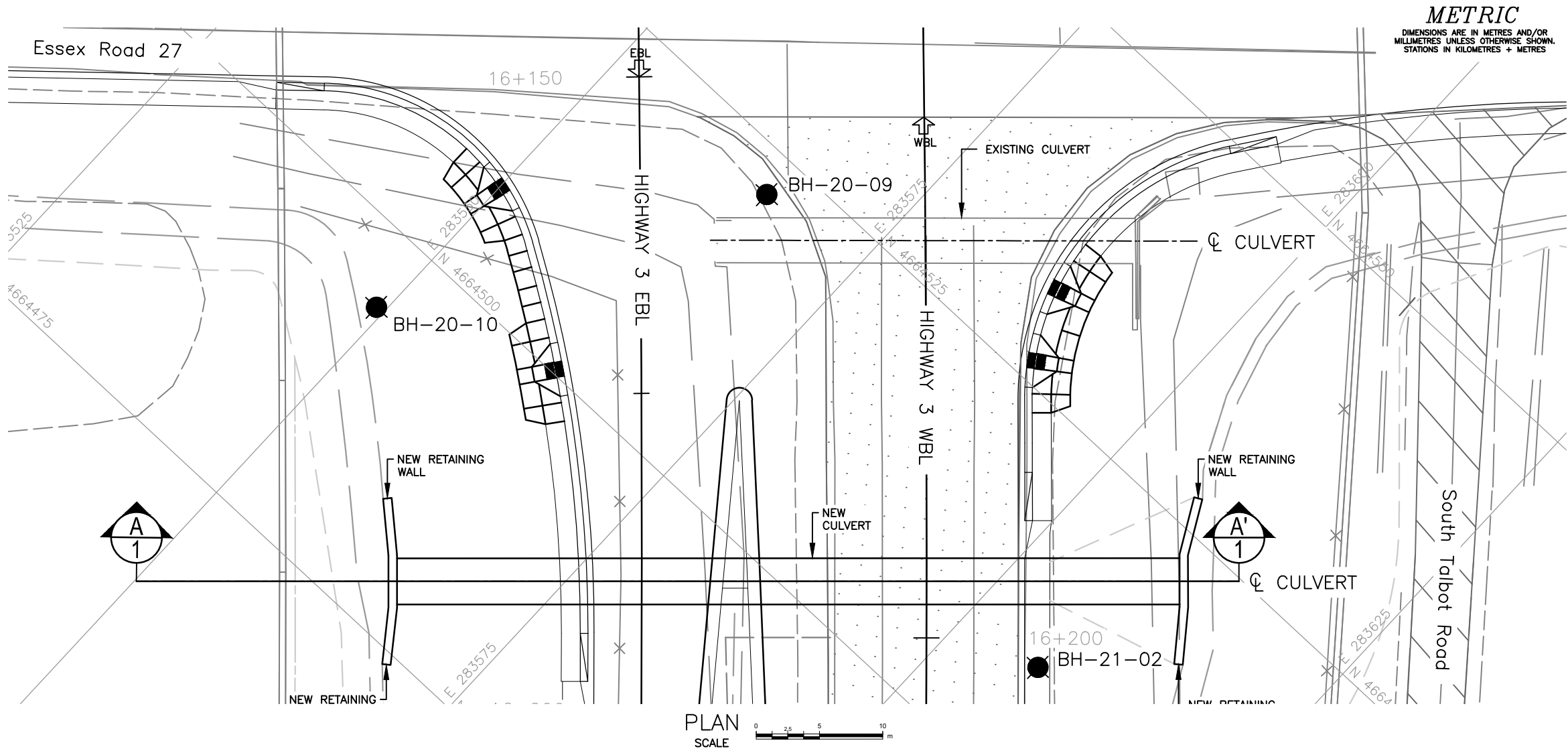
Base plans provide in digital format by Callon Dietz, drawing file: B-117-003-1 DB, B-116-003-1 DB, received March 5, 2021.

NO.	DATE	BY	REVISION

Geocres No.: 40J2-147

HWY. 3	PROJECT NO. 11202886	DIST. CHATHAM
SUBM'D. MN/MRM	CHKD. SS	DATE: 1.10.2022
DRAWN: AW	CHKD. SS	APPD. SMM

SITE: 06X-0423/C0  
DWG. 5



CONT No.  
GWP No. 3021-18-00

CULVERT No. 06X-0426/C0  
HIGHWAY 3  
BOREHOLE LOCATIONS AND SOIL STRATA

GHD

KEY PLAN  
SCALE

LEGEND

- Borehole
- N Standard Penetration Test Value  
Blows/0.3m unless otherwise stated  
(Std. Pen. Test. 475 j/blow)
- Water Level in open borehole upon completion of drilling

BOREHOLE CO-ORDINATES (MTM ZONE 11)

NO	ELEVATION	NORTHING	EASTING
BH-20-09	195.1	4664521.8	283565.9
BH-20-10	193.3	4664494.3	283549.3
BH21-02	195.7	4664509.0	283607.0

NOTES

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REFERENCE

Base plans provide in digital format by Callon Dietz, drawing file: B-117-003-1 DB, B-116-003-1 DB, received March 5, 2021.

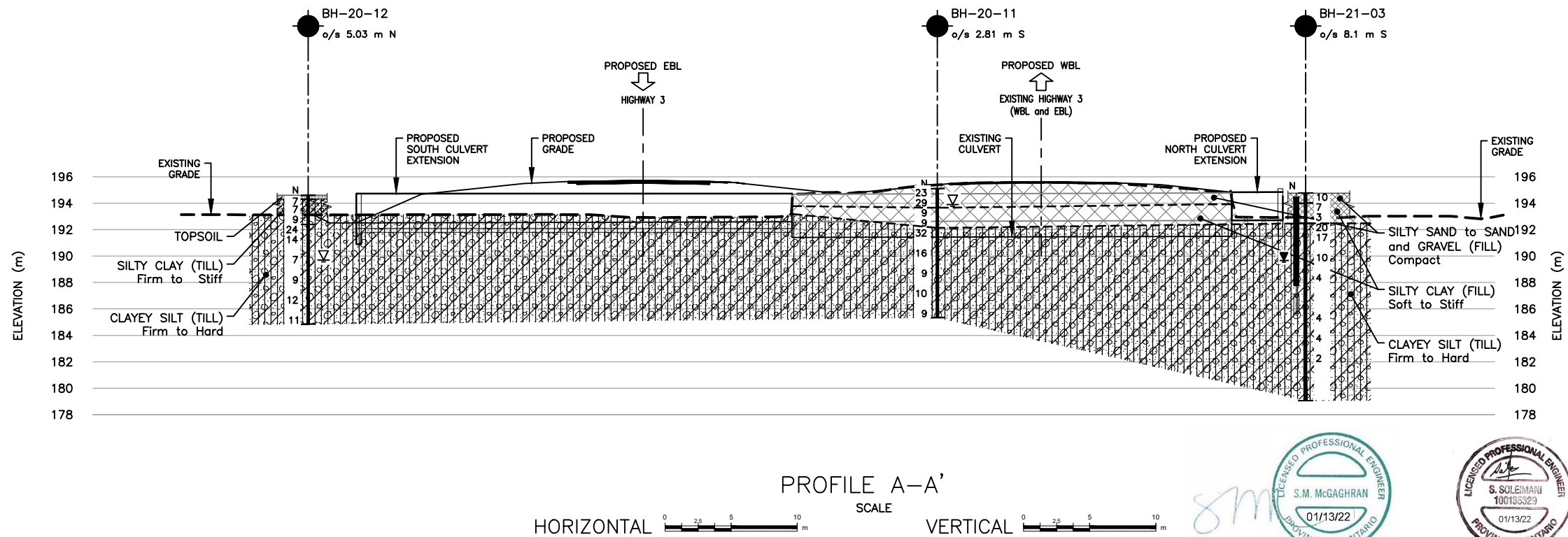
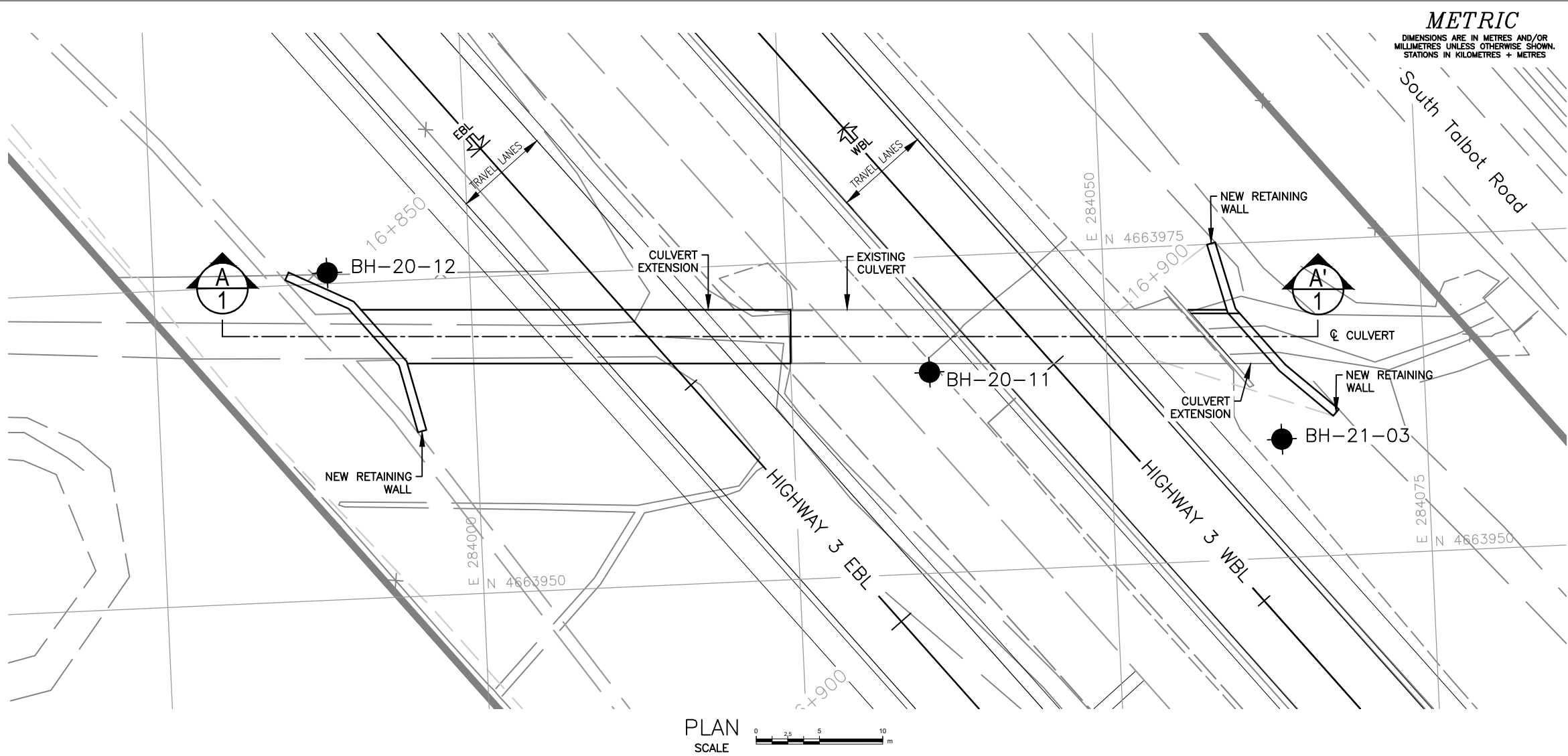
NO.	DATE	BY	REVISION

Geocres No.: 40J2-147

HWY. 3	PROJECT NO. 11202886	DIST. CHATHAM
SUBM'D. MN/MRM	CHKD. SS	DATE: 1.10.2022
DRAWN: AW	CHKD. SS	APPD. SMM

SITE: 06X-0426/C0  
DWG. 6





CONT No.  
GWP No. 3021-18-00

CULVERT No. 06X-0427/C0  
HIGHWAY 3  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



KEY PLAN  
SCALE

#### LEGEND

- Borehole
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test. 475 j/blow)
- Water Level in open borehole upon completion of drilling
- Water Level measured in piezometer (Nov. 24/2021)

#### BOREHOLE CO-ORDINATES (MTM ZONE 11)

NO	ELEVATION	NORTHING	EASTING
BH-20-11	195.1	4663965.9	284035.9
BH-20-12	194.6	4663975.9	283988.7
BH21-03	194.8	4663959.4	284063.5

#### NOTES

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#### REFERENCE

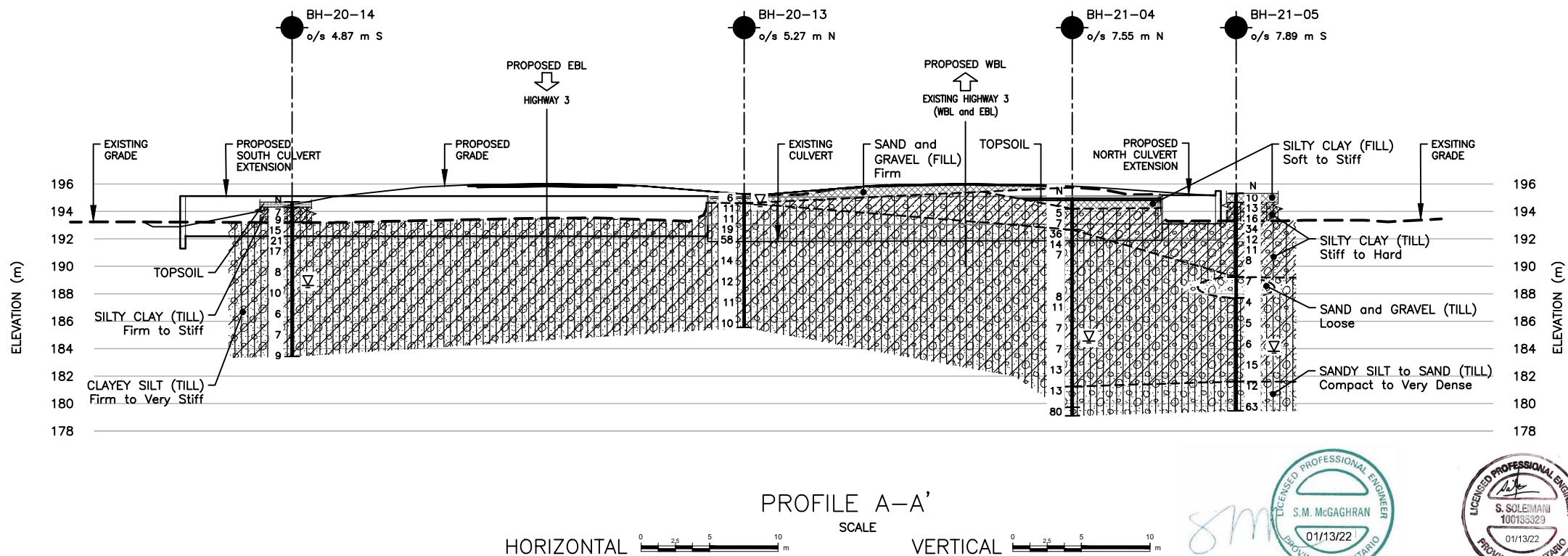
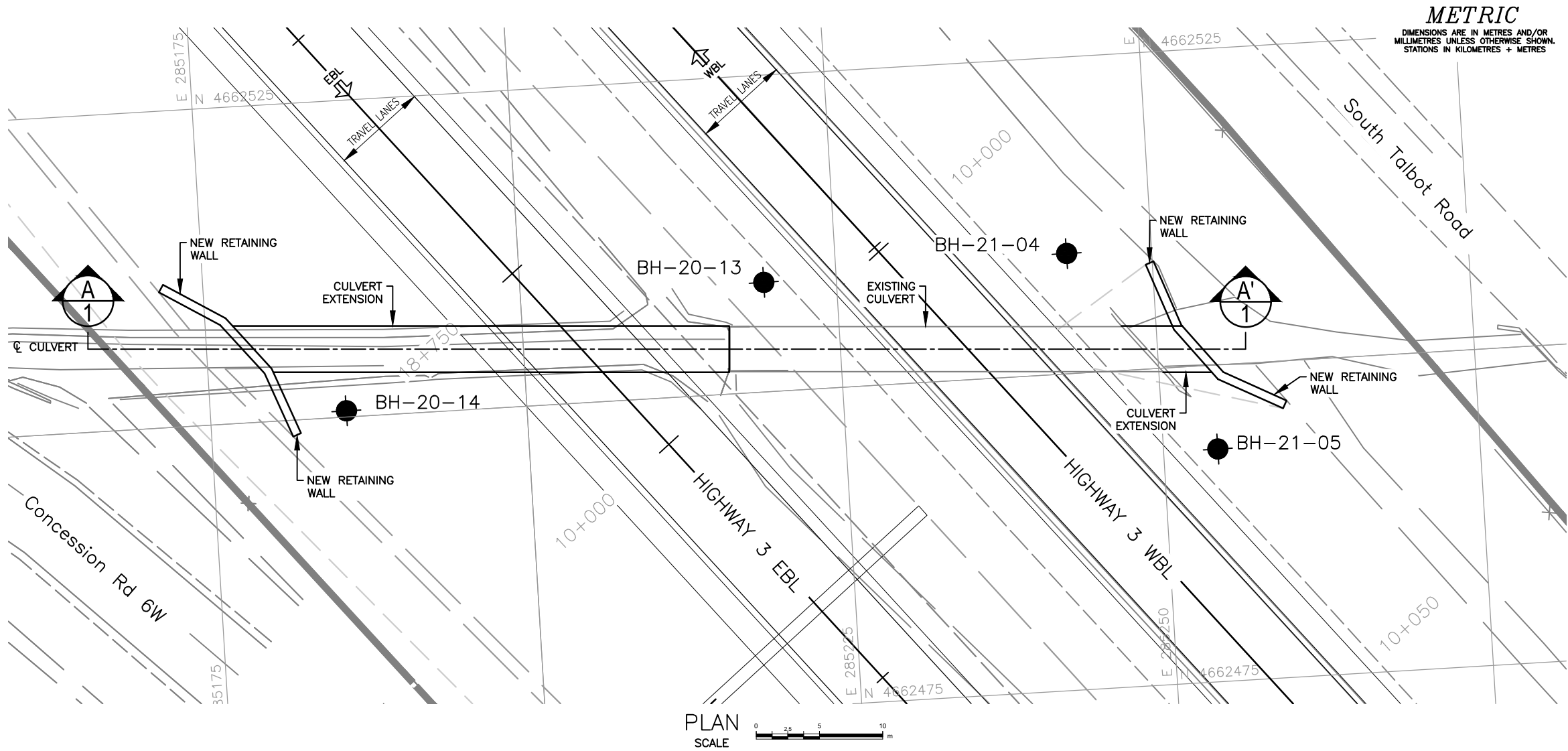
Base plans provide in digital format by Callon Dietz, drawing file: B-117-003-1 DB, B-116-003-1 DB, received March 5, 2021.

NO.	DATE	BY	REVISION

Geocres No.: 40J2-147

HWY. 3	PROJECT NO. 11202886	DIST. CHATHAM
SUBM'D. MN/MRM	CHKD. SS	DATE: 1.10.2022
DRAWN: AW	CHKD. SS	APPD. SMM
		SITE: 06X-0427/C0
		DWG. 7





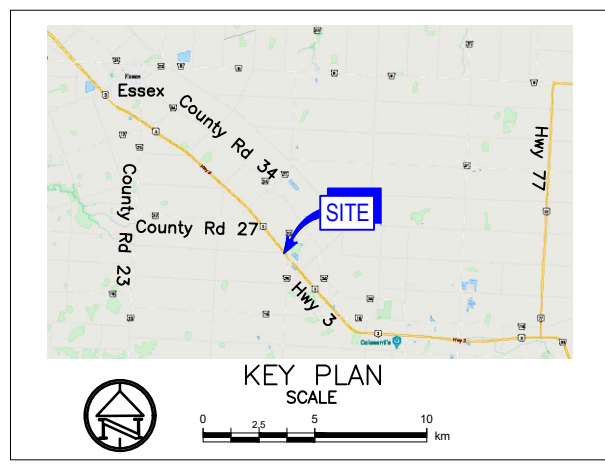
**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES

CONT No.  
GWP No. 3021-18-00

CULVERT No. 06X-0429/C0  
HIGHWAY 3  
BOREHOLE LOCATIONS AND SOIL STRATA

GHD

SHEET



LEGEND

Borehole

N Standard Penetration Test Value

16 Blows/0.3m unless otherwise stated  
(Std. Pen. Test. 475 j/blow)

Water Level in open borehole upon completion of drilling

BOREHOLE CO-ORDINATES (MTM ZONE 11)			
NO	ELEVATION	NORTHING	EASTING
BH-20-13	195.3	4662508.6	285219.3
BH-20-14	194.7	4662500.5	285185.7
BH21-04	195.0	4662509.5	285243.3
BH21-05	195.3	4662493.4	285254.3

**NOTES**

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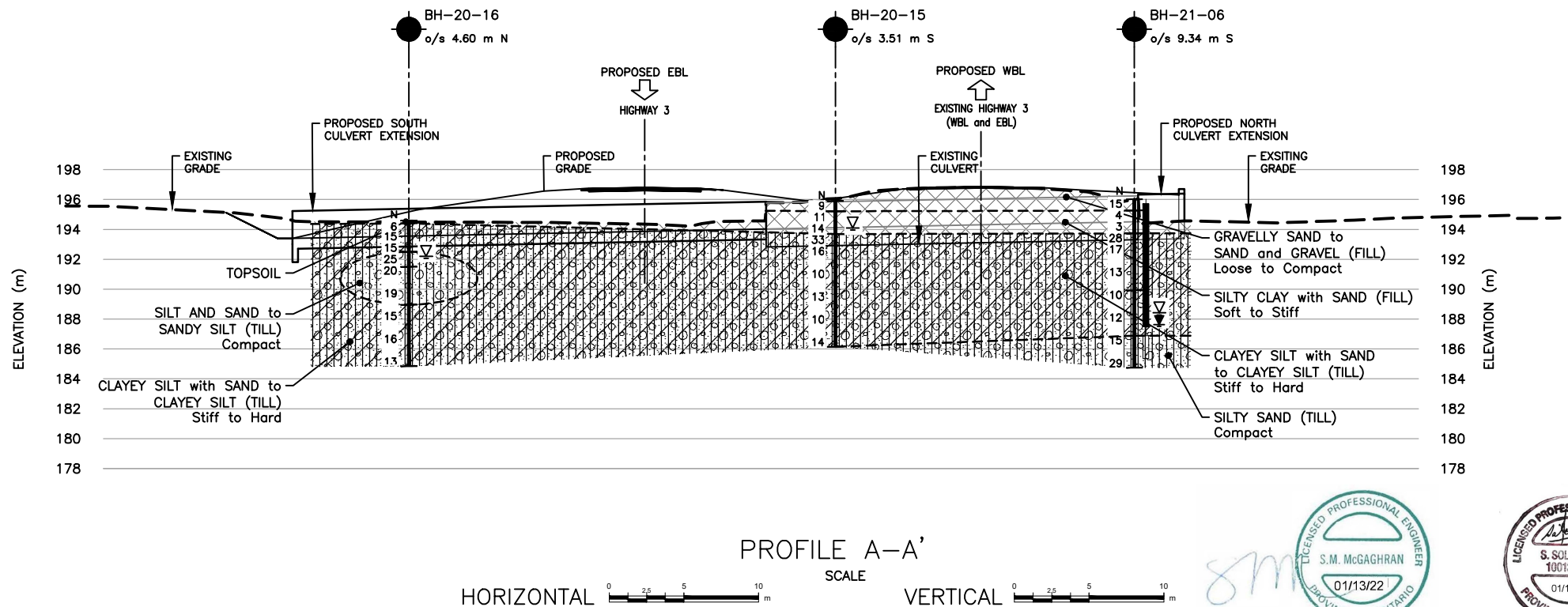
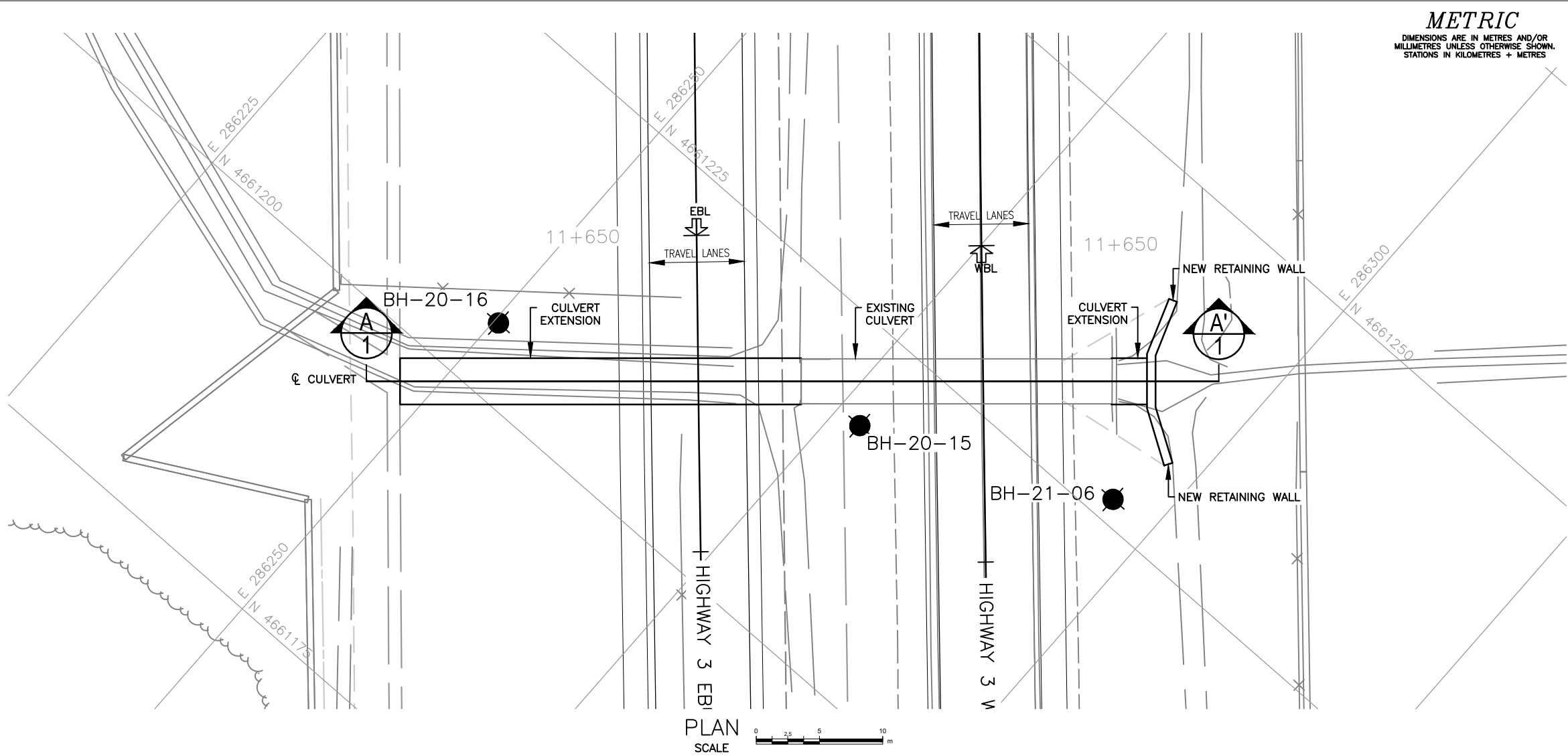
**REFERENCE**

Base plans provide in digital format by Callon Dietz, drawing file: B-117-003-1 DB, B-116-003-1 DB, received March 5, 2021.

NO.	DATE	BY	REVISION
Geocres No.: 40J2-147			
HWY. 3	PROJECT NO. 11202886		DIST. CHATHAM
SUBM'D. MN/MRM	CHKD. SS	DATE: 1.10.2022	SITE: 06X-0429/C0
DRAWN: AW	CHKD. SS	APPD. SMM	DWG. 8







CONT No.  
GWP No. 3021-18-00



CULVERT No. 06X-0432/C0  
HIGHWAY 3  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEY PLAN  
SCALE

LEGEND

- Borehole
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test. 475 j/blow)
- Water Level in open borehole upon completion of drilling
- Water Level measured in piezometer (Nov. 24/2021)

BOREHOLE CO-ORDINATES (MTM ZONE 11)

NO	ELEVATION	NORTHING	EASTING
BH-20-15	195.9	4661218.0	286277.2
BH-20-16	194.6	4661205.3	286250.4
BH21-06	196.0	4661226.8	286296.1

NOTES

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REFERENCE

Base plans provide in digital format by Callon Dietz, drawing file: B-117-003-1 DB, B-116-003-1 DB, received March 5, 2021.

NO.	DATE	BY	REVISION

Geocres No.: 40J2-147

HWY. 3	PROJECT NO. 11202886	DIST. CHATHAM
SUBM'D. MN/MRM	CHKD. SS	DATE: 1.10.2022
DRAWN: AW	CHKD. SS	APPD. SMM
		SITE: 06X-0432/C0
		DWG. 9



# Appendices

# **Appendix A**

## **Site Photographs**



**Photo 1 – Culvert No. 06X-420/C0 – Concession Road 9**



**Photo 2 – A Sample of Silty Clay at BH-20-02 – Culvert No. 06X-420/C0**





**Photo 3 – Culvert No. 06X-421/C0 – Intersection between Hwy 3 and Concession Road 8**



**Photo 4 – Drilling at BH-20-03 – Culvert No. 06X-421/C0**





**Photo 5 – Culvert No. 06X-422/C0 – Concession Road 8**



**Photo 6 – Drilling at BH-20-06 – Culvert No. 06X-422/C0**





**Photo 7 – Drilling at BH-20-07 – Culvert No. 06X-423/C0 – Hwy 3, 220 m East of Concession Road 8**



**Photo 8 – Drilling at BH-20-08 – Culvert No. 06X-423/C0, Hwy 3, 220 m East of Concession Road 8**





**Photo 9- Culvert No. 06X-423/C0, North Extension- Location of BH-21-01**



**Photo 10 – Culvert No. 06X-426/C0 – Intersection between Hwy 3 and County Road 27**





**Photo 11 – Drilling Set up at BH-20-10 – Culvert No. 06X-426/C0 – Hwy 3 between County Road 27**



**Photo 12 – Drilling at BH-21-02 – Culvert No. 06X-426/C0 North Extension– Hwy 3 Shoulder**





**Photo 13 – Drilling at BH-20-11 – Culvert No. 06X-427/C0 – Hwy 3, 700 m east of County Road 27**



**Photo 14 – Drilling at BH-20-12 – Culvert No. 06X-427/C0 – Hwy 3, 700 m east of County Road 27**





**Photo 15 – BH-21-03– Culvert No. 06X-427/C0 North Extension – Hwy 3**



**Photo 16 – Culvert No. 06X-429/C0 – Hwy 3, 460 m west of Division Road**





**Photo 17 – Drilling at BH-20-13 – Culvert No. 06X-429/C0 – Hwy 3, 460 m West of Division Road**



**Photo 18– Drilling at BH-21-04 – Culvert No. 06X-429/C0, North Extension – Hwy 3 Shoulder**





**Photo 19—BH-21-05 Location – Culvert No. 06X-429/C0, North Extension – Hwy 3 Shoulder**



**Photo 20 – Culvert No. 06X-432/C0 – Hwy 3, 600 m East of County Road 34**





**Photo 21– Drilling at BH-20-16 - Culvert No. 06X-432/C0 – Hwy 3, 600 m East of County Road 34**



**Photo 22– Location of BH-21-016 with respect to Culvert No. 06X-432/C0 , North Extension– Hwy 3**

# **Appendix B**

## **Borehole Records**



## Notes on Borehole and Test Pit Reports

### Soil description :

Each subsurface stratum is described using the following terminology. The relative density of granular soils is determined by the Standard Penetration Index ("N" value), while the consistency of clayey soils is measured by the value of undrained shear strength ( $S_u$ ).

#### Classification (Unified system)

Clay	< 0.002 mm		
Silt	0.002 to 0.075 mm		
Sand	0.075 to 4.75 mm	fine	0.075 to 4.25 mm
		medium	0.425 to 2.0 mm
		coarse	2.0 to 4.75 mm
Gravel	4.75 to 75 mm	fine	4.75 to 19 mm
		coarse	19 to 75 mm
Cobbles	75 to 300 mm		
Boulders	>300 mm		

#### Terminology

"trace"	1-10%
"some"	10-20%
adjective (silty, sandy)	20-35%
"and"	35-50%

#### Relative density of granular soils

#### Standard penetration index "N" value (BLOWS/ft – 300 mm)

Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

#### Consistency of cohesive soils

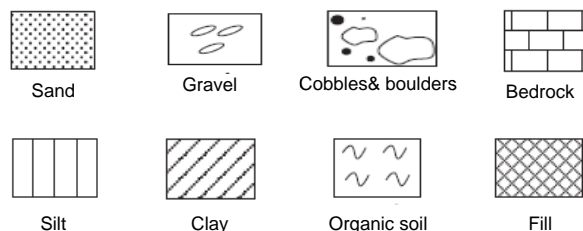
#### Undrained shear strength ( $C_u$ )

	(P.S.F)	(kPa)
Very soft	<250	<12
Soft	250-500	12-25
Firm	500-1000	25-50
Stiff	1000-2000	50-100
Very stiff	2000-4000	100-200
Hard	>4000	>200

#### Rock quality designation

"RQD" (%) Value	Quality
<25	Very poor
25-50	Poor
50-75	Fair
75-90	Good
>90	Excellent

#### STRATIGRAPHIC LEGEND



### Samples:

#### Type and Number

The type of sample recovered is shown on the log by the abbreviation listed hereafter. The numbering of samples is sequential for each type of sample.

SS: Split spoon

ST: Shelby tube

AG: Auger

SSE, GSE, AGE: Environmental sampling

PS: Piston sample (Osterberg)

RC: Rock core

NR: No Recovery

GS: Grab sample

#### Recovery

The recovery, shown as a percentage, is the ratio of length of the sample obtained to the distance the sampler was driven/pushed into the soil

#### RQD

The "Rock Quality Designation" or "RQD" value, expressed as percentage, is the ratio of the total length of all core fragments of 4 inches (10 cm) or more to the total length of the run.

#### IN-SITU TESTS:

N: Standard penetration index

$N_c$ : Dynamic cone penetration index

k: Permeability

R: Refusal to penetration

$S_u$ : Undrained Shear Strength

ABS: Absorption (Packer test)

Pr: Pressuremeter

#### LABORATORY TESTS:

$I_p$ : Plasticity index

H: Hydrometer analysis

A: Atterberg limits

C: Consolidation

O.V.: Organic

$W_L$ : Liquid limit

GSA: Grain size analysis

w: Water content

CS: Swedish fall cone

vapor

$W_p$ : Plastic limit

NP: non-plastic

$\gamma$ : Unit weight

CHEM: Chemical analysis



# RECORD OF BOREHOLE No BH-21-01

1 OF 2

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0423/C0 (Northing: 4665407.5, Easting: 282642.3, MTM Zone 11, NAD 83) ORIGINATED BY Manvit.M  
 DIST Chatham HWY 3 BOREHOLE TYPE Hollow Stem Auger (4") DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2021.10.04 LATITUDE 42.127864 LONGITUDE -82.768005 CHECKED BY Sandra McGaghran

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED							
194.9 0.0	FILL - SAND, trace clay Loose Brown Moist		1	SS	5							15 ○			
194.1 0.8	FILL - SILTY CLAY, contains organics, trace sand, trace gravel Soft Brown to Grey Moist		2	SS	3		194					24 ○			
			3	SS	4		193					24 ○			
192.6 2.3	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to Very Stiff Grey Moist		4	SS	8		192					21 ○	19		1 15 45 39 LL=34% PL=18% PI=16%
			5	SS	15							20 ○			
							191								
			6	SS	10		190					18 ○			
							189								
			7	SS	6							23 ○	22		LL=33% PL=13% PI=20%
							188			2.3 +					
												>100 kPa +			
			8	TW	PH		187								

Continued Next Page

+ 3 Numbers refer to  
Sensitivity

File: N:\CAWATERLOO\PROJECTS\662\11202886\TECH\12 FOUNDATIONS\04\FIELDWORK\06\FIELD NOTES AND LOGS\2021 GINT LOGS\_SCOPE CHANGE\11202886 HWY 3\_SCOPE CHANGE BH LOGS V02.GPJ  
 Library File: 11202886 MTO LIBRARY V01.GLB Report: 11202886 SCOPE CHANGE Date: 19/12/21

1 15 45 39  
 LL=34% PL=18% PI=16%

LL=33% PL=13% PI=20%



# RECORD OF BOREHOLE No BH-21-02

1 OF 2

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0426/C0 (Northing: 4664509.0, Easting: 283607.0, MTM Zone 11, NAD 83) ORIGINATED BY Manvit.M  
 DIST Chatham HWY 3 BOREHOLE TYPE Hollow Stem Auger (4") DRILLING RIG TYPE Truck Mounted COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2021.11.10 LATITUDE 42.119801 LONGITUDE -82.756304 CHECKED BY Sandra McGaghran

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED	+ FIELD VANE						
						● QUICK TRIAXIAL	× REMOULDED	WATER CONTENT (%)							
195.7	0.0	FILL - GRAVELLY SAND, some silt Dense to Very Dense Brown Moist	1	SS	30						50				
			2	SS	53						90				
194.2	1.5	SILTY CLAY, trace gravel, trace to some sand (TILL) Very Stiff to Firm Greyish Brown Moist	3	SS	25						230				LL=46% PL=30% PI=16%
			4	SS	6						220				
			5	SS	16						190				
		becoming with SAND	6	SS	11						200				4 26 45 25 LL=40% PL=17% PI=23%
191.1	4.6	CLAYEY SILT, some sand, trace gravel (TILL) Very Stiff to Stiff Brown to Grey Moist	7	SS	7						180				2 12 53 33 LL=35% PL=18% PI=17%
											>100 kPa				
											>100 kPa				
			8	SS	6						200				LL=34% PL=15% PI=19%
											1.8				
											>100 kPa				
			1	TW	PH										C

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+ 3 Numbers refer to  
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# RECORD OF BOREHOLE No BH-21-03

1 OF 2

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0427/C0 (Northing: 4663959.4, Easting: 284063.5, MTM Zone 11, NAD 83) ORIGINATED BY Manvit.M  
 DIST Chatham HWY 3 BOREHOLE TYPE Hollow Stem Auger (4") DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2021.10.05 LATITUDE 42.114864 LONGITUDE -82.750763 CHECKED BY Sandra McGaghran

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
194.8								20 40 60 80 100						
0.0	FILL - SILTY SAND, some gravel, some clay, contains rootlets Compact Dark Brown to Grey Moist		1	SS	10									
194.0							194							
0.8	FILL - SILTY CLAY, trace sand, trace gravel, contains rootlets, Firm to Soft Greyish Brown to Grey Moist		2	SS	7									
			3	SS	3		193							
192.5														
2.3	CLAYEY SILT, some sand (TILL) Very Stiff to Stiff Brown to Grey Moist		4	SS	20		192							
			5	SS	17									
							191							
			6	SS	10		190							0 12 49 39
							189							
			7	SS	4									
							188							0 13 45 42
														LL=34% PL=19% PI=15%
							187							
			8	TW	PH									

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## METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED      + FIELD VANE	● QUICK TRIAXIAL      × REMOULDED						
195.0								20 40 60 80 100							
194.9	TOPSOIL - CLAYEY SILT, trace sand, trace gravel, containing rootlets														
0.2	Dark Brown to Black Moist		1	SS	2										
194.2	FILL - SILTY CLAY, some gravel, contains rootlets,														
0.8	Soft Dark Brown Moist		2	SS	5										
	SILTY CLAY, some sand, trace gravel (TILL)														
	Firm Brown to grey Moist		3	SS	7										
192.7															
2.3	CLAYEY SILT and SAND, trace gravel to CLAYEY SILT, some sand, trace gravel (TILL)		4	SS	36										
	Stiff to Hard Dark Brown Wet														
				5	SS	14									
				6	SS	7									
				1	TW	PH									
			2	TW	PH										
			7	SS	8										
			8	SS	11										

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	Sensitivity		

# RECORD OF BOREHOLE No BH-21-04

2 OF 2

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0429/C0 (Northing: 4662509.5, Easting: 285243.3, MTM Zone 11, NAD 83) ORIGINATED BY Manvit.M  
DIST Chatham HWY 3 BOREHOLE TYPE Hollow Stem Auger (4") DRILLING RIG TYPE Truck Mounted COMPILED BY Anne Wang  
DATUM Geodetic DATE 2021.11.11 LATITUDE 42.101840 LONGITUDE -82.736448 CHECKED BY Sandra McGaghran

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
								SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED						
								20	40	60	80	100		
								WATER CONTENT (%)						
								20	40	60				
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
								W <sub>p</sub> W W <sub>L</sub>						
181.3	CLAYEY SILT and SAND, trace gravel to CLAYEY SILT, some sand, trace gravel (TILL) Stiff to Hard Dark Brown Wet		9	SS	7		186							
							185							
							184							
							183							
							182							
							181							
							180							
13.7	SAND, some gravel, some fines (TILL) Compact Brown Wet		12	SS	13									
179.8	SANDY SILT, some gravel (TILL) Very Dense Brown Wet		13	SS	80									
15.8	END OF BOREHOLE													
	Notes: 1. Groundwater level at a depth of 10.4 m below ground surface (Elev. 184.6 m) upon completion of drilling.													

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# RECORD OF BOREHOLE No BH-21-06

1 OF 2

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0432/C0 (Northing: 4661226.8, Easting: 286296.1, MTM Zone 11, NAD 83) ORIGINATED BY Manvit.M  
 DIST Chatham HWY 3 BOREHOLE TYPE Hollow Stem Auger (4") DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2021.10.05 LATITUDE 42.090317 LONGITUDE -82.723679 CHECKED BY Sandra McGaghran

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
196.0	FILL - GRAVELLY SAND, trace silt, some organics (plants) Compact Brown Moist		1	SS	15									
195.2	FILL - SILTY CLAY with SAND, contains rootlets and organics Soft Brown to Grey Moist		2	SS	4		195							
0.8			3	SS	3		194							0 29 37 34 LL=39% PL=21% PI=18%
193.7	CLAYEY SILT with SAND (TILL) Stiff to Very Stiff Brown to Grey Moist		4	SS	28		193							LL=25% PL=15% PI=10%
2.3			5	SS	17		192							0 27 42 31 LL=26% PL=13% PI=13%
			6	SS	13		191							
189.9	CLAYEY SILT, some sand (TILL) Stiff Grey Moist to Wet		7	SS	10		190							LL=25% PL=14% PI=11%
6.1			8	SS	12		189							
							188							

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# RECORD OF BOREHOLE No BH-21-06

2 OF 2

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0432/C0 (Northing: 4661226.8, Easting: 286296.1, MTM Zone 11, NAD 83) ORIGINATED BY Manvit.M  
 DIST Chatham HWY 3 BOREHOLE TYPE Hollow Stem Auger (4") DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2021.10.05 LATITUDE 42.090317 LONGITUDE -82.723679 CHECKED BY Sandra McGaghran

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED				W <sub>p</sub> W      W <sub>L</sub>				
						20   40   60   80   100				20   40   60						
186.9	CLAYEY SILT, some sand (TILL) Stiff Grey Moist to Wet						187									7   60   (33)
9.1	SILTY SAND, trace to some gravel (TILL) Compact Grey Wet		9	SS	15		186									
184.7			10	SS	29		185									
11.3	END OF BOREHOLE  Notes: 1. Groundwater level at a depth of 7.6 m below ground surface (Elev. 188.4 m) upon completion of drilling. 2. Groundwater level at a depth of 8.4 m (Elev. 187.6 m) on Nov 24, 2021.															



# RECORD OF BOREHOLE No BH-20-01

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0420/C0 (Northing: 4666959.4, Easting: 280836.9, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.04.27 LATITUDE 42.141783 LONGITUDE -82.789905 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
194.8 0.0	FILL - SAND and GRAVEL, some silt Compact Light Brown Moist		1	SS	23		194						9 0	
194.1 0.7	SILTY CLAY, some sand, trace gravel (TILL) Stiff Brown to Grey Moist to Wet		2	SS	9		193						21 0	1 15 39 45 LL=52% PL=21% PI=31%
192.6 2.2	CLAYEY SILT, some sand, trace gravel (TILL) Very Stiff to Stiff Grey Moist		3	SS	11		192						25 0	
			4	SS	17		191						18 0	
			5	SS	21		190						16 0	2 14 41 43 LL=34% PL=16% PI=18%
			6	SS	13		189						19 0	
			7	SS	13		188						20 0	
			8	SS	13		187						22 0	
			9	SS	9		186						22 0	
185.0 9.8	END OF BOREHOLE													
	Notes: 1. Borehole dry during and upon completion of drilling.													

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# RECORD OF BOREHOLE No BH-20-02

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0420/C0 (Northing: 4666946.7, Easting: 280856.9, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.04.27 LATITUDE 42.141670 LONGITUDE -82.789663 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
194.3 0.0	TOPSOIL - Clayey Silt, trace sand and gravel, containing rootlets		1	SS	7		194						24	0 14 36 50 LL=46% PL=20% PI=26%
194.0 0.3	Dark Brown Moist Firm		2	SS	7		193						26	
	SILTY CLAY, some sand, trace gravel (TILL) Firm		3	SS	12		192						19	
192.8 1.5	Light Brown to Grey Moist		4	SS	30		191						15	0 12 41 47 LL=31% PL=18% PI=13%
	CLAYEY SILT, some sand, trace gravel (TILL) Firm to Hard Grey Moist		5	SS	16		190						18	
			6	SS	9		189						21	
			7	SS	7		188						22	0 14 41 45 LL=35% PL=18% PI=17%
			8	SS	9		187						23	
			9	SS	12		186						22	
184.5 9.8	END OF BOREHOLE						185							
Notes: 1. Borehole dry during and upon completion of drilling.														

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Sensitivity

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# RECORD OF BOREHOLE No BH-20-03

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0421/C0 (Northing: 4665573.4, Easting: 282433.8, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.04.28 LATITUDE 42.129352 LONGITUDE -82.770533 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
195.3 0.0	FILL - SAND and GRAVEL, trace to some fines Compact Light Brown Moist		1	SS	16		195						2	
			2	SS	15		194						2	46 45 (9)
193.9 1.4	SILTY CLAY, some sand, trace gravel (TILL) Stiff Brown to Grey Moist to Wet		3	SS	9		193						24	
			4	SS	11								25	2 14 36 48 LL=38% PL=18% PI=20%
192.5 2.8	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to Very Stiff Grey Moist		5	SS	28		192						20	
			6	SS	26		191						17	
			7	SS	15		190						20	2 13 39 46 LL=34% PL=16% PI=18%
			8	SS	11		189						22	
			9	SS	10		188						23	
			10	SS	10		186						24	
185.5 9.8	END OF BOREHOLE													
	Notes: 1. Groundwater level at a depth of 2.2 m below ground surface (Elev. 193.1 m) upon completion of drilling.													

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# RECORD OF BOREHOLE No BH-20-04

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0421/C0 (Northing: 4665539.7, Easting: 282422.5, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
 DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2020.04.28 LATITUDE 42.129048 LONGITUDE -82.770669 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
								20   40   60   80   100			W <sub>p</sub> W   W <sub>L</sub>				
								○ UNCONFINED   + FIELD VANE			○				
								● QUICK TRIAXIAL   × REMOULDED							
								20   40   60   80   100			20   40   60				
194.9															
0.0	FILL - SAND and GRAVEL, some silt Loose to Compact Light Brown Moist		1	SS	12						3 ○				
193.8			2A	SS	8		194				4 ○				
1.1	SILTY CLAY, some sand, trace gravel (TILL) Stiff Grey Wet		2B									25 ○			
			3	SS	9		193					20 ○	┌───┐	1   15   45   39 LL=37% PL=19% PI=18%	
192.7															
2.2	CLAYEY SILT, some sand, trace gravel (TILL) Very Stiff to Stiff Grey Moist		4	SS	22		192					17 ○			
			5	SS	27							17 ○			
							191								
			6	SS	13		190					19 ○	┌───┐	1   12   47   40 LL=34% PL=14% PI=20%	
			7	SS	12		189					22 ○			
							188								
			8	SS	11		187					21 ○			
							186								
			9	SS	9							22 ○			
185.1															
9.8	END OF BOREHOLE														
	Notes: 1. Borehole dry during and upon completion of drilling.														

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RECORD OF BOREHOLE No BH-20-05

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0422/C0 (Northing: 4665516.3, Easting: 282413.7, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.04.28 LATITUDE 42.128837 LONGITUDE -82.770774 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>		
194.5	FILL - SAND and GRAVEL, trace to some fines Compact Brown Moist  SILTY CLAY, some sand, trace gravel (TILL) Firm to Stiff Grey Moist		1A	SS	10								3 12 46 39 LL=40% PL=19% PI=21%	
0.0 194.2			1B											
0.3			2	SS	5									
			3	SS	13									
192.4	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to Very Stiff Grey Moist		4	SS	13								5 11 48 36 LL=35% PL=19% PI=16%	
2.1			5	SS	15									
			6	SS	9									
			7	SS	10									
			8	SS	12									
184.7	END OF BOREHOLE		9	SS	15									
9.8														
	Notes: 1. Borehole dry during and upon completion of drilling.													

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# RECORD OF BOREHOLE No BH-20-06

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0422/C0 (Northing: 4665505.6, Easting: 282445.9, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
 DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2020.04.28 LATITUDE 42.128742 LONGITUDE -82.770385 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
194.4							20   40   60   80   100							
0.0	TOPSOIL, Clayey Silt, trace sand, containing rootlets		1A											
194.0	Stiff													
0.4	Dark Brown to Black Moist		1B	SS	11							23		
	SILTY CLAY, some sand, trace gravel, some organic (TILL)		2	SS	12							24		0   11   37   52 LL=51% PL=21% PI=30%
	Stiff to Very Stiff													
	Light Brown to Grey Moist		3	SS	15							20		
			4	SS	18							17		1   12   46   41 LL=37% PL=18% PI=19%
191.5														
2.9	CLAYEY SILT, some sand, trace gravel (TILL)													
	Stiff to Very Stiff		5	SS	15							19		
	Grey Moist													
			6	SS	12							22		
188.8														
5.6	SILT and SAND, trace to some clay (TILL)													
	Loose													
	Grey Moist		7	SS	8							23		0   39   51   10
187.2														
7.2	CLAYEY SILT, some sand, trace gravel (TILL)													
	Stiff to Very Stiff													
	Grey Moist		8	SS	15							18		
			9	SS	9							17		
184.6														
9.8	END OF BOREHOLE													
	Notes: 1. Groundwater level at a depth of 6.1 m below ground surface (Elev. 188.3m) upon completion of drilling.													

+ 3 Numbers refer to  
Sensitivity

File: N:\CAWATERLOO\PROJECTS\662\11202886\TECH\12 FOUNDATIONS\04\FIELDWORK\06\FIELD NOTES AND LOGS\2020 GINT LOGS\11202886 HWY 3 WIDENING - WINDSOR TO LEAMINGTON BH LOGS V02.GPJ  
 Library File: 11202886 MTO LIBRARY V01.GLB Report: 11202886 SCOPE CHANGE Date: 19/12/21






# RECORD OF BOREHOLE No BH-20-07

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0423/C0 (Northing: 4665404.5, Easting: 282622.8, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.04.30 LATITUDE 42.127837 LONGITUDE -82.768241 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							W <sub>p</sub> W                      W <sub>L</sub>					
								○ UNCONFINED                      + FIELD VANE ● QUICK TRIAXIAL                      × REMOULDED							WATER CONTENT (%)					
195.5								20	40	60	80	100								
0.0	FILL - SAND and GRAVEL, some fines Loose Brown Moist		1	SS	9		195							3 ○					38 49    (13)	
194.4			2A											4 ○						
1.1	FILL - SILTY CLAY with SAND, trace gravel Firm Grey Moist to Wet		2B	SS	8		194							16 ○						
			3	SS	6									19 ○						
			4	SS	7		193							24 ○					4 26 33 37 LL=45% PL=19% PI=26%	
192.5																				
3.0	CLAYEY SILT, some sand, trace gravel (TILL) Hard to Stiff Grey Moist		5	SS	31		192							18 ○						
			6	SS	20		191													
			7	SS	10		189							23 ○					0 13 47 40 LL=34% PL=18% PI=16%	
			8	SS	9		188							24 ○						
							187													
			9	SS	10		186							23 ○						
185.7																				
9.8	END OF BOREHOLE																			
	Notes: 1. Borehole dry during and upon completion of drilling.																			

+ 3 Numbers refer to  
Sensitivity

File: N:\CAWATERLOO\PROJECTS\662\11202886\TECH\12 FOUNDATIONS\04\FIELDWORK\06-FIELD NOTES AND LOGS\2020 GINT LOGS\11202886 HWY 3 WIDENING - WINDSOR TO LEAMINGTON BH LOGS V02.GPJ  
Library File: 11202886 MTO LIBRARY V01.GLB Report: 11202886 SCOPE CHANGE Date: 19/12/21

# RECORD OF BOREHOLE No BH-20-08

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0423/C0 (Northing: 4665399.6, Easting: 282581.1, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
 DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2020.04.30 LATITUDE 42.127792 LONGITUDE -82.768745 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED					Wp      W      W <sub>L</sub>				
194.3							20	40	60	80	100	20	40	60			
0.0	TOPSOIL, Clayey Silt, trace sand, trace gravel, containing rootlets		1A														
194.0																	
0.3	Firm Dark Brown to Black Moist		1B	SS	9							20					
	CLAYEY SILT, some sand, trace gravel (TILL)		2	SS	10							18					
	Very Stiff to Stiff																
	Light Brown to Grey		3	SS	26							14				1 18 49 32	
	Moist															LL=32% PL=17% PI=15%	
			4	SS	20							16					
			5	SS	19							18				0 12 46 42	
																LL=31% PL=18% PI=13%	
			6	SS	9							22					
			7	SS	9							23					
			8	SS	8							24					
			9	SS	9							24					
184.5																	
9.8	END OF BOREHOLE																
	Notes: 1. Borehole dry during and upon completion of drilling.																

+ 3 Numbers refer to  
Sensitivity

File: N:\CAWATERLOO\PROJECTS\662\11202886\TECH\12 FOUNDATIONS\04\FIELDWORK\06-FIELD NOTES AND LOGS\2020 GINT LOGS\11202886 HWY 3 WIDENING - WINDSOR TO LEAMINGTON BH LOGS V02.GPJ  
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# RECORD OF BOREHOLE No BH-20-09

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0426/C0 (Northing: 4664521.8, Easting: 283565.9, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.04.30 LATITUDE 42.119915 LONGITUDE -82.756802 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			W <sub>p</sub>	W	W <sub>L</sub>		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED	20 40 60 80 100					
195.1 0.0	FILL - SAND and GRAVEL, trace silt Compact Light Brown Moist		1	SS	11								8 ○		
194.4 0.7	SILTY CLAY, some sand, trace gravel (TILL) Firm Grey Moist		2	SS	7								21 ○		4 17 40 39 LL=40% PL=21% PI=19%
193.7 1.4	CLAYEY SILT, some sand, trace gravel (TILL) Very Stiff to Stiff Grey Moist		3	SS	10								20 ○		
			4	SS	17								19 ○		
			5	SS	29								17 ○		0 12 49 39 LL=34% PL=18% PI=16%
			6	SS	13								19 ○		
			7	SS	14								22 ○		1 12 48 39 LL=31% PL=18% PI=13%
			8	SS	10								23 ○		
			9	SS	13								23 ○		
185.3 9.8	END OF BOREHOLE														
Notes: 1. Borehole dry during and upon completion of drilling.															

+ 3 Numbers refer to  
Sensitivity

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# RECORD OF BOREHOLE No BH-20-10

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0426/C0 (Northing: 4664494.3, Easting: 283549.3, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
 DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2020.05.01 LATITUDE 42.119667 LONGITUDE -82.757001 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x REMOULDED							W <sub>p</sub> W      W <sub>L</sub>			
193.3							20	40	60	80	100	20	40	60	GR	SA	SI	CL
0.0	CLAYEY SILT, some sand, trace gravel, some organics (TILL) Firm to Very Stiff Light Brown to Grey Moist to Wet		1	SS	8		193						25			0 12 50 38 LL=33% PL=19% PI=14%		
			2	SS	9		192						19					
			3	SS	12		191						20					
			4	SS	19		190						17					
			5	SS	13		189						18					
			6	SS	10		188						20					
			7	SS	9		187						23					
			8	SS	8		186						23					
			9	SS	5		184						25					
			10	SS	7		183						27					
182.0	END OF BOREHOLE																	
11.3	Note: 1. Groundwater level at a depth of 10.7 m below ground surface (Elev. 182.6 m) upon completion of drilling.																	

+ 3 Numbers refer to  
Sensitivity

File: N:\CAWATERLOO\PROJECTS\662\11202886\TECH\12 FOUNDATIONS\04\FIELDWORK\06-FIELD NOTES AND LOGS\2020 GINT LOGS\11202886 HWY 3 WIDENING - WINDSOR TO LEAMINGTON BH LOGS V02.GPJ  
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# RECORD OF BOREHOLE No BH-20-11

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0427/C0 (Northing: 4663965.9, Easting: 284035.9, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.05.01 LATITUDE 42.114922 LONGITUDE -82.751097 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
195.1 0.0	FILL - SAND and GRAVEL, trace fines Compact Brown Moist		1	SS	23		195						7 o	35 57 (8)
			2	SS	29		194						11 o	
193.7 1.4	FILL - SILTY CLAY, some sand, trace gravel, some organics Stiff Light Brown to Grey Moist to Wet		3	SS	9		193						28 o	
			4	SS	9		193						22 o	
192.1 3.0	CLAYEY SILT, some sand, trace gravel (TILL) Hard to Stiff Brown to Grey Moist		5	SS	32		192						18 o	1 19 36 44 LL=55% PL=22% PI=33%
							191							
			6	SS	16		190						20 o	
							189						22 o	
							188						22 o	
			8	SS	10		187							
							186						23 o	
			9	SS	9									
185.3 9.8	END OF BOREHOLE													
	Note: 1. Groundwater level at a depth of 1.2 m below ground surface (Elev. 193.9 m) upon completion of drilling.													

+ 3 Numbers refer to  
Sensitivity



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# RECORD OF BOREHOLE No BH-20-12

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0427/C0 (Northing: 4663975.9, Easting: 283988.7, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.05.01 LATITUDE 42.115011 LONGITUDE -82.751668 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
194.6 0.0	TOPSOIL, Clayey Silt, trace sand and gravel, containing rootlets		1A				194	20 40 60 80 100		20 40 60			1 14 43 42 LL=41% PL=20% PI=21%	
194.3 0.3	Firm Dark Brown to Black Moist		1B	SS	7			20 40 60 80 100		25				
	SILTY CLAY, some sand, trace gravel, some organics (TILL) Firm to Stiff Light Brown to Grey Moist		2	SS	7			20 40 60 80 100		21				
			3	SS	9			20 40 60 80 100		18				
192.4 2.2	CLAYEY SILT, some sand, trace gravel (TILL) Firm to Very Stiff Brown to Grey Moist		4	SS	24			20 40 60 80 100		18				
			5	SS	14			20 40 60 80 100		18				
			6	SS	7			20 40 60 80 100		20				
			7	SS	9			20 40 60 80 100		22				
			8	SS	12			20 40 60 80 100		24				
184.8 9.8	END OF BOREHOLE	9	SS	11	20 40 60 80 100		185		19			0 14 49 37 LL=31% PL=17% PI=14%		
	Note: 1. Groundwater level at a depth of 4.9 m below ground surface (Elev. 189.7 m) upon completion of drilling.													

+<sup>3</sup> Numbers refer to  
Sensitivity

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# RECORD OF BOREHOLE No BH-20-13

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0429/C0 (Northing: 4662508.6, Easting: 285219.3, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 2020.05.04 LATITUDE 42.101832 LONGITUDE -82.736739 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
195.3 0.0	FILL - SAND and GRAVEL, some clay, trace silt Loose		1	SS	6		195							0 14 55 31 LL=32% PL=18% PI=14%
194.6 0.7	Brown Moist		2	SS	11		194							
	CLAYEY SILT, some sand, trace gravel (TILL) Hard to Stiff Brown to Grey Moist		3	SS	11		193							
			4	SS	19		192							
			5	SS	58		191							
			6	SS	14		190							
			7	SS	12		189							
			8	SS	11		188							
			9	SS	10		187							
185.5 9.8	END OF BOREHOLE						186							
Note: 1. Groundwater level at a depth of 0.8 m below ground surface (Elev. 194.5 m) upon completion of drilling.														

+ 3 Numbers refer to  
Sensitivity

File: N:\CAWATERLOO\PROJECTS\662\11202886\TECH\12 FOUNDATIONS\04-FIELDWORK\06-FIELD NOTES AND LOGS\2020 GINT LOGS\11202886 HWY 3 WIDENING - WINDSOR TO LEAMINGTON BH LOGS V02.GPJ  
Library File: 11202886 MTO LIBRARY V01.GLB Report: 11202886 SCOPE CHANGE Date: 19/12/21

# RECORD OF BOREHOLE No BH-20-14

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0429/C0 (Northing: 4662500.5, Easting: 285185.7, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
 DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
 DATUM Geodetic DATE 2020.05.04 LATITUDE 42.101758 LONGITUDE -82.737144 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED							W <sub>p</sub> W      W <sub>L</sub>		
194.7							20	40	60	80	100	20	40	60			
0.0	TOPSOIL, Clayey Silt, trace sand, trace gravel, containing rootlets		1A														
194.3	Firm		1B	SS	7								26				
0.4	Dark Brown to Black																
	Moist		2	SS	9								21			0 12 43 45 LL=43% PL=20% PI=23%	
	SILTY CLAY, some sand, some organic (TILL)																
193.2	Firm to Stiff																
1.5	Brown		3	SS	15								18				
	Moist																
	CLAYEY SILT, some sand, trace gravel (TILL)																
	Very Stiff to Firm		4	SS	21								18			0 14 46 40 LL=34% PL=18% PI=16%	
	Grey																
	Moist		5	SS	17								19				
			6	SS	8								23				
			7	SS	10								26			0 11 48 41 LL=34% PL=19% PI=15%	
			8	SS	6								24				
			9	SS	7								26				

+ 3 Numbers refer to  
Sensitivity

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 Library File: 11202886 MTO LIBRARY V01.GLB Report: 11202886 SCOPE CHANGE Date: 19/12/21

# RECORD OF BOREHOLE No BH-20-15

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0432/C0 (Northing: 4661218.0, Easting: 286277.2, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 0202.05.19 LATITUDE 42.090237 LONGITUDE -82.723907 CHECKED BY Sahar Soleimani

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
195.9 0.0	FILL - SAND and GRAVEL, trace silt, trace clay Loose Brown Moist		1	SS	9		195						12	
195.2 0.7	FILL - CLAYEY SILT with SAND, trace to some gravel Stiff Grey Moist		2	SS	11								12	
			3	SS	14								15	
193.7 2.2	CLAYEY SILT, some sand (TILL) Stiff to Hard Grey Moist		4	SS	33								18	
			5	SS	16								18	
			6	SS	10								15	
			7	SS	13								27	
		8	SS	10						15				
		9	SS	14						12				
186.1 9.8	END OF BOREHOLE													
Note: 1. Groundwater level at a depth of 1.8 m below ground surface (Elev. 194.1 m) upon completion of drilling.														

+ 3 Numbers refer to  
Sensitivity

File: N:\CAWATERLOO\PROJECTS\662\11202886\TECH\12 FOUNDATIONS\04-FIELDWORK\06-FIELD NOTES AND LOGS\2020 GINT LOGS\11202886 HWY 3 WIDENING - WINDSOR TO LEAMINGTON BH LOGS V02.GPJ  
Library File: 11202886 MTO LIBRARY V01.GLB Report: 11202886 SCOPE CHANGE Date: 19/12/21

# RECORD OF BOREHOLE No BH-20-16

1 OF 1

METRIC

G.W.P. NO. 3021-18-00 LOCATION Culvert No. 06X-0432/C0 (Northing: 4661205.3, Easting: 286250.4, MTM Zone 11, NAD 83) ORIGINATED BY Moe Nasir  
DIST Chatham HWY 3 BOREHOLE TYPE Solid Stem Auger DRILLING RIG TYPE Diedrich D-50 Track COMPILED BY Anne Wang  
DATUM Geodetic DATE 0202.05.19 LATITUDE 42.090123 LONGITUDE -82.724231 CHECKED BY Sahar Soleimani

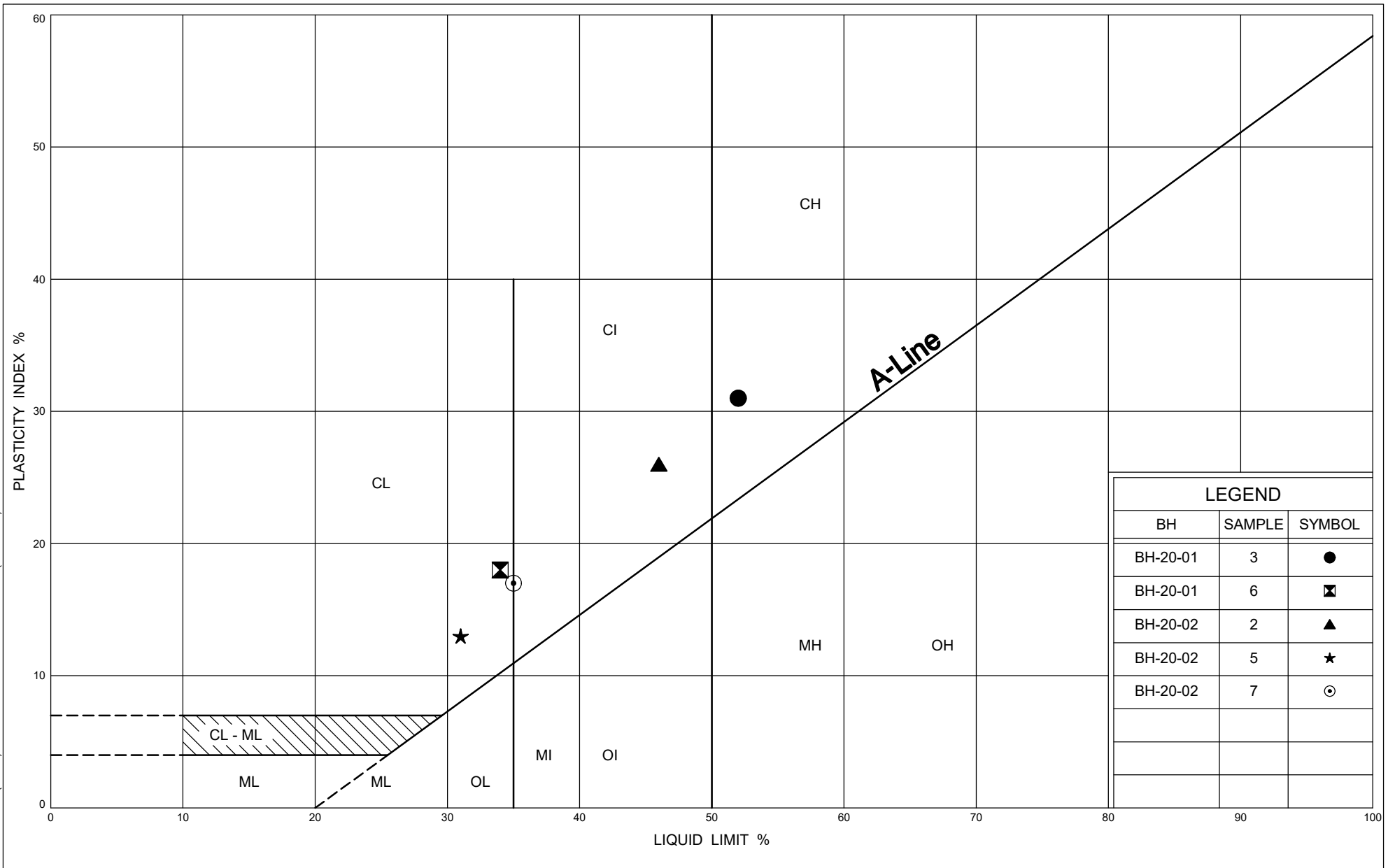
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	20 40 60	WATER CONTENT (%)	GR SA SI CL			
194.6 0.0	TOPSOIL, Clayey Silt, trace sand, trace gravel, containing rootlets		1A											7 57 29 7	
194.4 0.2	Firm Dark Brown Moist		1B	SS	6										
	CLAYEY SILT, some sand, trace gravel (TILL)	2	SS	15											
	Stiff Grey Moist														
		3	SS	15											
192.5															
2.1	SILTY SAND, trace gravel, trace clay (TILL)														
	Compact Grey Moist	4	SS	25											
191.5															
3.1	SILT and SAND, trace clay (TILL)														
	Compact Grey Moist	5	SS	20											
		6	SS	19											

+ 3 Numbers refer to Sensitivity

File: N:\CAWATERLOO\PROJECTS\662\11202886\TECH\12 FOUNDATIONS\04\FIELDWORK\06\FIELD NOTES AND LOGS\2020 GINT LOGS\11202886 HWY 3 WIDENING - WINDSOR TO LEAMINGTON BH LOGS V02.GPJ  
Library File: 11202886 MTO LIBRARY V01.GLB Report: 11202886 SCOPE CHANGE Date: 19/12/21

# **Appendix C**

## **Geotechnical Laboratory Test**



Ministry of  
Transportation

## PLASTICITY CHART

Culvert No. 06X-0420/C0 - Clayey Silt to Silty Clay (Till)

Figure:

C1-1

Assignment No.:

3017-E-0012

G.W.P. No.:

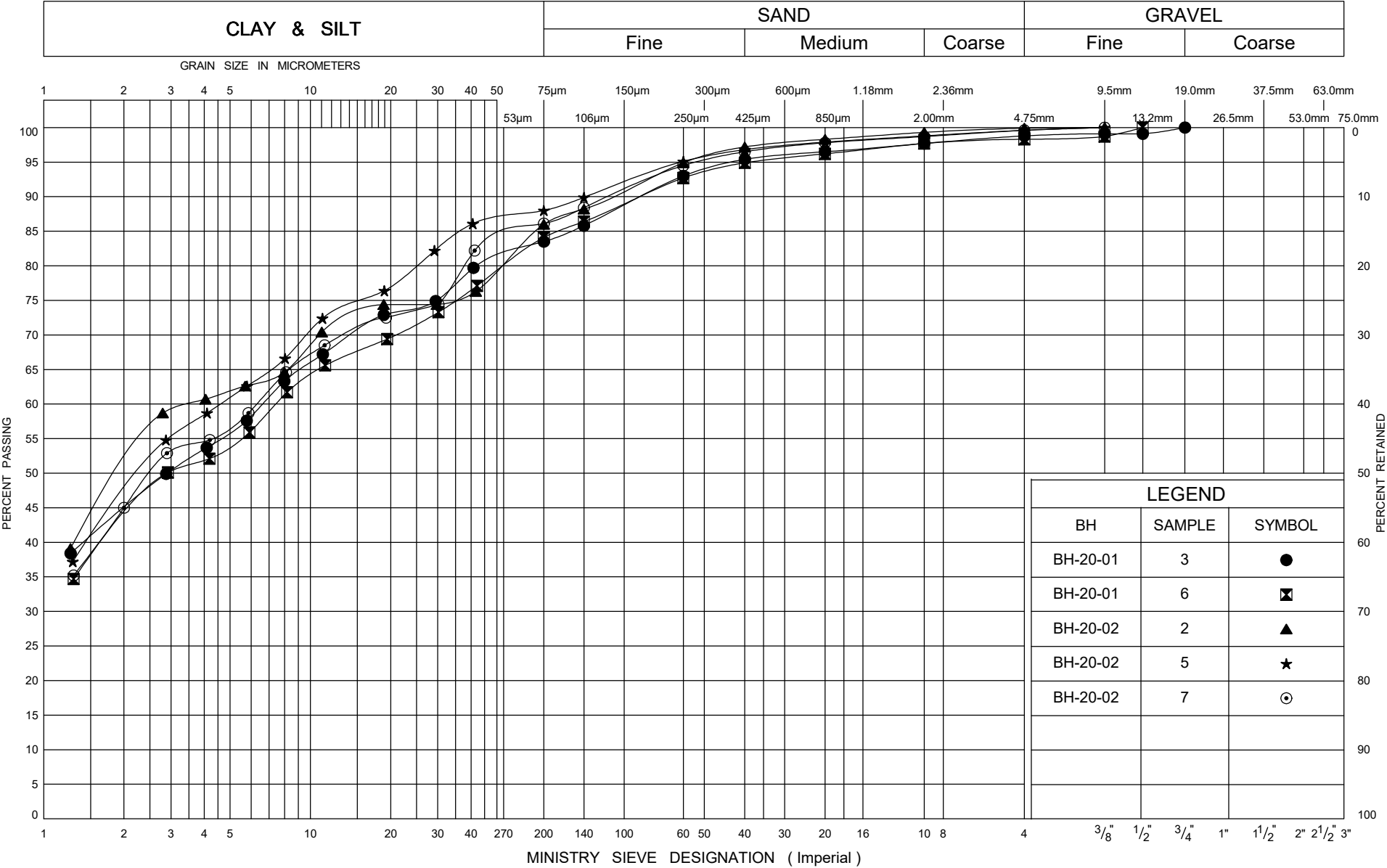
3021-18-00

GHD Project No.:

11202886



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION

Culvert No. 06X-0420/C0 - Clayey Silt to Silty Clay (Till)

Figure:

C1-2

Assignment No.:

3017-E-0012

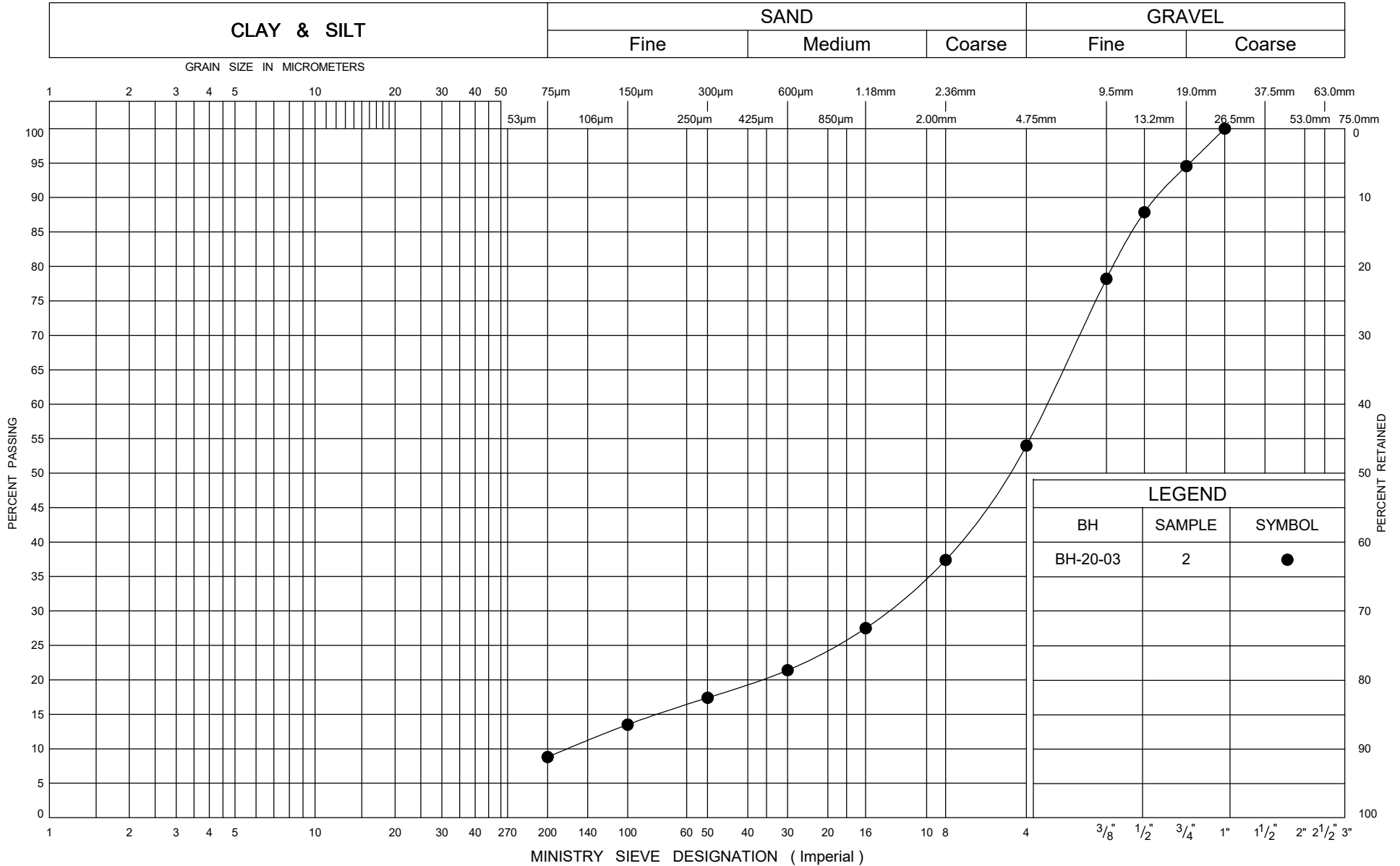
G.W.P. No.:

3021-18-00

GHD Project No.:

11202886

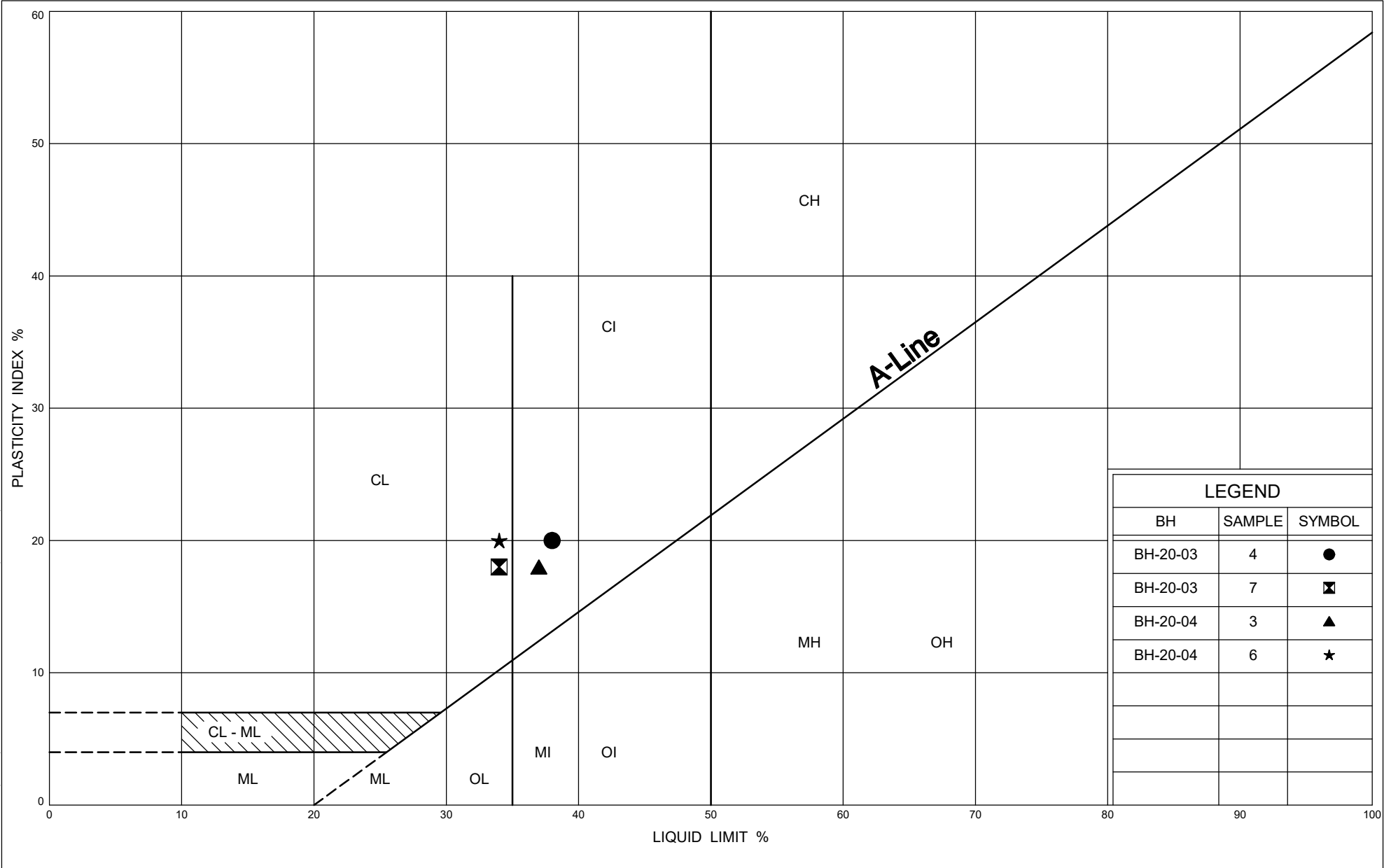
# UNIFIED SOIL CLASSIFICATION SYSTEM



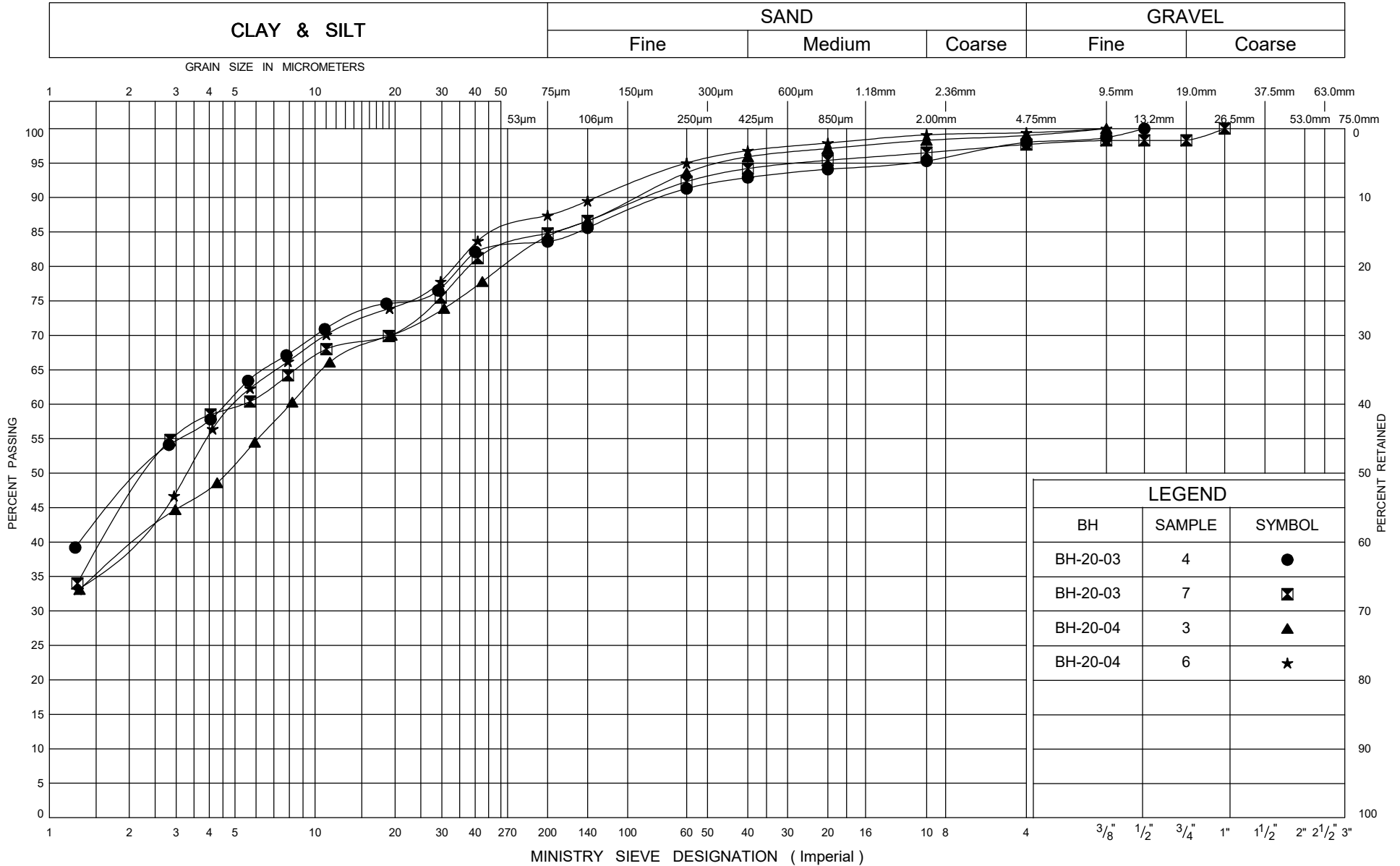
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
Culvert No. 06X-0421/C0 - Fill - Sand and Gravel

Figure:	C2-1
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886



# UNIFIED SOIL CLASSIFICATION SYSTEM

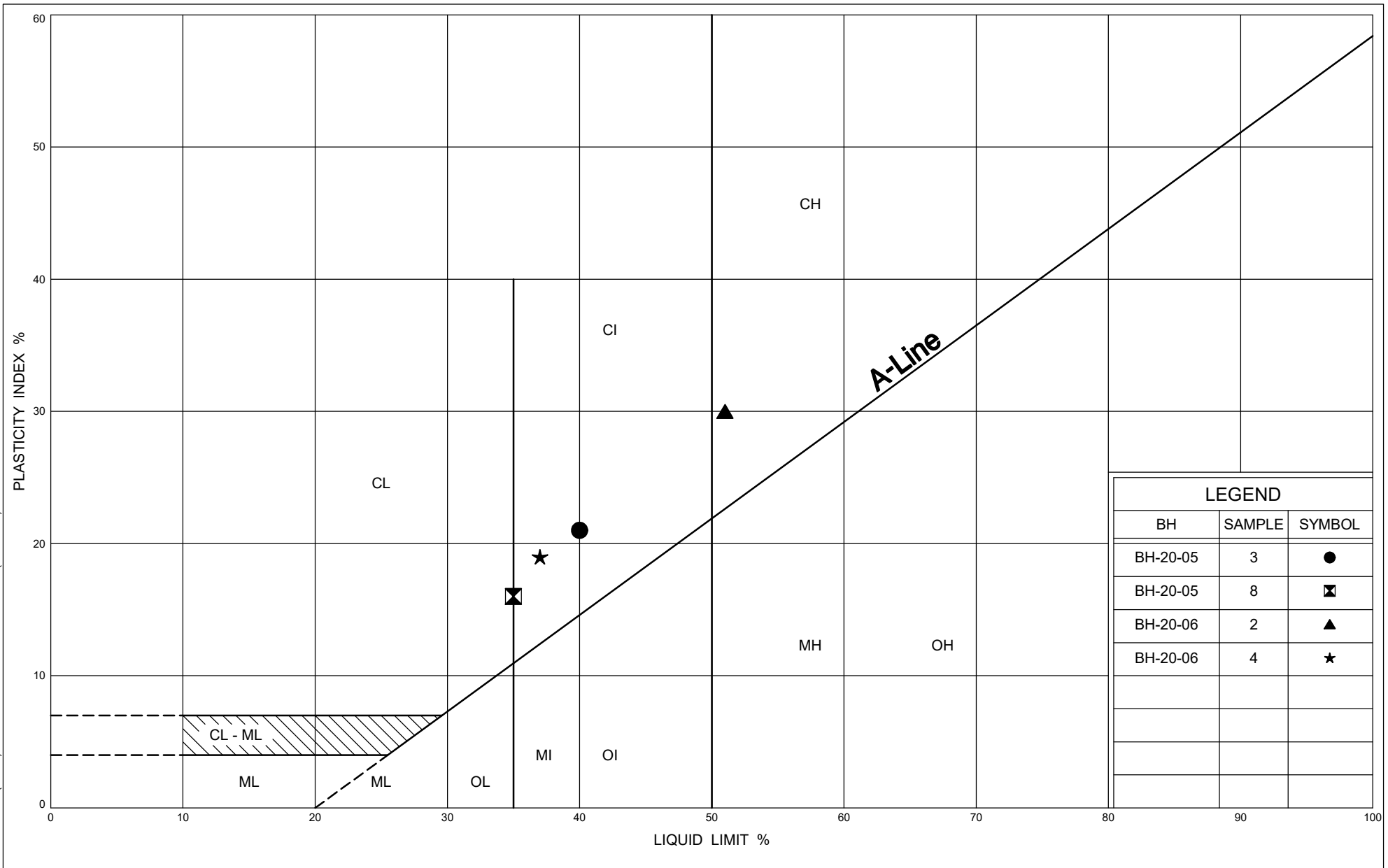


LEGEND		
BH	SAMPLE	SYMBOL
BH-20-03	4	●
BH-20-03	7	⊠
BH-20-04	3	▲
BH-20-04	6	★



GRAIN SIZE DISTRIBUTION  
Culvert No. 06X-0421/C0 - Clayey Silt to Silty Clay (Till)

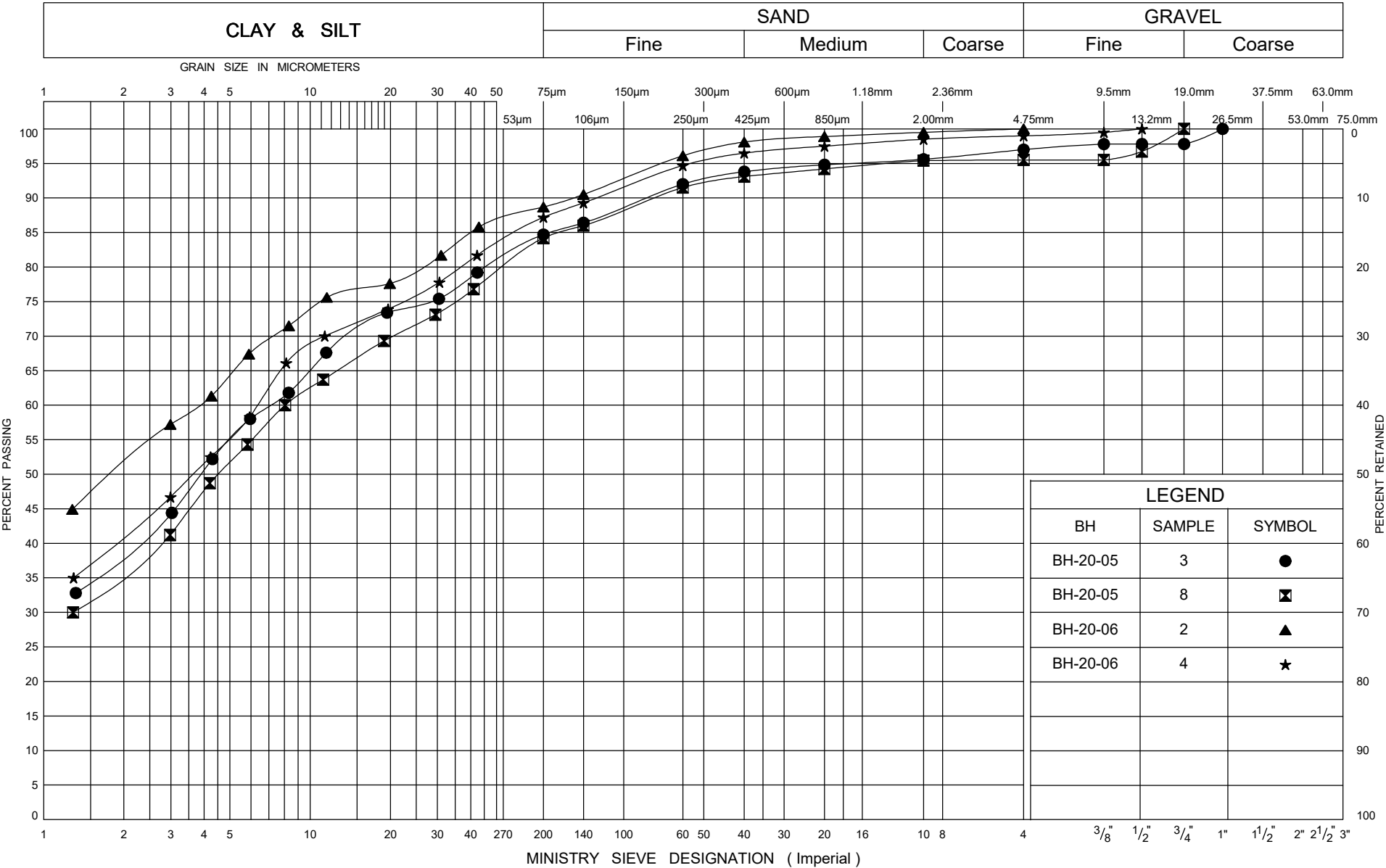
Figure:	C2-3
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886



**PLASTICITY CHART**  
Culvert No. 06X-0422/C0 - Clayey Silt to Silty Clay (Till)

Figure:	C3-1
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

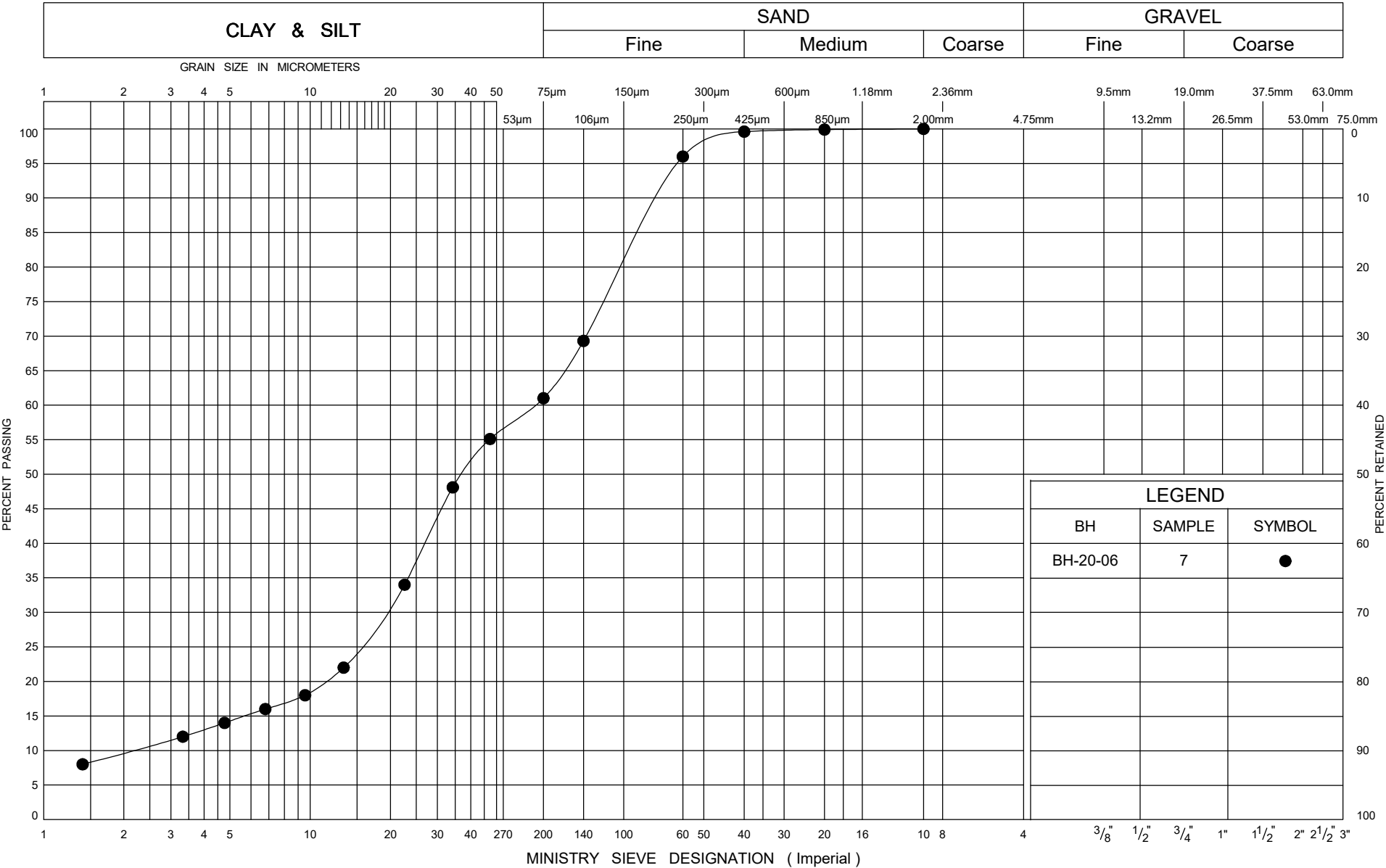
GRAIN SIZE DISTRIBUTION

Culvert No. 06X-0422/C0 - Clayey Silt to Silty Clay (Till)

Figure:	C3-2
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886



UNIFIED SOIL CLASSIFICATION SYSTEM

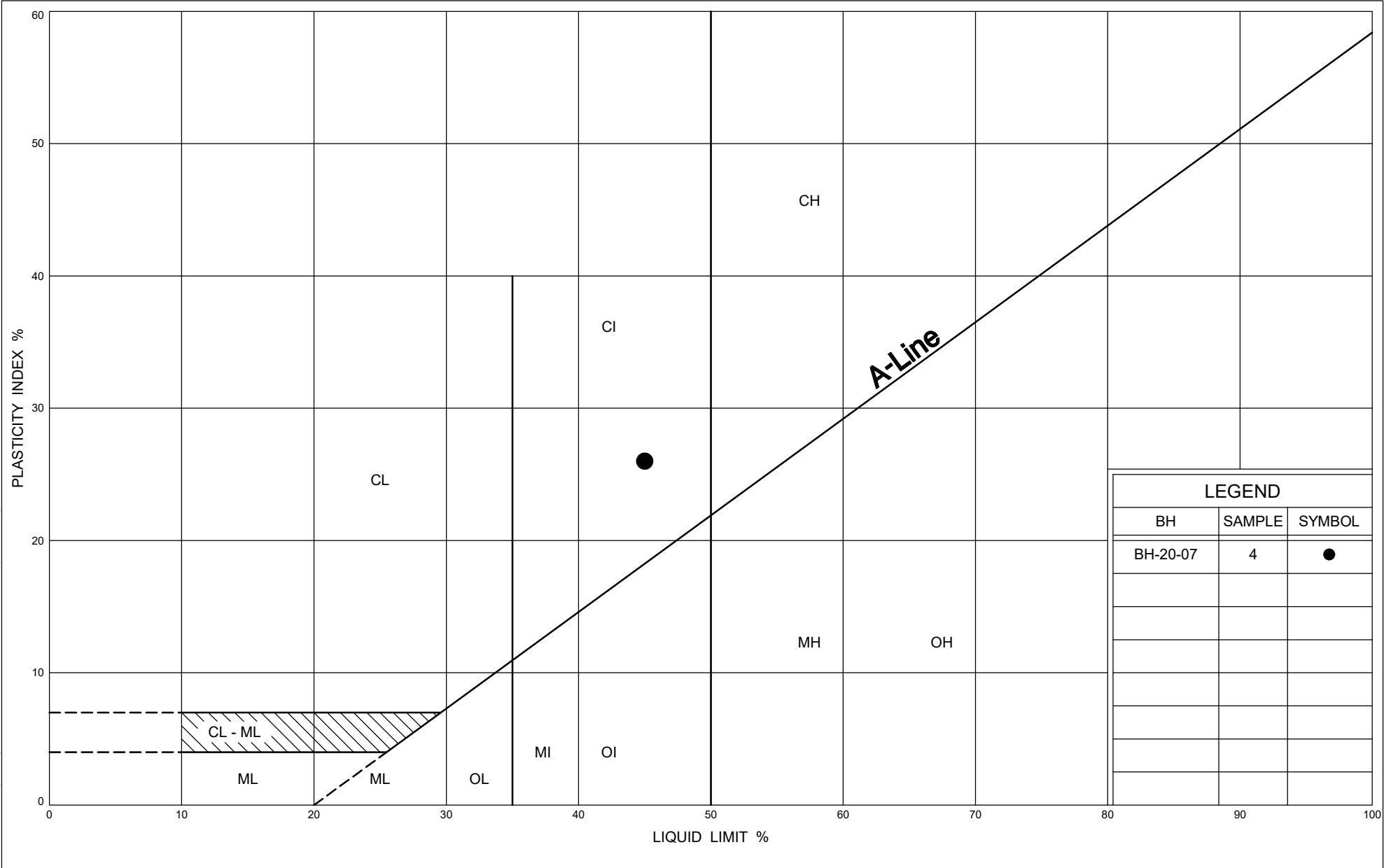


GRAIN SIZE DISTRIBUTION

Culvert No. 06X-0422/C0 - Silt and Sand (Till)

Figure:	C3-3
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

ONTARIO MOT PLASTICITY CHART (TITLE) 11202886 COMBINE FOR FIGURE(20211217)-1.GPJ ONTARIO MOT.GDT 17/12/21

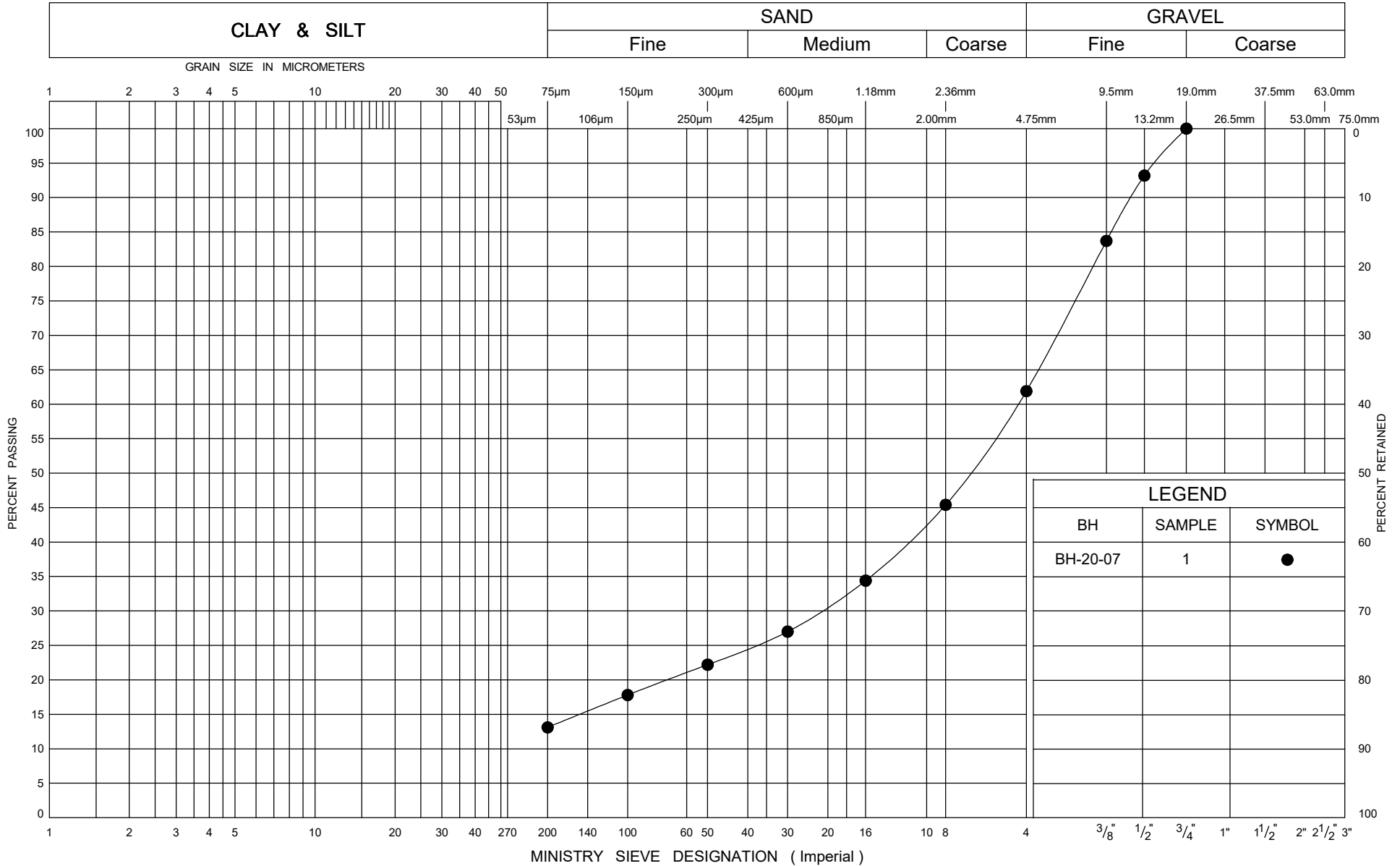


PLASTICITY CHART

Culvert No. 06X-0423/C0 - Silty Clay Fill

Figure:	C4-1
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

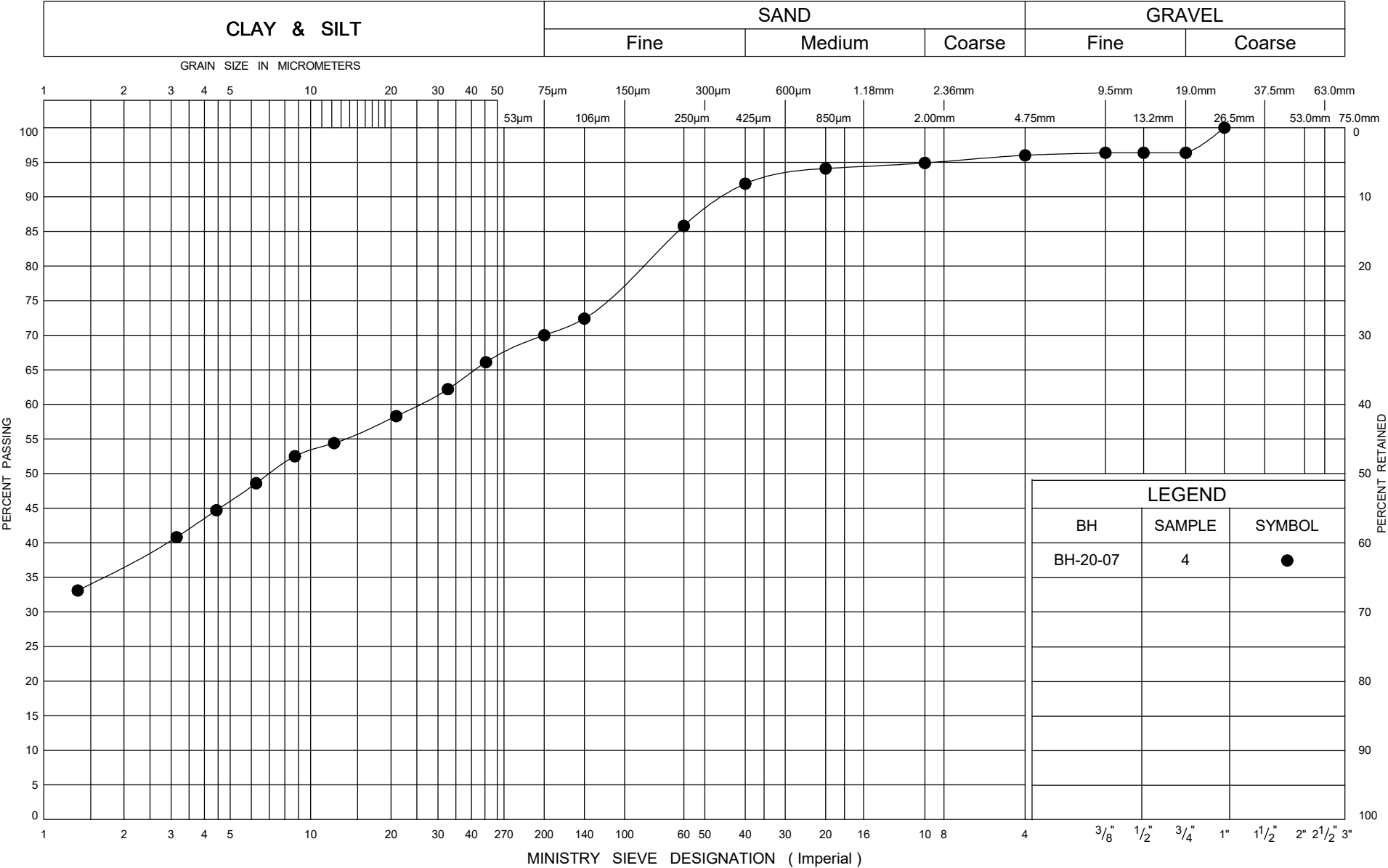
# UNIFIED SOIL CLASSIFICATION SYSTEM



**GRAIN SIZE DISTRIBUTION**  
Culvert No. 06X-0423/C0 - Sand and Gravel Fill

Figure:	C4-2
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

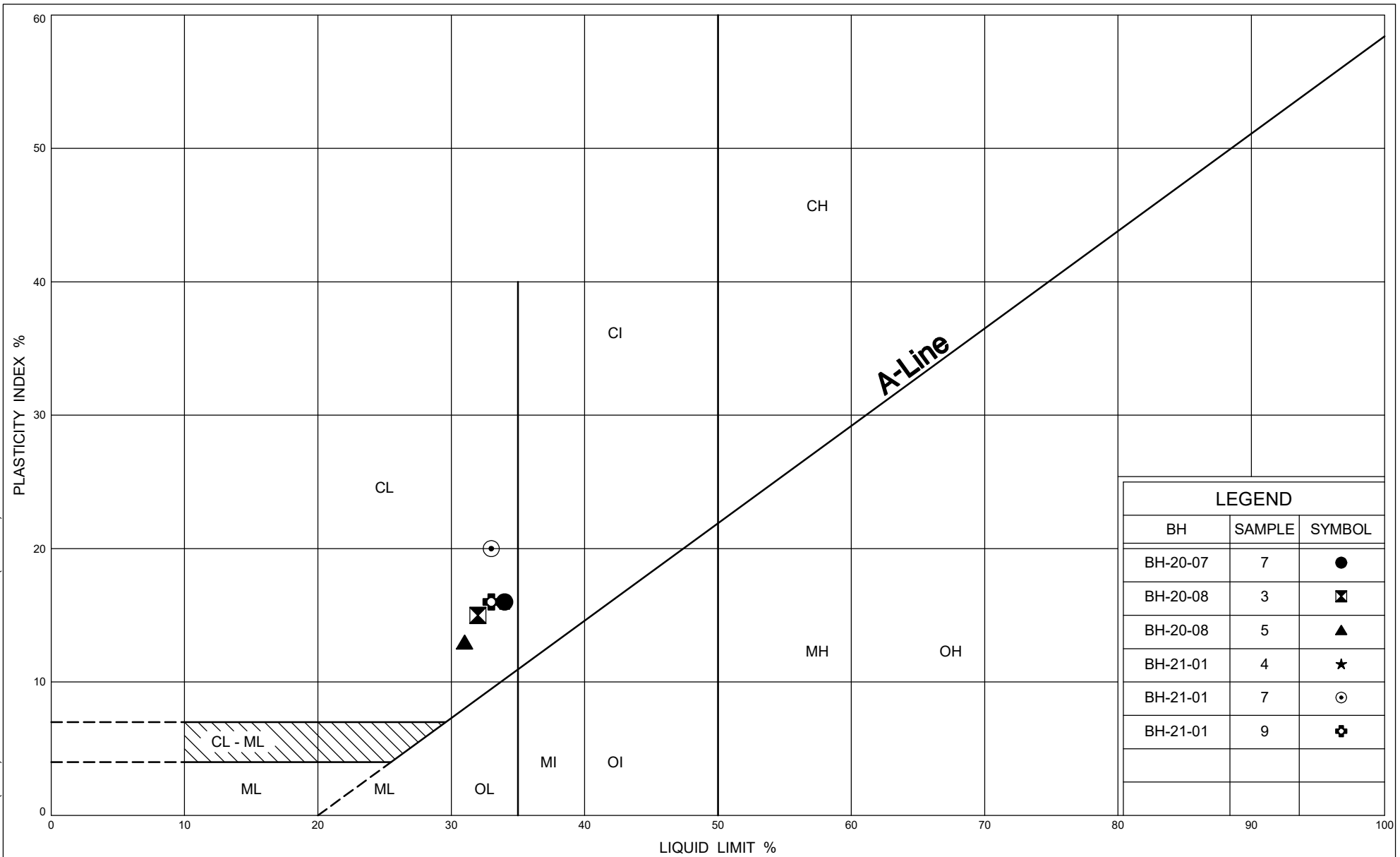
UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
Culvert No. 06X-0423/C0 - Silty Clay Fill

Figure:	C4-3
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886



Ministry of  
Transportation

## PLASTICITY CHART

Culvert No. 06X-0423/C0 - Clayey Silt (Till)

Figure:

C4-4

Assignment No.:

3017-E-0012

G.W.P. No.:

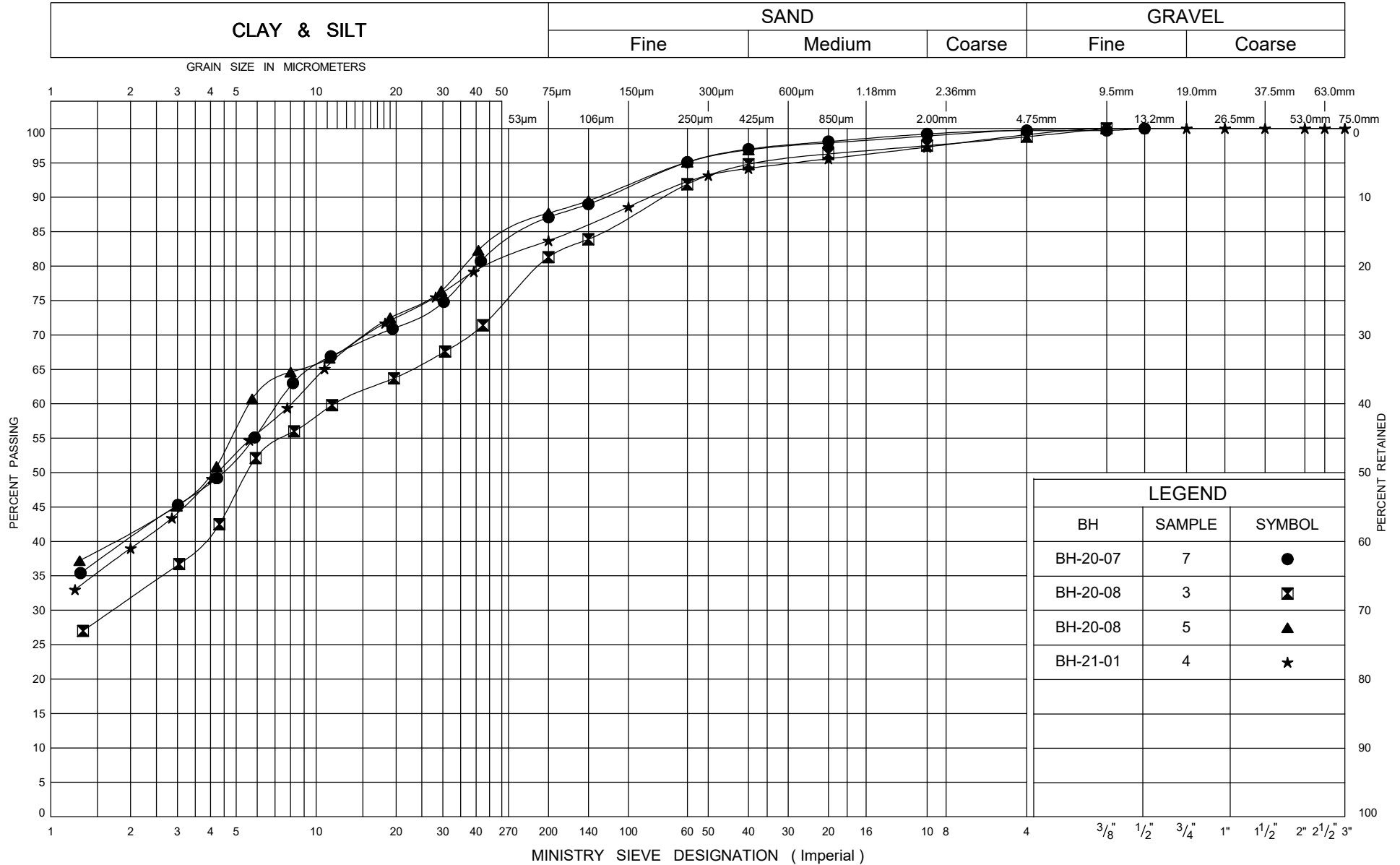
3021-18-00

GHD Project No.:

11202886



# UNIFIED SOIL CLASSIFICATION SYSTEM

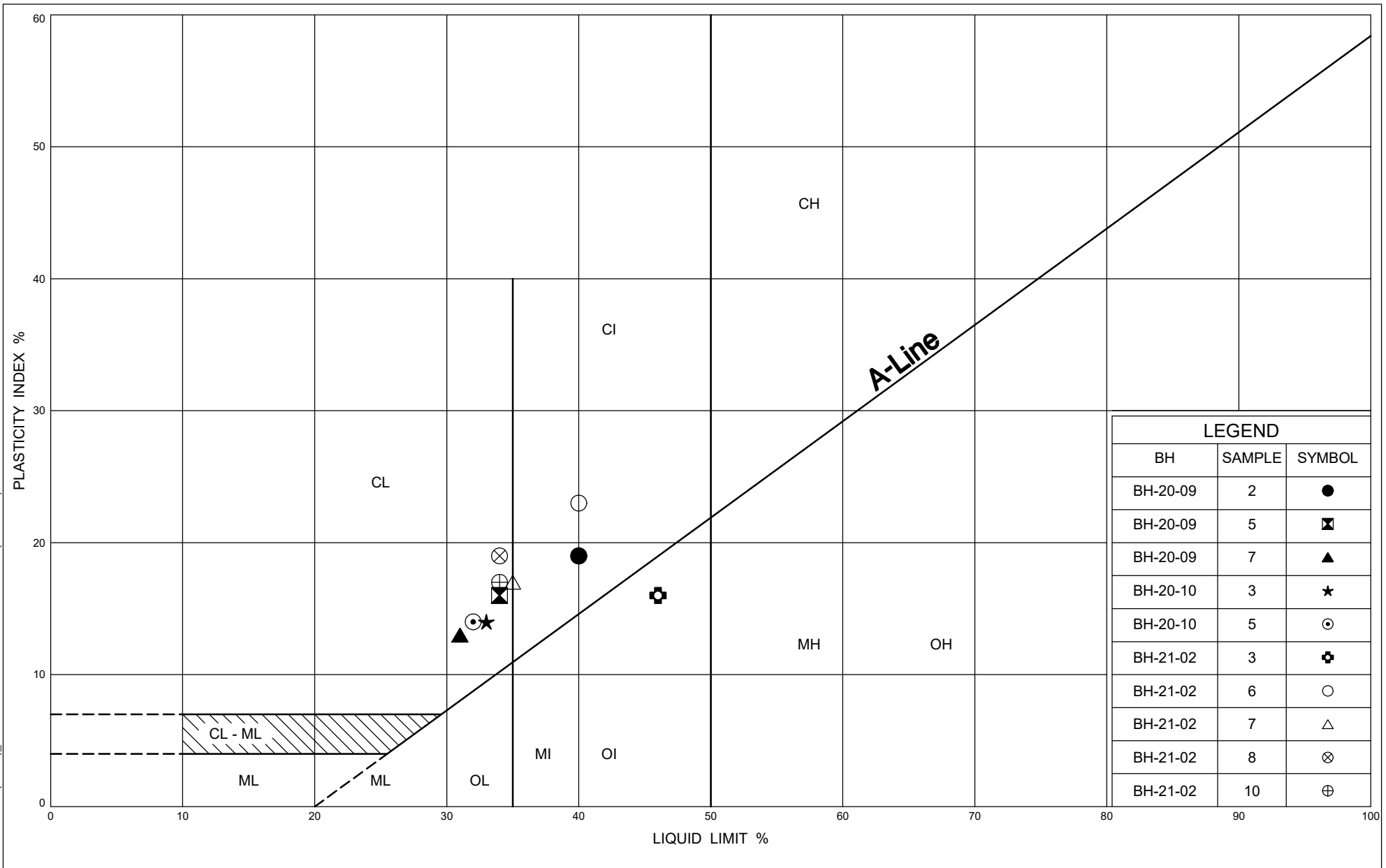


Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

Culvert No. 06X-0423/C0 - Clayey Silt (Till)

Figure:	C4-5
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886



Ministry of  
Transportation

## PLASTICITY CHART

Culvert No. 06X-0426/C0 - Clayey Silt to Silty Clay (Till)

Figure:	C5-1
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

# UNIFIED SOIL CLASSIFICATION SYSTEM

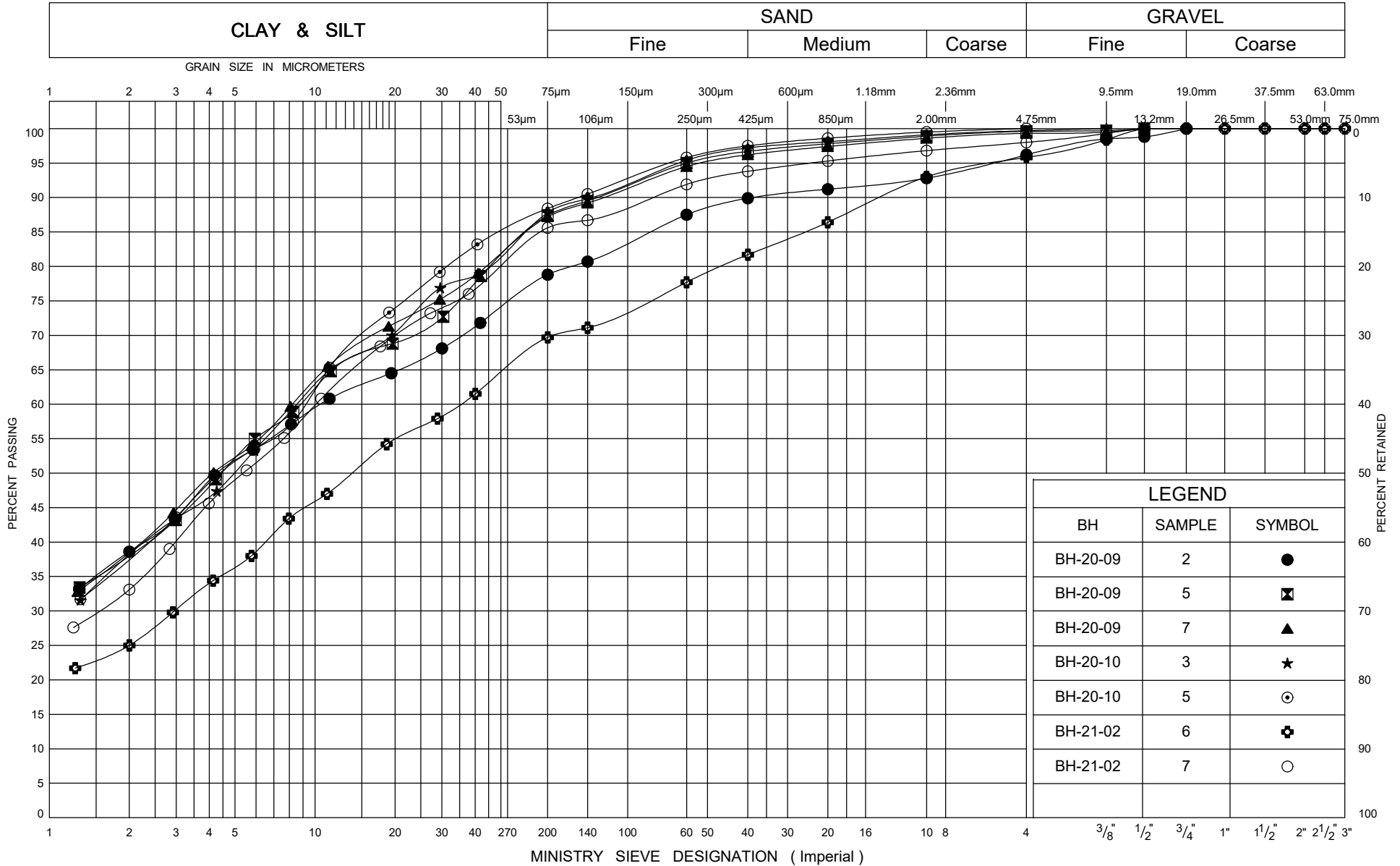
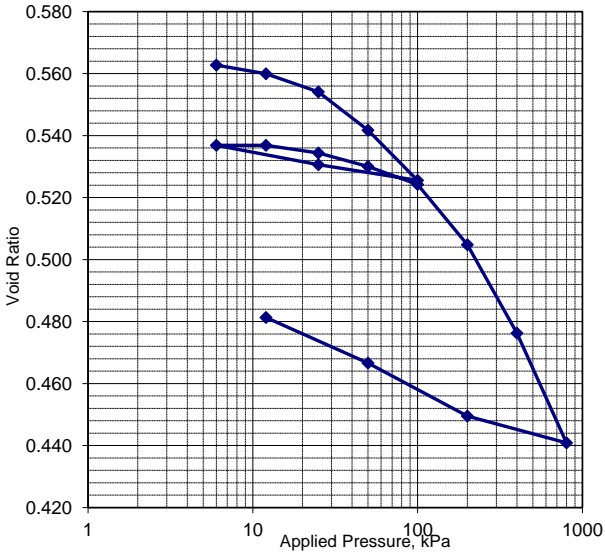
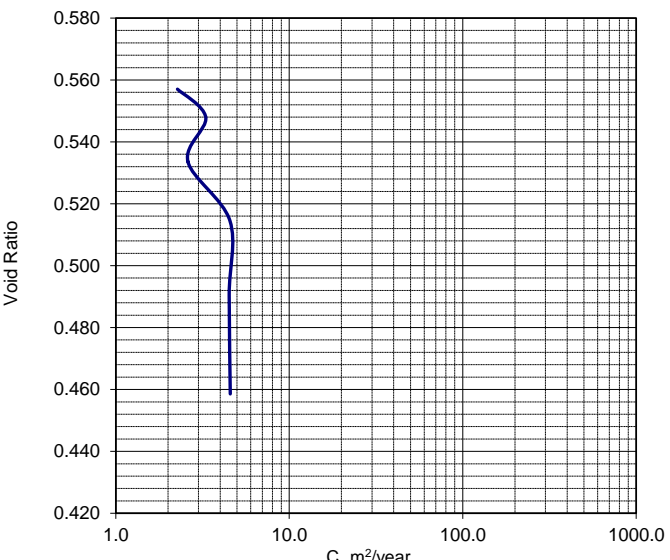


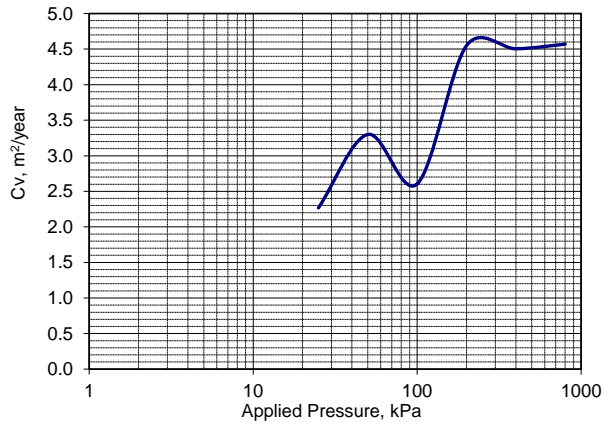


Figure C5-3 Consolidation Test Results

<b>CLIENT:</b>	Ministry of Transportation of Ontario	<b>PROJECT No:</b>	11202886
<b>PROJECT:</b>	GWP 3021-18.00 Highway 3 Widening, Windsor to Leamington, Phase 3, Contract 2	<b>LAB No:</b>	WLT 710-1
<b>BOREHOLE No:</b>	BH21-02	<b>SAMPLE No:</b>	TW1
<b>DEPTH:</b>	7.6 - 8.2 m (25'0" - 27'0")		
<b>DESCRIPTION OF MATERIAL:</b>	Culvert No. 06X-0426/C0 - Clayey Silt (Till)		







Axial Stress kPa	Specimen Height mm	Axial Strain %	Void Ratio e	$c_v$ m <sup>2</sup> /year
Initial	19.910	0.00	0.565	
6	19.887	0.12	0.563	
12	19.852	0.29	0.560	
25	19.777	0.67	0.554	2.3
50	19.619	1.46	0.542	3.3
100	19.414	2.49	0.526	2.6
25	19.478	2.17	0.531	
6	19.557	1.77	0.537	
12	19.557	1.77	0.537	
25	19.526	1.93	0.534	
50	19.471	2.21	0.530	
100	19.397	2.58	0.524	
200	19.149	3.82	0.505	4.5
400	18.786	5.64	0.476	4.5
800	18.336	7.91	0.441	4.6
200	18.446	7.36	0.449	
50	18.663	6.26	0.467	
12	18.851	5.32	0.481	

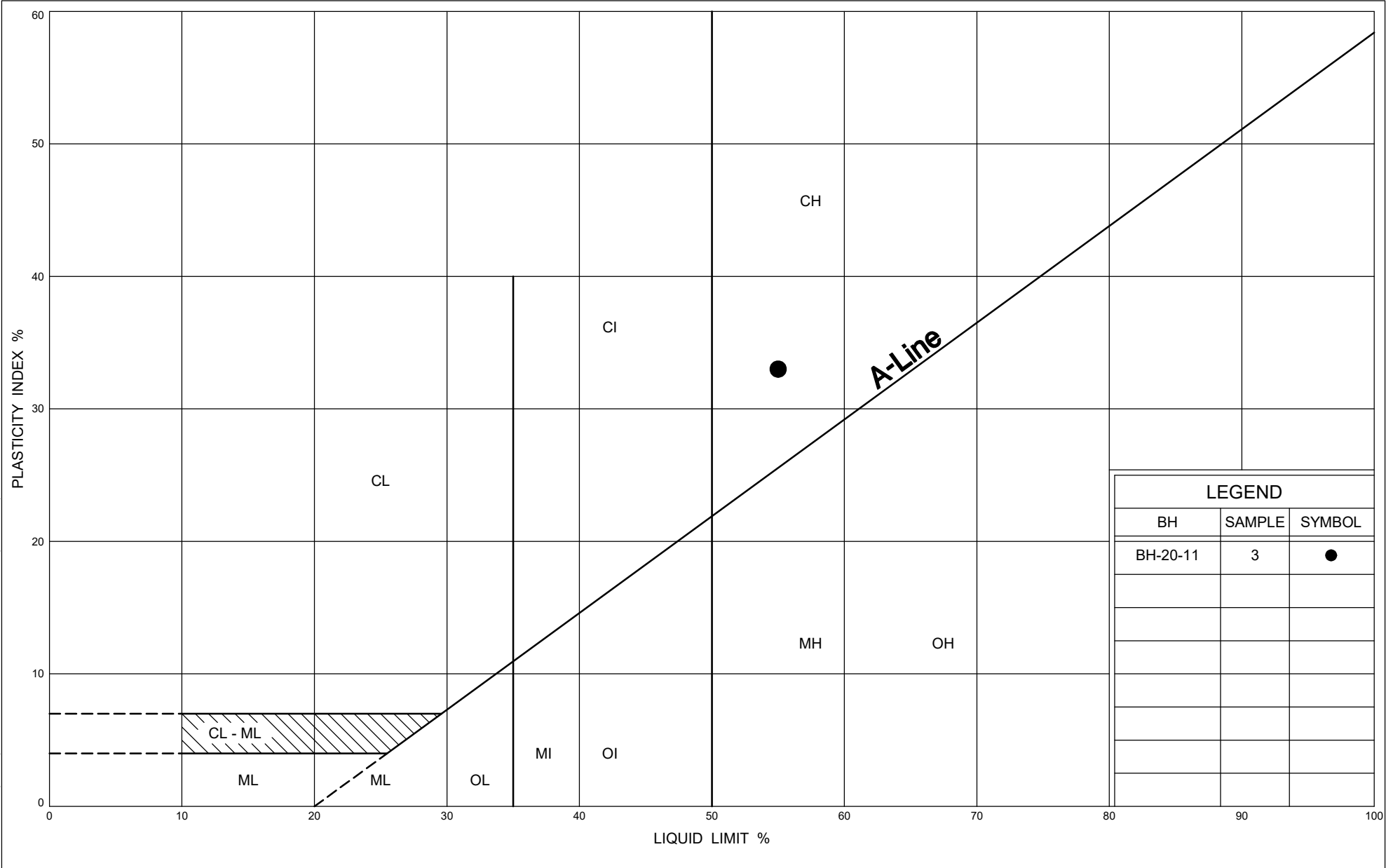
Test Summary			
$\sigma'_p$ Preconsolidation pressure, kPa	153.0	$e_0$ Initial Void Ratio	0.565
$\sigma'_0$ Effective vertical pressure, kPa	141.7	$e_f$ Final Void Ratio	0.481
$\sigma'_p - \sigma'_0$ Overconsolidation, kPa	11.3	Initial Degree of Saturation	0.97
Overconsolidation ratio ("OCR")	1.1	Final Degree of Saturation	1.00
$C_c$ Compression Index	0.116	$C_R$ Recompression Index	0.010

Sample dry density, g/cm <sup>3</sup>		Moisture content (W) %	
Initial state	1.757	Initial state	20.0
Final state	1.855	Final state	17.5

**REMARKS:**

<b>PERFORMED BY:</b> Melanie Mitchell	<b>DATE:</b> Nov 12 - Nov 28, 2021
<b>VERIFIED BY:</b> Michael Braverman	<b>DATE:</b> November 30, 2021

ONTARIO MOT PLASTICITY CHART (TITLE)\_8\_11202886 COMBINE FOR FIGURE(20211217)-1.GPJ ONTARIO MOT.GDT 17/12/21

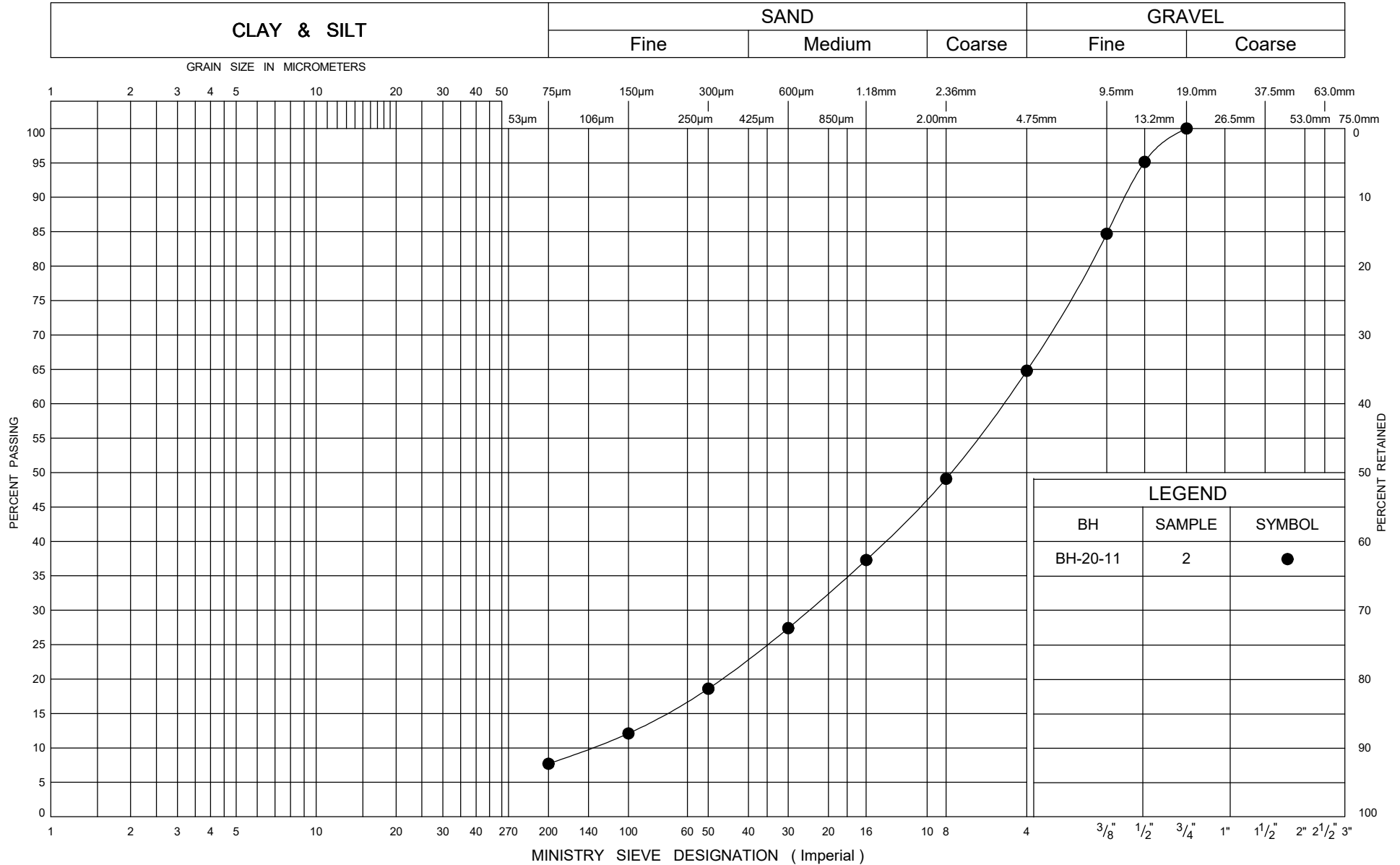


**PLASTICITY CHART**  
Culvert No. 06X-0427/C0 - Silty Clay Fill

Figure:	C6-1
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886



# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

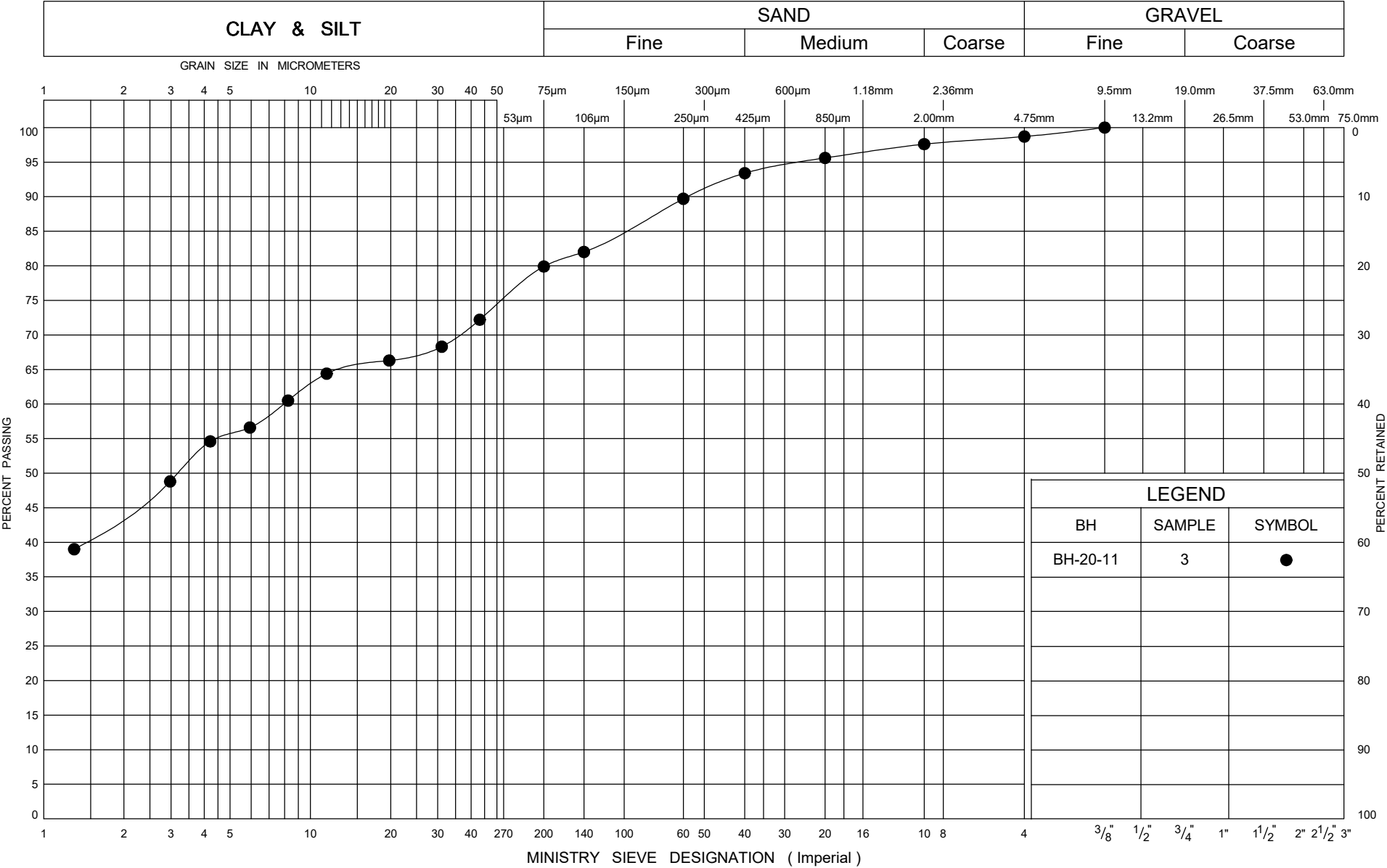
## GRAIN SIZE DISTRIBUTION

Culvert No. 06X-0427/C0 - Sand and Gravel Fill

Figure:	C6-2
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

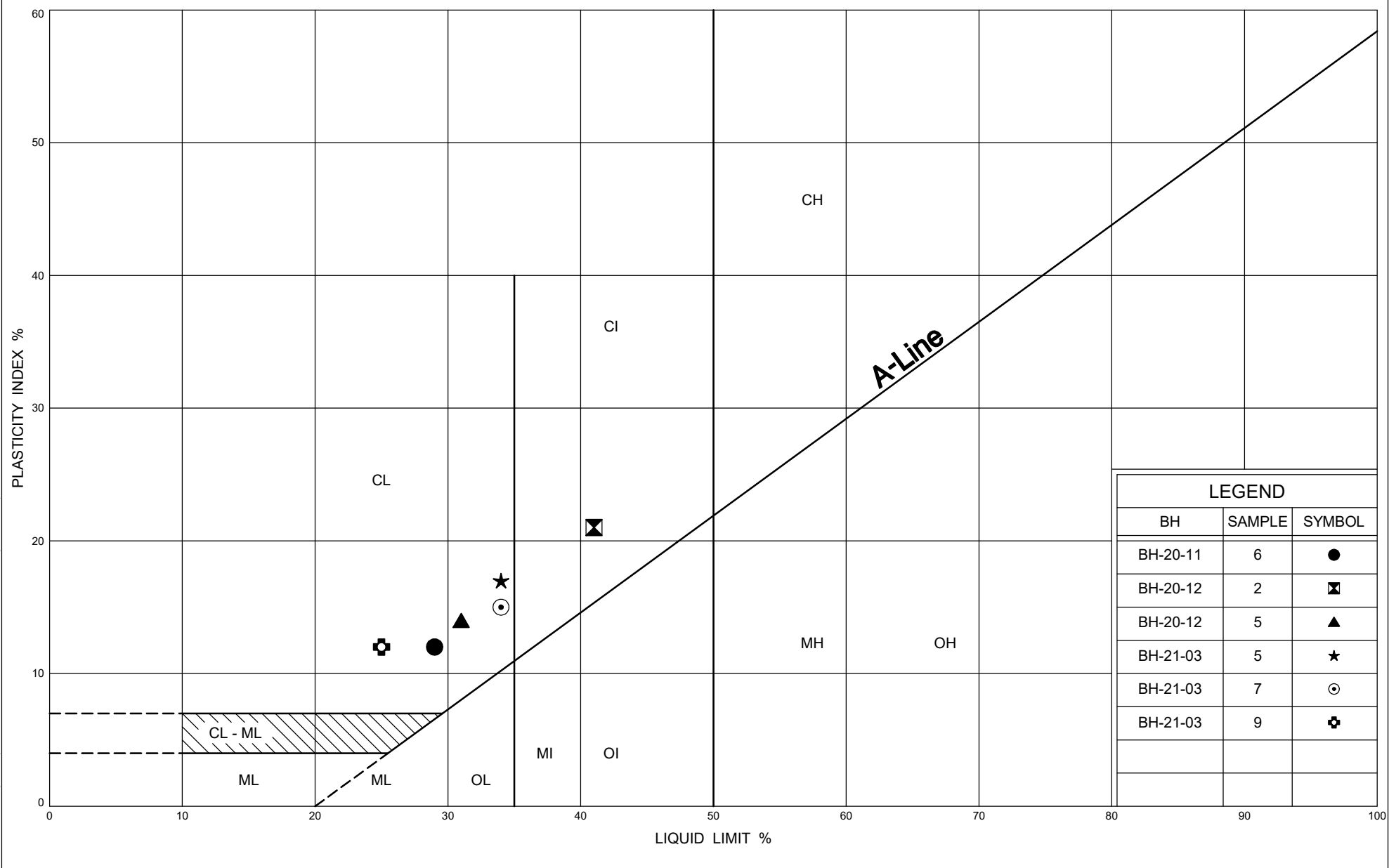
ONTARIO MOT GRAIN SIZE (TITLE) 11202886 COMBINE FOR FIGURE(20211217)-1.GPJ ONTARIO MOT.GDT 17/12/21

UNIFIED SOIL CLASSIFICATION SYSTEM

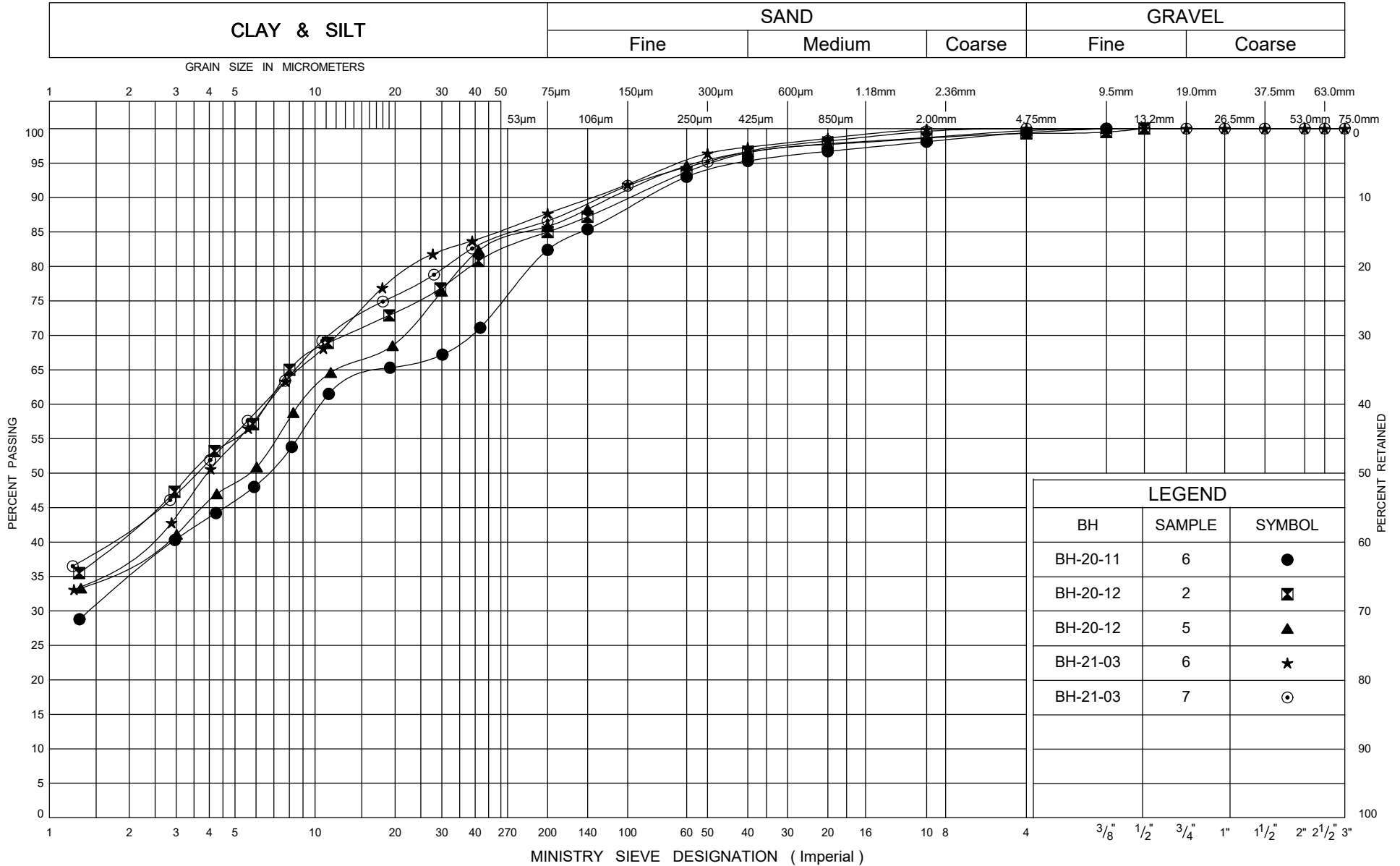


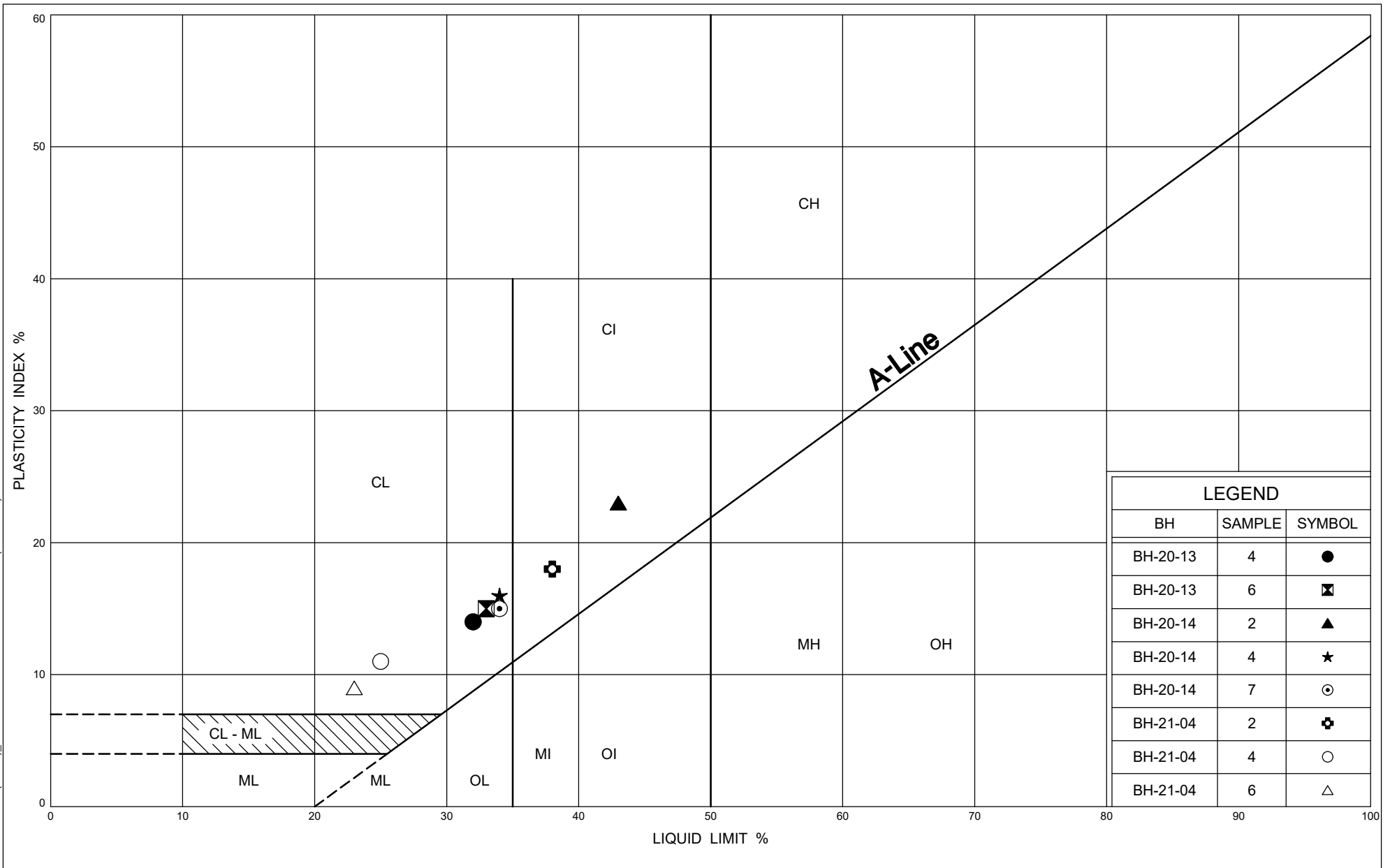
GRAIN SIZE DISTRIBUTION  
Culvert No. 06X-0427/C0 - Silty Clay Fill

Figure:	C6-3
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886



# UNIFIED SOIL CLASSIFICATION SYSTEM





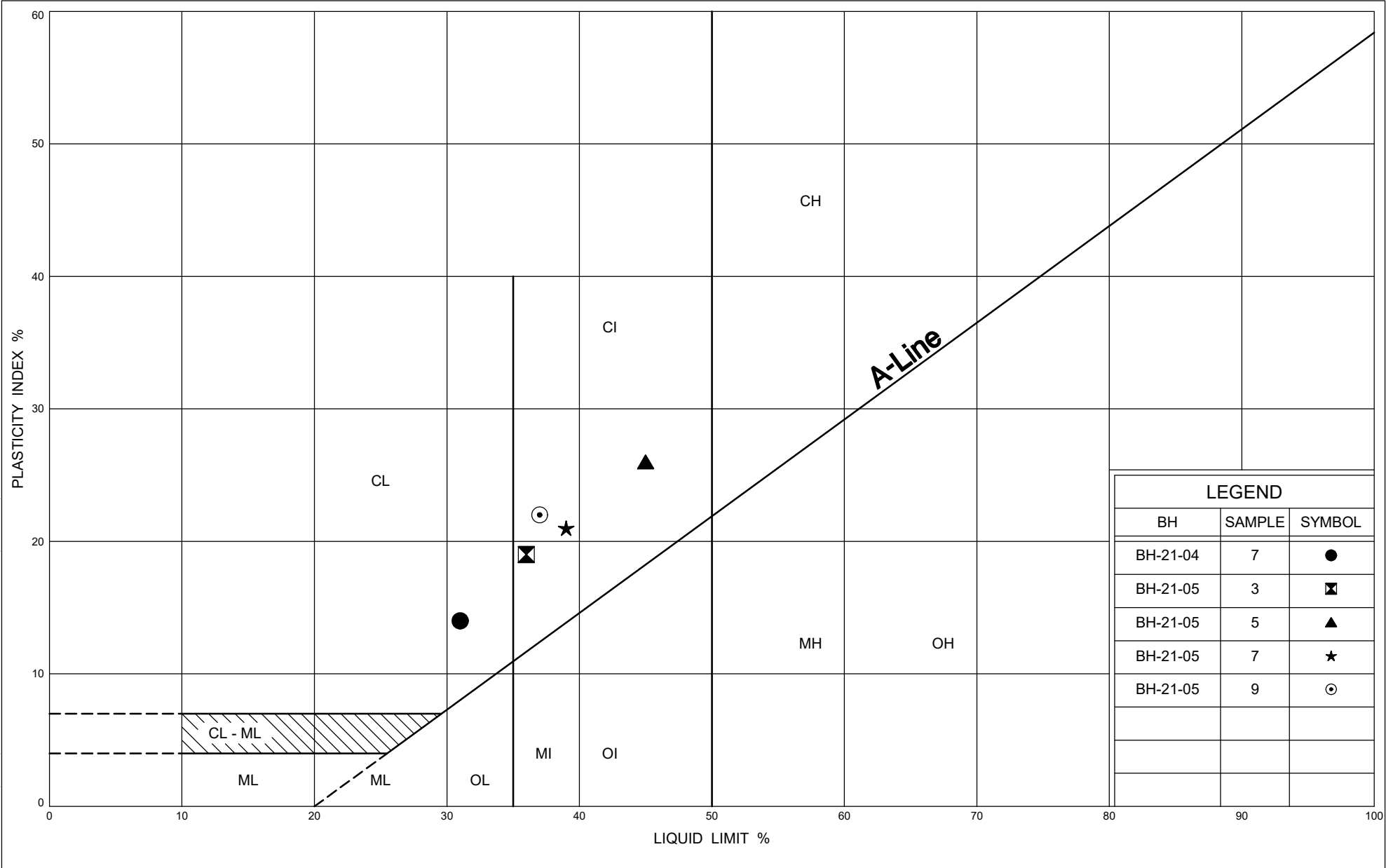
Ministry of  
Transportation

## PLASTICITY CHART

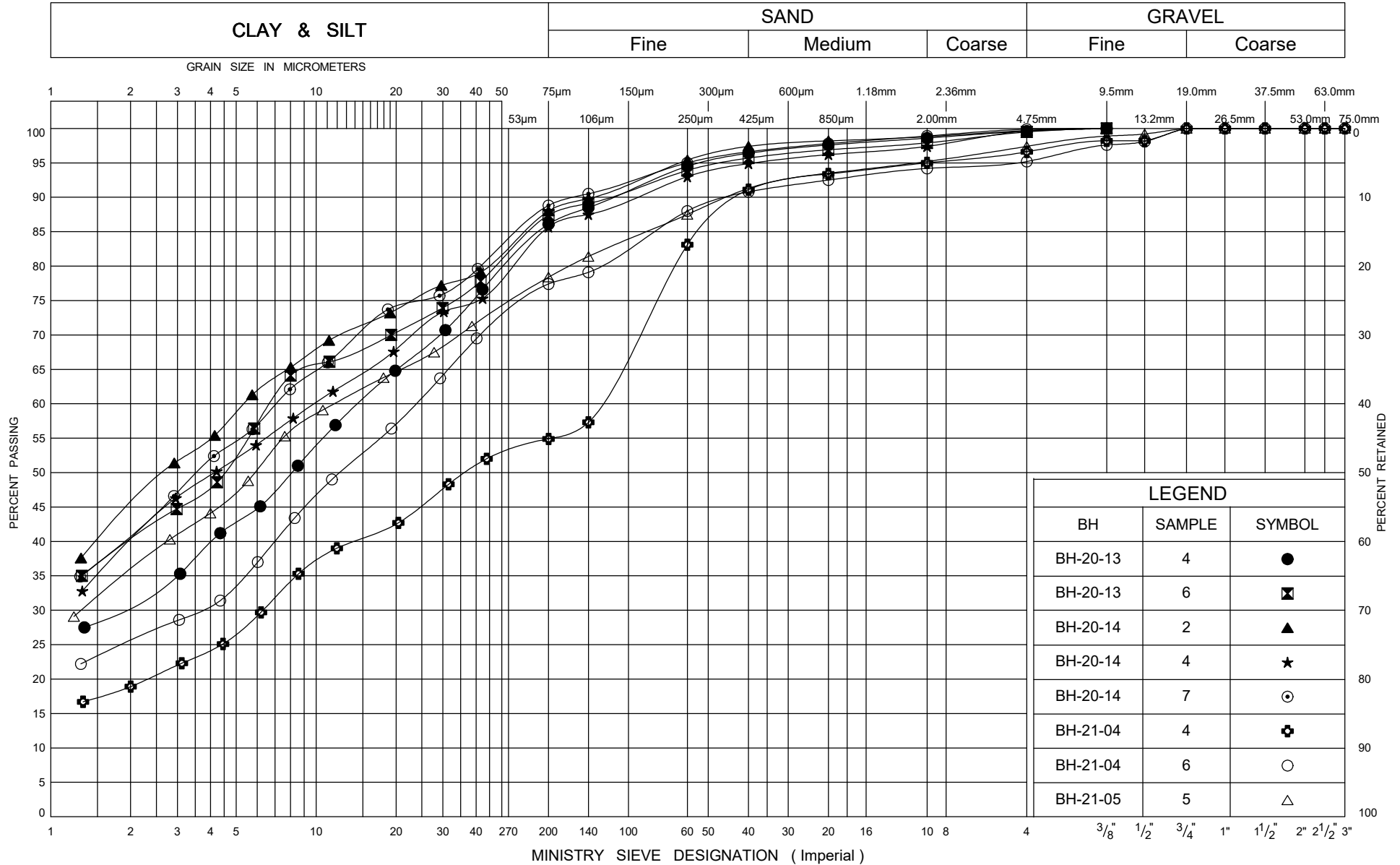
Culvert No. 06X-0429/C0 - Clayey Silt and Sand to Silty Clay (Till)

Figure:	C7-1A
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886





# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

Culvert No. 06X-0429/C0 - Clayey Silt and Sand to Silty Clay (Till)

Figure:	C7-2
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

# UNIFIED SOIL CLASSIFICATION SYSTEM

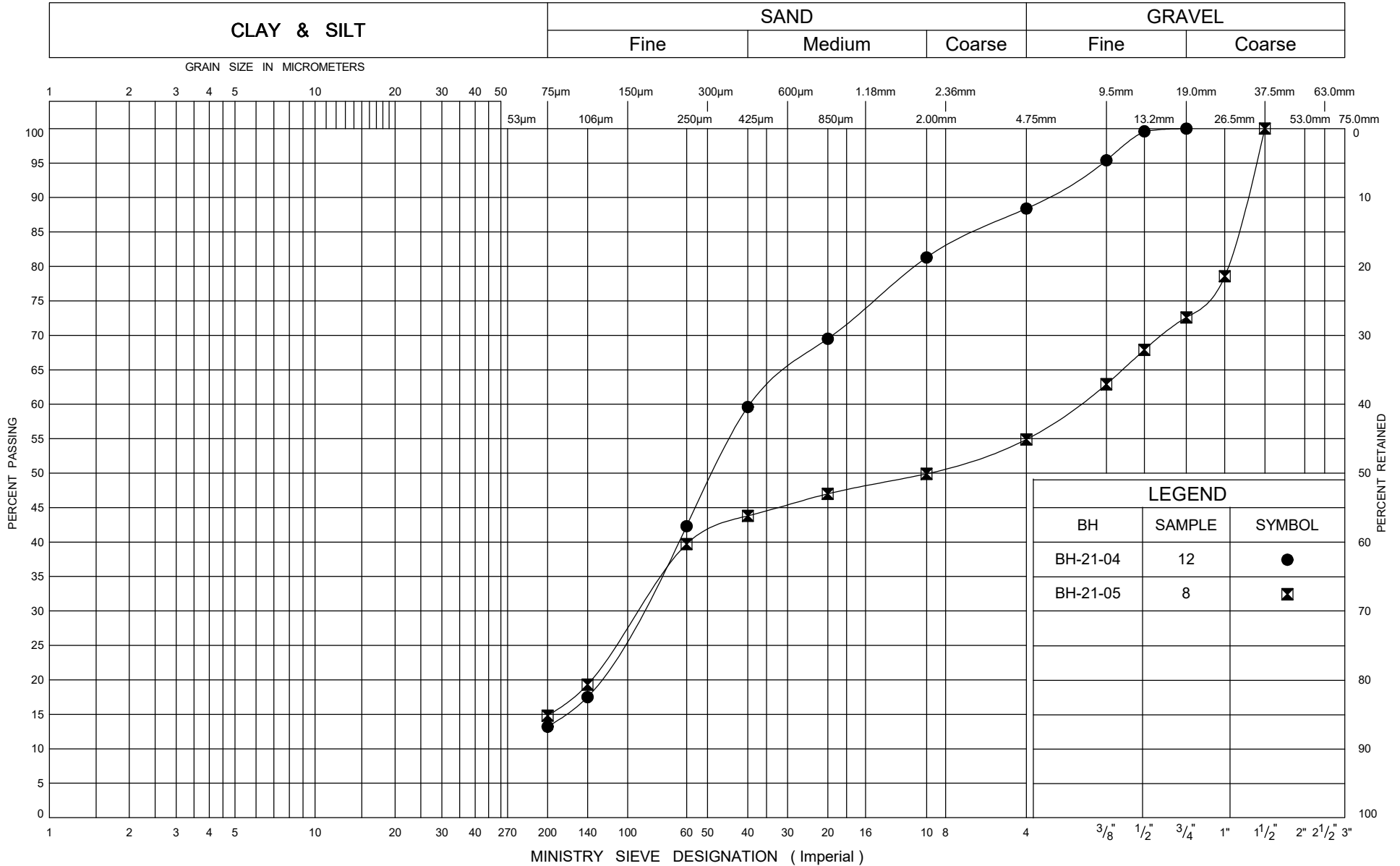




Figure C7-4 Consolidation Test Results

<b>CLIENT:</b>	Ministry of Transportation of Ontario	<b>PROJECT No:</b>	11202886
<b>PROJECT:</b>	GWP 3021-18.00 Highway 3 Widening, Windsor to Leamington, Phase 3, Contract 2	<b>LAB No:</b>	WLT 710-2
<b>BOREHOLE No:</b>	BH21-04	<b>SAMPLE No:</b>	TW2
<b>DEPTH:</b>	6.1 - 6.7 m (20'0" - 22'0")		
<b>DESCRIPTION OF MATERIAL:</b>	Culvert No. 06X-0429/C0 - Clayey Silt (Till)		

Axial Stress kPa	Specimen Height mm	Axial Strain %	Void Ratio e	$c_v$ m²/year
Initial	19.590	0.00	0.636	
6	19.563	0.14	0.633	
12	19.510	0.41	0.629	
25	19.462	0.66	0.625	2.0
50	19.365	1.15	0.617	3.5
100	19.143	2.28	0.598	2.7
25	19.198	2.00	0.603	
6	19.299	1.49	0.611	
12	19.295	1.50	0.611	
25	19.261	1.68	0.608	
50	19.210	1.94	0.604	
100	19.099	2.51	0.595	
200	18.841	3.83	0.573	3.4
400	18.464	5.75	0.541	4.0
800	17.940	8.42	0.498	3.7
200	18.074	7.74	0.509	
50	18.328	6.44	0.530	
12	18.553	5.30	0.549	

Test Summary			
$\sigma'_p$ Preconsolidation pressure, kPa	145.0	$e_0$ Initial Void Ratio	0.636
$\sigma'_0$ Effective vertical pressure, kPa	125.5	$e_f$ Final Void Ratio	0.549
$\sigma'_p - \sigma'_0$ Overconsolidation, kPa	19.5	Initial Degree of Saturation	0.97
Overconsolidation ratio ("OCR")	1.16	Final Degree of Saturation	1.00
$C_c$ Compression Index	0.116	$C_R$ Recompression Index	0.010

Sample dry density, g/cm³	Moisture content (W) %
Initial state <u>1.681</u> Final state <u>1.775</u>	Initial state <u>22.3</u> Final state <u>19.9</u>

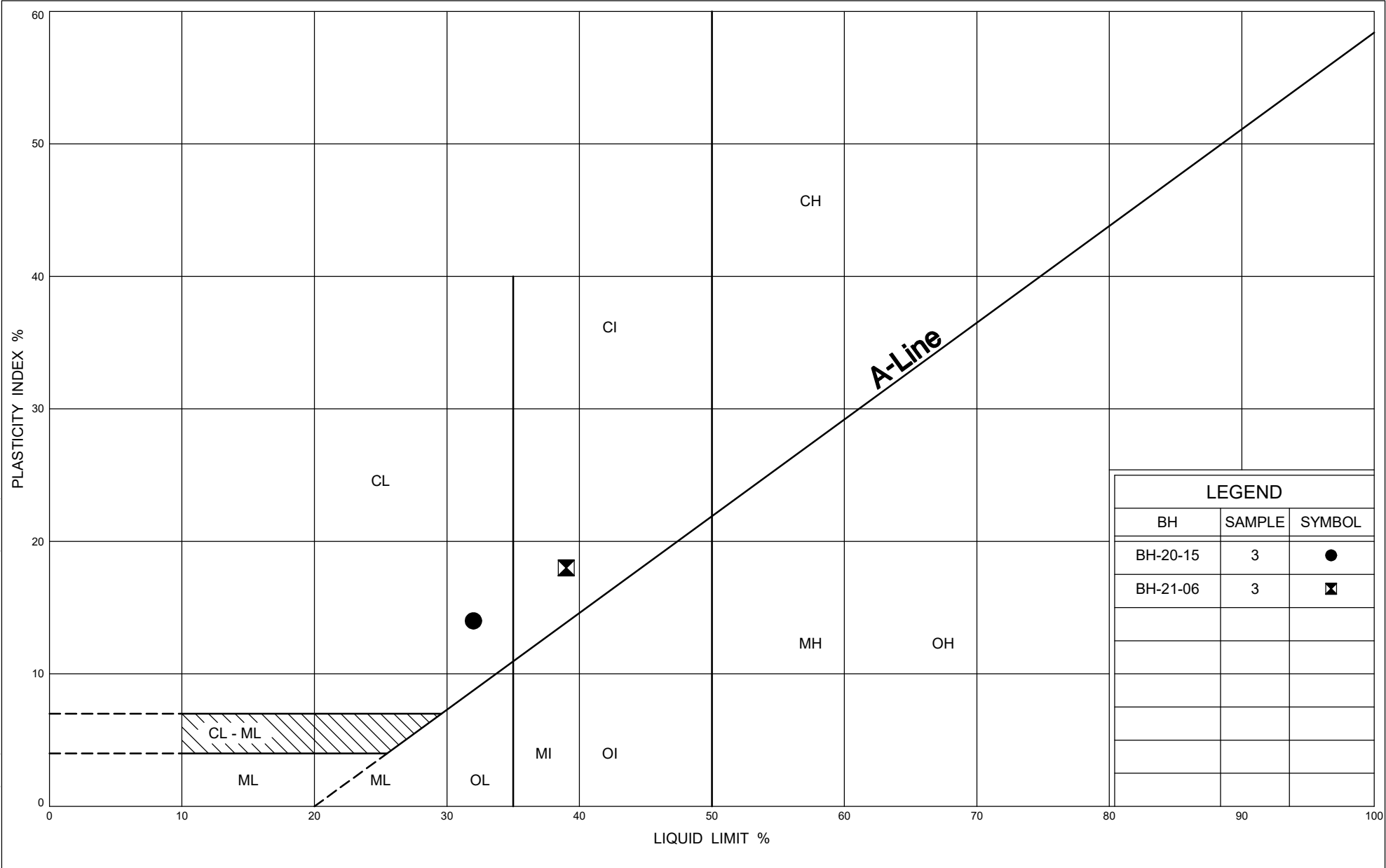
  

**REMARKS:** \_\_\_\_\_

<b>PERFORMED BY:</b> Melanie Mitchell	<b>DATE:</b> Nov 12 - Nov 28, 2021
<b>VERIFIED BY:</b> Michael Braverman	<b>DATE:</b> November 30, 2021

ONTARIO MOT PLASTICITY CHART (TITLE)\_8\_11202886 COMBINE FOR FIGURE(20211217)-1.GPJ ONTARIO MOT.GDT 17/12/21

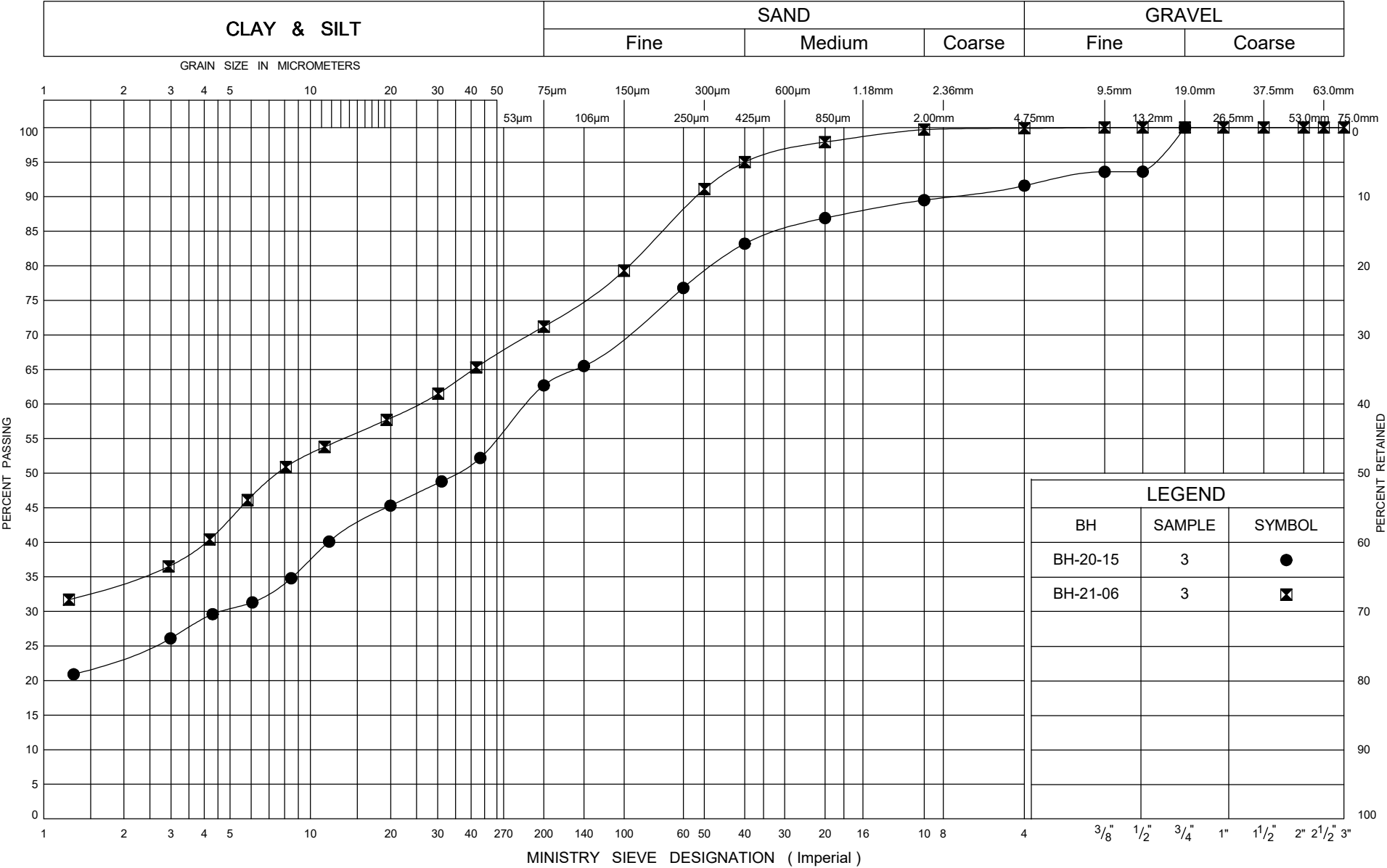


**PLASTICITY CHART**  
Culvert No. 06X-0432/C0 - Silty Clay with Sand Fill

Figure:	C8-1
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886



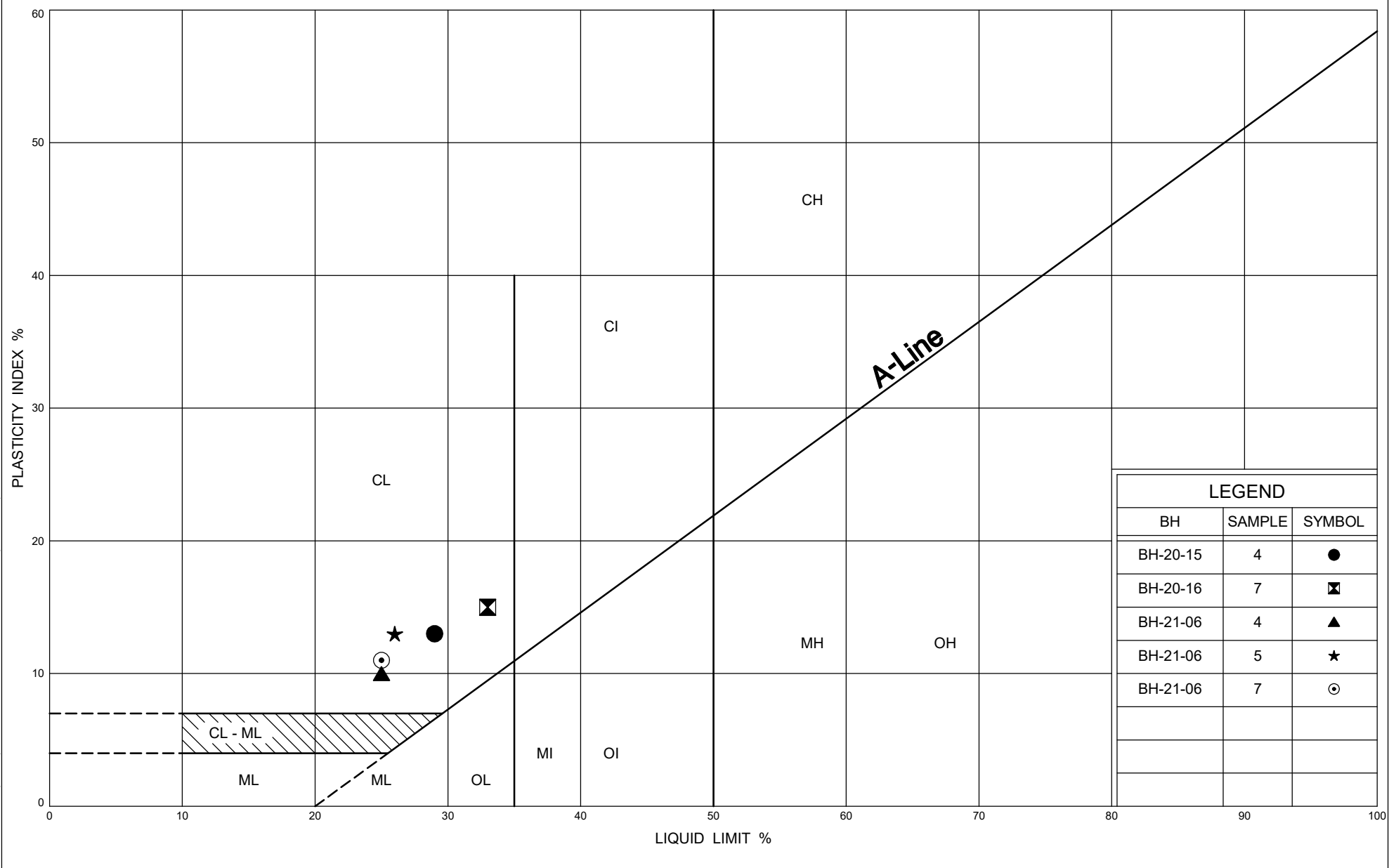
UNIFIED SOIL CLASSIFICATION SYSTEM

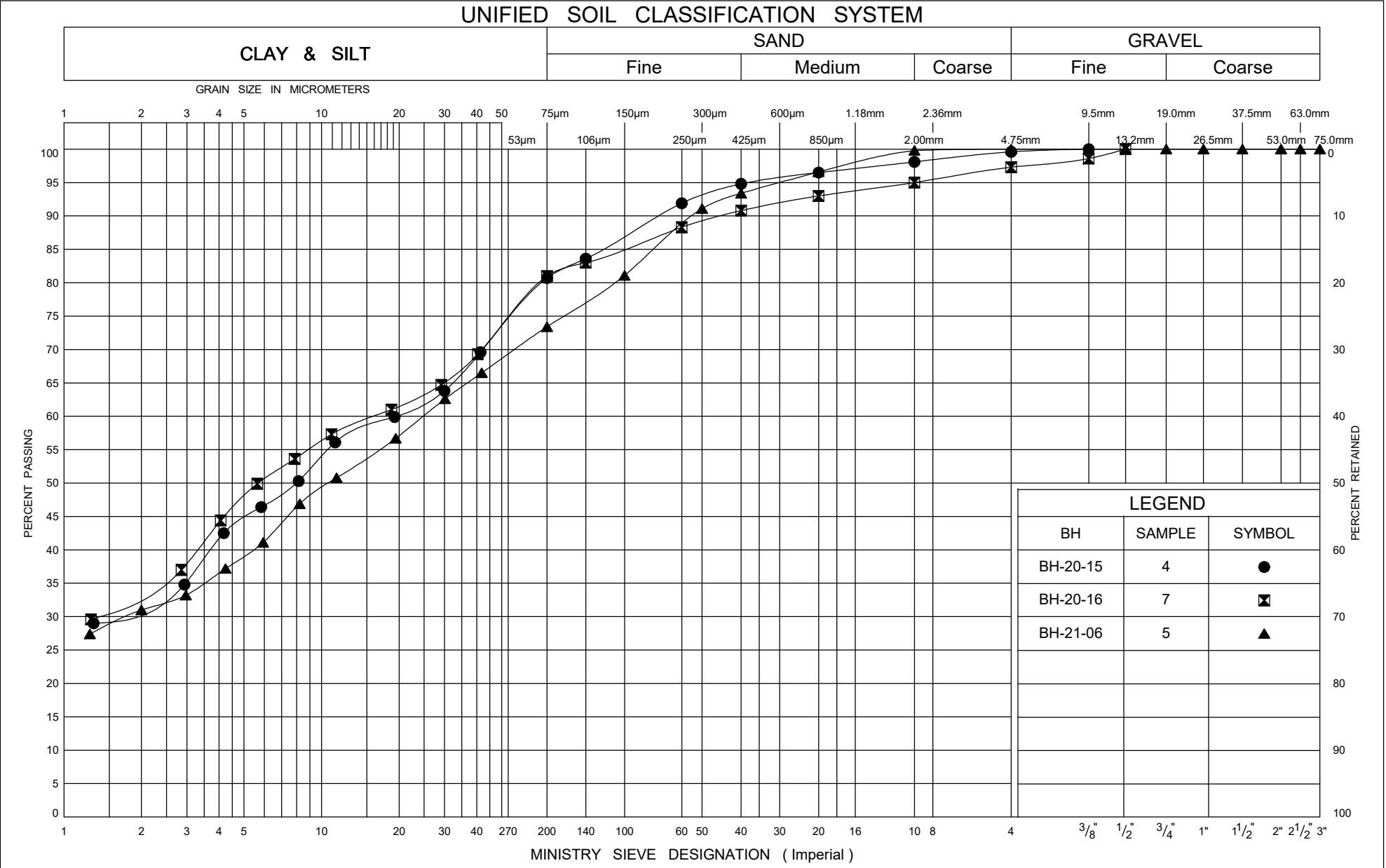


GRAIN SIZE DISTRIBUTION

Culvert No. 06X-0432/C0 - Silty Clay with Sand Fill

Figure:	C8-2
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886





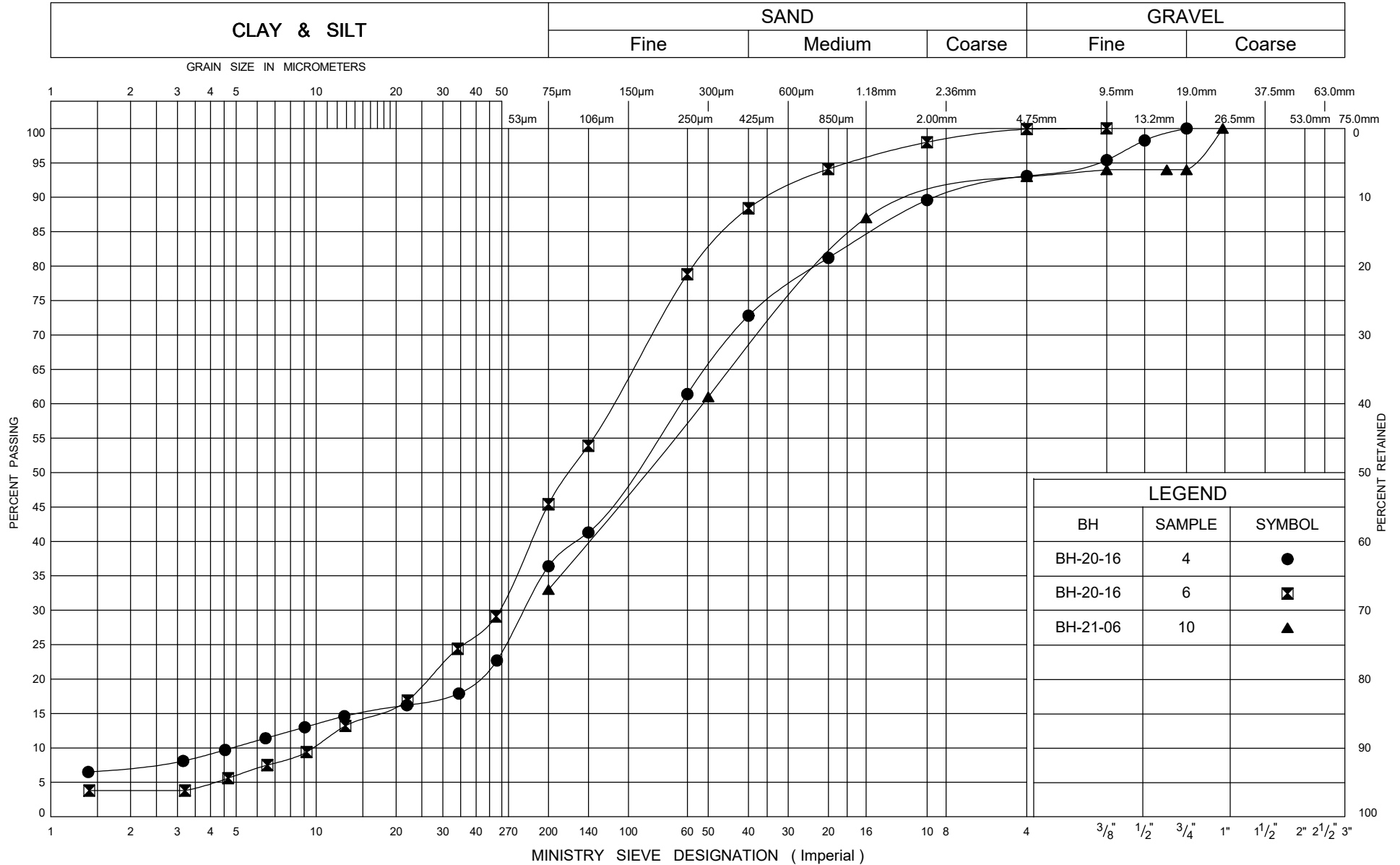
Ministry of  
Transportation

Ontario

**GRAIN SIZE DISTRIBUTION**  
Culvert No. 06X-0432/C0 - Clayey Silt (Till)

Figure:	C8-4
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

Culvert No. 06X-0432/C0 - Silt and Sand to Silty Sand (Till)

Figure:	C8-5
Assignment No.:	3017-E-0012
G.W.P. No.:	3021-18-00
GHD Project No.:	11202886

# **Appendix D**

## **Analytical Test Results**

**C.O.C.: G93264**

**REPORT No. B20-13601**

**Report To:**

**GHD Limited**

455 Phillip Street,  
Waterloo Ontario N2L 3X2 Canada

**Attention:** Vincent Zappia

**Caduceon Environmental Laboratories**

110 West Beaver Creek Rd Unit 14  
Richmond Hill ON L4B 1J9

Tel: 289-475-5442

Fax: 289-562-1963

DATE RECEIVED: 20-May-20

JOB/PROJECT NO.: Hwy 3 Widening

DATE REPORTED: 27-May-20

P.O. NUMBER:

SAMPLE MATRIX: Soil

WATERWORKS NO.

			Client I.D.		BH-20-02; SS-6	BH-20-03; SS-6	BH-20-05; SS-6	BH-20-08; SS-5
			Sample I.D.		B20-13601-1	B20-13601-2	B20-13601-3	B20-13601-4
			Date Collected		19-May-20	19-May-20	19-May-20	19-May-20
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed				
pH @25°C	pH Units		MOEE3530	21-May-20/R	7.78	7.80	7.69	7.68
Resistivity	ohms-cm		SM 2510B	26-May-20/O	1870	1240	1410	1880
REDOX potential	mV		In-House	22-May-20/R	161	189	173	172
Chloride	µg/g	5	SM4110C	26-May-20/O	13	129	71	12
Sulphate	µg/g	10	SM4110C	26-May-20/O	510	980	800	510
Sulfide	µg/g	5	In-House	26-May-20	< 5 <sup>1</sup>	< 5 <sup>1</sup>	< 5 <sup>1</sup>	< 5 <sup>1</sup>

<sup>1</sup> Subcontracted to Testmark Labs



Christine Burke  
Lab Manager

R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an \*

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.



**C.O.C.: G93264**

**REPORT No. B20-13601**

**Report To:**

**GHD Limited**

455 Phillip Street,  
Waterloo Ontario N2L 3X2 Canada

**Attention:** Vincent Zappia

**Caduceon Environmental Laboratories**

110 West Beaver Creek Rd Unit 14  
Richmond Hill ON L4B 1J9

Tel: 289-475-5442

Fax: 289-562-1963

DATE RECEIVED: 20-May-20

JOB/PROJECT NO.: Hwy 3 Widening

DATE REPORTED: 27-May-20

P.O. NUMBER:

SAMPLE MATRIX: Soil

WATERWORKS NO.

			Client I.D.		BH-20-10; SS-6	BH-20-11; SS-5	BH-20-13; SS-5A	BH-20-16; SS-5
			Sample I.D.		B20-13601-5	B20-13601-6	B20-13601-7	B20-13601-8
			Date Collected		19-May-20	19-May-20	19-May-20	19-May-20
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed				
pH @25°C	pH Units		MOEE3530	21-May-20/R	7.70	7.75	7.71	7.70
Resistivity	ohms-cm		SM 2510B	26-May-20/O	1730	2060	2880	2420
REDOX potential	mV		In-House	22-May-20/R	163	208	222	167
Chloride	µg/g	5	SM4110C	26-May-20/O	16	230	171	30
Sulphate	µg/g	10	SM4110C	26-May-20/O	580	130	30	280
Sulfide	µg/g	5	In-House	26-May-20	< 5 <sup>1</sup>	< 5 <sup>1</sup>	< 5 <sup>1</sup>	< 5 <sup>1</sup>

<sup>1</sup> Subcontracted to Testmark Labs



Christine Burke  
Lab Manager

R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an \*

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.



GHD Limited (Waterloo)  
ATTN: JENNIFER BALKWILL  
455 PHILLIP STREET  
WATERLOO ON N2L 3X2

Date Received: 19-OCT-21  
Report Date: 29-OCT-21 14:46 (MT)  
Version: FINAL

Client Phone: 519-884-0510

## Certificate of Analysis

Lab Work Order #: L2652975  
Project P.O. #: 735-001026  
Job Reference: 11202886  
C of C Numbers:  
Legal Site Desc:

Rick Hawthorne  
Account Manager

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ADDRESS: 60 Northland Road, Unit 1, Waterloo, ON N2V 2B8 Canada | Phone: +1 519 886 6910 | Fax: +1 519 886 9047  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2652975-1    BH21-01-SS4 Sampled By:    CLIENT on 18-OCT-21 @ 16:00 Matrix:        WATER  <b>Physical Tests</b> Conductivity                      0.845 % Moisture                        18.7 pH                                  7.48 Redox Potential                  263 Resistivity                        1180 <b>Leachable Anions &amp; Nutrients</b> Chloride                          80.3 <b>Anions and Nutrients</b> Sulphate                          729 <b>Inorganic Parameters</b> Acid Volatile Sulphides        <0.20							
L2652975-2    BH21-03-SS4 Sampled By:    CLIENT on 18-OCT-21 @ 16:00 Matrix:        WATER  <b>Physical Tests</b> Conductivity                      1.17 % Moisture                        15.1 pH                                  7.46 Redox Potential                  297 Resistivity                        857 <b>Leachable Anions &amp; Nutrients</b> Chloride                          263 <b>Anions and Nutrients</b> Sulphate                          840 <b>Inorganic Parameters</b> Acid Volatile Sulphides        <0.20							

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0
5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).			
EC-WT	Soil	Conductivity (EC)	MOEE E3138
A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
MOISTURE-WT	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)
PH-WT	Soil	pH	MOEE E3137A
A minimum 10g portion of the sample 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 and then analyzed using a pH meter and electrode.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580
This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.			
RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	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.			
SO4-WT	Soil	Sulphate	EPA 300.0
5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.			
SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J
This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.			

\*\* ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

## Reference Information

### GLOSSARY OF REPORT TERMS

*Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.*

*mg/kg - milligrams per kilogram based on dry weight of sample*

*mg/kg ww - milligrams per kilogram based on wet weight of sample*

*mg/kg lwt - milligrams per kilogram based on lipid weight of sample*

*mg/L - unit of concentration based on volume, parts per million.*

*< - Less than.*

*D.L. - The reporting limit.*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

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

*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*

*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*



**Environmental**

## Quality Control Report

Workorder: L2652975

Report Date: 29-OCT-21

Page 1 of 3

Client: GHD Limited (Waterloo)  
455 PHILLIP STREET  
WATERLOO ON N2L 3X2  
Contact: JENNIFER BALKWILL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-R511-WT		Soil						
Batch	R5630777							
WG3645863-3	CRM	AN-CRM-WT						
Chloride			93.3		%		70-130	27-OCT-21
WG3645863-4	DUP	WG3645863-5						
Chloride		80.1	79.5		ug/g	0.7	30	27-OCT-21
WG3645863-2	LCS							
Chloride			99.9		%		80-120	27-OCT-21
WG3645863-1	MB							
Chloride			<5.0		ug/g		5	27-OCT-21
EC-WT		Soil						
Batch	R5632792							
WG3645937-6	DUP	WG3645937-3						
Conductivity		0.400	0.394		mS/cm	1.5	20	29-OCT-21
WG3645937-2	IRM	WT SAR4						
Conductivity			112.1		%		70-130	29-OCT-21
WG3648689-1	LCS							
Conductivity			96.8		%		90-110	29-OCT-21
WG3645937-1	MB							
Conductivity			<0.0040		mS/cm		0.004	29-OCT-21
MOISTURE-WT		Soil						
Batch	R5626550							
WG3642699-3	DUP	L2647897-28						
% Moisture		79.2	82.7		%	4.3	20	22-OCT-21
WG3642699-2	LCS							
% Moisture			99.5		%		90-110	22-OCT-21
WG3642699-1	MB							
% Moisture			<0.25		%		0.25	22-OCT-21
PH-WT		Soil						
Batch	R5628935							
WG3643896-1	DUP	L2653172-6						
pH		8.11	8.09	J	pH units	0.02	0.3	26-OCT-21
WG3646007-1	LCS							
pH			6.95		pH units		6.9-7.1	26-OCT-21
REDOX-POTENTIAL-WT		Soil						
Batch	R5627178							
WG3643513-1	CRM	WT-REDOX						
Redox Potential			99.4		%		80-120	22-OCT-21
WG3641736-1	DUP	L2651880-1						





**Environmental**

## Quality Control Report

Workorder: L2652975

Report Date: 29-OCT-21

Page 2 of 3

Client: GHD Limited (Waterloo)  
455 PHILLIP STREET  
WATERLOO ON N2L 3X2  
Contact: JENNIFER BALKWILL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>REDOX-POTENTIAL-WT Soil</b>								
Batch	R5627178							
WG3641736-1	DUP	L2651880-1						
Redox Potential		277	252		mV	9.5	25	22-OCT-21
<b>SO4-WT Soil</b>								
Batch	R5630777							
WG3645863-3	CRM	AN-CRM-WT						
Sulphate			101.3		%		60-140	27-OCT-21
WG3645863-4	DUP	WG3645863-5						
Sulphate		729	683		ug/g	6.5	25	27-OCT-21
WG3645863-2	LCS							
Sulphate			100.1		%		70-130	27-OCT-21
WG3645863-1	MB							
Sulphate			<20		ug/g		20	27-OCT-21
<b>SULPHIDE-WT Soil</b>								
Batch	R5629101							
WG3646000-3	DUP	L2653158-1						
Acid Volatile Sulphides		<0.20	<0.20	RPD-NA	mg/kg	N/A	45	26-OCT-21
WG3646000-2	LCS							
Acid Volatile Sulphides			71.9		%		70-130	26-OCT-21
WG3646000-1	MB							
Acid Volatile Sulphides			<0.20		mg/kg		0.2	26-OCT-21

# Quality Control Report

Workorder: L2652975

Report Date: 29-OCT-21

Client: GHD Limited (Waterloo)  
455 PHILLIP STREET  
WATERLOO ON N2L 3X2  
Contact: JENNIFER BALKWILL

Page 3 of 3

## Legend:

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Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

## Sample Parameter Qualifier Definitions:

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Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

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## Hold Time Exceedances:

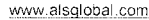
All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

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The ALS Quality Control Report is provided to ALS clients upon request. ALS includes 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 pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



L2652975-COFC

Page of

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YELLOW - CLIENT COPY

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**.

AUG 2020 E 5024



GHD Limited (Waterloo)  
ATTN: JENNIFER BALKWILL  
455 PHILLIP STREET  
WATERLOO ON N2L 3X2

Date Received: 15-NOV-21  
Report Date: 23-NOV-21 11:12 (MT)  
Version: FINAL

Client Phone: 519-884-0510

## Certificate of Analysis

Lab Work Order #: L2662811  
Project P.O. #: 735-001026  
Job Reference: 11202886  
C of C Numbers:  
Legal Site Desc:

Rick Hawthorne  
Account Manager

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ADDRESS: 60 Northland Road, Unit 1, Waterloo, ON N2V 2B8 Canada | Phone: +1 519 886 6910 | Fax: +1 519 886 9047  
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2662811-1 11202886-BH-21-02, SS5 Sampled By: CLIENT on 10-NOV-21 @ 12:00 Matrix: SOIL  <b>Physical Tests</b> Conductivity % Moisture pH Redox Potential Resistivity <b>Leachable Anions &amp; Nutrients</b> Chloride <b>Anions and Nutrients</b> Sulphate <b>Inorganic Parameters</b> Acid Volatile Sulphides								
		0.484		0.0040	mS/cm		22-NOV-21	R5655044
		15.6		0.25	%	16-NOV-21	17-NOV-21	R5650566
		7.89		0.10	pH units		18-NOV-21	R5653879
		319		-1000	mV		17-NOV-21	R5652635
		2070		1.0	ohm*cm		22-NOV-21	
		133		5.0	ug/g	19-NOV-21	22-NOV-21	R5655790
		166		20	ug/g	19-NOV-21	22-NOV-21	R5655790
		0.23		0.20	mg/kg	22-NOV-21	22-NOV-21	R5655518
L2662811-2 11202886-BH-21-04, SS5 Sampled By: CLIENT on 11-NOV-21 @ 12:00 Matrix: SOIL  <b>Physical Tests</b> Conductivity % Moisture pH Redox Potential Resistivity <b>Leachable Anions &amp; Nutrients</b> Chloride <b>Anions and Nutrients</b> Sulphate <b>Inorganic Parameters</b> Acid Volatile Sulphides								
		0.626		0.0040	mS/cm		22-NOV-21	R5655044
		18.2		0.25	%	16-NOV-21	17-NOV-21	R5650566
		7.61		0.10	pH units		18-NOV-21	R5653879
		288		-1000	mV		17-NOV-21	R5652635
		1600		1.0	ohm*cm		22-NOV-21	
		133		5.0	ug/g	19-NOV-21	22-NOV-21	R5655790
		84		20	ug/g	19-NOV-21	22-NOV-21	R5655790
		<0.20		0.20	mg/kg	22-NOV-21	22-NOV-21	R5655518

\* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0
5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).			
EC-WT	Soil	Conductivity (EC)	MOEE E3138
A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
MOISTURE-WT	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)
PH-WT	Soil	pH	MOEE E3137A
A minimum 10g portion of the sample 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 and then analyzed using a pH meter and electrode.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580
This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.			
RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	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.			
SO4-WT	Soil	Sulphate	EPA 300.0
5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.			
SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J
This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.			

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The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

## Reference Information

### GLOSSARY OF REPORT TERMS

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*mg/kg - milligrams per kilogram based on dry weight of sample*

*mg/kg ww - milligrams per kilogram based on wet weight of sample*

*mg/kg lwt - milligrams per kilogram based on lipid weight of sample*

*mg/L - unit of concentration based on volume, parts per million.*

*< - Less than.*

*D.L. - The reporting limit.*

*N/A - Result not available. Refer to qualifier code and definition for explanation.*

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

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## Quality Control Report

Workorder: L2662811

Report Date: 23-NOV-21

Page 1 of 3

Client: GHD Limited (Waterloo)  
455 PHILLIP STREET  
WATERLOO ON N2L 3X2  
Contact: JENNIFER BALKWILL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>CL-R511-WT</b>		<b>Soil</b>						
Batch	R5655790							
<b>WG3661697-7</b>	<b>CRM</b>	<b>AN-CRM-WT</b>						
Chloride			104.4		%		70-130	22-NOV-21
<b>WG3661697-8</b>	<b>DUP</b>	<b>WG3661697-9</b>						
Chloride		6.0	5.8		ug/g	4.4	30	22-NOV-21
<b>WG3661697-6</b>	<b>LCS</b>							
Chloride			101.2		%		80-120	22-NOV-21
<b>WG3661697-5</b>	<b>MB</b>							
Chloride			<5.0		ug/g		5	22-NOV-21
<b>EC-WT</b>		<b>Soil</b>						
Batch	R5655044							
<b>WG3661808-3</b>	<b>DUP</b>	<b>L2662751-4</b>						
Conductivity		0.187	0.186		mS/cm	0.2	20	22-NOV-21
<b>WG3661808-2</b>	<b>IRM</b>	<b>WT SAR4</b>						
Conductivity			112.5		%		70-130	22-NOV-21
<b>WG3662461-1</b>	<b>LCS</b>							
Conductivity			98.3		%		90-110	22-NOV-21
<b>WG3661808-1</b>	<b>MB</b>							
Conductivity			<0.0040		mS/cm		0.004	22-NOV-21
<b>MOISTURE-WT</b>		<b>Soil</b>						
Batch	R5650566							
<b>WG3659023-3</b>	<b>DUP</b>	<b>L2662161-1</b>						
% Moisture		13.3	13.5		%	2.0	20	17-NOV-21
<b>WG3659023-2</b>	<b>LCS</b>							
% Moisture			101.3		%		90-110	17-NOV-21
<b>WG3659023-1</b>	<b>MB</b>							
% Moisture			<0.25		%		0.25	17-NOV-21
<b>PH-WT</b>		<b>Soil</b>						
Batch	R5653879							
<b>WG3658893-1</b>	<b>DUP</b>	<b>L2662156-8</b>						
pH		7.20	7.17	J	pH units	0.03	0.3	18-NOV-21
<b>WG3660796-1</b>	<b>LCS</b>							
pH			6.98		pH units		6.9-7.1	18-NOV-21
<b>REDOX-POTENTIAL-WT</b>		<b>Soil</b>						
Batch	R5652635							
<b>WG3659997-1</b>	<b>CRM</b>	<b>WT-REDOX</b>						
Redox Potential			100.4		%		80-120	17-NOV-21
<b>WG3659748-1</b>	<b>DUP</b>	<b>L2663014-9</b>						



**Environmental**

## Quality Control Report

Workorder: L2662811

Report Date: 23-NOV-21

Page 2 of 3

Client: GHD Limited (Waterloo)  
455 PHILLIP STREET  
WATERLOO ON N2L 3X2  
Contact: JENNIFER BALKWILL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
<b>REDOX-POTENTIAL-WT</b>	<b>Soil</b>							
<b>Batch</b>	<b>R5652635</b>							
<b>WG3659748-1</b>	<b>DUP</b>	<b>L2663014-9</b>						
Redox Potential		272	256		mV	6.1	25	17-NOV-21
<b>SO4-WT</b>	<b>Soil</b>							
<b>Batch</b>	<b>R5655790</b>							
<b>WG3661697-7</b>	<b>CRM</b>	<b>AN-CRM-WT</b>						
Sulphate			110.3		%		60-140	22-NOV-21
<b>WG3661697-8</b>	<b>DUP</b>	<b>WG3661697-9</b>						
Sulphate		<20	<20	RPD-NA	ug/g	N/A	25	22-NOV-21
<b>WG3661697-6</b>	<b>LCS</b>							
Sulphate			100.2		%		70-130	22-NOV-21
<b>WG3661697-5</b>	<b>MB</b>							
Sulphate			<20		ug/g		20	22-NOV-21
<b>SULPHIDE-WT</b>	<b>Soil</b>							
<b>Batch</b>	<b>R5655518</b>							
<b>WG3662900-3</b>	<b>DUP</b>	<b>L2662794-1</b>						
Acid Volatile Sulphides		<0.20	<0.20	RPD-NA	mg/kg	N/A	45	22-NOV-21
<b>WG3662900-2</b>	<b>LCS</b>							
Acid Volatile Sulphides			90.8		%		70-130	22-NOV-21
<b>WG3662900-1</b>	<b>MB</b>							
Acid Volatile Sulphides			<0.20		mg/kg		0.2	22-NOV-21

# Quality Control Report

Workorder: L2662811

Report Date: 23-NOV-21

Client: GHD Limited (Waterloo)  
455 PHILLIP STREET  
WATERLOO ON N2L 3X2  
Contact: JENNIFER BALKWILL

Page 3 of 3

## Legend:

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Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

## Sample Parameter Qualifier Definitions:

---

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

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## Hold Time Exceedances:

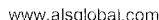
All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

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The ALS Quality Control Report is provided to ALS clients upon request. ALS includes 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 pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



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