REPORT

PRELIMINARY GEOTECHNICAL ASSESSMENT

Environmental Assessment (EA) Adelaide Street North Widening from Fanshawe Park Road East to Sunningdale Road East, London, Ontario

Submitted to:

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Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

This report provides the results of the geotechnical assessment carried out for the preliminary design of the widening of Adelaide Street North, from Fanshawe Park Road East to Sunningdale Road East. The Environmental Assessment (EA) study area extends along Adelaide Street North from Fanshawe Park Road East to 350 metres north of Sunningdale Road East, and along Sunningdale Road East from Blackwater Road west of Adelaide Street North to the Stoney Creek Community Centre entrance east of Adelaide Street North in London, Ontario. Based on the information provided, the project is comprised of widening the subject portion of Adelaide Street North from the current two-lane geometry to four lanes including intersection improvements at Sunningdale Road East. Based on the results of the previously completed Sunningdale Road EA study, it is understood that the preferred intersection treatment at Sunningdale Road East and Adelaide Street North is to maintain a signalized intersection. Raised grades and an east extension of the culvert crossing at the Powell Drain may also be required.

The purpose of the geotechnical assessment was to evaluate the subsurface soil and groundwater conditions along the subject sections of roadway based on borehole data from current and previous geotechnical work along the alignments of the project and provide preliminary geotechnical engineering recommendations for the service excavations, backfill, pipe bedding, roadway widening and pavement design.

Authorization to proceed with the preliminary geotechnical assessment in accordance with our March 19, 2018 proposal was provided by Mr. Henry Huotari, P.Eng., of Parsons in an email dated June 28, 2018. Parsons provided a digital copy of the base plans for this project site.

This report should be read in conjunction with the attached “Important Information and Limitations of This Report” which comprises an integral part of this document. The reader’s attention is specifically drawn to this material, as it is essential for proper use and interpretation of the information presented and discussed herein.

2.0 METHODOLOGY

To evaluate the subsurface conditions along the subject sections of roadway, existing geotechnical information in the area of the site readily available from our files was compiled and reviewed. The information consisted of topographical mapping, aerial mapping, soils and bedrock mapping, geological data, and site-specific geotechnical data from previous site explorations carried out on or adjacent to the site. The previous site explorations are identified as follows:

- Golder Report No. 73345 titled “Subsurface Investigation, Proposed Apartment Building Complex, Fanshawe Road and Adelaide Street, London, Ontario”, dated August 1973;
- Golder Report No. 743103 titled “Subsurface Investigation, Proposed Stoney Creek Bridge and Fanshawe Park Road/Adelaide Street Intersection Improvements, London, Ontario”, dated August 1974;
- Golder Report No. 881-3077 titled “Geotechnical Investigation, Proposed Fanshawe Park Road and Adelaide Street Intersection Improvements and Widenings, London, Ontario”, dated October 1988; and
- Golder Report No. 06-1130-092 titled “Geotechnical Investigation, Adelaide Street Reconstruction, Grenfell Drive to Sunningdale Road, London, Ontario”, dated September 19, 2006.

A geotechnical report was also completed by Trow Consulting Engineers Ltd. (Trow) in the area of the site titled "Geotechnical Investigation, Proposed 400 mm Feeder Watermain, From Sunningdale Road on Adelaide St., Richmond St. and Wonderland Rd. N., London, Ontario", Trow Project No. L03804AGI dated April 2004. The previous report was reviewed during preparation of this current report and Borehole Logs 9, 10 and 11 are included in Appendix A for reference.

In addition, a current geotechnical exploration was carried out by Golder between November 19 and 28, 2018 to supplement and update the existing subsurface data. A total of seven new boreholes designated as BH-201 to BH-207, were drilled within the study area along Adelaide Street North and Sunningdale Road East as shown on the Location Plans, Figures 1A and 1B. The boreholes were drilled using truck- and track-mounted equipment supplied and operated by a specialist drilling contractor. The subsurface conditions encountered in the boreholes are shown in detail on the attached Record of Borehole sheets and in profile on Figures 1A and 1B.

Standard penetration testing and sampling was carried out in the boreholes at suitable intervals of depth using 35-millimetre inside diameter split spoon sampling equipment in accordance with American Society of Testing and Materials (ASTM) standard D1586: 'Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils'. All of the samples obtained during the exploration were placed in sealed plastic sample jars and transported to our laboratory for further examination and geotechnical laboratory testing. The results of the field and laboratory testing are shown in detail on the Record of Borehole sheets and on Figures 1A, 1B and 5 to 8.

Groundwater seepage conditions were observed in the boreholes during drilling and the encountered groundwater levels are shown on the corresponding Record of Borehole sheets and summarized in Table I. Following drilling, monitoring wells were installed in boreholes BH-205 and BH-207 for subsequent measurement of groundwater levels. Upon completion of the exploration and installation activities, the boreholes were backfilled in accordance with the requirements of the Revised Regulations of Ontario (R.R.O.) 1990, Regulation 903 (as amended) of the Ontario Water Resources Act. The boreholes drilled through the roadways were topped with cold mix asphalt patch and compacted.

The borehole locations were designated in the field by members of our geotechnical engineering staff who also obtained underground utility clearances, supervised the drilling, logged the boreholes and cared for the samples obtained. Ground surface elevations at the borehole locations were surveyed to site monuments identified in the base plans provided by Parsons, which are understood to be referenced to geodetic datum.

A field reconnaissance was carried out by a geotechnical engineer from our staff on August 20, 2018 to provide a geotechnical overview of the general site conditions in conjunction with the preparation of this report, to carry out a visual pavement condition survey and to carry out a preliminary geotechnical slope assessment for the Stoney Creek Valley North slope. The current Record of Borehole Sheets are attached to this report and the previous Record of Borehole Sheets and selected site photographs are attached in Appendices A and B, respectively. The approximate locations of the current and previous boreholes used in the development of this report are illustrated on the Location Plans, and Figures 1A and 1B.

3.0 SITE DESCRIPTION AND PROPOSED PROJECT

The study area extends along Adelaide Street North from Fanshawe Park Road to about 350 metres north of Sunningdale Road East, a distance of some 1.75 kilometres, and includes Sunningdale Road East from Blackwater Road west of Adelaide Street North to the Stoney Creek Community Centre entrance east of Adelaide Street North, as shown on the Location Plan, Figure 1. It is understood that the major components of the proposed project will consist of replacing or upgrading municipal servicing such as sewers and watermain, maintaining a signalized intersection at Sunningdale Road and widening Adelaide Street North from two to four lanes. Raised grades and an east extension of the culvert crossing at the Powell Drain may also be required.

The subject section of Adelaide Street North consists of single northbound and southbound lanes with turning lanes at several intersections, businesses and residential access ways with an arterial roadway urban cross-section featuring curb and gutter south of Sunningdale Road East. Relatively wide grassed boulevards are located along the subject section of Adelaide Street North. The existing ground surface elevation varies from about 251.5 metres at Fanshawe Park Road (south limit) to about 266 metres at the north limit of the site, as shown on the Profile, Figure 1.

A tributary creek (tributary to Stoney Creek flowing from west to east) and associated flood plain coursed through the area prior to development of the surrounding areas. Poorly drained, low lying swampy areas are still present adjacent to the roadway at the creek location between Grenfell Drive and Blackwater Road and a stormwater management pond is located on the west side of Adelaide Street North just north of the creek. An existing 1800-millimetre diameter CSP storm outlet crosses Adelaide Street North at the creek/Stoney Creek Valley North.

The condition of the existing Adelaide Street North and Sunningdale Road East pavements is generally fair to good throughout the project area. However, localized areas of longitudinal, transverse and alligator cracking with patches were observed north of Sunningdale Road within the southbound lane and within the intersection of Sunningdale Road. Selected site photographs (Photographs 1 to 8) showing the existing condition of the pavements are attached in Appendix B. The location, direction and identification of the photographs are shown on the Location Plan, Figure 1.

4.0 SITE GEOLOGY

The study area is located in the physiographic region of southwestern Ontario known as the Stratford Till Plain as indicated in “The Physiography of Southern Ontario”, by Chapman and Putnam (1984). The Stratford Till Plain is a broad clay plain predominantly of fine-grained (silt and clay) glacial till extending across the north end of London.

Based on the Ontario Division of Mines Preliminary Map P.1048 titled “Quaternary Geology, Lucan Area, Southern Ontario” as outlined on Figure 2, the surficial soils along the subject sections of roadway vary from sandy silt loam till (Arva moraine), Deltaic sand deposits, Bogs and Swamps with peat, muck and marl (along the creek and north limit of the site), and Lacustrine deposits of sand, clayey silt and clay.

The site is reportedly underlain by middle Devonian-age limestone of the Dundee Formation of the Hamilton Group. The upper member consists of microcrystalline limestone and the lower member consists of crinoidal limestone containing quartz sand grains and chert. Based on the Ontario Department of Mines, Preliminary Map. P.291 titled “Bedrock Topography Series, Lucan Sheet”, the bedrock surface at the site is at about elevation 213.4 metres or some 38 to 53 metres below the existing pavement surface.

5.0 SUBSURFACE CONDITIONS

The subsurface conditions encountered in the current and previous boreholes advanced along the subject portions of the roadways are shown in plan and profile on Figures 1A and 1B and are detailed on the attached Record of Borehole sheets. The following discussion has been simplified in terms of major soil strata for the purposes of preliminary geotechnical design. The soil boundaries indicated are inferred from non-continuous samples and observations of drilling and sampling resistance and typically represent transitions from one soil type to another rather than exact planes of geological change. Further, subsurface conditions may vary significantly between and beyond the borehole locations.

Some of the borehole data used for this report was gathered during previous explorations that date from the 1970s through to 2006 and, therefore, conditions since the time of the previous explorations may have changed due to roadway reconstruction, impacts on drainage patterns, or other development that occurred since the boreholes were drilled.

5.1 Soil Conditions - General

Based on our review of available geotechnical and geological data, the soil conditions in the study area are generally consistent with the geological mapping described above. The soil conditions encountered in the boreholes drilled along the subject portion of roadway generally consisted of the pavement structure overlying fill, silts and sands which were, in turn, underlain by silty clay, clayey silt and glacial till. The Trow Report (Trow, 2004) indicated the presence of peat and marl in borehole 10 in the area of the creek and surrounding marsh.

5.2 Pavement Structure

5.2.1 Adelaide Street North Pavements

Current BH-201 and BH-206 were drilled through the Adelaide Street North pavements. The asphalt thicknesses were about 80 and 180 millimetres at the borehole locations. Beneath the asphalt, the granular base materials were about 70 and 120 millimetres thick and the granular subbase materials were about 310 and 520 millimetres thick at the borehole locations.

Sand and gravel fill was encountered within the west gravel surfaced shoulder in BH-202. The sand and gravel fill was about 610 millimetres thick.

Based on the results of the previous boreholes and augerholes advanced along Adelaide Street North, asphalt thickness varied from about 30 to 150 millimetres, with an average thickness of about 80 millimetres at the borehole/augerhole locations. Beneath the asphalt, the previous boreholes/augerholes encountered from 80 to 1,270 millimetres of road base materials overlying from 350 to 1,150 millimetres of granular subbase materials.

5.2.2 Sunningdale Road East Pavements

Current BH-203 and BH-204 were drilled through the Sunningdale Road East pavements. The asphalt thicknesses were about 130 and 140 millimetres at the borehole locations. Beneath the asphalt, the granular base materials were about 80 and 160 millimetres thick and the granular subbase materials were about 430 and 160 millimetres thick at the borehole locations.

5.3 Topsoil and Fill

Surficial topsoil was encountered at the ground surface at BH-205 and BH-207. The topsoil was about 0.2 to 0.3 metres thick at the borehole locations. A layer of buried topsoil, 1.5 metres thick, was encountered beneath the fill in BH-202. Topsoil fill was encountered beneath the pavement surface in BH-206 and beneath the sand and gravel fill in BH-207. The topsoil fill was 0.6 to 2.0 metres thick at the borehole locations. The topsoil fill was loose to compact with N values, as measured by the standard penetration tests, of 5 to 10 blows per 0.3 metres with water contents of about 19 to 43 per cent. Materials designated as topsoil in this report were classified solely based on visual and textural evidence. Testing of organic content, or for other nutrients, was not carried out. Accordingly, materials classified as topsoil herein cannot necessarily be relied upon for the support and growth of landscaping vegetation without supplementary soil fertility testing.

Sand and gravel fill was encountered beneath the pavement structure in BH-203 and the surficial topsoil in BH-205 and BH-207. The sand and gravel fill was about 0.3 to 4.2 metres thick and had N values of 19 and 93 blows per 0.3 metres with water contents of about 4 and 9 per cent. A layer of clayey silt fill and silt fill was encountered beneath the sand and gravel fill in BH-203 and BH-205, respectively. These fill layers were about 0.5 to 0.8 metres thick, respectively, and had N values of 15 and 17 blows per 0.3 metres with water contents of about 15 to 17 per cent.

Beneath the pavement structure, previous borehole 5 (06-1130-092) encountered 3.7 metres of fill material consisting of 1.4 metres of sand and gravel overlying 2.3 metres of predominantly silt. The fill is likely associated with the existing culvert and/or adjacent sewer backfill. The granular fill had N values of 5 and 16 blows per 0.3 metres with water contents of about 4 and 9 per cent, respectively, for the samples obtained. The silt fill had N values of 9 to 18 blows per 0.3 metres with water contents of 12 to 17 per cent.

Fill, including the pavement structure, is inferred to a depth of about 2.7 metres in DPT2. A buried topsoil layer was identified at a depth of about 2 metres below the ground surface in the fill in borehole 9 (Trow, 2004).

Beneath the pavement structure, previous boreholes 101 and 103 (881-3077) encountered sandy silt fill with topsoil to a depth of about 1.4 metres below the pavement surface. The sandy silt fill had N values of 9 and 10 blows per 0.3 metres with water contents of about 12 to 22 per cent.

Previous Borehole 27 (743103) encountered silty sand and gravel fill beneath the pavement structure. The granular fill had an N value of 11 blows per 0.3 metres with a water content of about 21 per cent.

5.4 Organic Soils

Peat was encountered above the topsoil fill in BH-206. The peat was 0.4 metres thick and had an N value of 3 blows per 0.3 metres with a water content of about 243 per cent. Organic silt was encountered beneath the peat in BH-206. The organic silt was about 0.3 metres thick and had a water content of about 34 per cent.

Previous borehole 10 (Trow, 2004), referenced above, encountered peat and marl at depths of 1.7 and 3.7 metres below ground surface. N values in the organics were reported as 2 to 20 blows per 0.3 metres of penetration. The higher value is based on a penetration test only partially completed in the peat. Water contents ranged from about 70 to 180 per cent within the organic soils.

Organic deposits should be anticipated, particularly in the lowest lying portions of the site near the creek and within the surrounding marsh areas.

5.5 Silt

Silt was encountered beneath the sand and gravel in BH-202, beneath the silty clay in BH-202 and BH-205, beneath the organic silt in BH-206 and beneath the silty clay till in BH-207. The silt was about 0.8 to 2.2 metres thick at the borehole locations and had N values of 5 to 28 blows per 0.3 metres with water contents ranging from about 10 to 24 per cent.

Previous boreholes and/or augerholes 1, 2, 3, 4 and 6 (06-1130-092) and borehole 101 (881-3077) encountered silt layers immediately beneath the pavement structure or fill materials. Silt layers were encountered in borehole 4 (06-1130-092) and borehole 7 (743103) beneath sand and silty sand layers. A layer of silt was encountered within the glacial till in borehole 103 (881-3077). Borehole 4 (06-1130-092) and augerholes 3 and 6 (06-1130-092) were terminated in silt layers. Where fully penetrated, the silt layers varied in thickness from about 0.4 to 3.1 metres. A silt layer some 1.6 metres thick is inferred at DPT2. The silt layers had N values ranging from 6 to 34 blows per 0.3 metres and water contents ranging from about 11 to 26 per cent. Grain size distribution curves for two samples of the silt obtained during the standard penetration testing are shown on Figure 5.

5.6 Sandy Silt

Sandy silt was encountered beneath the silty clay in BH-204, beneath the fill in BH-205 and BH-207 and beneath the silt and silty sand in BH-206. The sandy silt layers were about 0.8 to 1.5 metres thick, had N values of 5 and 31 blows per 0.3 metres with water contents of about 17 and 27 per cent. Grain size distribution curves for two samples of the sandy silt obtained during the standard penetration testing are shown on Figure 6.

Previous borehole 103 (881-3077) encountered sandy silt layers beneath the fill materials and sand layer. The sandy silt layers were each about 0.8 metres thick, had N values of 6 and 8 blows per 0.3 metres, and had water contents of about 14 and 16 per cent.

5.7 Sand to Silty Sand

Layers of sand and/or silty sand were encountered beneath the Sunningdale Road East pavement structure in BH-204 and beneath the sandy silt in BH-206 and BH-207. The sand layers were about 0.4 to 0.9 metres thick with N values ranging from 5 to 15 blows per 0.3 metres and water contents ranged from about 15 to 25 per cent.

The previous boreholes encountered layers of sand and/or silty sand beneath the Adelaide Street North pavement structure or beneath the fill materials in boreholes 7, 24, 25, 26 and 27 (743103) and borehole 104 (881-3077), beneath the sandy silt in borehole 103 (881-3077), beneath the silt in borehole 2 (06-1130-092) and between silt layers in borehole 4 (06-1130-092). Where fully penetrated, these layers were from 0.5 to 1.6 metres thick. Boreholes 24 to 27 (743103) and borehole 104 (881-3077) were terminated in the sands after exploring the deposits for 0.5 to 1.2 metres. N values measured in the sand and silty sand layers varied from 6 to 36 blows per 0.3 metres and water contents ranged from about 17 to 26 per cent.

5.8 Silty Clay and Clayey Silt

Silty clay was encountered beneath the silty sand in BH-204, beneath the sandy silt and silt layers in BH-205, and beneath the sand in BH-207. Where fully penetrated, the silty clay layers were about 0.3 to 1.5 metres thick. BH-205 was terminated in the silty clay after exploring the layer for some 2.1 metres. The silty clay had N values ranging from 6 to 27 blows per 0.3 metres and water contents ranged from about 13 to 26 per cent. A grain size distribution curve for a sample of the silty clay obtained during the standard penetration testing is shown on Figure 7. An Atterberg limits test carried out on a sample of the silty clay gave plastic and liquid limits of 23 and 42 per cent, respectively, indicating an inorganic silty clay of intermediate plasticity. The results of the Atterberg limits test are shown on Figure 8.

A 0.7-metre thick layer of silty clay was encountered beneath the silt in previous borehole 1 (06-1130-092). The silty clay had an N value of 11 blows per 0.3 metres of penetration based on a single test and a natural water content of about 25 per cent.

Previous borehole 2 (06-1130-092) encountered a 0.7-metre thick layer of clayey silt beneath the silty sand. Penetration tests partially completed in the clayey silt indicated N values of 6 blows per 0.3 metres to 100 blows per 75 millimetres of penetration. This higher value reflects a coarse gravel fragment or cobble in the split spoon tip. A water content of about 22 per cent was measured on a sample of the clayey silt.

5.9 Glacial Till

Layers of glacial till, consisting of silty clay to sandy silt, were encountered beneath the Adelaide Street North pavement structure in BH-201, beneath the silt in BH-202, beneath the fill in BH-203, beneath the sandy silt in BH-204 and BH-206 and beneath the silty clay and silt in BH-207. Where fully penetrated, the glacial till was about 0.8 to 2.3 metres thick. Where encountered at lower depths, the boreholes were terminated in the glacial till after exploring the deposits for some 0.6 to 5.3 metres. The glacial till had N values ranging from 12 to 47 blows per 0.3 metres and water contents ranging from about 9 to 18 per cent.

Layers of glacial till, consisting of clayey silt, silty clay or sandy silt, were encountered beneath the silty clay in previous borehole 1 (06-1130-092), the clayey silt in borehole 2 (06-1130-092), the fill in borehole 5 (06-1130-092), the sandy silt in borehole 103 (881-3077), the silt in borehole 101 (881-3077) and borehole 7 (743103) and borehole 103 (881-3077). Boreholes 1 and 2 (06-1130-092), 7 (743103), 101 and 103 (881-3077) were terminated in the glacial till following penetration of up to 5.1 metres. Glacial till is inferred at a depth of about 4.7 metres in DPT2. The cohesive glacial till had N values ranging from 13 to 100 blows per 0.3 metres and water contents ranging from about 5 to 19 per cent. An Atterberg limits test carried out on a sample of the glacial till gave plastic and liquid limits of 9 and 17 per cent, respectively. Till materials described with similar characteristics were encountered in boreholes 9 and 11 (Trow, 2004) at depths of about 1.8 and 3.6 metres below the ground surface.

The presence of cobbles and boulders should be anticipated in the glacial till deposits.

5.10 Sand and Gravel

Layers of sand and gravel were encountered beneath the pavement structure in borehole 21 (743103) and beneath the glacial till in borehole 5 (06-1130-092). The sand and gravel had N values of 17 to 25 blows per 0.3 metres and water contents of about 3 to 11 per cent.

5.11 Groundwater

Groundwater levels were observed in the open boreholes during drilling and, on completion of drilling and sampling, and subsequently in the monitoring wells installed in BH-205 and BH-207.

Standpipes were installed in previous boreholes 1, 2 and 5 (06-1130-092), boreholes 9 and 10 (Trow, 2004), boreholes 101 and 103 (881-3077), boreholes 6, 7 and 8 (743103), and boreholes 101, 102, 103 and 104 (73345).

The installations are shown in detail on the Record of Borehole sheets , together with the encountered and measured groundwater levels. The water levels are also shown on the inferred profiles on Figures 1A and 1B. A comprehensive summary of the encountered and measured groundwater levels in the current and previous boreholes is provided in Table I following the text of this report. As indicated, in the boreholes that did not remain dry during drilling, groundwater was encountered at depths of about 1.2 to 3.4 metres (elevations of about 249.5 to 264.7 metres) and measured groundwater depths ranged from about 1.3 to 4.9 metres (elevations of 248.0 to 263.9about metres).

It should be noted that the boreholes were drilled over a period of several decades and during various seasons. Seasonal variations in groundwater levels should be anticipated. Development activities subsequent to the dates of the previous explorations can also significantly impact groundwater levels.

6.0 GEOTECHNICAL SLOPE ASSESSMENT

As part of this EA Study, a preliminary geotechnical slope assessment was carried out along the Stoney Creek North Valley slope within the area of the tributary creek immediately east of Adelaide Street North. The creek flows from west to east and outlets into Stoney Creek southeast of the site.

The site reconnaissance was carried out by the undersigned Golder engineer on August 20, 2018. During the reconnaissance, observations were made of vegetation, soil type(s), seepage conditions and erosion activity. Two slope sections (Sections A-A' and B-B'), shown on the Slope Plan and Cross Sections, Figures 3 and 4, respectively, were observed and evaluated using the Ontario Ministry of Natural Resources (MNR) Slope Stability Rating Chart as presented in Table II. The slope stability rating chart is based on a visual inspection of the slope, measurements of slope inclinations with an Abney hand level and heights and distances measured with a measuring tape. Soil classifications at the site were based on geological mapping and subsurface information from the previous subsurface explorations. It should be noted that the slope geometries were inferred based on the City of London topographic mapping and our observations and measurements carried out on site. No topographic surveys were carried out at the section locations and no intrusive exploration was carried out at the site as part of this preliminary assessment.

Photographs of significant features were taken and selected photographs (Photographs 9 to 15) are presented in Appendix B. The location, direction and identification of the photographs are shown on the Slope Plan, Figure 3.

For the purposes of field classification, the following generalization is used to visually assess the stability of slopes:

- Stable: no evidence of surficial or deep-seated movements, an abundance of vegetation and a well-protected toe of slope;
- Marginally Stable: slope has undergone discernible changes in geometry resulting either from toe erosion or from regression of sliding surfaces up the slope and the slope is very steep but typically vegetated with small trees, shrubs and/or grasses; and
- Unstable: slope has undergone substantial changes in geometry with loss of most vegetation and significant active erosion.

The subject valley slope located along the tributary creek east of Adelaide Street North is heavily vegetated with mature trees and bush. Tension cracks, seepage and erosion were not observed within the slope. A 1,800-millimetre diameter CSP culvert outlet crosses Adelaide Street North at the creek (Powell Drain) location and rip rap material has been placed at the outlet.

Based on the topographic information and measurements carried out during the site visit, the south valley wall slope at Section A-A’ is about 1.5 metres in vertical height and has an overall slope inclination of about 10 degrees to the horizontal, or about 5.7 Horizontal (H): 1 Vertical (V), as illustrated on the section on Figure 4. A swampy area is located north of the creek. General views of the slope, creek and CSP culvert outlet at Section A-A’ are shown in Photographs 9 to 12 in Appendix B.

At Section B-B’, the south valley wall slope is about 3.2 metres in vertical height and has an overall slope inclination of about 18 degrees to the horizontal, or about 3.1H:1V, as illustrated on the section on Figure 4. General views of the slope and creek at Section B-B’ are shown in Photographs 13 to 15 in Appendix B.

Based on the results of the existing information from nearby boreholes, the subsurface conditions at the slope likely consist of topsoil and fill materials, peat and muck overlying silt, sand and glacial till. The groundwater level is anticipated to be approximately coincident with the creek level.

Based on the results of the geotechnical slope assessment, the slope is considered to be stable in its current configuration. It is understood that raised grades and an east extension of the culvert at the Powell Drain may be required as part of the road widening project. Recommendations for the culvert widening are provided below in Section 7.5.

7.0 DISCUSSION

This section of the report provides our interpretation of the available geotechnical data and it is intended for the guidance of the design engineer during conceptual design within the context of the overall geotechnical assessment. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. It is understood that Adelaide Street North is proposed to be widened to four lanes from Fanshawe Park Road to Sunningdale Road with turn lanes as required. The proposed works will also likely include new municipal services including watermain, sanitary sewer and storm sewer servicing and maintaining a signalized intersection at Sunningdale Road. Raised grades and an east extension of the culvert crossing at the Powell Drain may also be required.

7.1 Municipal Services

Based on the information provided, new sewer and watermain may be required along the subject section of roadway. No details regarding the locations and anticipated invert depths were provided at the time of preparing this report; therefore, the following discussion is general in nature.

7.2 Excavations and Groundwater Control

Based on the existing sewer depths, it is anticipated that the excavations for the works proposed at this site will generally be less than 5 metres in depth and will primarily encounter the existing pavement structure, surficial fill or topsoil overlying fill, silt, sands, sand and gravel and cohesive deposits of silty clay and clayey silt and glacial till. Organic deposits were encountered in the area of the creek and near the north limit of the site at Sunningdale Road. Groundwater was encountered in several of the boreholes drilled along the subject section of Adelaide Street North. Based on the results of the current and previous boreholes, groundwater was encountered at depths ranging from about 1.2 to 3.4 metres below the ground surface, within silts, sands and sand and gravel, and the depth of excavation below the groundwater level will depend on the time of year of construction and final designs. Perched groundwater may also be present within granular and uncontrolled fill layers that may be encountered at this project site. Based on the groundwater level measurements and anticipated proposed invert depths, the service excavations may extend below the groundwater level and a permit to take water (PTTW) or Environmental Activity and Sector Registry (EASR) will most likely be required. For example, a PTTW would be required if a typical sewer excavation (say 5 metres deep, 5 metres wide and 100 metres long) was required in the area of BH-202, where a 0.8-metre thick sand and gravel layer was encountered beneath the groundwater level. In this scenario, a pumping flow rate of greater than 400,000 litres/day would be required to dewater the sand and gravel layer, which would trigger the requirement of a PTTW.

Depending on the timing of construction, variations potentially resulting in groundwater levels higher than those encountered during the explorations should be expected. Proactive groundwater lowering in the sand and gravel, sands and silts would be required to ensure stability of both the base and the walls of the excavations. Such groundwater lowering could be accomplished by deep wells, well point systems or the like. Groundwater lowering methods should be developed by a specialist dewatering contractor. The use of proactive dewatering will aid in the potential reuse of the wet sands and other soils as trench backfill materials.

For conceptual planning, temporary open cut slopes should be planned to be no steeper than 1 horizontal to 1 vertical. It may be necessary to flatten the excavation side slopes in the surficial sands and silts in addition to blanketing portions of the cut slopes with free draining granular material to enhance the stability of the excavation walls.

To reduce the width of open cut excavations, consideration should be given to installing the sewers using a properly designed trench box. The trench box only provides protection for the workers once it is in place and does not preclude movement of the excavation walls or the flow of saturated materials under the influence of groundwater. Any gaps between the trench box and adjacent excavation side walls should be filled immediately to limit lateral movements.

All excavations should be carried out in accordance with the latest edition of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. The fill materials, sands, silts, silty clay, clayey silt and organic soils above the groundwater water level would be generally classified as Type 3 soils, and the glacial till would be classified as a Type 2 soil. Care should be taken to direct all surface water away from open excavations.

7.3 Bedding

Bedding for the proposed services should consist of suitably graded granular material consistent with the type, size and class of pipe and City of London standards. Care should be taken to extend the bedding through all fill and topsoil to bear on native, undisturbed soils.

Bedding materials should be placed in maximum 300-millimetre thick loose lifts and uniformly compacted to at least 95 per cent of standard Proctor maximum dry density (SPMDD). In areas where groundwater seepage may be of sufficient volume that the bedding material cannot be adequately compacted, it may be necessary to use 19-millimetre clear stone with a full-encapsulating non-woven geotextile surround. Where appropriate, the clear stone bedding would also facilitate groundwater control and pumping from sumps, as required. Should a trench liner box be employed, measures should be taken to ensure that the compacted pipe bedding is not disturbed when the liner box is moved.

7.4 Trench Backfill

Based on the results of the current and previous explorations, the excavated materials from the new municipal service trenches will consist primarily of fill, silt, sands, sand and gravel, silty clay and clayey silt and glacial till.

Provided that all deleterious materials such as the existing asphalt, concrete, topsoil, organics and unsuitable fill materials, including the silts, are wasted together with any excessively wet materials, the remaining drier portions of the excavated materials are considered suitable for use as trench backfill. Organic soils, including surficial and buried topsoil, topsoil fill, peat and organic silt, were encountered in the area of the creek and in the area of the intersection of Adelaide Street North and Sunningdale Road East. In addition, based on the results of the boreholes, the majority of the silts and silty clays encountered had measured water contents above their optimum water content and difficulty in achieving the specified degree of compaction is anticipated. These materials, along with the organic and deleterious materials, should be replaced with imported Granular C or approved native material.

The general trench backfill should be placed in maximum loose lift thicknesses of not greater than 300 millimetres and uniformly compacted to at least 95 per cent of SPMDD. The upper one metre of backfill in settlement sensitive areas and where the backfill forms the roadway subgrade should be placed in maximum 200-millimetre thick lifts and uniformly compacted to at least 98 per cent of SPMDD.

7.5 Powell Drain Culvert Extension and Headwall

7.5.1 Existing Conditions

The Powell Drain flows beneath Adelaide Street North from west to east through a Steel Plate Corrugated Steel Pipe (CSP) Arch culvert. Based on the As-Built drawings provided, the CSP culvert has dimensions of 1140 x 1830 millimetres in cross section. Based on the conceptual drawings provided by Parsons, the Adelaide Street North pavement surface is at about elevation 252.5 metres, the invert is at about elevation 250 metres with a 1 per cent grade to the east. An extension of the east end (outlet) of the culvert is proposed to accommodate the roadway widening, bike path and sidewalk. It is understood that the culvert extension is to be about 5 metres in length and may include a headwall.

7.5.2 Founding Soils

Based on the results of BH-206, the subsoil conditions encountered in the area of the proposed culvert extension consist of peat and organic silt above loose silts, loose to compact sandy silt, compact silty sand and firm to very stiff silty clay till. Based on the proposed culvert invert elevation, the culvert pipe extension will be founded on a layer of granular bedding overlying the native loose silt deposit at about elevation 249.5 to 249.6 metres (to accommodate a 300-millimetre thick bedding layer).

It is not necessary to found a circular pipe culvert at the standard depth for frost protection purposes, as these structures are tolerant of small magnitudes of movement related to freeze-thaw cycles, should these occur.

Headwall foundations bearing in the loose silt, as noted above, may be designed with a factored geotechnical resistance at Ultimate Limit States (ULS) of 110 kilopascals (kPa) and a factored geotechnical resistance at Serviceability Limit States (SLS) of 75 kPa. The SLS value corresponds to a maximum of 25 millimetres of total settlement. The existing drain/open channel flow will need to be diverted/piped during construction with appropriate erosion and sedimentation controls.

7.5.3 Excavations and Subgrade Inspections

Based on BH-206, the temporary excavation for the culvert extension will be made through the existing embankment fill and into native soils, which are comprised of very loose peat and soft organic silt and an underlying layer of loose silt. All excavations should be carried out in accordance with the latest edition of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. The fill and native soils are considered to be Type 3 soils above the groundwater table and Type 4 soils below. Temporary open-cut excavations in Type 3 soils should remain stable if side slopes are formed no stepper than 1H:1V. In Type 4 soils, the side sloes should be formed no steeper than 3H:1V.

Prior to placement of any bedding material, granular fill or concrete, all organics (including peat, topsoil and mixed organic soil materials such as organic silt) and any softened or disturbed soils, should be sub-excavated from below the plan limits of the proposed works.

The culvert subgrade should be inspected following sub-excavation to ensure that all organics and other unsuitable materials have been removed. Following inspection, if further sub-excavation of unsuitable subgrade materials is required, the material should be replaced with imported Granular C. The use of Granular ‘B’ Type II is recommended in wet ground conditions or below water. The native soils will be susceptible to disturbance from construction traffic and/or ponded water. To limit the effect of this disturbance, the 300-mm thick granular bedding layer should be placed in a timely manner. The foundation subgrade should be inspected immediately prior to placement of the bedding layer to confirm that the subgrade has been properly prepared for placement of the bedding/pipe.

It is important that the backfill at the haunches be well compacted for adequate soil-structure interaction. Given the potential for surface water flow and some groundwater seepage through the adjacent granular fill and native soils during excavation to the invert and bedding level and the potential for further loosening of the fine grained native soils, it is recommended that a minimum 300-millimetre thick layer of Granular ‘A’ or ‘B’ Type II material be used for bedding purposes.

7.5.4 Backfill

Backfill above/around the pipe culvert should consist of granular fill meeting the specifications for Granular ‘A’ or Granular ‘B’ Type I, II or III. The backfill should be placed in maximum 200-millimetre thick loose lifts and be uniformly compacted to at least 95 per cent of SPMDD.

The conceptual drawing provided by Parsons shows a reconstructed embankment above the culvert extension with a vertical height of about 1.5 metres and with a side slope of 3H to 4H:1V. Following stripping of the surficial topsoil and any organic or deleterious materials, the embankment widening should be constructed using granular fill meeting the grading requirements Granular C, placed in maximum 300-millimetre thick loose lifts, properly benched into the existing embankments in accordance with OPSD 208.010 and uniformly compacted to at least 98 per cent of SPMDD.

Inspection and field density testing should be carried out by qualified geotechnical personnel during all engineered fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved.

7.6 Roadway Widening

Widening of the existing Adelaide Road North roadway platform will be required during construction. Based on the condition of the asphalt in the area of the intersection with Sunningdale Road, we suggest that these pavements also be fully reconstructed. In general, all surficial topsoil, organic, loose, soft and/or deleterious materials should be stripped from the areas requiring widening. Based on the current boreholes and geologic mapping (see Figure 2), organic soils are anticipated in the area of the intersection. Subexcavations for pavement widening should extend from the existing edge of pavement and consist of a vertical cut to the proposed subgrade level.

Any fill required to bring the areas to subgrade level should consist of City of London Granular B or Granular C. Any fill materials required to achieve subgrade elevation should be carefully benched into the existing materials in accordance with Ontario Provincial Standard Drawing (OPSD) 209.010.

7.7 Preliminary Pavement Design

Traffic data obtained from the City of London website indicated average annual daily traffic volumes of 6,500, 14,000 and 20,000 for Adelaide Street North, north of Sunningdale Road, between Sunningdale Road and Phillbrook Drive, and between Phillbrook Drive and Fanshawe Park Road, respectively, and 8,000 and 12,000 vehicles for Sunningdale Road, west and east of Adelaide Street North, respectively. The percentage of truck traffic in the traffic flow was not provided but has been assumed to be 5 per cent for both roadways for the purposes of this report.

Based on the traffic data provided, Adelaide Street North, north of Sunningdale Road, and Sunningdale Road, west of Adelaide Street North, can be classified as minor arterial roadways. The remaining portions of Adelaide Street North and Sunningdale Road can be classified as major arterial roadways. The pavement structures may be designed using Benkelman beam design rebound criteria of 0.89 and 0.64 millimetres, respectively. Using the traffic volumes and estimated proportions of heavy vehicles noted above, together with the anticipated subgrade conditions, the following preliminary pavement structures are provided for the proposed widenings for both Marshall and SuperPave asphalts:

Roadway	**Pavement Component Thickness (mm)**			
	HL 3/SuperPave 12.5 FC1 Surface Asphalt	**HL 8/SuperPave 19.0 Binder Asphalt**	**Granular A Base**	**City of London Granular B Subbase**
Sunningdale Road (west of Adelaide Street North)	50	130 (2 @ 65)	150	450
Sunningdale Road (east of Adelaide Street North)	50	130 (2 @ 65)	150	600
Adelaide Street North (north of Sunningdale Road)	50	130 (2 @ 65)	150	450
Adelaide Street North (south of Sunningdale Road)	50	130 (2 @ 65)	150	600
Intersection at Sunningdale Road	50	130 (2 @ 65)	150	600

The Superpave 12.5 surface asphalt and top lift of Superpave 19.0 binder asphalt shall use Performance Graded Asphalt Cement (PGAC) 64-28. The lower lift of Superpave 19.0 binder asphalt may use PGAC 58-28. Based on the traffic data provided, Ontario Traffic Category C is applicable for Adelaide Street and Sunningdale Road pavements.

Any fill, organic or deleterious materials encountered at subgrade level should be removed prior to placement of subbase material. All subgrades should be heavily proofrolled under the direction of the geotechnical engineer and remedial work carried out as required.

The indicated preliminary pavement structures are based on properly prepared and graded subgrades with appropriate drainage of the pavement granulars provided.

The Granular A base and Granular B subbase should be placed in maximum 300-millimetre thick loose lifts and uniformly compacted to at least 100 per cent of SPMDD. Short, perforated stub drains should be provided at subgrade level at all catchbasin locations.

The asphaltic materials should be produced, placed and compacted in accordance with the current Ontario Provincial Standard Specifications (OPSS) and City of London requirements. Milled notches the depth of the surface course and 500 millimetres wide should be provided where new pavements abut existing pavements and care should be taken to properly tack coat all butt joints and milled surfaces.

7.8 Geotechnical Involvement

Geotechnical input will be required throughout the design of this project to evaluate the potential ramifications of design decisions and final details. A regular program of geotechnical monitoring, inspections and testing will be required during construction to confirm that the conditions being encountered are consistent with the results of the boreholes, to ensure that the intent of the recommendations provided are being met and that the various project specifications are being consistently achieved.

The factual data, interpretation and preliminary recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. This report addresses only the geotechnical (physical) aspects of the subsurface conditions at this site. The geo-environmental (chemical) aspects, including the consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site are outside the terms of reference for this report and have not been investigated or assessed.

We trust that this preliminary geotechnical assessment report provides sufficient information for your present requirements. Should any point require further clarification, please contact this office.

Signature Page

Golder Associates Ltd.

LICENSED PROFESSIONAL ENGINEER
D.R.P. BABCOCK
100109319
Feb 26/19
PROVINCE OF ONTARIO

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

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Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

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The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground Water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client’s expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder’s report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder’s report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder’s report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder’s report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder’s responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

TABLE I

SUMMARY OF GROUNDWATER LEVELS

Preliminary Geotechnical Assessment
Adelaide Street North Widening From
Fanshawe Park Road East to Sunningdale Road East
London, Ontario

BOREHOLE	GOLDER PROJECT NO.	DATE	GROUND SURFACE ELEVATION (m)	INSTALLATION	BOREHOLE DEPTH (m)	ENCOUNTERED GROUNDWATER LEVELS		MEASURED GROUNDWATER LEVELS			
						Depth (m)	Elevation (m)	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
								December 6, 2018			
201	Current	November 19, 2018	276.12	-	5.8	Dry to 270.3		-	-		
202	Current	November 19, 2018	266.85	-	7.3	2.2	264.7	-	-		
203	Current	November 28, 2018	278.60	-	6.6	Dry to 272.1		-	-		
204	Current	November 19, 2018	264.09	-	5.8	Dry to 258.3		-	-		
205	Current	November 23, 2018	265.93	Monitoring Well	7.3	3.4	262.5	2.0	263.9		
206	Current	November 23, 2018	252.43	-	8.1	2.9	249.5	-	-		
207	Current	November 28, 2018	252.60	Monitoring Well	8.1	2.9	249.7	2.2	250.4		
								June 13, 2006		June 27, 2006	
1	06-1130-092	June 12, 2006	263.69	Standpipe	6.1	1.4	262.3	4.9	258.8	1.7	262.0
2	06-1130-092	June 12, 2006	262.31	Standpipe	6.0	1.2	261.1	2.4	259.9	2.5	259.8
3	06-1130-092	June 16, 2006	259.70	-	2.3	Dry to 257.4		-	-	-	-
4	06-1130-092	June 12, 2006	254.51	-	4.3	2.0	252.5	-	-	-	-
5	06-1130-092	June 12, 2006	252.14	Standpipe	7.3	1.9	250.2	1.6	250.5	1.7	250.4
6	06-1130-092	June 16, 2006	252.79	-	1.7	Dry to 251.1		-	-	-	-
								April 7, 1994			
9	Trow 2004	March 23, 1994	263.50	Standpipe	5.0	2.7	260.8	1.5	262.0		
10	Trow 2004	March 23, 1994	252.20	Standpipe	3.7	1.5	250.7	1.5	250.7		
11	Trow 2004	March 24, 1994	253.60	-	3.5	2.7	250.9	-	-		
								June 1, 1988			
101	881-3077	May 30, 1988	253.88	Standpipe	7.2	1.7	252.2	1.6	252.3		
102	881-3077	May 30, 1988	253.03	-	1.4	Dry to 251.7		-	-		
103	881-3077	May 30, 1988	252.63	Standpipe	7.3	2.3	250.3	2.3	250.3		
104	881-3077	May 30, 1988	252.00	-	1.4	Dry to 250.6		-	-		

SUMMARY OF GROUNDWATER LEVELS

BOREHOLE	PROJECT NO.	DATE	GROUND SURFACE ELEVATION (m)	INSTALLATION	BOREHOLE DEPTH (m)	ENCOUNTERED GROUNDWATER LEVELS		MEASURED GROUNDWATER LEVELS			
						Depth	Elevation	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
								July 16, 1974		August 13, 1974	
6	743103	June 11, 1974	250.76	Standpipe	5.0	-	-	2.0	248.8	2.5	248.3
7	743103	June 11, 1974	251.67	Standpipe	5.0	-	-	2.2	249.5	2.2	249.5
8	743103	June 11, 1974	251.95	Standpipe	5.0	-	-	2.1	249.8	2.1	249.8
21	743103	June 12, 1974	251.49	-	1.7	Dry		-	-	-	-
25	743103	June 13, 1974	252.28	-	1.7	Dry		-	-	-	-
26	743103	June 13, 1974	252.34	-	1.8	Dry		-	-	-	-
27	743103	June 13, 1974	251.95	-	1.8	Dry		-	-	-	-
								July 5, 1973			
101	73345	June 27, 1973	250.18	Standpipe	5.0	-	-	1.3	248.9		
102	73345	June 27, 1973	250.58	Standpipe	5.0	-	-	1.7	248.9		
103	73345	July 3, 1973	250.30	Standpipe	6.1	-	-	2.3	248.0		
104	73345	July 3, 1973	250.64	Standpipe	6.6	-	-	1.8	248.9		

NOTES:
1. For borehole locations, see Location Plans, Figures 1A and 1B.
2. Table to be read in conjunction with accompanying report.

Prepared By: DB
Checked By: MAS

TABLE II

SLOPE STABILITY RATING CHART

Geotechnical Assessment
Adelaide Street North Widening
Fanshawe Park Road East to Sunningdale Road East
London, Ontario

Site Location: Stoney Creek Valley North, Adelaide Street North, London, Ontario	Project No.: 1898273-1000
Property Owner: City of London	Inspection Date: August 20, 2018
Inspected By: Dan Babcock, P.Eng.	Weather: Sunny, 20°C

	Rating Value (select one)	
	Section A	Section B
1. SLOPE INCLINATION		
Degrees Horizontal:Vertical		
a) 16 or less 3:1 or flatter	**>0<**	**>0<**
b) 16 to 26 2:1 to 3:1	6	6
c) 26 or more steeper than 2:1	16	16
2. SOIL STRATIGRAPHY		
a) Shale, Limestone (bedrock)	0	0
b) Sand, Gravel	6	6
c) Till	9	9
d) Clay, Silt	**>12<**	**>12<**
e) Fill	16	16
3. SEEPAGE FROM SLOPE FACE		
a) None or near bottom only	**>0<**	**>0<**
b) Near mid-slope only	6	6
c) Near crest only or from several levels	12	12
4. SLOPE HEIGHT		
a) 2m or less	**>0<**	0
b) 2.1 to 5m	2	**>2<**
c) 5.1 to 10m	4	4
d) more than 10m	8	8
5. VEGETATION COVER ON SLOPE FACE		
a) Well vegetated: heavy shrubs or forested with mature trees	**>0<**	**>0<**
b) Light vegetation: mostly grass, weeds, occasional trees, shrubs	4	4
c) No vegetation, bare	8	8
6. TABLE LAND DRAINAGE		
a) Table land flat, no apparent drainage over slope	**>0<**	**>0<**
b) Minor drainage over slope, no active erosion	2	2
c) Drainage over slope, active erosion, gullies	4	4
7. PROXIMITY OF WATERCOURSE TO SLOPE TOE		
a) 15 metres or more from slope toe	0	0
b) Less than 15 metres from slope toe	**>6<**	**>6<**
8. PREVIOUS LANDSLIDE ACTIVITY		
a) No	**>0<**	**>0<**
b) Yes	6	6
SLOPE INSTABILITY RATING / RATING VALUES TOTAL / INVESTIGATION REQUIREMENTS	Total	Total
	18	**20**
Toe Erosion?	No	No

SLOPE INSTABILITY RATING	RATING VALUES TOTAL	INVESTIGATION REQUIREMENTS
1. Low potential	**<24**	Site Inspection only, confirmation, report letter.
2. Slight potential	25-35	Site inspection and surveying, preliminary study, detailed report.
3. Moderate potential	>35	Borehole investigation, piezometers, lab tests, surveying, detailed report.

NOTES:
a) This chart does not apply to rock slopes or to Leda Clay slopes (Ottawa area).
b) Choose only one from each category and compare total rating with above requirements.
c) If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe, the potential for toe erosion and undercutting should be evaluated in detail and, protection provided if required.

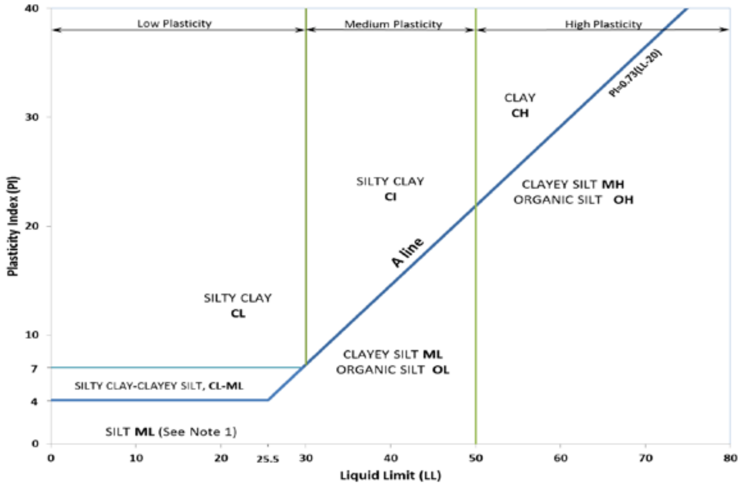
Reference: Table 4.2, Technical Guide – River & Stream Systems: Erosion Hazard Limit. Ontario Ministry of Natural Resources.

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

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

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\ \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson’s ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$ - u)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l – w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w – w_p) / I_p$
I_C	consistency index = $(w_l – w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} – e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength (ϕ = 0 analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 1898273

RECORD OF BOREHOLE BH-201

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

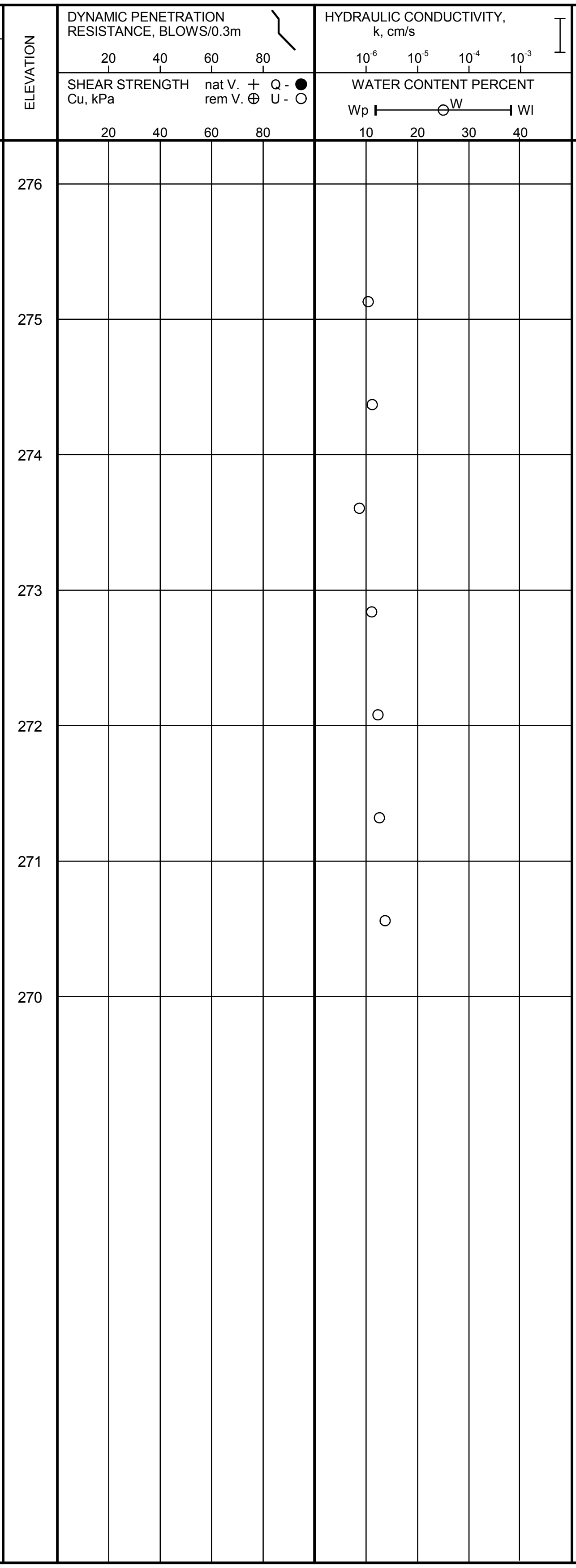
BORING DATE: November 19, 2018
DRILLING CONTRACTOR: London Soil Test Ltd.

DATUM: GEODETIC

BORING METHOD: DIEDRICH D-50, 210mm OD HOLLOW STEM

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
ROAD SURFACE	276.12
ASPHALT	0.00
FILL, Granular base	0.15
FILL, Granular subbase	275.66 0.46
(CL) sandy **SILTY CLAY**, some gravel, with cobbles; brown to grey below about elev. 273.2m, **TILL**; stiff to very stiff	270.33 5.79
END OF BOREHOLE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	SS	17
2	SS	12
3	SS	22
4	SS	18
5	SS	17
6	SS	18
7	SS	16



ADDITIONAL LAB. TESTING

INSTALLATION AND GROUNDWATER OBSERVATIONS

Borehole dry during drilling on November 19, 2018.

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE
1 : 50

GOLDER

LOGGED: SR
CHECKED: DB

PROJECT: 1898273

RECORD OF BOREHOLE BH-202

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

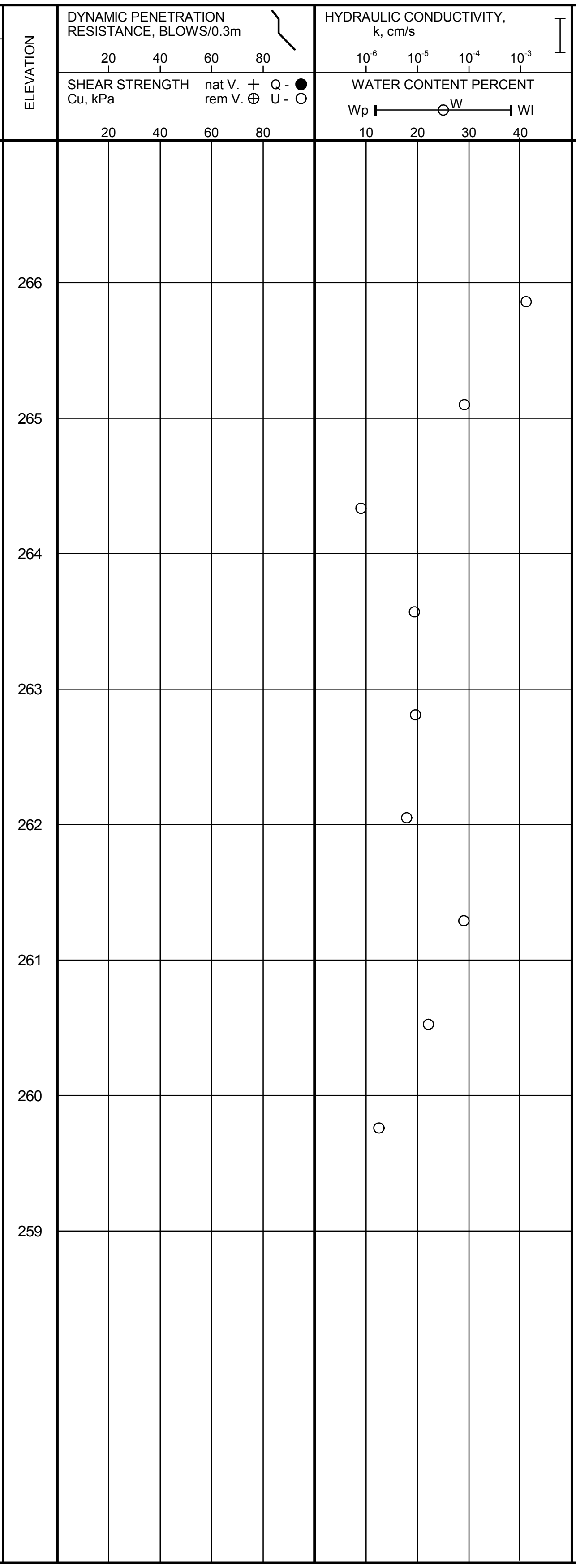
BORING DATE: November 19, 2018
DRILLING CONTRACTOR: London Soil Test Ltd.

DATUM: GEODETIC

BORING METHOD: DIEDRICH D-50, 210mm ID HOLLOW STEM

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	266.85 0.00
FILL, sand and gravel	266.24 0.61
TOPSOIL, silty, some clay, some sand and gravel; black; loose	264.72 2.13
(SW-GW) **SAND** and **GRAVEL**; some silt; brown; dense	263.95 2.90
(ML) **SILT**, trace to some clay, trace sand, with silty clay layers; grey; compact	261.67 5.18
(CI) **SILTY CLAY**; grey; very stiff	260.91 5.94
(ML) **SILT**, some sand; grey; compact	260.14 6.71
(CL) **SILTY CLAY**, trace sand, trace gravel, with silt seams; grey, **TILL**; hard	259.53 7.32
END OF BOREHOLE	

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	6	
2	SS	8	
3	SS	35	
4	SS	20	MH
5	SS	20	
6	SS	21	
7	SS	18	
8	SS	24	
9	SS	39	



INSTALLATION AND GROUNDWATER OBSERVATIONS

Enc. WL ▽

Groundwater encountered at about elev. 264.7m during drilling on November 19, 2018.

DEPTH SCALE
1 : 50

LOGGED: SR
CHECKED: DB

PROJECT: 1898273

RECORD OF BOREHOLE BH-203

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: November 28, 2018
DRILLING CONTRACTOR: London Soil Test Ltd.

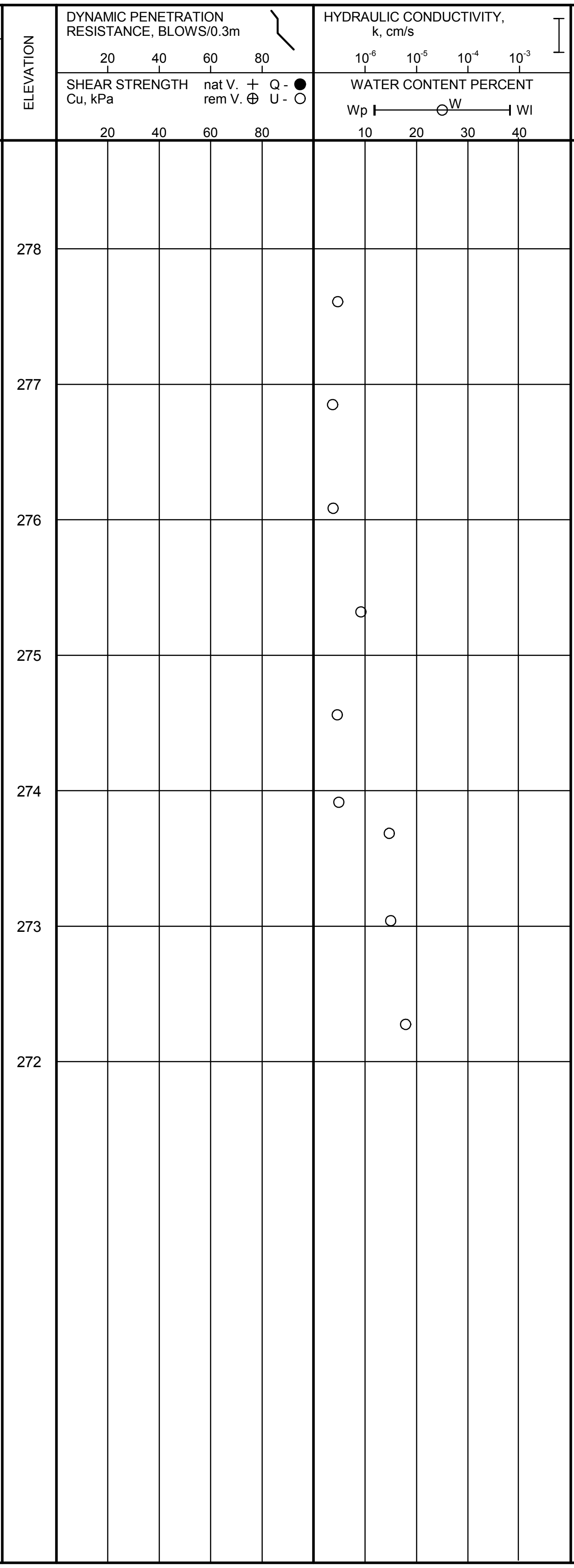
DATUM: GEODETIC

DEPTH SCALE METRES: 0 – 10

BORING METHOD: GEOPROBE, 203mm ID HOLLOW STEM

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
ROAD SURFACE	278.60
ASPHALT	0.00
FILL, granular base, sand and gravel, some silt, crushed; brown	
FILL, granular subbase, sand and gravel, some silt, with cobbles; brown	0.21
FILL, sand and gravel, some silt, with asphalt pieces and topsoil; brown; compact to very dense	277.96 0.64
FILL, clayey silt, some sand, with topsoil; grey; very stiff	273.75 4.85
(CL) **SILTY CLAY**, some sand, some gravel; brown and grey, **TILL**; stiff	273.27 5.33
END OF BOREHOLE	272.05 6.55

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	SS	59
2	SS	53
3	SS	93
4	SS	53
5	SS	19
6	SS	15
7	SS	13
8	SS	9



ADDITIONAL LAB. TESTING

INSTALLATION AND GROUNDWATER OBSERVATIONS

Borehole dry during drilling on November 28, 2018.

LDN_BHS_07 1898273.GPJ GLDR_LON.GDT 17/12/18 08:41 DATA INPUT: AMS

DEPTH SCALE
1 : 50

GOLDER

LOGGED: MA
CHECKED: DB

PROJECT: 1898273

RECORD OF BOREHOLE BH-204

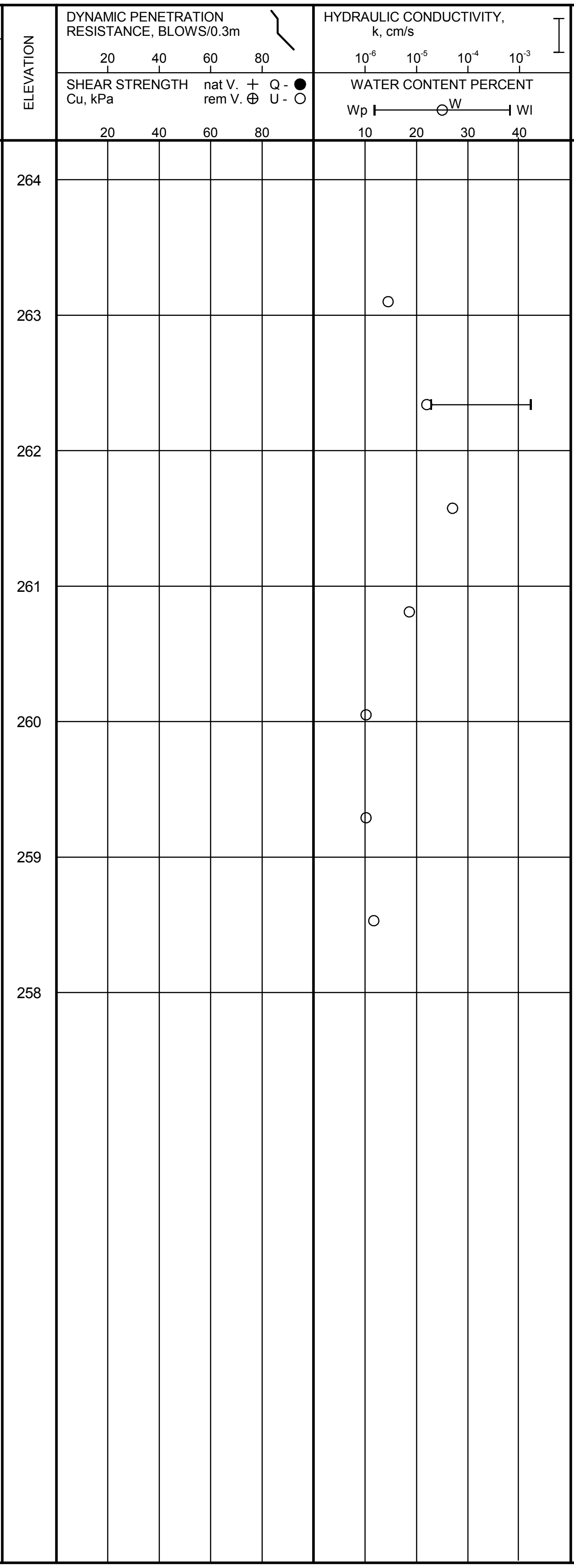
SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: November 19, 2018
DRILLING CONTRACTOR: London Soil Test Ltd.

DATUM: GEODETIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
0		ROAD SURFACE	264.09					
	DIEDRICH D-50 210mm ID HOLLOW STEM	**ASPHALT**	0.00					Borehole dry during drilling on November 19, 2018.
		FILL, Granular base	0.14					
		FILL, Granular subbase	0.30					
1		(SM) **SILTY SAND**, some gravel, trace clay; brown; compact	0.46	1	SS	15		
2		(CI) **SILTY CLAY**, trace sand; brown; stiff	262.72 1.37	2	SS	13	MH	
		(ML) sandy **SILT**; brown; compact	261.96 2.13	3	SS	27		
3		(ML) sandy **SILT**, trace clay, trace gravel, with cobbles, with silty clay and silt seams; grey, **TILL**; compact to dense	261.19 2.90	4	SS	16		
4				5	SS	45		
5				6	SS	47		
		(CL) **SILTY CLAY**, trace sand, trace gravel; grey, **TILL**; hard	258.91 5.18	7	SS	36		
6		END OF BOREHOLE	258.30 5.79					
7								
8								
9								
10								



DEPTH SCALE

1 : 50

GOLDER

LOGGED: SR

CHECKED: DB

PROJECT: 1898273

RECORD OF BOREHOLE BH-205

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

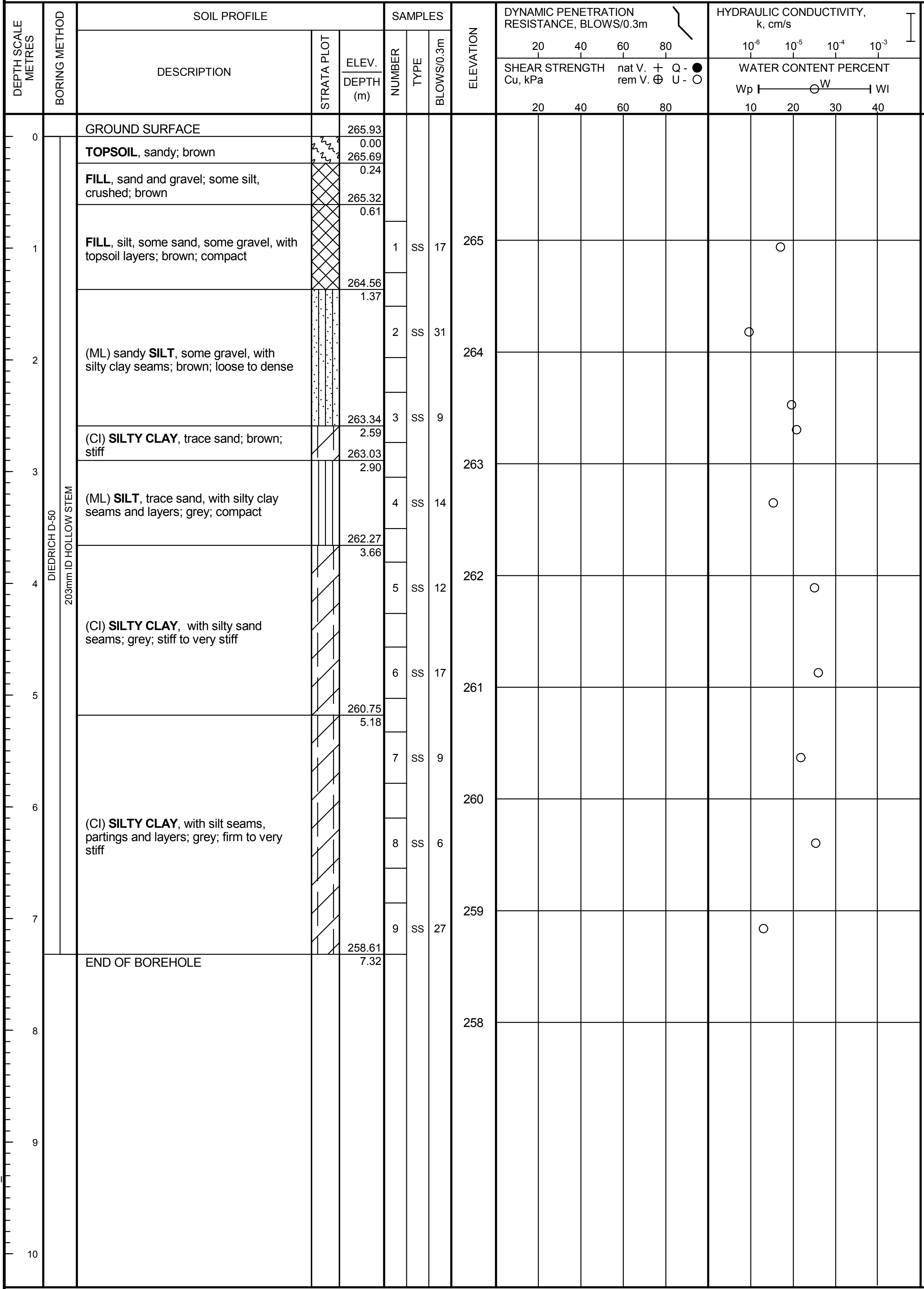
BORING DATE: November 23, 2018
DRILLING CONTRACTOR: London Soil Test Ltd.

DATUM: GEODETIC

BORING METHOD: DIEDRICH D-50 203mm ID HOLLOW STEM

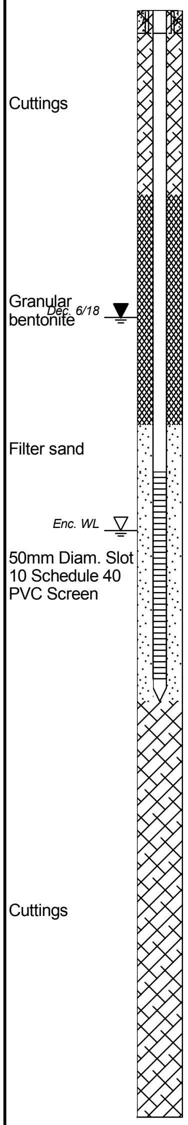
DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	265.93 0.00
TOPSOIL, sandy; brown	265.69 0.24
FILL, sand and gravel; some silt, crushed; brown	265.32 0.61
FILL, silt, some sand, some gravel, with topsoil layers; brown; compact	264.56 1.37
(ML) sandy **SILT**, some gravel, with silty clay seams; brown; loose to dense	263.34 2.59
(CI) **SILTY CLAY**, trace sand; brown; stiff	263.03 2.90
(ML) **SILT**, trace sand, with silty clay seams and layers; grey; compact	262.27 3.66
(CI) **SILTY CLAY**, with silty sand seams; grey; stiff to very stiff	260.75 5.18
(CI) **SILTY CLAY**, with silt seams, partings and layers; grey; firm to very stiff	258.61 7.32
END OF BOREHOLE	

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	17	
2	SS	31	
3	SS	9	
4	SS	14	MH
5	SS	12	
6	SS	17	
7	SS	9	
8	SS	6	
9	SS	27	



INSTALLATION AND GROUNDWATER OBSERVATIONS

MW-205



Groundwater encountered at about elev. 262.5m during drilling on November 23, 2018.

Water level measured in well at elev. 263.90m on December 6, 2018.

DEPTH SCALE
1 : 50

GOLDER

LOGGED: MA
CHECKED: DB

PROJECT: 1898273

RECORD OF BOREHOLE BH-206

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

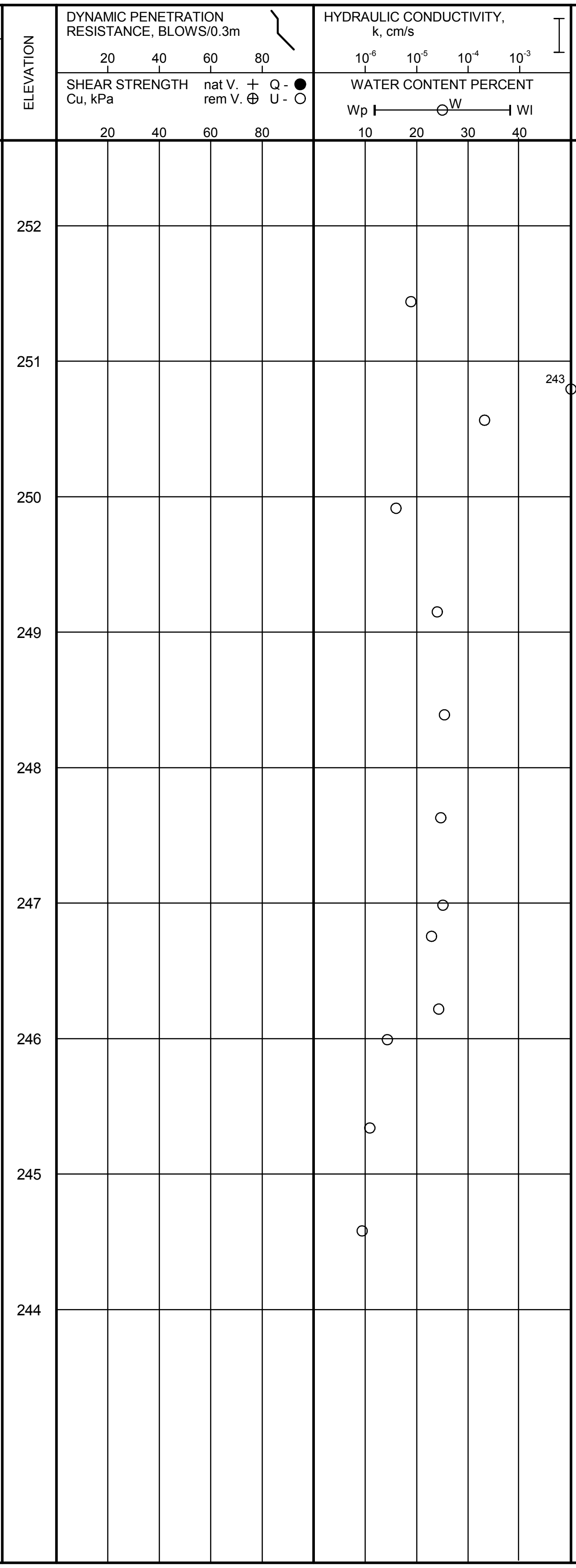
BORING DATE: November 23, 2018
DRILLING CONTRACTOR: London Soil Test Ltd.

DATUM: GEODETIC

BORING METHOD: DIEDRICH D-50
177mm ID HOLLOW STEM

DESCRIPTION	ELEV.	DEPTH (m)
ROAD SURFACE	252.43	0.00
ASPHALT	252.25	0.18
FILL, Granular base, sand and gravel, some silt, crushed; brown		0.30
FILL, Granular subbase, sand and gravel, some silt; brown	251.61	0.82
FILL sandy silty topsoil, trace gravel; black; loose	251.06	1.37
(PT) **PEAT**, with organics; black; very loose	250.63	1.80
(OH) **ORGANIC SILT**, with shells; grey; soft	250.30	2.13
(ML) **SILT**, trace to some sand, trace clay, with topsoil and rootlets; grey; loose	248.77	3.66
(ML) sandy **SILT**, with clayey silt seams; grey; loose to compact	247.25	5.18
(SM) **SILTY SAND**; grey; compact	246.85	5.58
(ML) sandy **SILT** to **SILT**, some sand, with silty sand seams; grey; loose to compact	246.03	6.40
(CL) **SILTY CLAY**, some sand, some gravel; brown to grey, **TILL**; firm to very stiff	244.35	8.08
END OF BOREHOLE		

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	5	
2	SS	3	
3	SS	5	
4	SS	9	
5	SS	5	MH
6	SS	10	
7	SS	11	
8	SS	7	
9	SS	17	
10	SS	20	



INSTALLATION AND GROUNDWATER OBSERVATIONS

Enc. WL ▽

Groundwater encountered at about elev. 249.5m during drilling on November 23, 2018.

DEPTH SCALE
1 : 50

GOLDER

LOGGED: MA
CHECKED: DB

PROJECT: 1898273

RECORD OF BOREHOLE BH-207

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

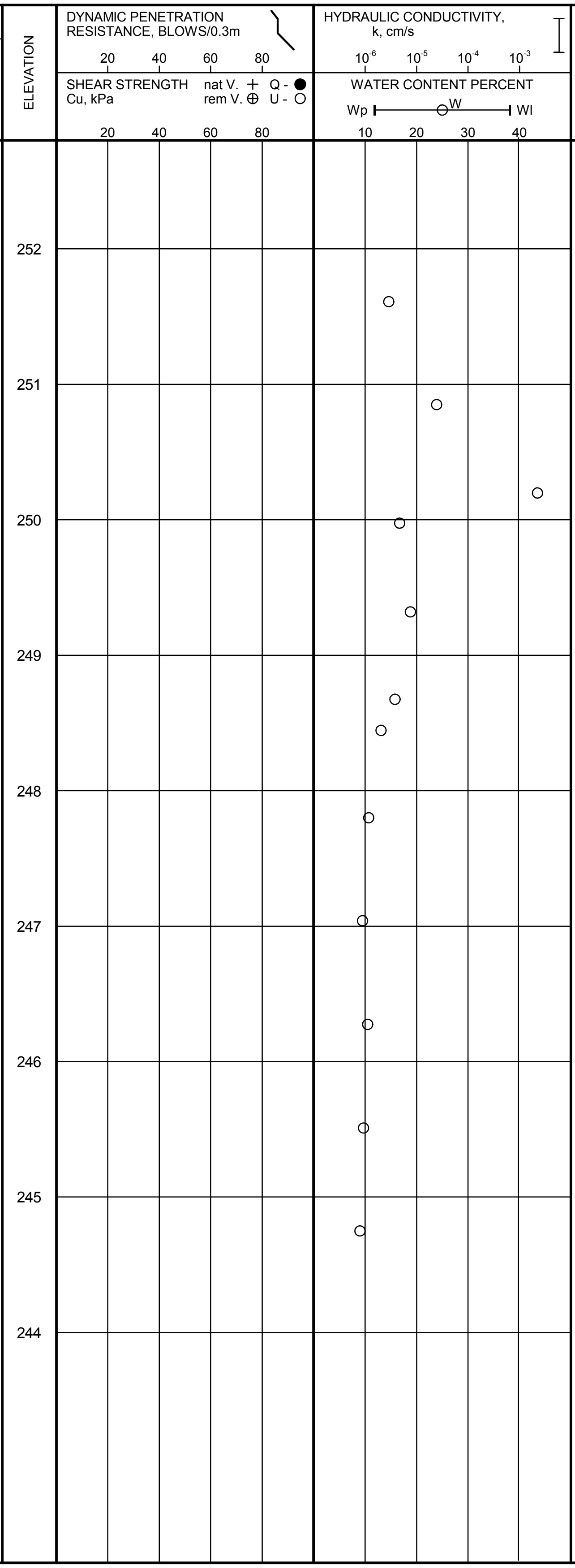
BORING DATE: November 28, 2018
DRILLING CONTRACTOR: London Soil Test Ltd.

DATUM: GEODETIC

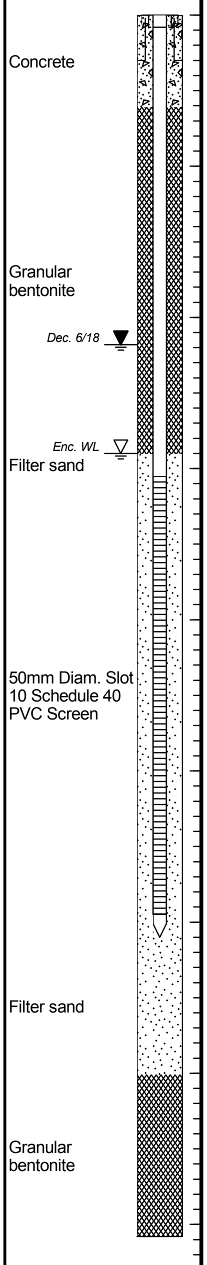
BORING METHOD: GEOPROBE, 203mm ID HOLLOW STEM

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	252.60 0.00
TOPSOIL, silty; brown	252.30 0.30
FILL, sand and gravel, some silt, crushed; brown	252.05 0.55
FILL, silty topsoil to silt and topsoil, trace to some sand, trace gravel, with organics; brown; compact to loose	250.07 2.53
(ML) sandy **SILT**, some gravel, with silty clay seams; grey; loose to compact	248.94 3.66
(SP) **SAND**, some silt, with silty clay layers; grey; loose	248.49 4.11
(CL) **SILTY CLAY**, some sand, some gravel, with sandy silt layers; grey; firm to stiff	247.42 5.18
(SM) sandy **SILTY CLAY**, some gravel; grey, **TILL**; stiff	246.66 5.94
(ML) **SILT**, some sand, trace to some clay, trace gravel; grey; compact	245.89 6.71
(CL) **SILTY CLAY**, some sand, some gravel; grey, **TILL**; stiff to very stiff	244.52 8.08
END OF BOREHOLE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	10	
2	SS	5	
3	SS	8	
4	SS	11	MH
5	SS	5	
6	SS	14	
7	SS	14	
8	SS	28	
9	SS	19	
10	SS	14	



INSTALLATION AND GROUNDWATER OBSERVATIONS



Groundwater encountered at about elev. 249.7m during drilling on November 28, 2018.

Water level measured in well at elev. 250.42m on December 6, 2018.

DEPTH SCALE
1 : 50

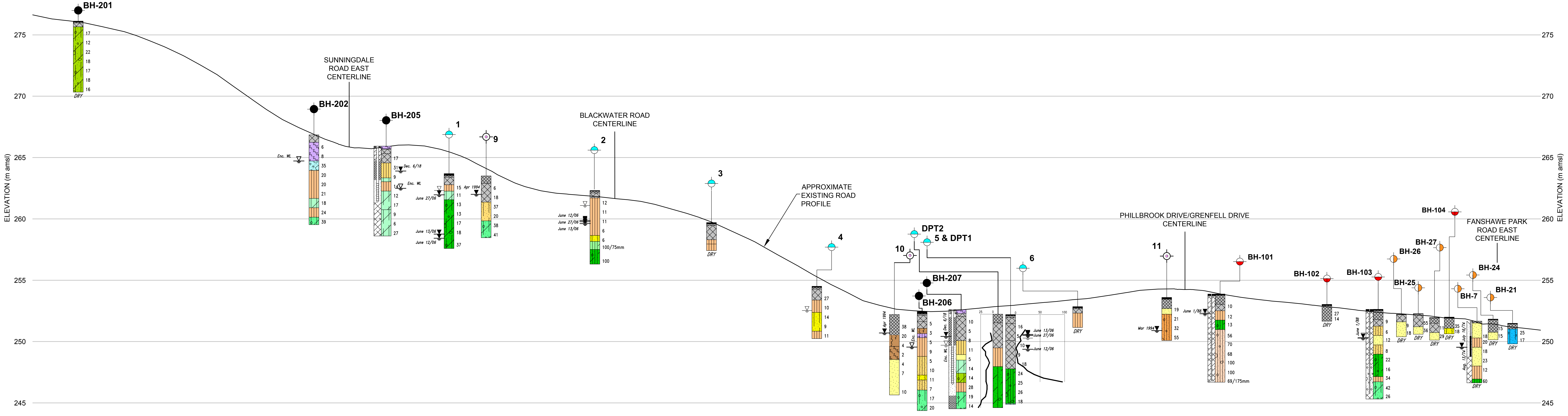
GOLDER

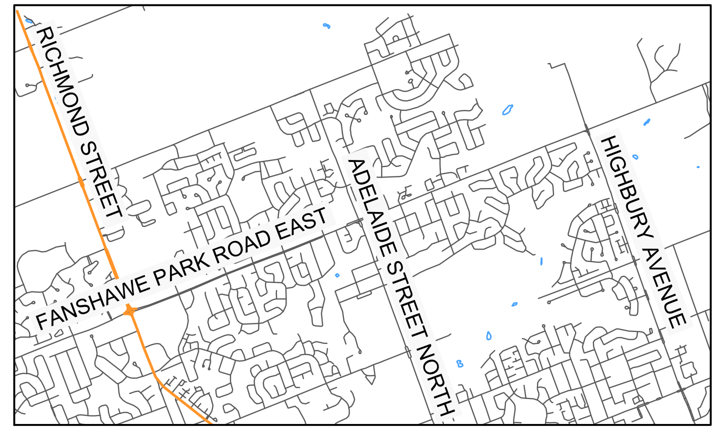
LOGGED: MA
CHECKED: DB

Client: Parsons

Original Format 279mm x 856mm

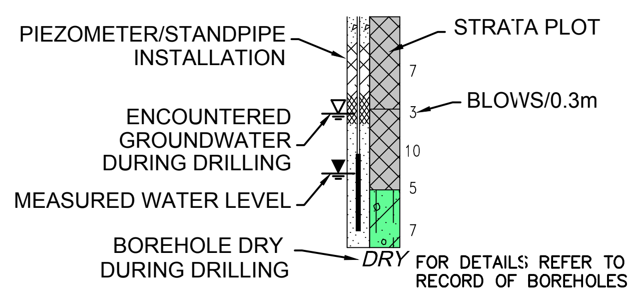
Drawing file: 1898273-R01001A.dwg Feb 25, 2019 – 8:48am





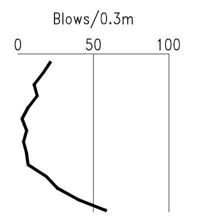
KEY PLAN

INSTALLATION DETAILS



FOR DETAILS REFER TO RECORD OF BOREHOLES

DYNAMIC PENETRATION RESISTANCE



HORIZONTAL
SCALE IN METRES
0 50 100m
1:3,000

VERTICAL
SCALE IN METRES
0 4 8m
1:200

LEGEND

- ● BOREHOLE (CURRENT EXPLORATION)
- ① PHOTOGRAPH LOCATION, VIEWING DIRECTION, AND PLATE NUMBER
- ⊙ BOREHOLE (TROW 2004)

BOREHOLE (Previous Golder Exploration):

- ◒ 06-1130-0092
- ◐ 743103
- ◒ 881-3077
- ◑ 73345

SIMPLIFIED STRATIGRAPHY

▬ ASPHALT	
▨ FILL ROADBASE	▨ SILT TILL
▨ FILL	▨ SANDY SILT
▨ TOPSOIL	▨ SANDY SILT TILL
▨ MARL	▨ SAND & GRAVEL
▨ PEAT	▨ SILTY CLAY
▨ SAND	▨ SILTY CLAY TILL
▨ SILTY SAND	▨ CLAYEY SILT
▨ SILT	▨ CLAYEY SILT TILL
▨ SILTY SAND & GRAVEL	▨ SANDY SILTY CLAY TILL
▨ ORGANIC SILT	

REFERENCE

DRAWING BASED ON ACAD DRAWING "476793-Plan and Profile.dwg" PROVIDED BY PARSONS; AND 2014 AERIAL IMAGERY FROM THE CITY OF LONDON, CITYCD.2014;

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

REFER TO RECORD OF BOREHOLE SHEETS FOR THOSE BOREHOLES NOT LOCATED WITHIN ROW.

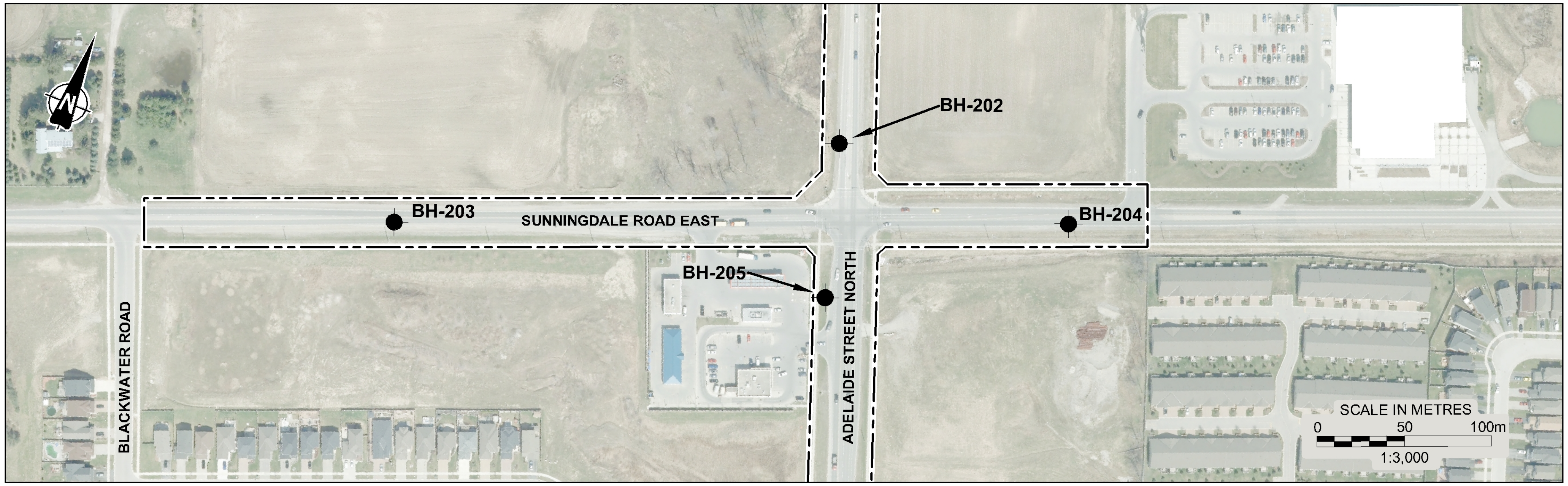
ALL LOCATIONS ARE APPROXIMATE.

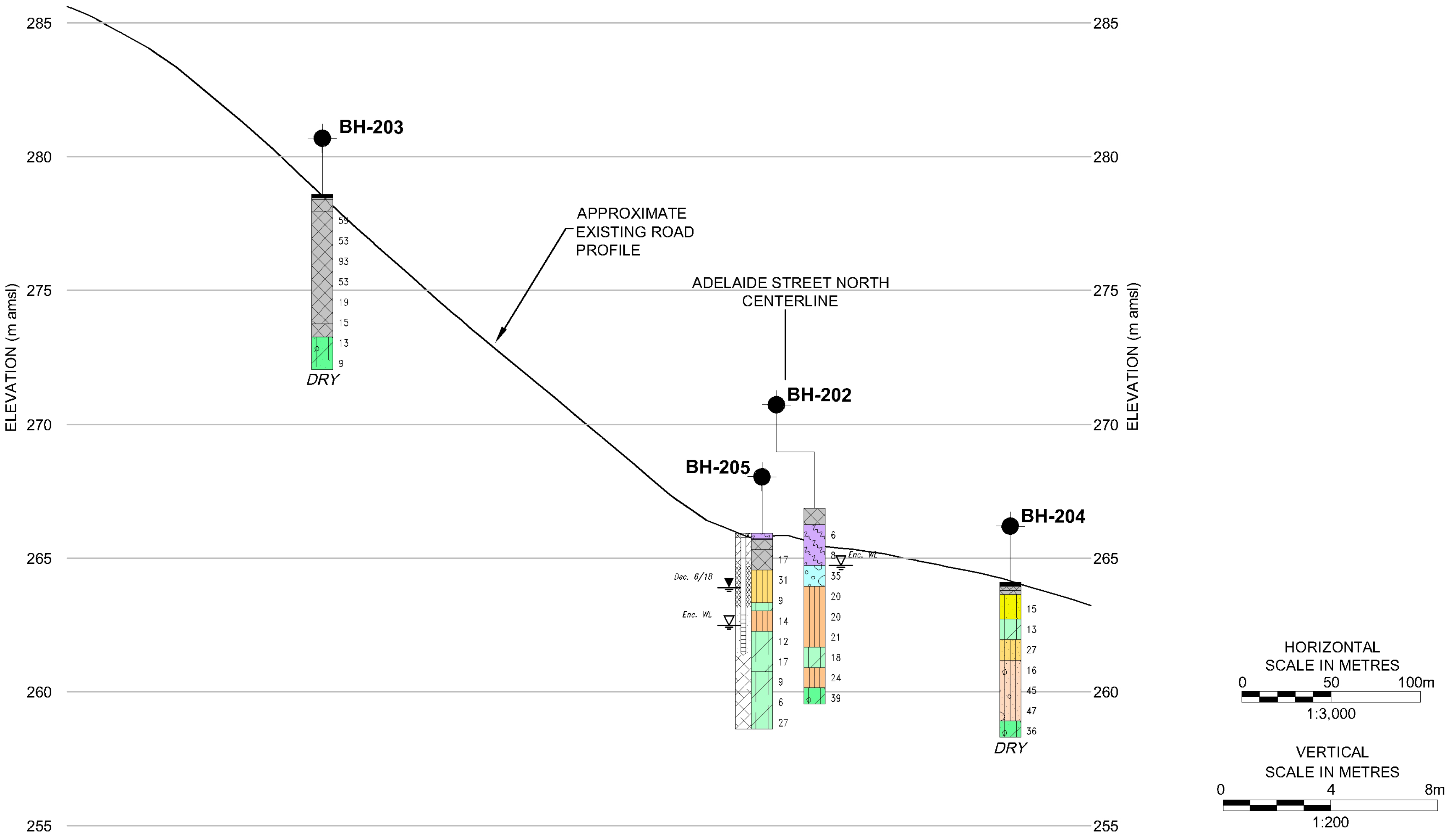
PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

TITLE
LOCATION PLAN AND PROFILE (ALONG ADELAIDE STREET NORTH)

GOLDER

PROJECT No.		1898273	FILE No.	1898273–R01001A
			SCALE AS SHOWN	REV.
CADD	AS/ZB/DH	Feb 25/19	**FIGURE 1A**	
CHECK DB				





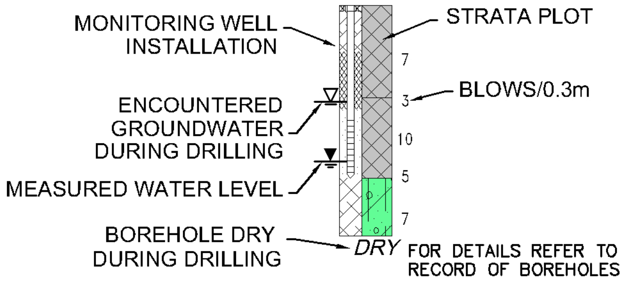
LEGEND

● BOREHOLE

SIMPLIFIED STRATIGRAPHY

▬ ASPHALT
▨ FILL ROADBASE
▨ FILL
▨ TOPSOIL
▨ SANDY SILT
▨ SANDY SILT TILL
▨ SAND
▨ SILTY SAND
▨ SILT
▨ SILTY CLAY
▨ SILTY CLAY TILL
▨ SAND & GRAVEL

INSTALLATION DETAILS



FOR DETAILS REFER TO RECORD OF BOREHOLES

REFERENCE

DRAWING BASED ON ACAD DRAWING "BasePlan_E-927.dwg" PROVIDED BY PARSONS; AND
2014 AERIAL IMAGERY FROM THE CITY OF LONDON, CITYCD.2014;

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

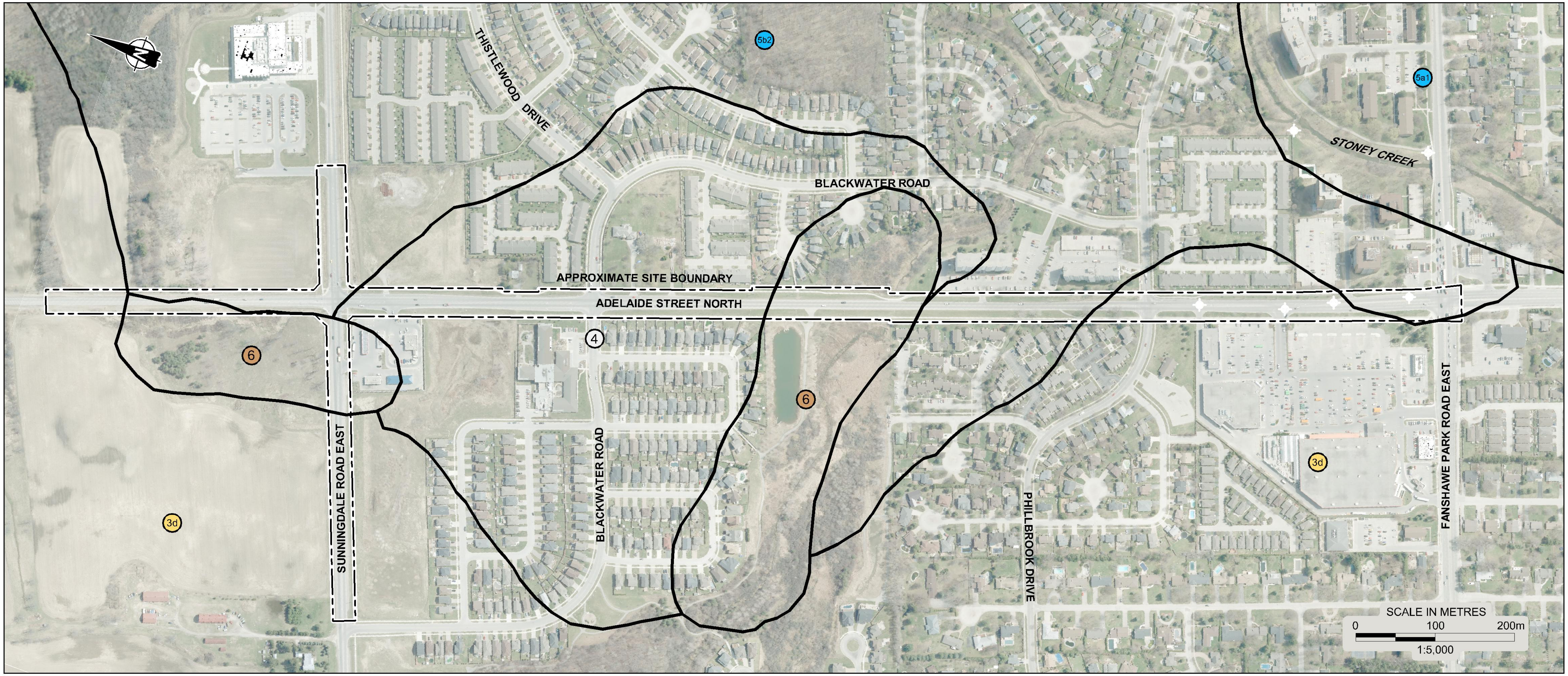
TITLE

LOCATION PLAN AND PROFILE (ALONG SUNNINGDALE ROAD EAST)

GOLDER

PROJECT No.		1898273	FILE No.	1898273–R01001B
			SCALE AS SHOWN	REV.
CADD	AMS/DCH	Dec 17/18	**FIGURE 1B**	
CHECK	DB			

Drawing file: 1898273–R01001B.dwg Dec 17, 2018 – 8:24am
0 25mm Original Format is Tabloid 279mm x 432mm
Client: Parsons



LEGEND

QUATERNARY GEOLOGY:

Glacial Deposits: Huron Lobe

- 3d Sandy silt loam till, Arva Moraine and related ground moraine west of it

---

- ④ Lacustrine deposits: sand, silt and clay

Gravels and Related Sediments: gravel, gravelly sand, sand

Deltaic and some beach complex deposits

- 5a1 Gravel

Outwash

- 5b2 Predominantly sand (some gravel)

- ⑥ Bogs and swamps: peat, muck, marl

REFERENCE

DRAWING BASED ON 2014 AERIAL IMAGERY FROM THE CITY OF LONDON, CITYCD.2014; AND DIVISION OF MINES, PRELIMINARY MAP P.1048, QUATERNARY GEOLOGY LUCAN AREA SOUTHERN ONTARIO", 1975.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

TITLE

QUATERNARY GEOLOGY

GOLDER

PROJECT No.		1898273	FILE No.	1898273–R01002
			SCALE AS SHOWN	REV.
CADD	AMS/ZJB	Sept. 5/18	**FIGURE 2**	
CHECK	DB			

Drawing file: 1898273–R01002.dwg Sep 05, 2018 – 11:52am 0 25mm Original Format is Tabloid 279mm x 432mm Client: Parsons

Client: Parsons

Original Format is Tabloid 279mm x 432mm

25mm

0

Sep 05, 2018 – 12:00pm

Drawing file: 1898273–R01003.dwg

LEGEND

SECTION LOCATOR

3 PHOTOGRAPH NUMBER AND VIEWING DIRECTION

REFERENCE

DRAWING BASED ON 2014 DATA FROM THE CITY OF LONDON, CITYCD2014.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

FOR CROSS-SECTIONS, REFER TO FIGURE 4.

ALL LOCATIONS ARE APPROXIMATE.

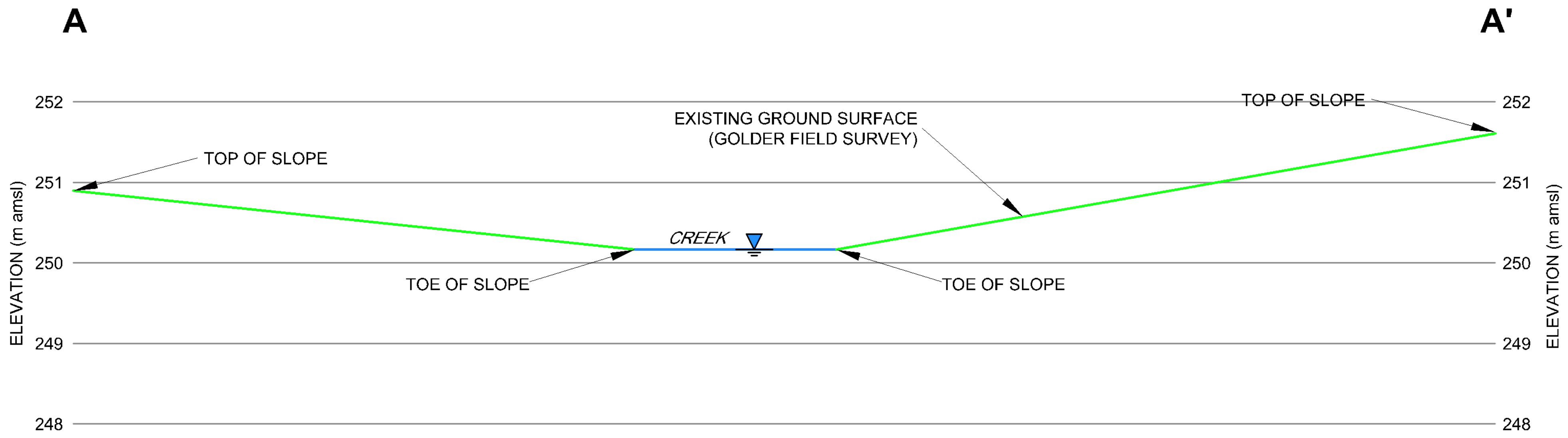
PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

TITLE

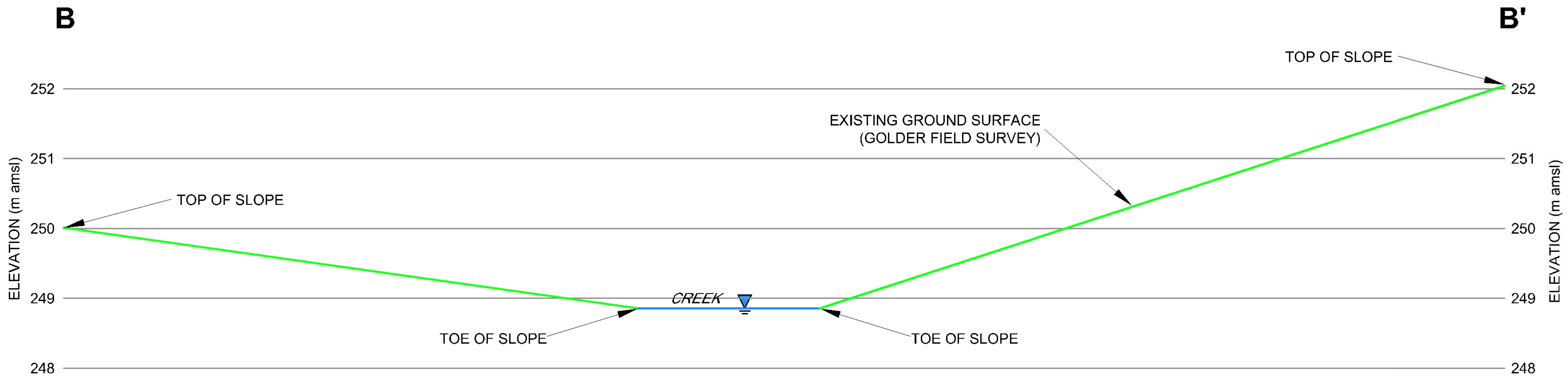
SLOPE PLAN

GOLDER

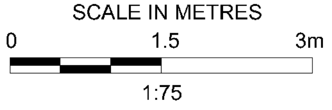
PROJECT No.		1898273	FILE No.	1898273–R01003
			SCALE	AS SHOWN
CADD	DCH/ZJB	Sept. 5/18	REV.	
CHECK	DB		FIGURE 3	



CROSS-SECTION A-A'



CROSS-SECTION B-B'



REFERENCE

DRAWING BASED ON 2014 DATA FROM THE CITY OF LONDON, CITYCD2014.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

FOR CROSS-SECTION LOCATIONS, REFER TO FIGURE 3.

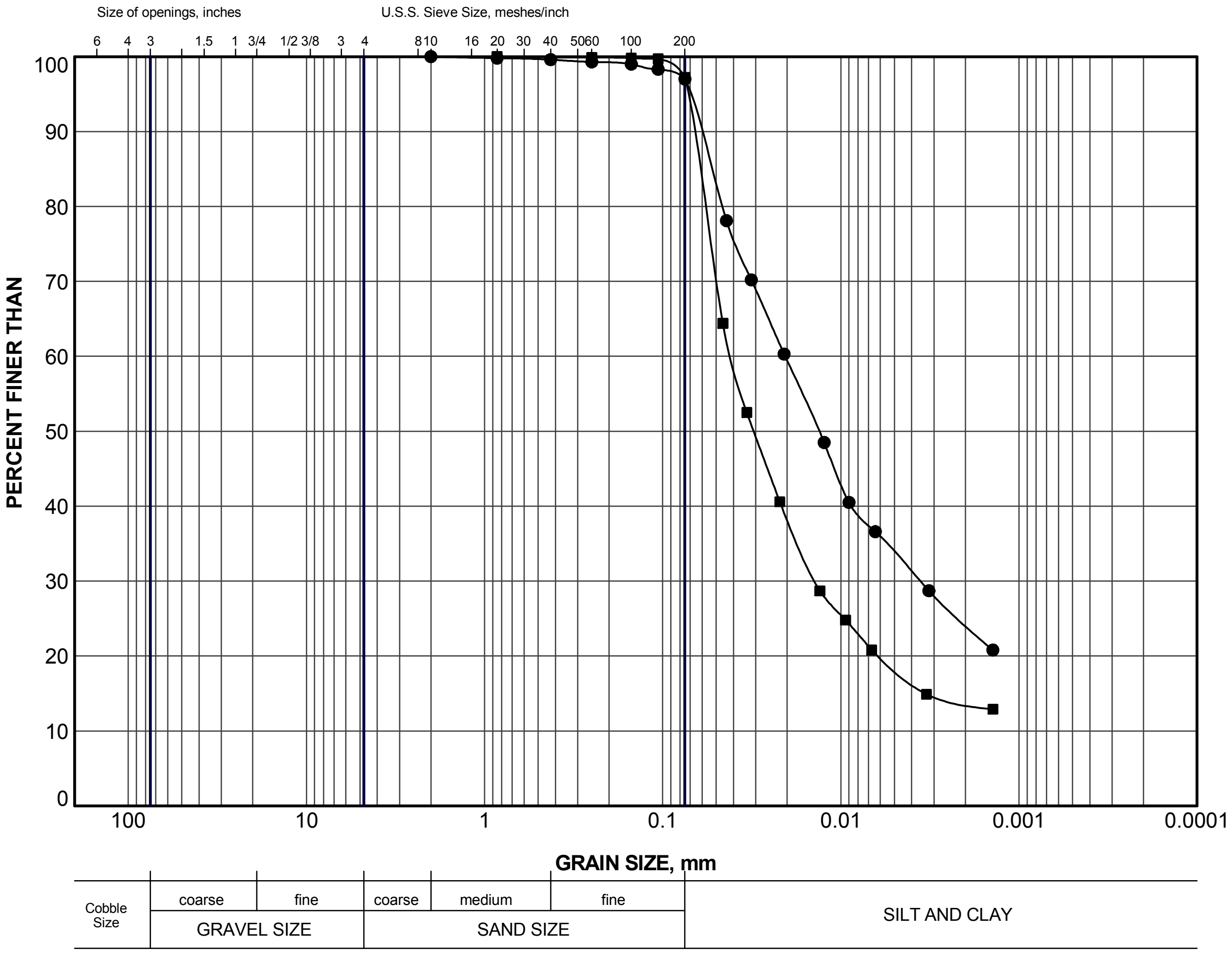
ALL LOCATIONS ARE APPROXIMATE.

PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

TITLE
CROSS-SECTIONS
A-A' AND B-B'

GOLDER

PROJECT No.		1898273	FILE No.	1898273–R01003
			SCALE AS SHOWN	REV.
CADD	DCH	Sept. 5/18		
CHECK	DB		**FIGURE 4**	



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-202	4	263.6
■	BH-205	4	262.7

PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

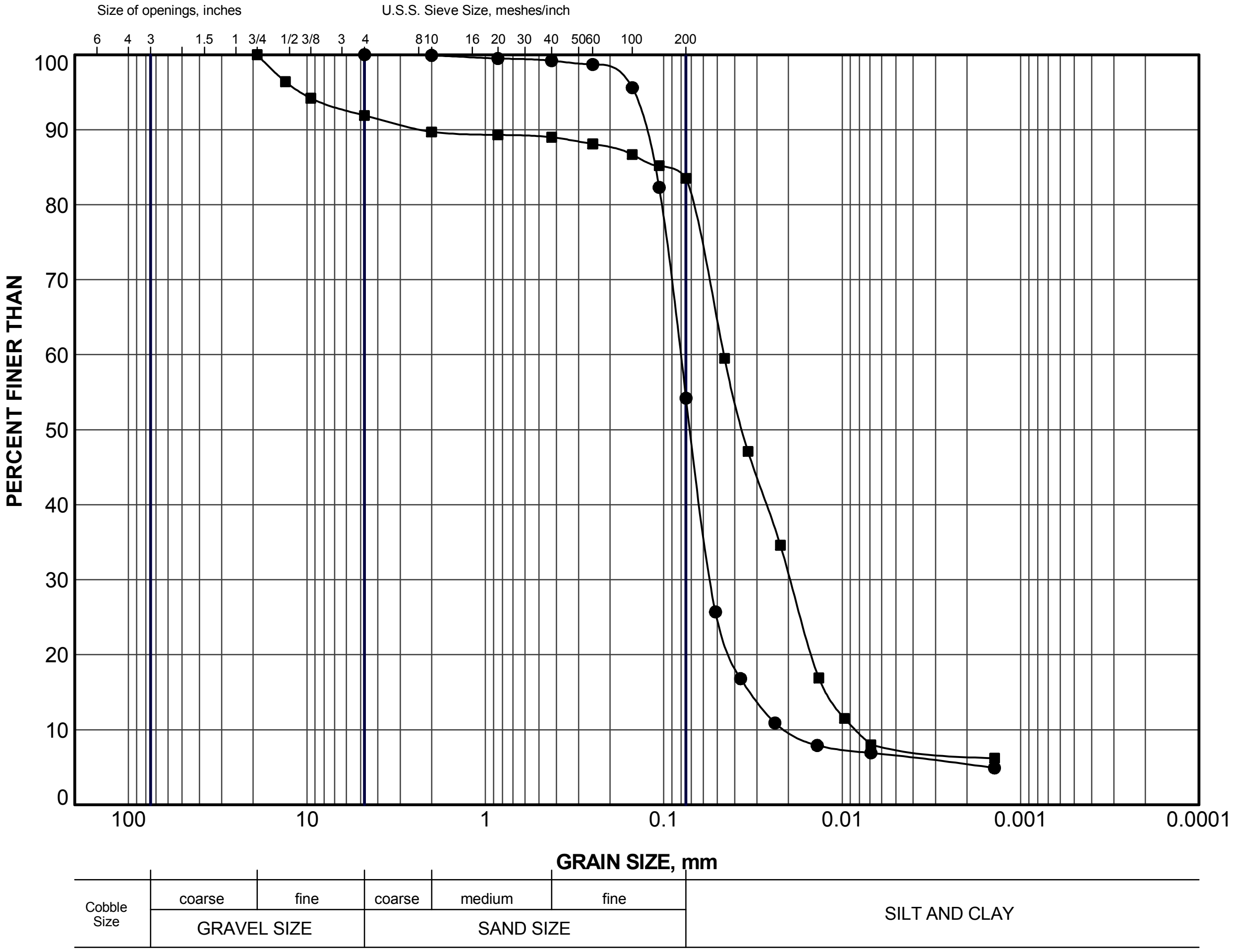
TITLE
GRAIN SIZE DISTRIBUTION
SILT

GOLDER

PROJECT No.	1898273	FILE No.	1898273-1000-R01005	
		SCALE	N/A	REV.
DRAWN	AMS	Dec 17/18		
CHECK	DB			

FIGURE 5

LDN_GSD GLDR_LDN.GDT 07-12-18 16:47



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-206	5	248.4
■	BH-207	4	249.3

PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

TITLE

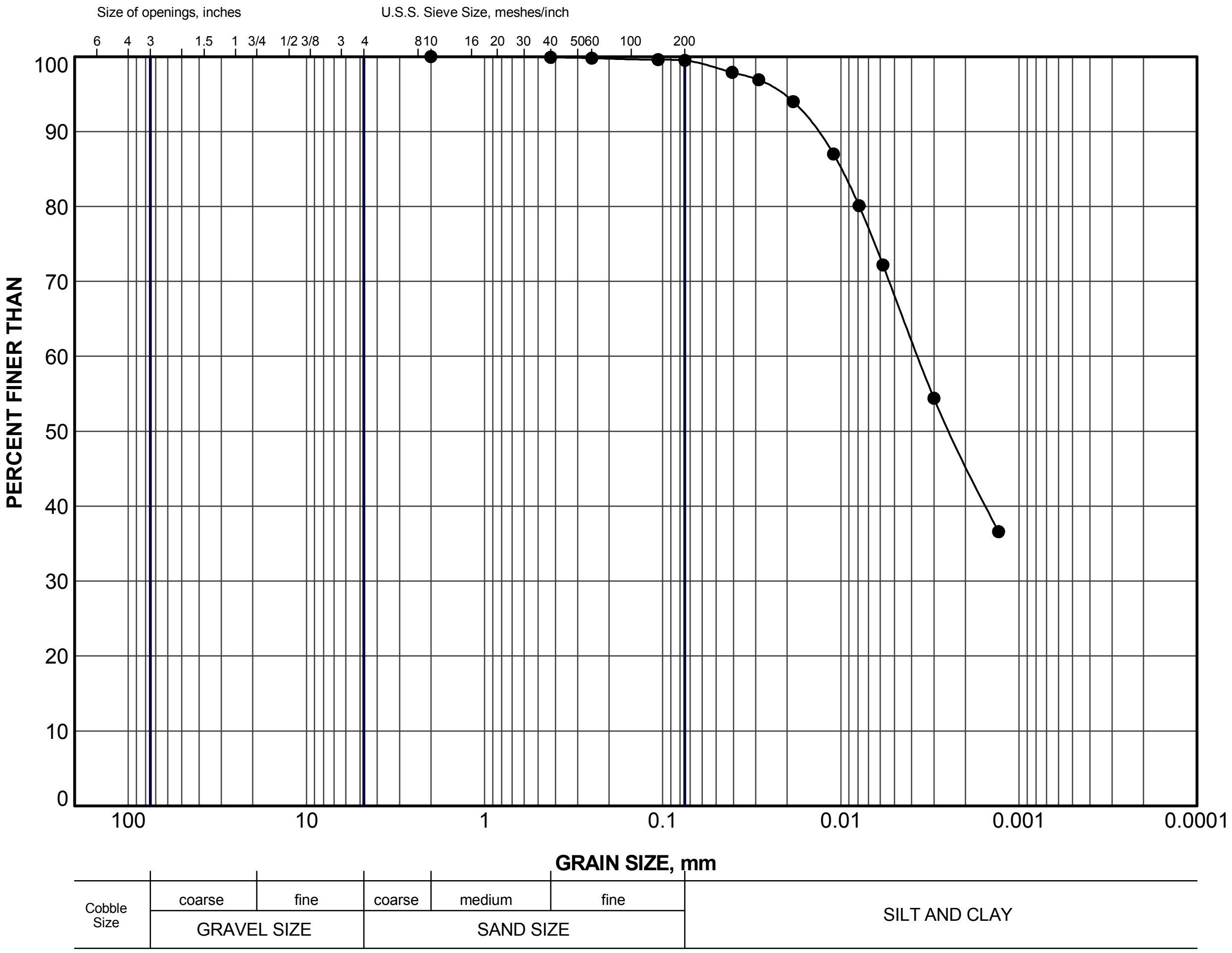
GRAIN SIZE DISTRIBUTION

sandy SILT

GOLDER

PROJECT No.	1898273		FILE No.	1898273-1000-R01006
			SCALE N/A	REV.
DRAWN	AMS	Dec 17/18	**FIGURE 6**	
CHECK	DB			

LDN_GSD GLDR_LDN.GDT 07-12-18 16:52



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-204	2	262.3

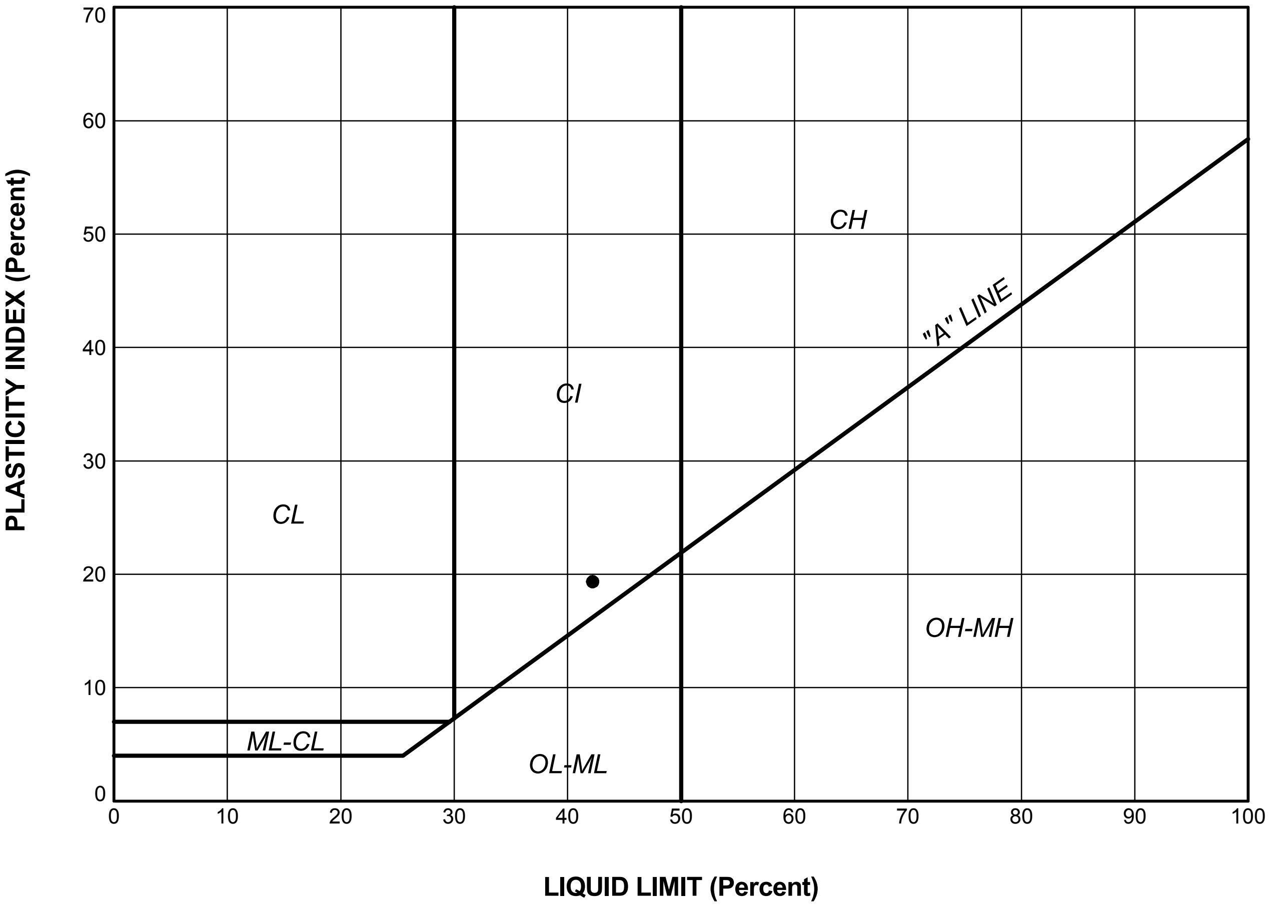
PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

TITLE
GRAIN SIZE DISTRIBUTION
SILTY CLAY

GOLDER

PROJECT No.		1898273	FILE No.	1898273-1000-R01007
			SCALE N/A	REV.
DRAWN	AMS	Dec 17/18	**FIGURE 7**	
CHECK	DB			

LDN_GSD GLDR_LDN.GDT 07-12-18 16:49



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BH-204	2	42.2	22.9	19.4

PROJECT
PRELIMINARY GEOTECHNICAL ASSESSMENT
ADELAIDE STREET NORTH WIDENING FROM
FANSHAWE PARK ROAD EAST
TO SUNNINGDALE ROAD EAST, LONDON, ONTARIO

TITLE
PLASTICITY CHART

GOLDER

PROJECT No.		1898273	FILE No.	1898273-1000-R01008
			SCALE N/A	REV.
DRAWN	AMS	Dec 17/18	**FIGURE 8**	
CHECK	DB			

LDN_PI GLDR_LON.GDT 07-12-18 16:54

APPENDIX A

Records of Previous Borehole Sheets

PROJECT: 06-1130-092

RECORD OF BOREHOLE 1

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

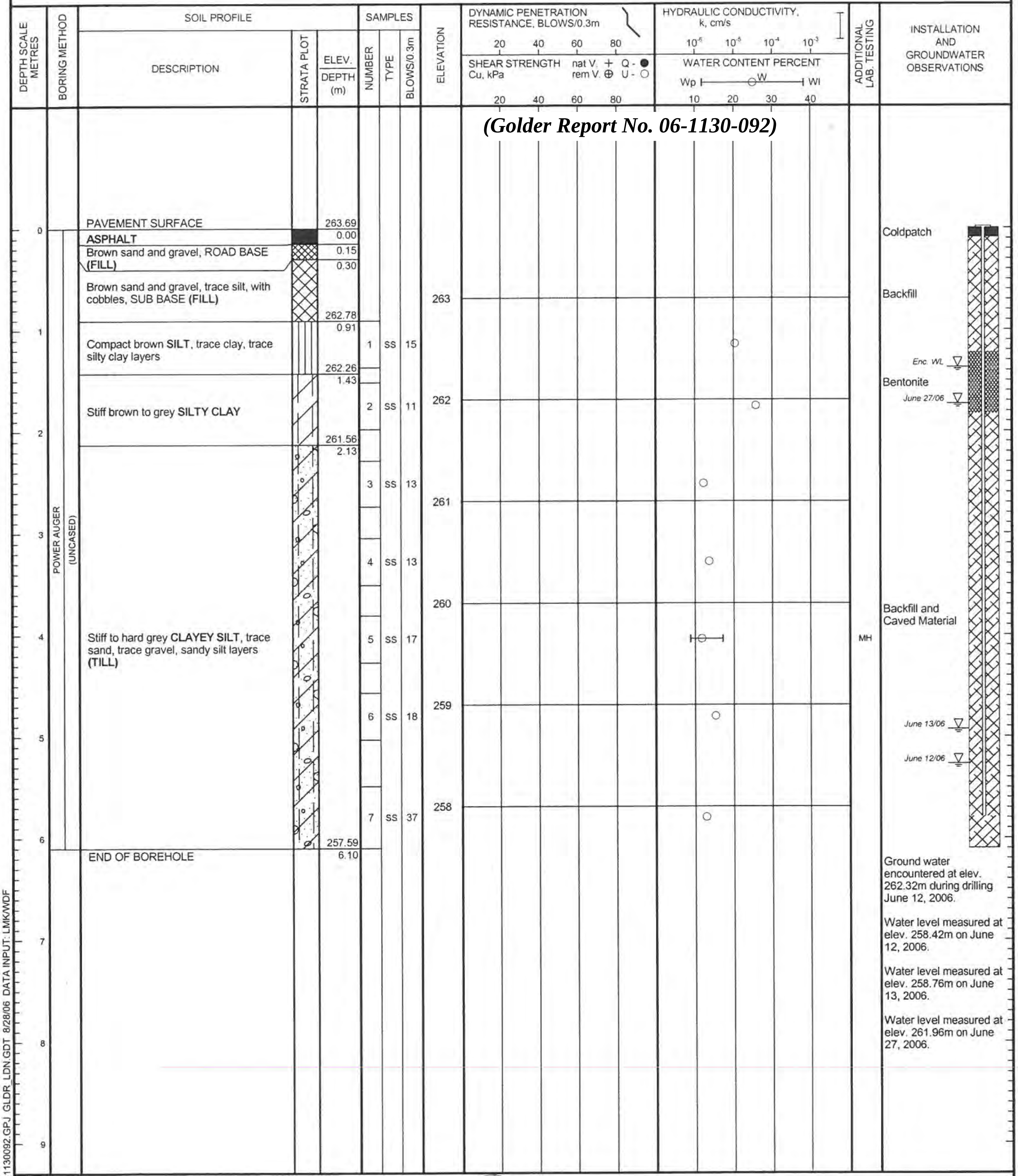
BORING DATE: June 12, 2006

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

(Golder Report No. 06-1130-092)



DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
PAVEMENT SURFACE	263.69				
ASPHALT	0.00				
Brown sand and gravel, ROAD BASE **(FILL)**	0.15				
Brown sand and gravel, trace silt, with cobbles, SUB BASE **(FILL)**	0.30				
Compact brown **SILT**, trace clay, trace silty clay layers	262.78 0.91	1	SS	15	
Stiff brown to grey **SILTY CLAY**	262.26 1.43	2	SS	11	
Stiff to hard grey **CLAYEY SILT**, trace sand, trace gravel, sandy silt layers **(TILL)**	261.56 2.13	3	SS	13	
		4	SS	13	
		5	SS	17	MH
		6	SS	18	
		7	SS	37	
END OF BOREHOLE	257.59 6.10				

Ground water encountered at elev. 262.32m during drilling June 12, 2006.

Water level measured at elev. 258.42m on June 12, 2006.

Water level measured at elev. 258.76m on June 13, 2006.

Water level measured at elev. 261.96m on June 27, 2006.

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: GAA
CHECKED:

PROJECT: 06-1130-092

RECORD OF BOREHOLE 2

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

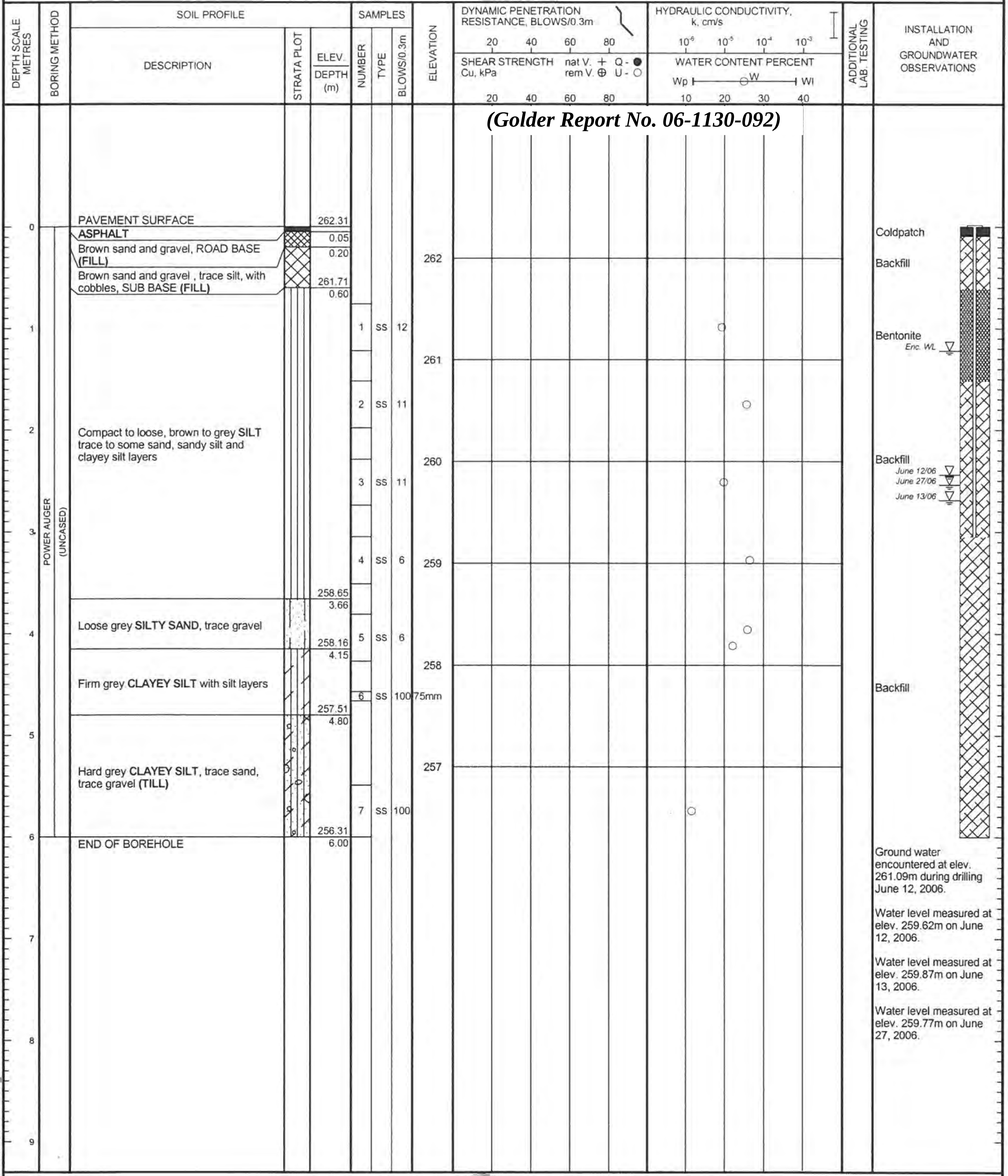
BORING DATE: June 12, 2006

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

(Golder Report No. 06-1130-092)



DESCRIPTION	ELEV. DEPTH (m)
PAVEMENT SURFACE	262.31
ASPHALT	0.05
Brown sand and gravel, ROAD BASE **(FILL)**	0.20
Brown sand and gravel , trace silt, with cobbles, SUB BASE **(FILL)**	261.71 0.60
Compact to loose, brown to grey **SILT** trace to some sand, sandy silt and clayey silt layers	258.65 3.66
Loose grey **SILTY SAND**, trace gravel	258.16 4.15
Firm grey **CLAYEY SILT** with silt layers	257.51 4.80
Hard grey **CLAYEY SILT**, trace sand, trace gravel **(TILL)**	256.31 6.00
END OF BOREHOLE	

NUMBER	TYPE	BLOWS/0.3m
1	SS	12
2	SS	11
3	SS	11
4	SS	6
5	SS	6
6	SS	100/75mm
7	SS	100

Ground water encountered at elev. 261.09m during drilling June 12, 2006.

Water level measured at elev. 259.62m on June 12, 2006.

Water level measured at elev. 259.87m on June 13, 2006.

Water level measured at elev. 259.77m on June 27, 2006.

DEPTH SCALE

1 : 50

LOGGED: GAA

CHECKED:

LDN_BHS 061130092.GPJ GLDR_LDN.GDT 8/28/06 DATA INPUT: LMK/WDF

PROJECT: 06-1130-092

RECORD OF AUGERHOLE 3

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: June 16, 2006

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

(Golder Report No. 06-1130-092)

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 10 20 30 40

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ELEVATION	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	POWER AUGER (UNCASED)	PAVEMENT SURFACE		259.70						
		ASPHALT		0.00						
		Brown sand and gravel, ROAD BASE **(FILL)**		0.11 0.25	1	AS	-			
1		Brown sand and gravel, trace silt, with cobbles, SUB BASE **(FILL)**		258.30 1.40				259		Augerhole dry during drilling June 16, 2006
		Grey **SILT**, trace sand, some topsoil, trace gravel		257.95 1.75				258		
2		Brown **SILT**, trace clay		257.42 2.28						
		END OF AUGERHOLE								
3										
4										
5										
6										
7										
8										
9										

LDN_BHS 061130092.GPJ GLDR_LDN.GDT 8/28/06 DATA INPUT: LMK/WDF

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: GAA
CHECKED:

PROJECT: 06-1130-092

RECORD OF BOREHOLE 4

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: June 12, 2006

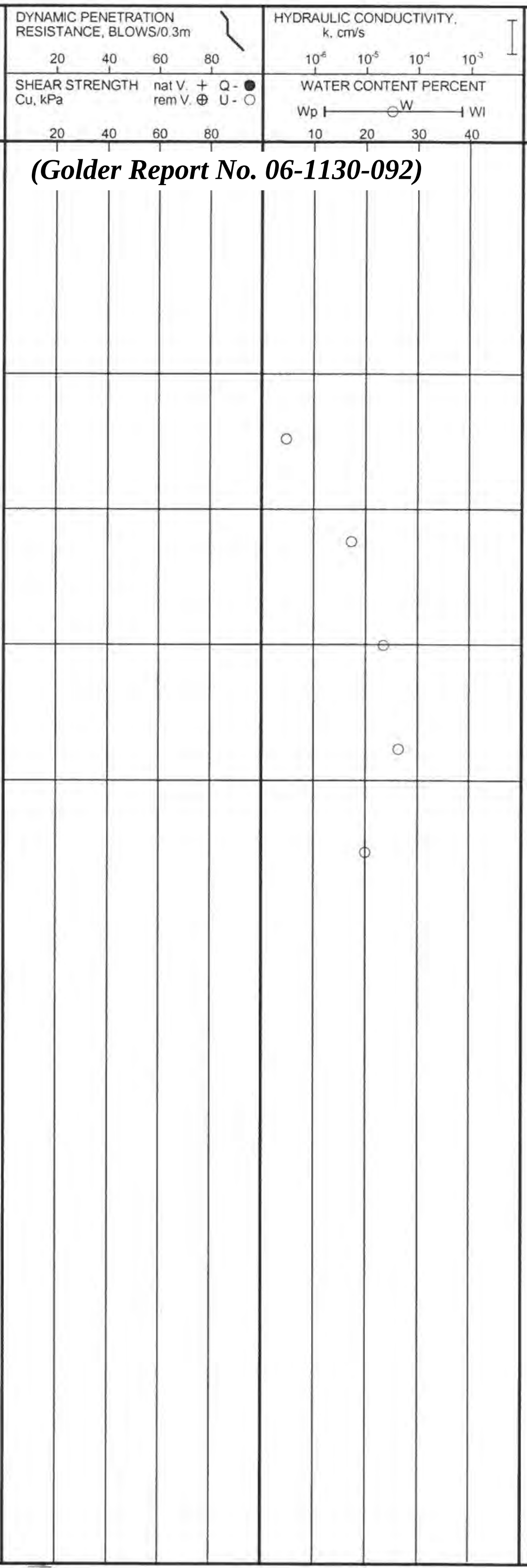
DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

(Golder Report No. 06-1130-092)

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ELEVATION	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	POWER AUGER UNCASED	PAVEMENT SURFACE	254.51					
		ASPHALT	0.00					
		Brown sand and gravel, ROAD BASE **(FILL)**	0.09					
		Compact brown sand and gravel, trace silt, with cobbles, SUB BASE **(FILL)**	0.24				254	
1			253.38 1.13	1	SS	27		
		Compact brown **SILT**, some sand		2	SS	10	253	
2			252.38 2.13					∇
		Compact to loose brown fine to medium **SAND to SILTY FINE SAND**		3	SS	14	252	Ground water encountered at elev. 252.53m during drilling June 12, 2006.
3				4	SS	9	251	
			250.85 3.66					
4		Compact brown **SILT**, trace clay		5	SS	11		
		END OF BOREHOLE	250.24 4.27					
5								
6								
7								
8								
9								



DEPTH SCALE
1 : 50

LOGGED: GAA
CHECKED:

PROJECT: 06-1130-092

RECORD OF BOREHOLE 5 & DPT1

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

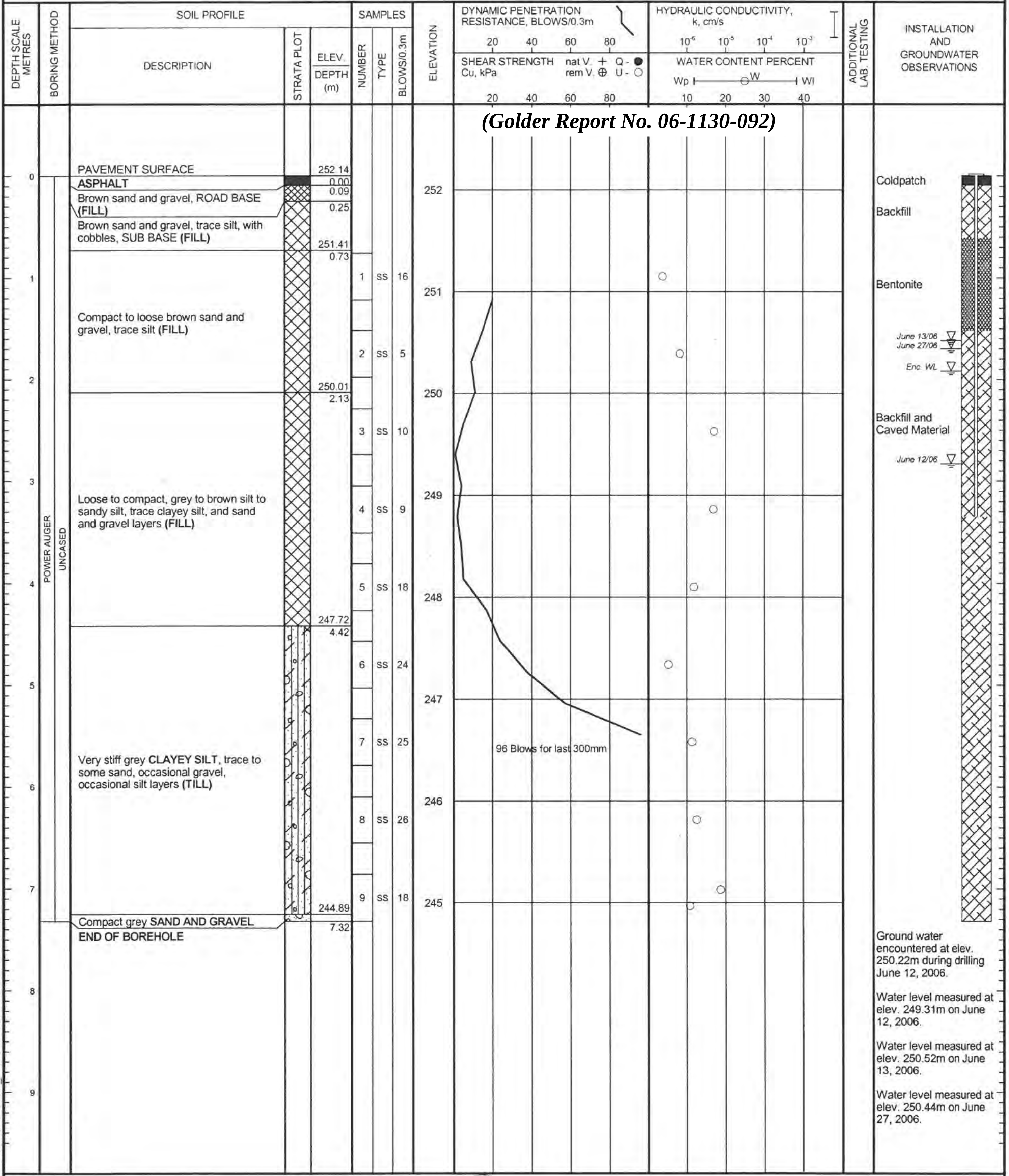
BORING DATE: June 12, 2006

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

(Golder Report No. 06-1130-092)



DESCRIPTION	ELEV. / DEPTH (m)
PAVEMENT SURFACE	252.14
ASPHALT	0.00
Brown sand and gravel, ROAD BASE **(FILL)**	0.09
Brown sand and gravel, trace silt, with cobbles, SUB BASE **(FILL)**	0.25
Compact to loose brown sand and gravel, trace silt **(FILL)**	251.41 0.73
Loose to compact, grey to brown silt to sandy silt, trace clayey silt, and sand and gravel layers **(FILL)**	250.01 2.13
Very stiff grey **CLAYEY SILT**, trace to some sand, occasional gravel, occasional silt layers **(TILL)**	247.72 4.42
Compact grey **SAND AND GRAVEL**	244.89 7.32
END OF BOREHOLE	

NUMBER	TYPE	BLOWS/0.3m
1	SS	16
2	SS	5
3	SS	10
4	SS	9
5	SS	18
6	SS	24
7	SS	25
8	SS	26
9	SS	18

Ground water encountered at elev. 250.22m during drilling June 12, 2006.

Water level measured at elev. 249.31m on June 12, 2006.

Water level measured at elev. 250.52m on June 13, 2006.

Water level measured at elev. 250.44m on June 27, 2006.

DEPTH SCALE
1 : 50

LOGGED: GAA
CHECKED:

PROJECT: 06-1130-092

RECORD OF AUGERHOLE 6

SHEET 1 OF 1

LOCATION: REFER TO LOCATION PLAN

BORING DATE: June 16, 2006

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg; DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

(Golder Report No. 06-1130-092)

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	POWER AUGER (UNCASED)	PAVEMENT SURFACE		252.79								
		ASPHALT		0.00								
		Brown sand and gravel, ROAD BASE **(FILL)**		0.10 0.18								
		Brown sand and gravel, trace silt, with cobbles, SUB BASE **(FILL)**		252.26 0.53								Augerhole dry during drilling June 16, 2006
								252				
1		Brown **SILT**			1	AS	-			○		
				251.09								
		END OF AUGERHOLE		1.70								
2												
3												
4												
5												
6												
7												
8												
9												

LDN_BHS 061130092.GPJ GLDR_LDN.GDT 8/28/06 DATA INPUT: LMK/WDF

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: GAA
CHECKED:

RECORD OF BOREHOLE 101

SHEET 1

LOCATION - See Figure 2
BORING DATE May 30, 1988
DATUM Geodetic
SAMPLER HAMMER, 63.5kg, DROP, 760mm
PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

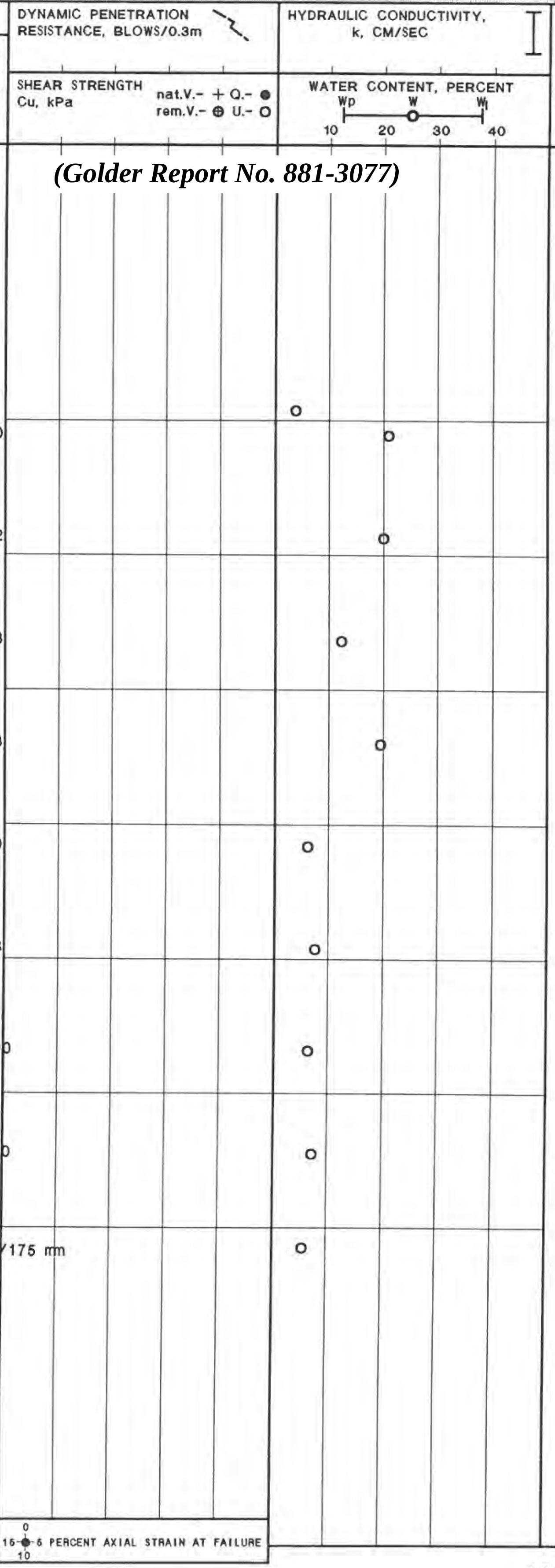
PROJECT 881-3077

(Golder Report No. 881-3077)

BORING METHOD: Power Auger 115 mm Dia. (UNCASED)

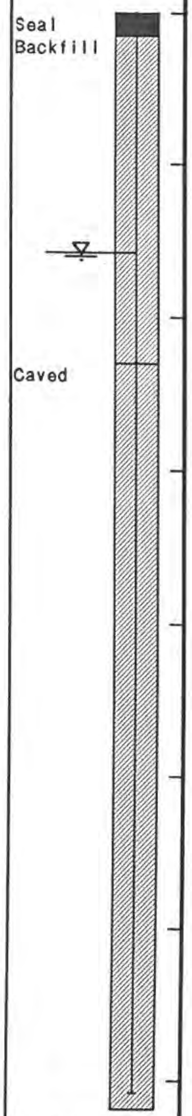
SOIL PROFILE DESCRIPTION	ELEV. DEPTH (M)
PAVEMENT SURFACE	253.88
ASPHALT	0.11
Compact brown sand and gravel (ROADBASE)	253.03 0.85
Compact brown sandy silt some topsoil occ. gravel (FILL)	252.51 1.37
Compact brown SILT	251.75 2.13
Stiff brown CLAYEY SILT trace sand occ. gravel (TILL)	250.98 2.90
Very dense grey SANDY SILT trace clay occ. gravel & cobbles (TILL) with layers of silty fine sand & silty clay above elev. 250.2 m.	246.69
END OF BOREHOLE	7.19

SAMPLES NUMBER	TYPE	BLOWS/0.3M
1	50 DO	10
2	50 DO	12
3	50 DO	13
4	50 DO	58
5	50 DO	70
6	50 DO	68
7	50 DO	100
8	50 DO	100
9	50 DO	69/175 mm



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



WL ENCOUNTERED AT ELEV. 252.20 DURING DRILLING MAY 30, 1988

WL IN STANDPIPE AT ELEV. 252.30 JUNE 1, 1988

DEPTH SCALE
1 : 50

Golder Associates

LOGGED M.M.H.
CHECKED KS

RECORD OF BOREHOLE 102

SHEET 1

LOCATION - See Figure 2

BORING DATE May 30, 1988

DATUM Geodetic

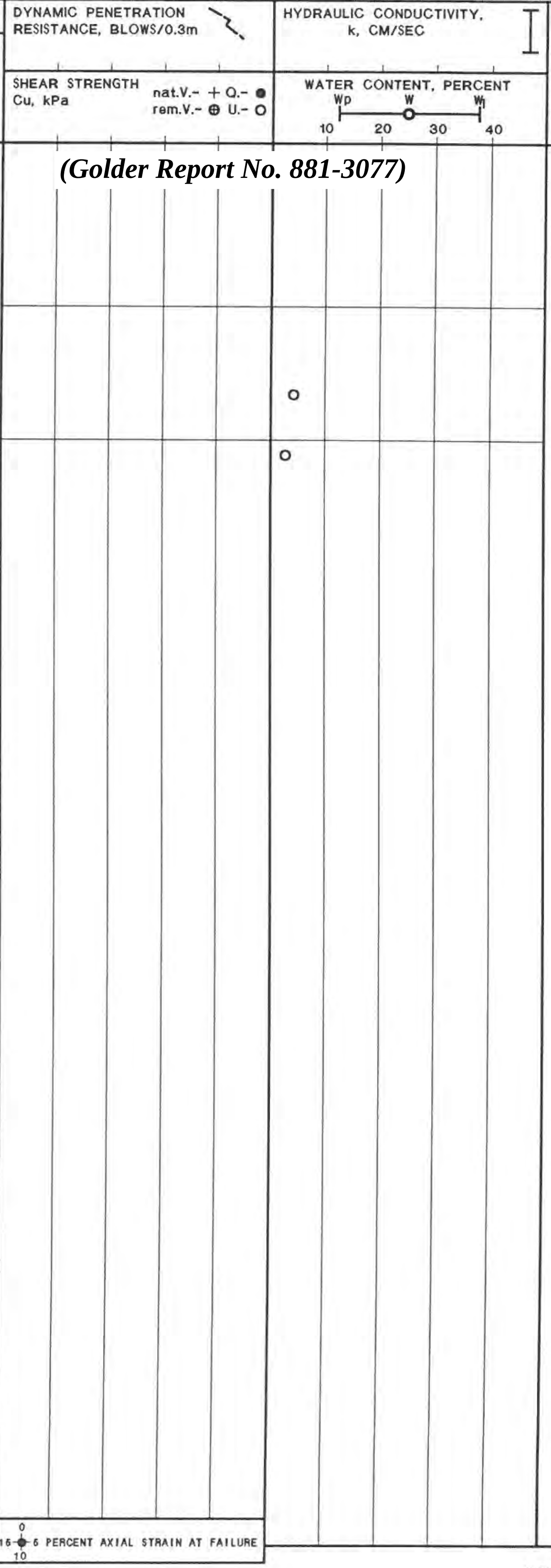
SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 881-3077

(Golder Report No. 881-3077)

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES: NUMBER	TYPE	BLOWS/0.3M	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		PAVEMENT SURFACE		253.03					
	Power Auger (UNCASED)	ASPHALT	■	0.10					
		Compact brown sand and gravel (ROADBASE)	▨		1	50 DO	27		BOREHOLE DRY DURING DRILLING MAY 30, 1988
1				251.66	2	50 DO	14		
		END OF BOREHOLE		1.37					
2									
3									
4									
5									
6									
7									
8									
9									



DEPTH SCALE

1 : 50

Golder Associates

LOGGED M.M.H.

CHECKED KS

RECORD OF BOREHOLE 103

SHEET 1

LOCATION - See Figure 2
BORING DATE May 30, 1988
DATUM Geodetic

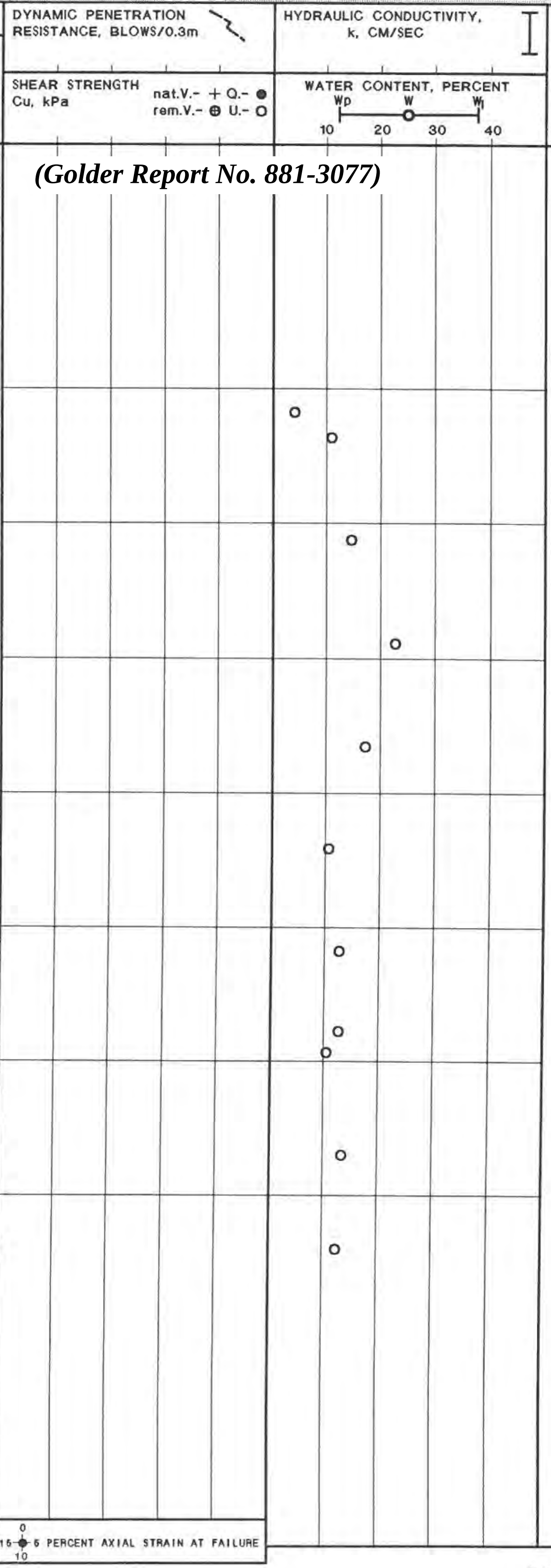
SAMPLER HAMMER, 63.5kg, DROP, 760mm
PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 881-3077

(Golder Report No. 881-3077)

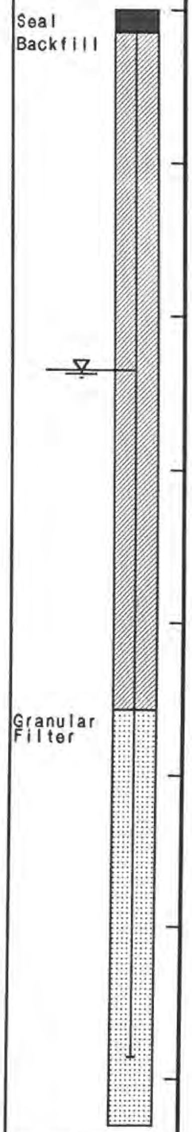
BORING METHOD: Power Auger 115 mm Dia. (UNCASED)

DESCRIPTION	ELEV. DEPTH (M)	NUMBER	TYPE	BLOWS/0.3M
PAVEMENT SURFACE	252.63			
ASPHALT	0.10			
Compact brown sand and gravel (ROADBASE)	251.78 0.85			
Loose brown sandy silt some topsoil occ. gravel (FILL)	251.26 1.37	1	50 DO	9
Loose brown SANDY SILT with layers of silty sand and clayey silt	250.50 2.13	2	50 DO	6
Compact brown fine SAND trace silt occ. gravel	249.73 2.90	3	50 DO	12
Loose grey SANDY SILT trace clay	248.97 3.66	4	50 DO	8
Very stiff to hard grey CLAYEY SILT trace sand occ. gravel (TILL)	247.14 5.49	5	50 DO	22
		6	50 DO	16
Dense grey SILT trace clay	246.72 5.91	7	50 DO	34
Very stiff to hard grey SILTY CLAY trace sand occ. gravel (TILL)	245.32 7.31	8	50 DO	42
		9	50 DO	26
END OF BOREHOLE				



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



WL ENCOUNTERED AT ELEV. 250.34 DURING DRILLING MAY 30, 1988

WL IN STANDPIPE AT ELEV. 250.28 JUNE 1, 1988

DEPTH SCALE
1 : 50

Golder Associates

LOGGED M.M.H.
CHECKED KT

RECORD OF BOREHOLE 104

SHEET 1

LOCATION - See Figure 2

BORING DATE May 30, 1988

DATUM Geodetic

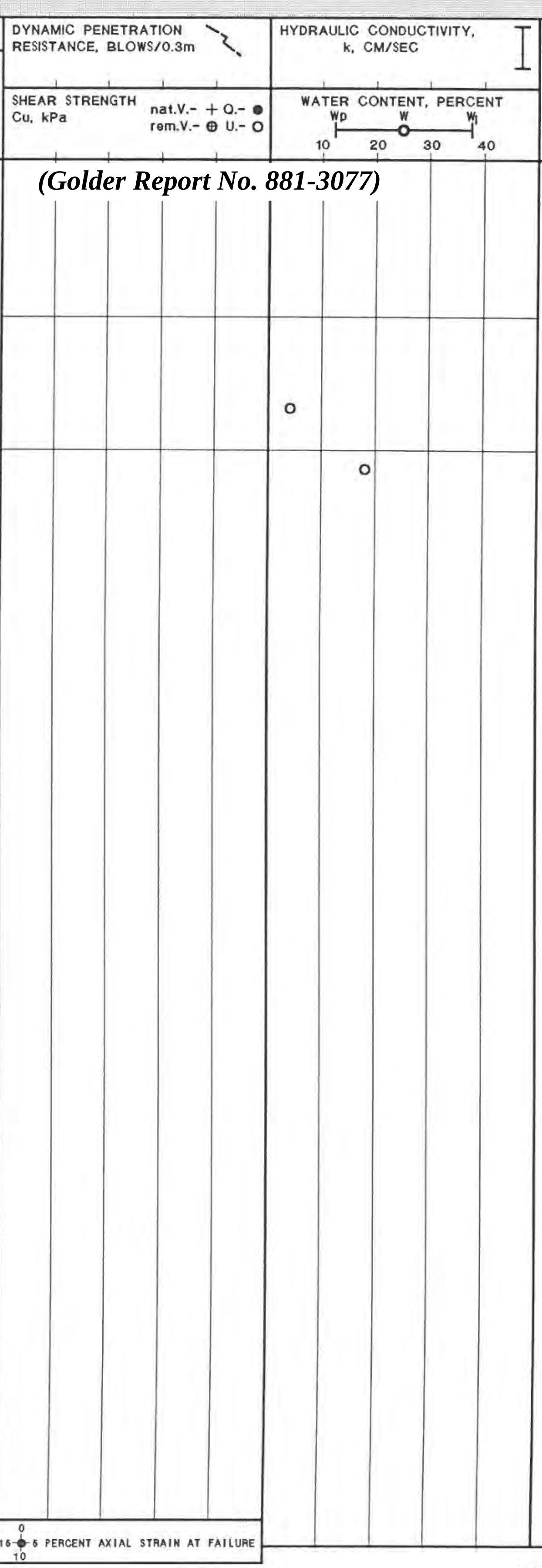
SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm

PROJECT 881-3077

(Golder Report No. 881-3077)

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	SAMPLES NUMBER	TYPE	BLOWS/0.3M	PIEZOMETER OR STANDPIPE INSTALLATION
0		ASPHALT PAVEMENT SURFACE		252.00				
	Power Auger (UNCASED)			0.08				
		Dense brown sand and gravel (ROADBASE)		251.09 0.91	1	50 DO	35	BOREHOLE DRY DURING DRILLING MAY 30, 1988
1		Compact brown SILTY SAND occ. rootlets and topsoil pockets		250.63 1.37	2	50 DO	18	
		END OF BOREHOLE						
2								
3								
4								
5								
6								
7								
8								
9								



DEPTH SCALE

1 : 50

Golder Associates

LOGGED M.M.H.

CHECKED KS

RECORD OF BOREHOLES 6 & 7

LOCATION See Figure 1 — BORING DATE JUNE 11, 1974 — DATUM GEODETIC

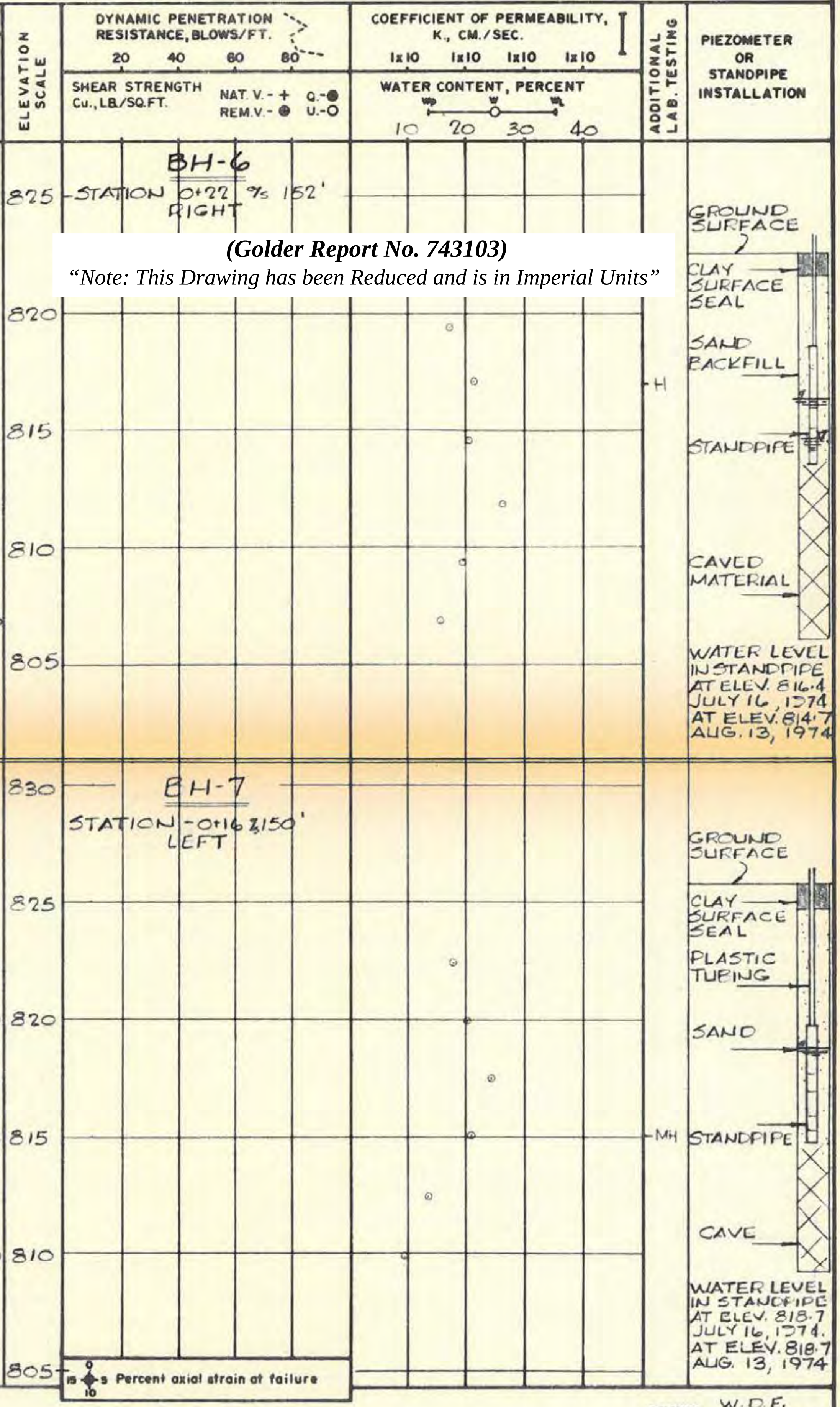
SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN. — PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

(Golder Report No. 743103)

"Note: This Drawing has been Reduced and is in Imperial Units"

BORING METHOD	SOIL PROFILE			SAMPLES		
	ELEV'N. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.
	822.7	GROUND LEVEL				
POWER AUGER 4.5" DIA. (UNCASED)	0.0	GRANULAR FILL				
	0.7 818.2	COMPACT BROWN FINE TO MEDIUM SAND TRACE SILT (FILL)		1	"	11
	4.5 815.7	LOOSE BROWN SILT TRACE FINE SAND AND CLAY		2	"	9
	7.0 810.2	COMPACT BROWN FINE TO MEDIUM SAND TRACE SILT OCCASIONAL GRAVEL		3 4	" "	19 21
	12.5 808.2	COMPACT GREY SILT SOME SAND		5	"	12
	14.5 806.2	VERY STIFF GREY SILTY CLAY TILL		6	"	25
	16.5	END OF HOLE				

BORING METHOD	SOIL PROFILE			SAMPLES		
	ELEV'N. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT.
	825.7	GROUND LEVEL				
POWER AUGER 4.5" DIA. (UNCASED)	0.0	GRANULAR FILL				
	0.5 821.2	COMPACT BROWN SILTY FINE SAND TRACE CLAY		1	2" D.O.	18
	4.5 818.7	COMPACT BROWN SILT SOME SAND		2	"	20
	7.0 813.7	COMPACT BROWN SILTY SAND OCCASIONAL GRAVEL AND CLAYEY SILT POCKETS		3 4	" "	18 23
	12.0 810.2	COMPACT GREY SILT SOME SAND OCC. POCKETS OF SILTY CLAY		5	"	12
	15.5			6	"	60
	16.5	END OF HOLE HARD GREY CLAYEY SILT OCC. SAND AND GRAVEL (TILL)				



VERTICAL SCALE
1 IN. TO 6 FT.

Golder Associates

DRAWN W. D. F.
CHECKED

RECORD OF BOREHOLES 8, 9 & 10

LOCATION See Figure 1 & 3 **BORING DATE** JUNE 11 & 12, 1974. **DATUM** GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN. **PENETRATION TEST HAMMER WEIGHT** 140 LB., DROP 30 IN.

(Golder Report No. 743103)

"Note: This Drawing has been Reduced and is in Imperial Units"

BH-8

STATION 1+87 ½ 20' LEFT.

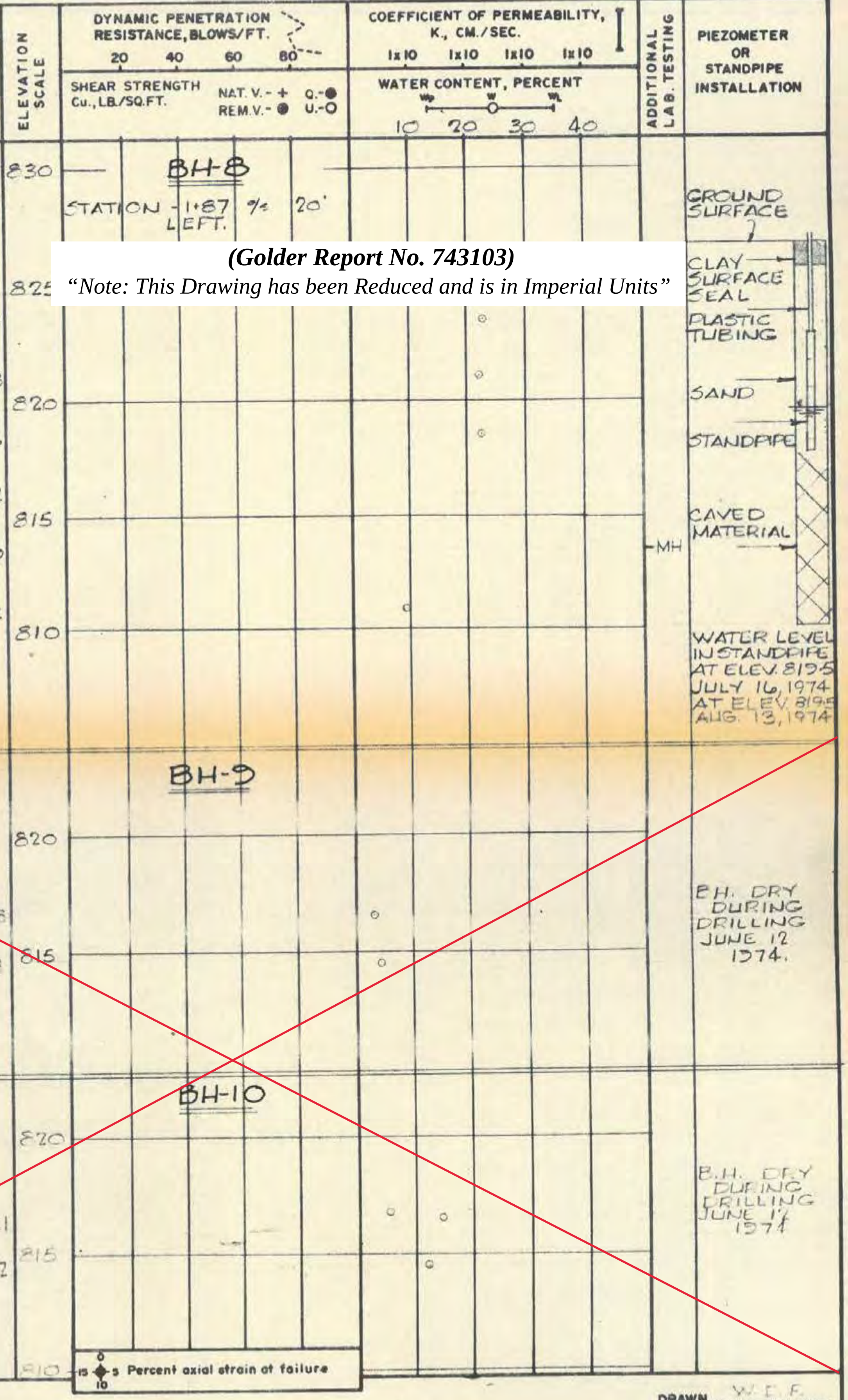
BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
	826.6	GROUND LEVEL			
POWER AUGER 4.5" DIA. (UNCASED)	0.0	GRANULAR FILL			
	0.9	COMPACT BROWN SANDY SILT POCKETS OF SILTY CLAY (FILL)	1	2" D.O.	10
	822.1 4.5	COMPACT BROWN FINE SAND SOME SILT	2	"	23
			3	"	26
	817.1 9.5	COMPACT BROWN SILT SOME SAND	4	"	24
	814.6 12.0	COMPACT GREY SANDY SILT TILL	5	"	29
	812.1 14.5	HARD GREY CLAYEY SILT TILL	6	"	32
	810.1 16.5	END OF HOLE			

BH-9

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
	818.6	ROAD SURFACE ASPHALT			
P.A. UNCASED	0.3	DENSE TO LOOSE BROWN SILTY SAND AND GRAVEL ROAD-BASE (FILL)	1	2" D.O.	38
			2	"	8
	813.6 5.0	END OF HOLE			

BH-10

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
	818.0	ROAD SURFACE			
P.A. UNCASED	0.0	ASPHALT			
	0.5	ROAD BASE			
	1.5	SANDY SILT FILL	1	2" D.O.	21
	2.5	COMPACT SAND SOME SILT (FILL)	2	"	12
	813.5 4.5	END OF HOLE			



BH-8: WATER LEVEL IN STANDPIPE AT ELEV. 819.5 JULY 16, 1974 AT ELEV. 819.5 AUG. 13, 1974

BH-9: B.H. DRY DURING DRILLING JUNE 12 1974.

BH-10: B.H. DRY DURING DRILLING JUNE 11 1974

VERTICAL SCALE 1 IN. TO 5 FT.

Golder Associates

DRAWN W.E.F.
CHECKED DKM

RECORD OF BOREHOLES 19 TO 22

LOCATION See Figure 3 BORING DATE JUNE 12, 1974 DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN. PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

BH-19

BORING METHOD	ELEV'N. / DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	PIEZOMETER OR STANDPIPE INSTALLATION
	829.8	ROAD SURFACE				
P. A. UNCASED	0.0	ASPHALT				B.H. DRY DURING DRILLING JUNE 12, 1974.
	0.6	ROAD BASE				
	1.5	DENSE BROWN SAND & GRAVEL (FILL)	1	2" D.O.	34	
	826.3 3.5	COMPACT BROWN SILTY FINE SAND	2	"	16	
	824.3 5.5	END OF HOLE				

BH-20

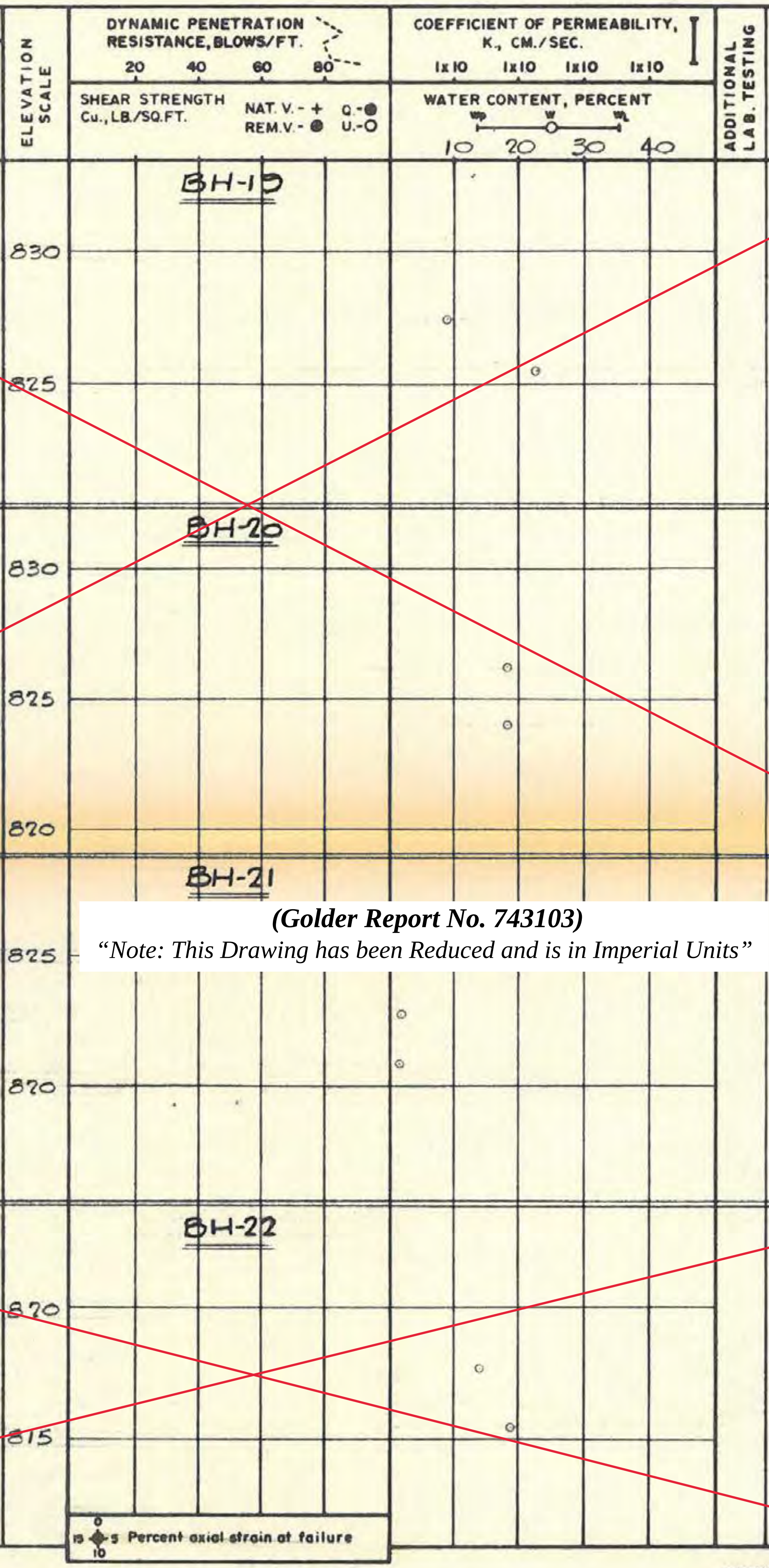
BORING METHOD	ELEV'N. / DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	PIEZOMETER OR STANDPIPE INSTALLATION
	828.5	ROAD SURFACE				
P. A. UNCASED	0.0	ASPHALT				B.H. DRY DURING DRILLING JUNE 12, 1974
	0.6	ROAD BASE				
	1.5	COMPACT BROWN SILTY FINE SAND	1	2" D.O.	22	
			2	"	29	
	823.0 5.5	END OF HOLE				

BH-21

BORING METHOD	ELEV'N. / DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	PIEZOMETER OR STANDPIPE INSTALLATION
	825.1	ROAD SURFACE ASPHALT				
P. A. UNCASED	0.2	SAND & GRAVEL				B.H. DRY DURING DRILLING JUNE 12, 1974
	823.6	ROAD BASE				
	1.5	COMPACT BROWN SILTY SAND AND GRAVEL	1	2" D.O.	25	
			2	"	17	
	819.6 5.5	END OF HOLE				

BH-22

BORING METHOD	ELEV'N. / DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	PIEZOMETER OR STANDPIPE INSTALLATION
	819.8	ROAD SURFACE				
P. A. UNCASED	0.0	ASPHALT				B.H. DRY DURING DRILLING JUNE 12, 1974
	0.6	ROAD BASE				
	1.5	COMPACT BROWN SAND TRACE SILT	1	2" D.O.	18	
			2	"	23	
	814.3 5.5	END OF HOLE				



(Golder Report No. 743103)

"Note: This Drawing has been Reduced and is in Imperial Units"

VERTICAL SCALE
1 IN. TO 5 FT.

Golder Associates

DRAWN H.D.A.
CHECKED DYM

RECORD OF BOREHOLES 23 TO 26

LOCATION See Figure 3 BORING DATE JUNE 12 & 13, 1974 DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN. PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

(Golder Report No. 743103)

"Note: This Drawing has been Reduced and is in Imperial Units"

BH-23

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE	PIEZOMETER OR STANDPIPE INSTALLATION
						820	
	817.5	ROAD SURFACE					
P. A. UNCASED	0.0	ASPHALT					
	0.4	ROAD BASE					
	1.5	LOOSE BROWN FINE TO MEDIUM SAND SOME SILT POCKETS OF TOPSOIL (FILL)	1	2" O.D.	8	815	B.H. DRY DURING DRILLING JUNE 12, 1974
	812.5		2	"	6		
	5.0	SILTY TOPSOIL					
	5.5	END OF HOLE					
						810	

BH-24

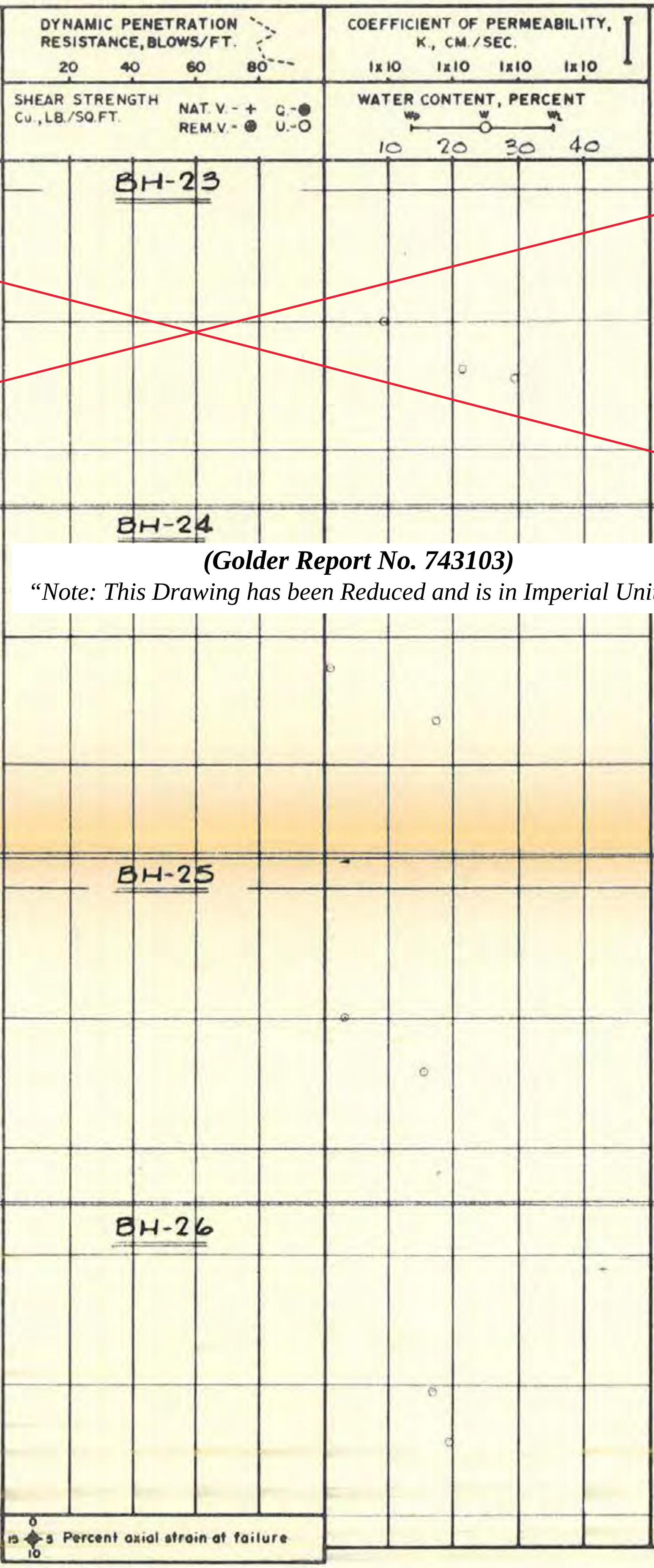
BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE	PIEZOMETER OR STANDPIPE INSTALLATION
		ASPHALT					
	826.2	ROAD SURFACE					
F. A. UNCASED	0.2	VERY DENSE TO COMPACT BROWN SAND AND GRAVEL (ROAD BASE)				825	
	822.7		1	2" O.D.	19		B.H. DRY DURING DRILLING JUNE 13, 1974
	3.5	COMPACT BROWN FINE TO MEDIUM SAND	2	"	19		
	820.7						
	5.5	END OF HOLE				820	

BH-25

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE	PIEZOMETER OR STANDPIPE INSTALLATION
						830	
		ASPHALT					
	827.7	ROAD SURFACE					
F. A. UNCASED	0.1	VERY DENSE BROWN SAND AND GRAVEL (ROAD BASE)	1	2" O.D.	55	825	B.H. DRY DURING DRILLING JUNE 13, 1974
	824.2						
	3.5	DENSE BROWN FINE TO MEDIUM SAND	2	"	36		
	822.2						
	5.5	END OF HOLE					
						820	

BH-26

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE	PIEZOMETER OR STANDPIPE INSTALLATION
						830	
		ASPHALT					
	827.9	ROAD SURFACE					
F. A. UNCASED	0.1	VERY DENSE SAND & GRAVEL (ROAD BASE)					
	825.9						
	2.0	LOOSE TO COMPACT BROWN FINE TO MEDIUM SAND TRACE SILT	1	2" O.D.	9	825	B.H. DRY DURING DRILLING JUNE 13, 1974
			2	"	18		
	821.9						
	6.0	END OF HOLE					
						820	



ADDITIONAL LAB. TESTING

VERTICAL SCALE
1 IN. TO 5 FT.

Golder Associates

DRAWN HDF.
CHECKED DGM

RECORD OF BOREHOLES 27 To 29

LOCATION See Figure 3

BORING DATE JUNE 13, 1974.

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

(Golder Report No. 743103)

"Note: This Drawing has been Reduced and is in Imperial Units"

BH-27

BORING METHOD	ELEV'N DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
	826.6	ASPHALT ROAD SURFACE			
P. A. UNCASED	0.1 825.1	SAND & GRAVEL (ROAD BASE)			
	1.5 822.6	COMPACT SILTY SAND AND GRAVEL (FILL)	1	2" D.O.	11
	4.0 820.6	COMPACT FINE TO MEDIUM SAND	2	"	29
	6.0	END OF HOLE			

PIEZOMETER OR STANDPIPE INSTALLATION: B.H. DRY DURING DRILLING JUNE 13, 1974

BH-28

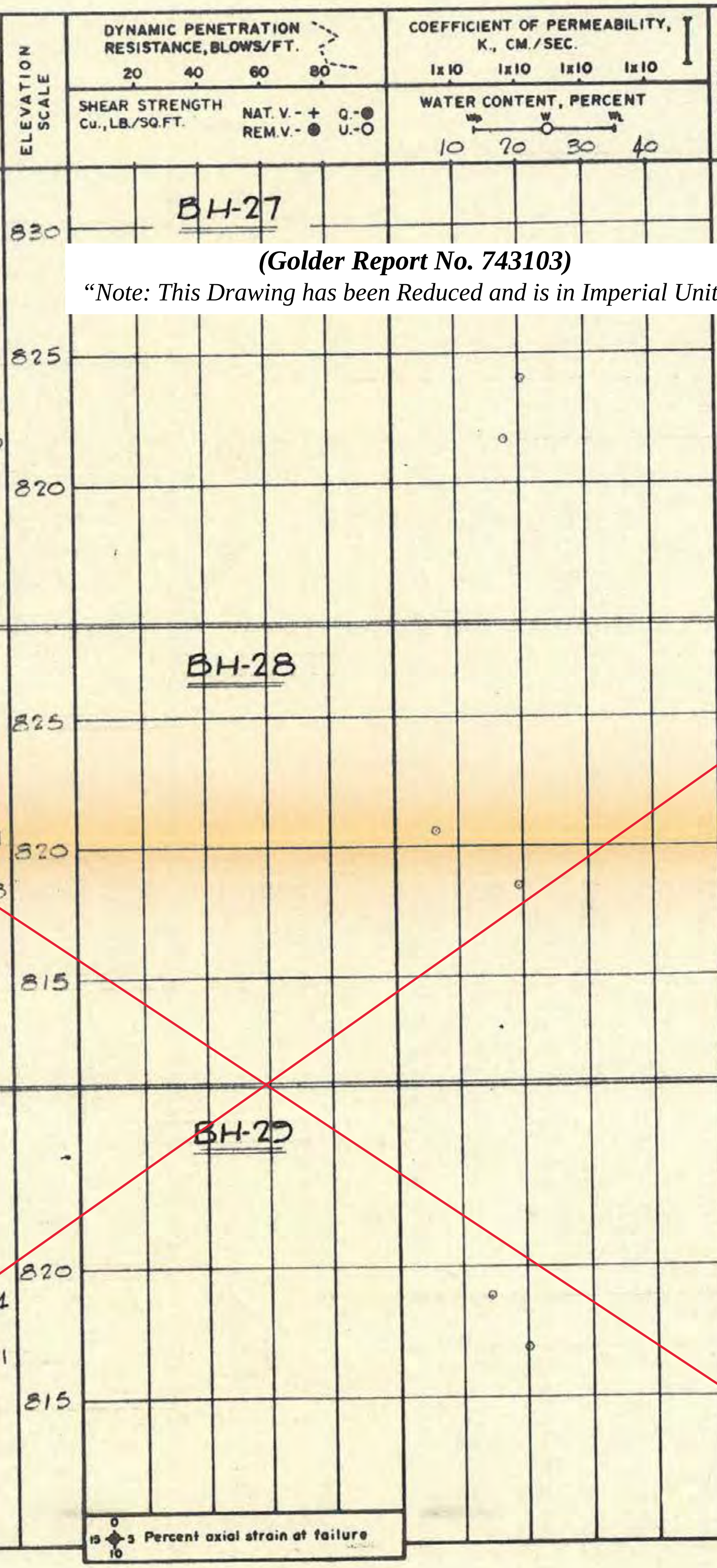
BORING METHOD	ELEV'N DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
	823.0	ASPHALT ROAD SURFACE			
P. A UNCASED	0.2 821.5	SAND & GRAVEL (ROAD BASE)			
	1.5 817.5	COMPACT BROWN FINE TO MEDIUM SAND	1	2" D.O.	11
			2	"	18
	5.5	END OF HOLE			

PIEZOMETER OR STANDPIPE INSTALLATION: B.H. DRY DURING DRILLING JUNE 13, 1974

BH-29

BORING METHOD	ELEV'N DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
	821.3	ASPHALT ROAD SURFACE			
P. A. UNCASED	0.1	CONCRETE			
	0.8 815.8	COMPACT BROWN FINE SAND SOME SILT	1	2" D.O.	14
			2	"	11
	5.5	END OF HOLE			

PIEZOMETER OR STANDPIPE INSTALLATION: B.H. DRY DURING DRILLING JUNE 13, 1974.



VERTICAL SCALE 1 IN. TO 5 FT.

Golder Associates

DRAWN H.D.F.

CHECKED DYM

RECORD OF BOREHOLES 4 & 5

LOCATION See Figure 1

BORING DATE FEB. 15, 1974

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

BORING METHOD | **SOIL PROFILE**: ELEV'N. DEPTH, DESCRIPTION, STRAT. PLOT | **SAMPLES**: NUMBER, TYPE, BLOWS/FT. | **ELEVATION SCALE** | **DYNAMIC PENETRATION RESISTANCE, BLOWS/FT.** 20 40 60 80 | **SHEAR STRENGTH** Cu., LB./SQ.FT. NAT. V. - + Q. - ● REM.V. - ● U. - O | **COEFFICIENT OF PERMEABILITY,** K., CM./SEC. 1x10 1x10 1x10 1x10 | **WATER CONTENT, PERCENT** Wp W WL 10 20 30 40 | **ADDITIONAL LAB. TESTING** | **PIEZOMETER OR STANDPIPE INSTALLATION**

(Golder Report No. 743033)

"Note: This Drawing has been Reduced and is in Imperial Units"

BH-4

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
	815.8	GROUND LEVEL			
POWER AUGER (UNCASED)	0.0 810.8	FIRM TO STIFF BROWN **CLAYEY SILT** SOME SAND	1	2" O.D.	12
	5.0 808.8	LOOSE GREY **SILT** SOME CLAY, SAND	2	"	7
	7.0 806.3	LOOSE GREY **SILTY** FINE **SAND**	3		7
	9.5 804.3	STIFF GREY **CLAYEY SILT** SOME SAND	4		12
	11.5	END OF HOLE			

WATER LEVEL AT EL. 811.3 DURING DRILLING FEB. 15, 1974.

BH-5

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.
	815.8	GROUND LEVEL			
POWER AUGER (UNCASED)	0.0 813.3	**TOPSOIL**			
	2.5 807.8	LOOSE TO VERY LOOSE **SILTY SAND AND GRAVEL**	1 2	2" O.D. "	5 1
	8.0 804.3	COMPACT GREY **SANDY SILT**	3 4	" "	18 17
	11.5	END OF HOLE			

WATER LEVEL AT EL. 812.1 DURING DRILLING FEB. 15, 1974.

15 ◆ 5 Percent axial strain at failure 0 10

VERTICAL SCALE 1 IN. TO 10 FT.

Golder Associates

DRAWN AN - W.C.F.

CHECKED

Form G.A. - D - I

Project No. 73345

RECORD OF BOREHOLES 101 & 102

LOCATION See Figure 1 **BORING DATE** JUNE 27, 1973 **DATUM** GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN. **PENETRATION TEST HAMMER WEIGHT** 140 LB., DROP 30 IN.

(Golder Report No. 73345)

"Note: This Drawing has been Reduced and is in Imperial Units"

BH-101

BORING METHOD	ELEV'N. DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE
	820.8	GROUND LEVEL				
POWER AUGER 4.5" DIA. (UNCASED)	0.0	COMPACT BROWN SILTY FINE SAND				820
	817.3		1	2" O.D.	15	
	3.5	COMPACT GREY SANDY SILT	2	"	12	815
	812.8					
	8.0	HARD GREY CLAYEY SILT SOME SAND OCCASIONAL GRAVEL (TILL)	3	"	26/8"	
			4	"	47	810
			5	"	68	
	804.3		6	"	46	805
	16.5	END OF HOLE				

BH-102

BORING METHOD	ELEV'N. DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE
	822.1	GROUND LEVEL				
POWER AUGER 4.5" DIA. (UNCASED)	0.0	COMPACT BROWN SILTY FINE SAND				820
			1	2" O.D.	18	
			2	"	22	
	815.1					815
	7.0	COMPACT GREY SANDY SILT	3	"	12	
	813.1 9.0	HARD GREY CLAYEY SILT TILL				
	811.6 10.5	VERY DENSE GREY SILTY FINE SAND	4	"	>100	
	810.1 12.0	HARD GREY CLAYEY SILT TILL				810
			5	"	>100	
	807.1 15.0	HARD GREY CLAYEY SILT	6	"	>100	
	805.6					
	16.5	END OF HOLE				805

DYNAMIC PENETRATION RESISTANCE, BLOWS/FT. 20 40 60 80

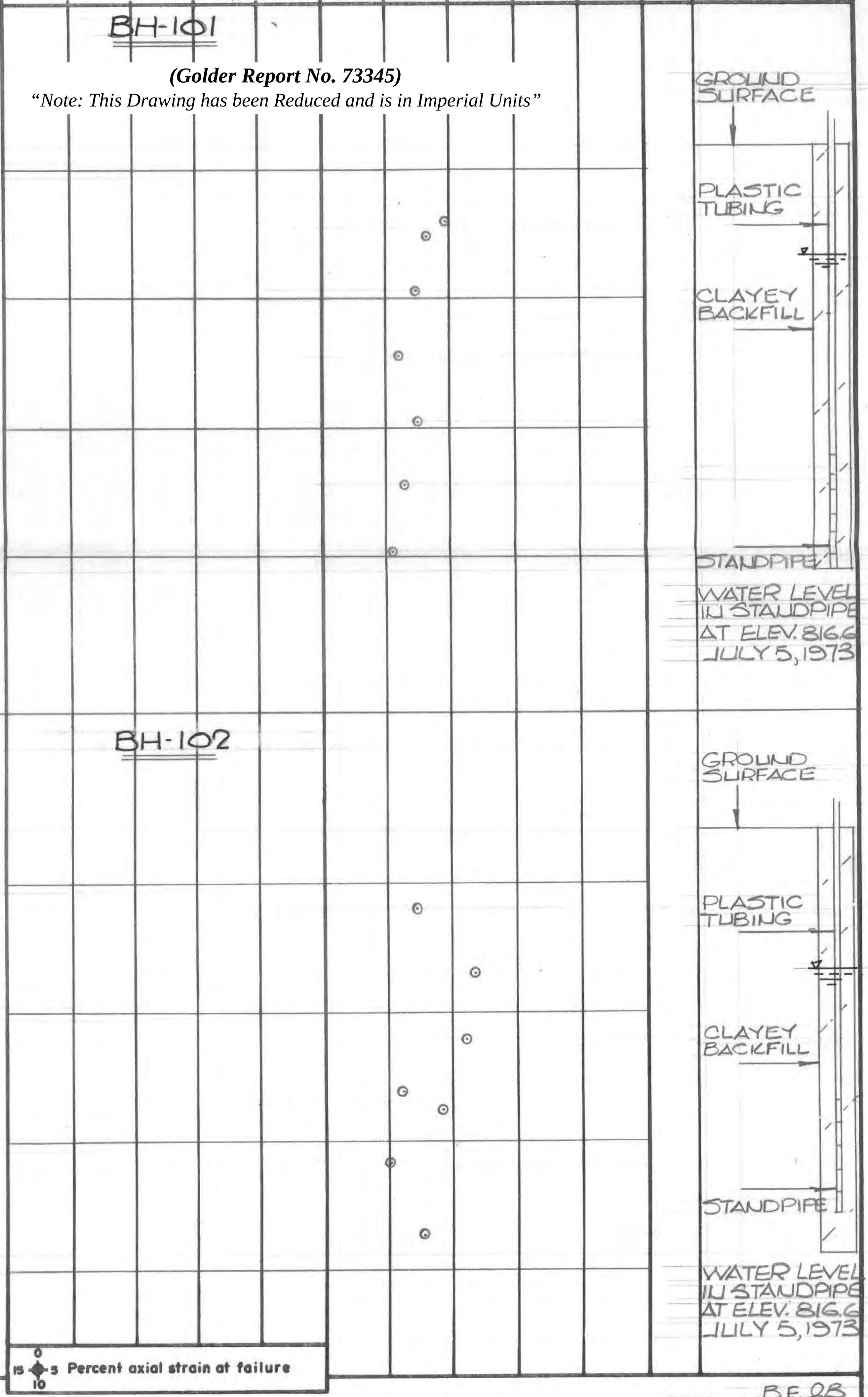
SHEAR STRENGTH Cu., LB./SQ.FT. NAT. V. - + Q. - ● REM.V. - ● U. - O

COEFFICIENT OF PERMEABILITY, K., CM./SEC. 1x10 1x10 1x10 1x10

WATER CONTENT, PERCENT Wp W WL 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



VERTICAL SCALE
1 IN. TO 5 FT.

Golder Associates

DRAWN B.F. 28
CHECKED B

Form G.A. - D - I

Project No. 73345

RECORD OF BOREHOLES 103 & 104

LOCATION See Figure 1 BORING DATE JULY 3, 1973 DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN. PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

(Golder Report No. 73345)

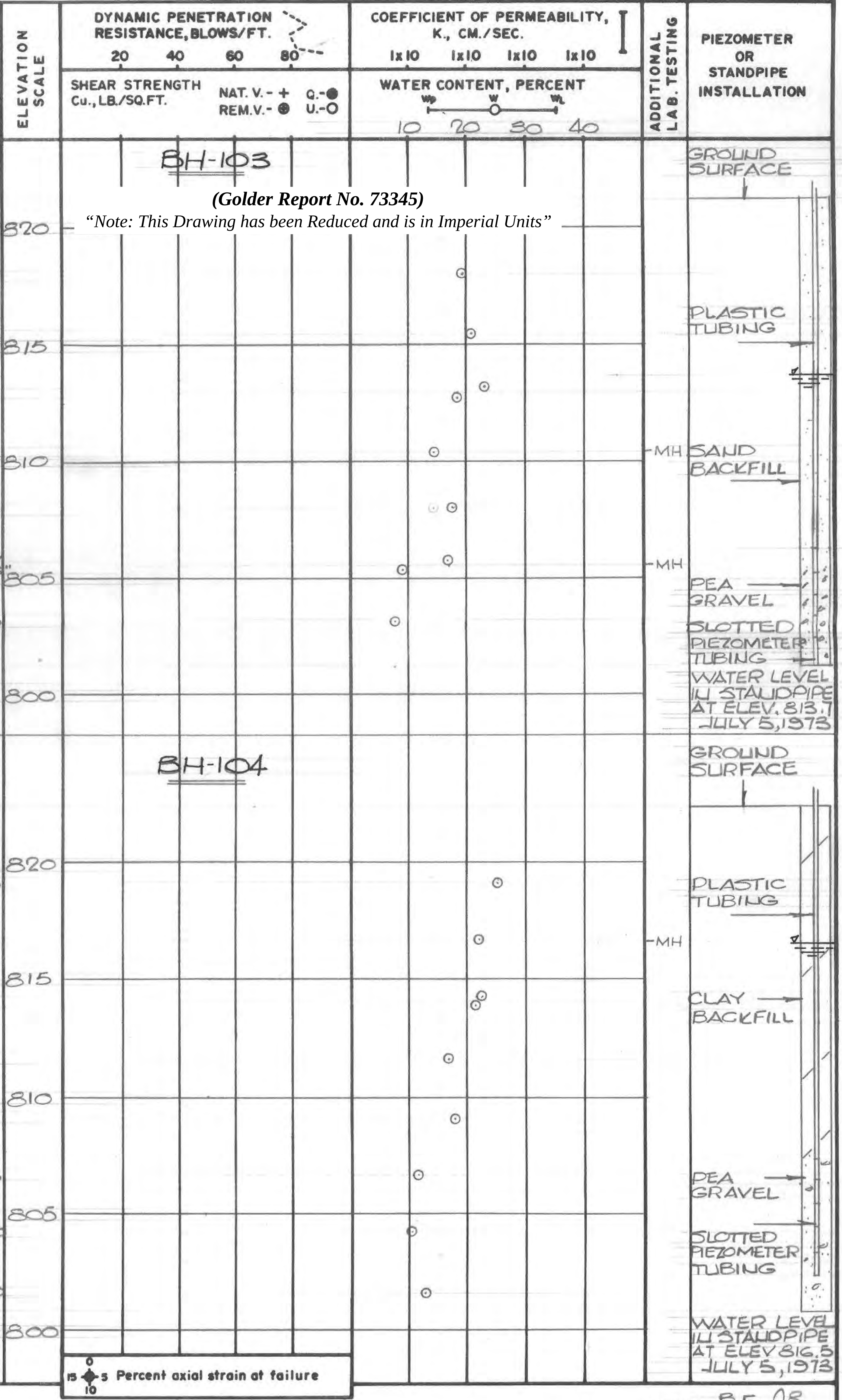
"Note: This Drawing has been Reduced and is in Imperial Units"

BH-103

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.	ADDITIONAL LAB. TESTING
POWER AUGER 4.5" DIA. (UNCASED)	821.2	GROUND LEVEL				
	0.0	SAND & GRAVEL (FILL)				
	0.5 819.7	BLACK SILTY TOPSOIL				
	1.5	COMPACT BROWN SANDY SILT	1	2" SO	23	
	816.7 4.5	COMPACT BROWN SILTY FINE SAND	2 3	" "	22 13	
	812.5 8.7	FIRM TO STIFF GREY CLAYEY SILT SOME SAND	4	"	7	MH
	808.2 13.0 806.7	HARD GREY CLAYEY SILT TILL	5	"	40	
	14.5 805.4	DENSE GREY SILT	6	"	40/3"	MH
	15.8	HARD GREY CLAYEY SILT TILL	7	"	>100	
	801.2 20.0	END OF HOLE				

BH-104

BORING METHOD	ELEV'N. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FT.	ADDITIONAL LAB. TESTING
POWER AUGER 4.5" DIA. (UNCASED)	822.3	GROUND LEVEL				
	0.0 821.3	BLACK SILTY TOPSOIL				
	1.0	COMPACT BROWN SANDY SILT	1	2" SO	20	
	817.8 4.5	COMPACT BROWN SILTY FINE SAND	2	"	21	MH
	815.3 7.0 814.1	LOOSE BROWN SILT				
	8.2	FIRM TO STIFF GREY CLAYEY SILT SOME SAND	3 4 5	" " "	7 8 12	
	807.8 14.5	HARD GREY CLAYEY SILT SOME SAND OCCASIONAL GRAVEL (TILL)	6 7	" "	65 >100	
	802.3 20.0 800.8	HARD GREY CLAYEY SILT	8	"	50	
	21.5	END OF HOLE				



VERTICAL SCALE
1 IN. TO 5 FT.

Golder Associates

DRAWN B.F.

CHECKED

LOG OF BOREHOLE 9

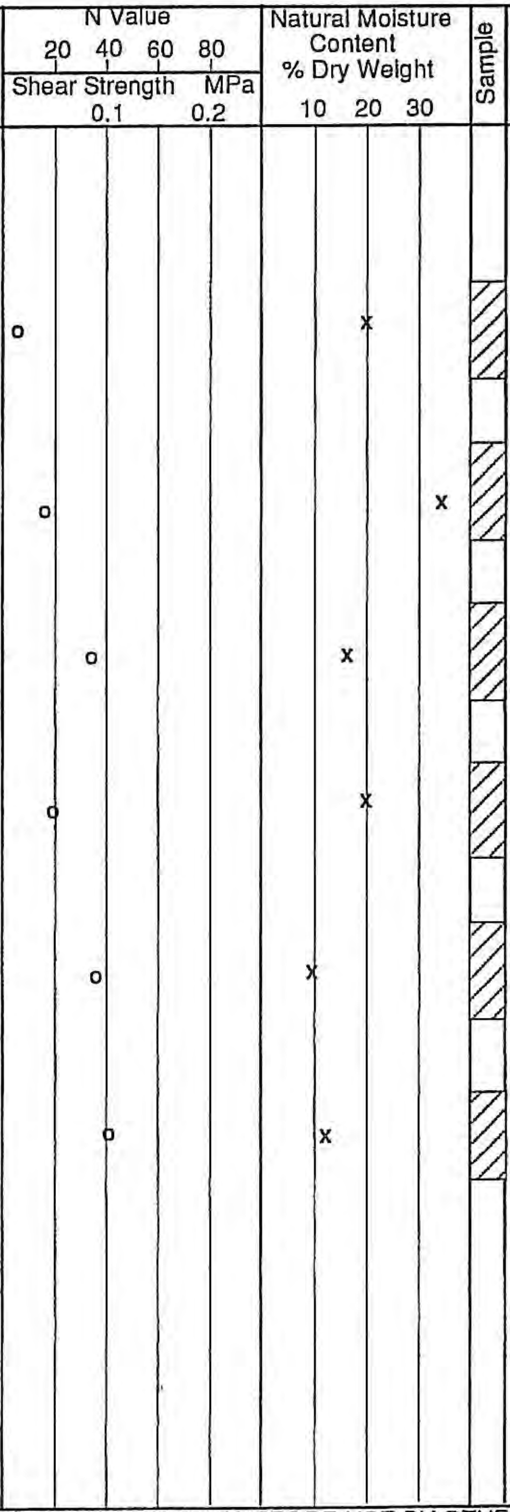
Auger Sample	☒
SPT (N) Value	○ ○ ▨
Natural Moisture	×
Penetrometer	▲

Dwg. No. 10

Project **Proposed Watermain Feeders**
City of London Project EW3680
Adelaide St., Richmond St. and Wonderland Rd.
London, Ontario

Hole location and datum see drawing No. 1

Project No. **L03804AGI**



Elev. Scale m (ft)	Water Level	Soil Description	Depth Scale m	N Value	Natural Unit Weight kN/m³
263.5 **(864.5)**		**GRANULAR FILL - brown, moist**			
262.9 **(862.5)**		**FILL - predominantly silt, occasional topsoil inclusions and rootlets, brown, moist**	1	6	
			2	18	
		TOPSOIL layer at 2 m depth			
261.4 **(857.5)**		**SILTY FINE SAND to SANDY SILT - occasional gravelly layers, brown, moist, compact to dense**		37	
		wet below about 2.6 m depth	3	20	
259.8 **(852.5)**		**SILTY CLAY TILL - trace gravel, grey, moist, very stiff**	4	38	
				41	**22.0**
258.5 **(848)**		**END OF BOREHOLE**	5		

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced by continuous flight auger equipment to termination on March 23, 1994.
2. M.S.A. explosimeter readings in the upper level of the open borehole at the time of drilling did not detect methane gas.
3. Water Level Records

Elapsed Time	Water Level	Hole Open to:	
Completion	2.7 m	2.7 m	
15 days*	1.5 m	--	*standpipe

4. 12.5 mm O.D. P.V.C. Standpipe installed to full depth of borehole.

LOG OF BOREHOLE 10

Auger Sample ☒
SPT (N) Value o o ▨
Natural Moisture ×
Penetrometer ▲

Project **Proposed Watermain Feeders**
City of London Project EW3680
Adelaide St., Richmond St. and Wonderland Rd.
London, Ontario

Dwg. No. 11

Hole location and datum see drawing No. 1

Project No. **L03804AGI**

Elev. Scale m (ft)	Water Level	Soil Description	N Value	Natural Moisture Content % Dry Weight	Sample	Natural Unit Weight kN/m3
252.2 (827.5)		**GRANULAR FILL - brown, moist**	38	x	▨	
250.5 (822)		**PEAT - roots throughout, shell fragments, black to brown, moist**	20	> x (70)	▨	
249.6 (819)		**MARL - occasional shell fragments, grey, wet**	4	> x (180)	▨	
			2	> x (120)	▨	
248.5 (815.5)		**SAND - fine grained, grey, wet, loose to compact**	4	x	▨	
			7	x	▨	
245.6 (806)			10	x	▨	
		END OF BOREHOLE				

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced by continuous flight auger equipment to termination on March 23, 1994.
2. M.S.A. explosimeter readings in the upper level of the open borehole at the time of drilling did not detect methane gas.
3. Water Level Records

Elapsed Time	Water Level	Hole Open to:
Completion	1.5 m	1.5 m
15 days*	1.5 m	--

*standpipe

4. 12.5 mm O.D. P.V.C. Standpipe/gas probe installed to full depth of borehole.

LOG OF BOREHOLE 11

Dwg. No. 12

Auger Sample	☒
SPT (N) Value	o o ▨
Natural Moisture	×
Penetrometer	▲

Project **Proposed Watermain Feeders**
City of London Project EW3680
Adelaide St., Richmond St. and Wonderland Rd.
London, Ontario

Hole location and datum see drawing No. 1 Project No. **L03804AGI**

Elev. Scale m (ft)	Water Level	Soil Description	Depth Scale m	Depth Scale ft	N Value	N Value 20 40 60 80 Shear Strength MPa 0.1 0.2	Natural Moisture Content % Dry Weight 10 20 30	Sample	Natural Unit Weight kN/m3
253.6 **(832)**		**ASPHALTIC CONCRETE - ~ 150 mm** **GRANULAR FILL - brown, moist**		2					
252.7 **(829)**		**SAND - medium grained, brown, wet**	1	4	19	o	x	▨	
252.2 **(827.5)**		**SILT TILL - trace gravel, brown, moist, compact to very dense**	2	6	21	o	x	▨	
				8	32	o	x	▨	**22.7**
			3	10	55	o	x	▨	
250.1 **(820.5)**		**END OF BOREHOLE**	4 5 6	12 14 16 18 20					

NOTE: BOREHOLE DATA REQUIRES INTERPRETATION ASSISTANCE FROM TROW BEFORE USE BY OTHERS.

1. Borehole advanced by continuous flight auger equipment to termination on March 24, 1994.
2. M.S.A. explosimeter readings in the upper level of the open borehole at the time of drilling did not detect methane gas.
3. Water Level Records

Elapsed Time	Water Level	Hole Open to:
Completion	2.7 m	3.0 m

APPENDIX B

Site Photographs

Photograph 1: Adelaide Street North looking north at north limit of site.

Photograph 2: Adelaide Street North looking southeast at Sunningdale Road East. Note cracking and patching.

Photograph 3: Sunningdale Road East, just west of Adelaide Street North, looking west.

Photograph 4: Sunningdale Road East, just east of Adelaide Street North, looking east.

Photograph 5: Adelaide Street North looking north at Stoney Creek Valley North crossing. Note wide boulevard.

Photograph 6: Adelaide Street North looking south at Stoney Creek Valley North crossing. Note wide boulevard.

Photograph 7: Adelaide Street North, just north of Fanshawe Park Road, looking north.

Photograph 8: Adelaide Street North, just north of Fanshawe Park Road, looking south.

Photograph 9: Section A-A’, Stoney Creek Valley North, looking north. Note heavy vegetation.

Photograph 10: Section A-A’, Stoney Creek Valley North, looking north. Note heavy vegetation.

Photograph 11: Section A-A’, Stoney Creek Valley North, looking west at CSP outlet.

Photograph 12: Section A-A’, Stoney Creek Valley North, looking downstream (east).

Photograph 13: Section B-B’, Stoney Creek Valley North, looking east from top of south slope.

Photograph 14: Section B-B’, Stoney Creek Valley North, looking upslope (south) from toe.

Photograph 15: Section B-B’, Stoney Creek Valley North, looking downstream (east).

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