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Appendix N

Geotechnical Investigation Report

GOLDER
MEMBER OF WSP

REPORT

GEOTECHNICAL INVESTIGATION

Schedule C Class EA Study for Improvements to Kennedy Road, From Major Mackenzie Drive to North of Elgin Mills Road, Markham, Ontario

Submitted to:

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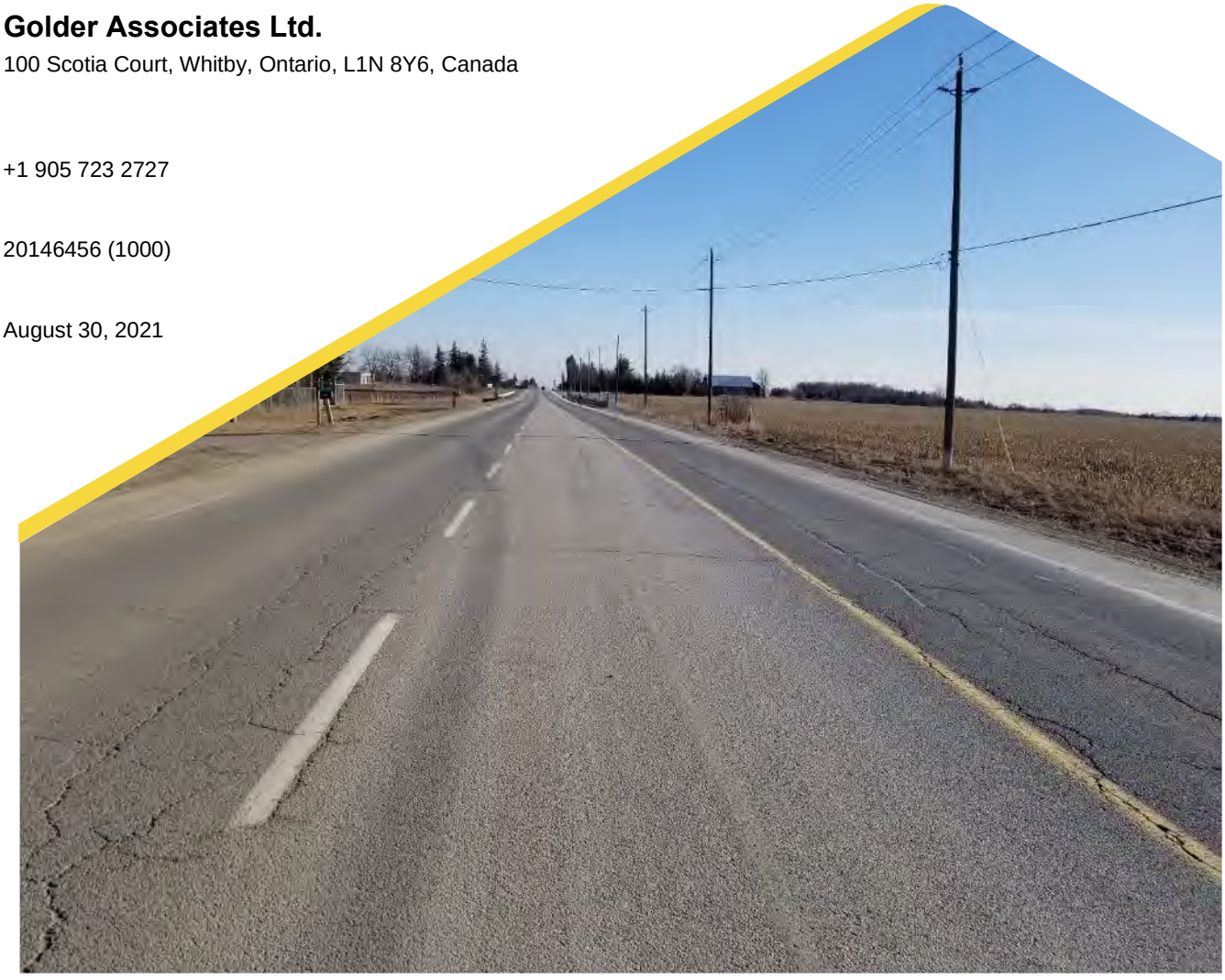

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1 eCopy - The Regional Municipality of York

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1.0 INTRODUCTION

1.1 General

Golder Associates Ltd. (Golder) was retained by the Regional Municipality of York (Region) to provide a combined pavement and geotechnical investigation Report with results of environmental quality testing in support of the Environmental Assessment of Kennedy Road improvements from Major Mackenzie Drive to about 400 m north of Elgin Mills Road, in the City of Markham, Ontario, as shown on the Key Plan on Figures 1 to 7.

The purpose of the field investigation was to obtain information on the existing pavement structure and subsurface soil and groundwater conditions at the site by means of a limited number of boreholes and based on our interpretation of the borehole data, provide pavement engineering and geotechnical recommendations for the proposed road improvements, and watermain and storm sewer servicing along Kennedy Road.

The factual data, interpretations and 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. If the project is modified in concept, location or elevation, or if the project is not initiated within eighteen months of the date of the field investigation, Golder should be given an opportunity to confirm that the recommendations are still valid. In addition, this report should be read in conjunction with the attached *"Important Information and Limitations of This Report",* included in Appendix A. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

1.2 Project and Site Description

Kennedy Road at present consists of a two-lane rural, asphalt paved road with partially paved shoulders and ditches along both sides of the road. A bridge over Bruce Creek is located about 100 m north of Elgin Mills Road. In addition, the road is bounded to the east and west by agricultural lands, residential structures and a Golf Course.

The proposed urbanization and widening works will extend along Kennedy Road from Major Mackenzie Drive to about 400 m north of Elgin Mills Road, in the City of Markham, Ontario, as shown on Figures 1 to 7. It is understood that the proposed works may include:

- Widening from the current two lanes to four lanes; no specific details of the widening have been provided.
- Addition of two turning lanes, in the northbound and southbound directions, at intersections with new sideroads to be constructed in the future, as shown on the "Community Structure Plan" provided by Webb+Co Limited in an email dated June 3, 2020.
- Road urbanization and addition of new off-road active transportation (AT) facilities on each side of the proposed right-of-way; no specific details of the AT facilities have been provided.
- A new watermain and storm sewer within the proposed road right-of-way and outside of the existing edge of pavement. The inverts of the new watermain and storm sewer are anticipated to extend to a maximum depth of 6 m below the existing centerline of the roads.

2.0 INVESTIGATION PROCEDURES

2.1 Pavement Condition Survey

A visual pavement condition survey was carried out by Golder staff on March 9, 2021. Pavements were evaluated in accordance with Ministry's "*Flexible Pavement Condition Rating – Guidelines for Municipalities, 1989*", SP-022. The purpose of the visual pavement condition survey was to record the severity and density of the distresses observed on the existing pavement surface and use the information to develop appropriate rehabilitation or reconstruction strategies. A summary of the visual pavement condition survey is as follows:

- Kennedy Road within the project limits is an asphalt paved, two-lane rural, regional road with turning lanes at the intersections with Major Mackenzie Drive and with Elgin Mills Road. The road has partially paved shoulders and ditches along both sides of the road. From Major Mackenzie Drive to approximately 240 m north, the road has an urban cross section and a sidewalk on the west side of the road.
- Based on the visual condition survey, the pavement within the project limits can be divided in two sections:
  - Section 1: approximately 400 m long, starting from about 250 m south to about 150 m north of the intersection with Elgin Mills Road (just north of the bridge over Bruce Creek), and
  - Section 2: the rest of the project limits.
- Along Section 1, the pavement is generally in poor to fair condition with more severe and dense distresses (PCR of 40-45). The predominant distresses are extensive, moderate map cracking, frequent, moderate transverse cracking, extensive, moderate longitudinal cracking and intermittent, moderate alligator cracking. Furthermore, most of the cracks in Section 1 are not sealed. The pavement along Section 2 is generally in fair condition (Pavement Condition Rating (PCR) of 50). The predominant distresses are frequent, slight longitudinal cracking, intermittent, moderate transverse cracking, intermittent, slight map and alligator cracking. Most of the cracks in Section 2 are sealed.

Details of the pavement condition survey are presented in Appendix B.

2.2 Borehole Investigation

The borehole investigation was carried out by Golder between the 4th and 28th of January 2021. A total of twenty-four boreholes (designated as Boreholes KP1 to KP13, and KS1 to KS11) were advanced along the lanes and shoulders of Kennedy Road at the approximate locations shown on Figures 1 to 7. Borehole KP1 to KP13 were advanced to depths of 2.0 m below ground surface; Boreholes KS1 to KS11 were advanced to depths ranging from 7.7 m to 17.1 m below ground surface.

A road occupancy permit was obtained from the Region, and the borehole locations were marked in the field and cleared of underground utility services prior to drilling. Traffic protection was provided in accordance with MTO's Book 7 Manual of Temporary Conditions.

The field investigation was directed by members of Golder engineering staff who also located the borehole locations in the field, logged the boreholes, and took custody of the recovered soil samples. The boreholes were advanced using truck-mounted drill rigs, operated by Landshark Drilling, using either 150 mm or 200 mm outside diameter hollow stem continuous flight augers.

Samples of the granular base, and subbase materials, and subgrade soils were obtained from the augers in all boreholes. The soil samples were obtained at regular intervals of depth using 50 mm outer diameter split spoon samplers and full weight automatic hammers, in accordance with Standard Penetration Testing (SPT) methods (ASTM D1586). The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension were not sampled or represented in the grain size distributions. The measured in-situ field results (i.e., SPT "N"-values) presented in this report are uncorrected.

The groundwater conditions were noted in the open boreholes during drilling and upon completion of drilling. Groundwater monitoring wells, consisting of 50 mm diameter PVC pipe, were installed in nine boreholes (Boreholes KS1 to KS4, KS7 to KS11) to allow for monitoring of groundwater levels over time. The deep boreholes were backfilled with a mixture of bentonite and soil cuttings, and the 2 m deep pavement boreholes were backfilled with soil cuttings in accordance with current environmental regulations. Where applicable, the boreholes were sealed with asphaltic cold patch material at road surface.

The borehole locations and ground surface elevations were obtained using a GPS (Trimble Geo7), with accuracy of about 0.1 m in both vertical and horizontal directions. The locations provided on the borehole records are relative to UTM NAD 83 (Zone 17) northing and easting coordinates, and the ground surface elevations are referenced to a geodetic datum.

The collected soil samples were identified in the field, placed in appropriate containers and transported to Golder laboratory in Whitby for detailed examination and geotechnical laboratory testing (moisture content, grain size analysis, and Atterberg Limit testing) on selected samples.

The collected soil samples were reviewed in the field and the presence (if any) of contamination based on visual and/or olfactory cues (staining or odours) was documented for each recovered sample. Based on these observations, select samples were submitted for analytical testing to AGAT Laboratories (AGAT) in Mississauga, Ontario, under chain-of-custody documentation. Three soil samples were submitted for testing of corrosion potential (pH, electrical conductivity, resistivity, chloride, and sulphate). Additionally, select samples were submitted for environmental quality testing including six soil samples for metals and inorganics, two soil samples for petroleum hydrocarbon fractions F1 to F4 (PHC F1 to F4), and benzene, toluene, ethylbenzene and xylene (BTEX); and one sample was submitted for testing for select parameters using the toxicity characteristic leaching procedure (TCLP). All analytical samples were placed into laboratory supplied sampling containers and stored on ice until delivered to the analytical laboratory, under chain-of-custody documentation.

3.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

3.1 Regional Geology

The site is located within the Peel Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984). The Peel Plain physiographic region extends northeastwards from the Niagara Escarpment and covers portions of the Regional Municipalities of York, Peel, and Halton. A surficial till sheet, which is mapped as the Halton Till, is present throughout much of the Peel Plain and generally follows the surface topography. As outlined in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984), the Halton Till typically consists of cohesive clayey silt to silty clay, with non-cohesive sand to silt zones and is known to contain cobbles and boulders throughout. Shallow, localized deposits of sand and silt and/or clay can overlie this uppermost till sheet, and these represent relatively recent deposits, formed in small glacial melt water ponds scattered throughout the Peel Plain and concentrated near river valleys. The recent sand, silt, and clay and

uppermost till deposits in this area overlie and are interbedded with stratified deposits of sand, silt and clay. There is some difficulty with water supply within the Peel Plain due to the presence of clays and low permeable till deposits which are poorly drained. However, in some areas, there are few thick beds of sands which serve as aquifers.

3.2 Subsurface Conditions

The subsurface soil and groundwater conditions encountered in the boreholes are shown in detail on the Records of Borehole sheets (i.e. borehole records) in Appendix C. *"Method of Soil Classification, Abbreviations and Terms Used on Records of Boreholes and Test Pits"* and *"List of Symbols"* sheets are also provided in Appendix C to assist in the interpretation of the borehole records. The geotechnical laboratory results and the analytical laboratory results are presented in Appendices D and E respectively.

The boundaries between the strata on the borehole records have been inferred from drilling observations and non-continuous sampling. Therefore, these boundaries typically represent transitions between soil types rather than exact planes of geological change. Furthermore, the subsurface conditions will vary between and beyond the borehole locations and across the site and caution should be used when extrapolating subsurface conditions between the boreholes.

3.2.1 Existing Pavement Structure

Based on the results of the field investigation, the typical existing pavement structure and the predominant subgrade soil types along Kennedy Road are summarized in Table 1.

Table 1: Summary of Pavement Thicknesses and Subgrade Soil Types

Location	HMA (mm)	Granular Base (mm)	Granular Subbase (mm)	Buried HMA or RAP [6)]	Total Thickness (mm)	Predominant Subgrade Soil Type
NB Lane	140-280 [1)] (240)	130-280 [2)] (200)	350-860 (620)	-	760-1,370 [3)] (980)	Silty Clay and gravelly Silty Clay and Sand
SB Lane	120-200 (160)	160-310 [2)] (230)	240-500 (360)	260 [4)]	580-880 (750)	Silty Clay and gravelly Silty Clay and Sand
Shoulder	-	300-570 (430)	290-950 (500)	230-240 (235) [5)]	700-1,370 [3)] (780)	Silty Clay and gravelly Silty Clay and Sand

Notes:
1) 140-280 (240) represents min-max (average) thickness.
2) Recycled asphalt pavement (RAP) mixed with granular base material was encountered in three boreholes: one in the northbound lane and two in the southbound lane.
3) One borehole in the northbound lane and three in the shoulders encountered total granular thickness >1.3 m. These values were not considered to be representative and were excluded from the averages.
4) The thickness of buried HMA was included in the granular subbase thickness.
5) Two shoulder boreholes encountered a layer of buried asphalt or RAP under the base material. These thicknesses are included in the subbase thickness. One shoulder borehole encountered subbase material mixed with RAP.
6) RAP - Recycled Asphalt Pavement.

It was observed that the Hot Mix Asphalt (HMA) and total pavement thickness in the northbound lane are thicker (an average HMA thickness is 240 mm and total pavement thickness is 980 mm) than those in the southbound lane (an average HMA thickness is 160 mm and total pavement thickens is 780 mm).

Gradation testing was carried out on two of the granular base samples, and two of the granular subbase samples. The results indicate that both granular base samples tested did not satisfy the current Ontario Provincial Standards Specification OPSS.PROV 1010 gradation requirements for Granular A, generally due to excessive material passing some of the sieve sizes, as shown on Figure D1. Both samples of the granular subbase material tested did not satisfy the current OPSS.PROV 1010 gradation requirements for Granular B, Type I, due to excessive material passing the 75 µm sieve, as shown on Figure D2 in Appendix D. The water content of the granular base samples ranged from 2 to 5 percent, while the water content of the granular subbase samples ranged from 7 to 14 percent.

3.2.2 Pavement Subgrade

The results of the borehole investigation indicate that the predominant subgrade encountered immediately under the granular materials is silty clay, gravely silty clay and sand, and gravely silty clay / clayey silt and sand. The results of laboratory gradation testing carried out on the subgrade samples are shown on Figure D3 and D6 in Appendix D.

3.2.2.1 Frost Susceptibility

The frost susceptibility of the subgrade soils within the frost depth of 1.4 m has been assessed in accordance with the Ministry of Transportation Ontario's (MTO) guidelines. Soils are classified as having low, moderate or high susceptibility to frost heaving based on the percent of silt sized particles between 5 µm to 75 µm as summarized in Table 2.

Table 2: MTO Frost Susceptibility Guidelines

Grain Size (5 75 µm)	Susceptibility to Frost Heaving
0 – 40 %	Low
40 – 55 %	Moderate
55 – 100 %	High

The laboratory test results indicate that the subgrade materials tested generally have low susceptibility to frost heaving. Moderate to highly frost susceptible soils were not encountered within the frost depth of 1.4 m.

3.2.2.2 Organic Materials

Organic inclusions were recorded in Boreholes KP3, KP10, KP11, KS7, KS8, KS9 and KS11, generally under the granular subbase material and at Borehole KS11, under the layer of buried asphalt, as detailed in the Record of Boreholes attached in Appendix C.

3.2.2.3 Buried Asphalt

Buried asphalt was encountered under the granular subbase layer -in Boreholes KP8 (southbound lane) and KS11 (northbound shoulder). The buried asphalt at these two locations extends to a depth of up to 880 mm. Furthermore, at Borehole KP5, RAP material was encountered under the granular subbase, from a depth of 550 mm to 780 mm, and in Borehole KP7, RAP material was encountered mixed with silty sand and gravel subgrade from a depth of 650 mm to 970 mm.

3.2.3 Subsurface Soils

3.2.3.1 Cohesive Fill

A cohesive fill was encountered beneath the non-cohesive fill in Boreholes KP2 to KP6, KP8 to KP10, KS1 to KS3, KS6, KS7, and KS9 to KS11. The cohesive fill extended to depths ranging between 1.4 m and 2.9 m below ground surface (mbgs). However, in Boreholes KP2, KP10 and KP11, the cohesive fill layer was not fully penetrated. The cohesive fill ranges in composition and is comprised of black to grey to brown silty clay, some gravel, silty clay and sand, gravelly to some gravel, and gravelly silty clay-clayey silt and sand. Organic inclusions were observed in Boreholes KP3, KP10, KP11, KS7, KS8, KS9 and KS11. In addition, auger resistance possibly due to boulder/cobbles was encountered in Boreholes KP8 and KP11 during drilling.

The SPT “N”-values measured within the cohesive fill range from 5 blows to 28 blows per 0.3 m of penetration, indicating a firm to very stiff consistency.

Grain size distribution tests were carried out on two samples of the cohesive fill and the results are shown on Figure D3. Atterberg limit testing was carried out on two samples of the cohesive fill and the results indicate liquid limits of about 19 and 25 percent, plastic limits of about 12 and 14 percent, and plasticity indices of about 7 and 11 percent. These test results, which are plotted on a plasticity chart on Figure D4, indicate the cohesive fill is classified as a silty clay to clayey silt of low plasticity. The in-situ water contents measured on samples of the cohesive fill range from about 8 percent to 25 percent.

3.2.3.2 Non-Cohesive Fill

A non-cohesive fill was encountered beneath the granular base and subbase in Boreholes KP1 to KP8, KP10 to KP13, and KS1 to KS10, extending to depths ranging from 0.5 m to 2.9 mbgs. The fill varies in composition from sandy silt, silty sand and gravel, silty sand, sand to gravelly sand, containing trace to some fines.

The SPT “N”-values measured within the non-cohesive fill range from 6 blows to 32 blows per 0.3 m of penetration, indicating a loose to dense compactness condition. The in-situ water contents measured on six samples of the non-cohesive fill range from about 2 percent to 14 percent.

A grain size distribution test was carried out on one sample of the non-cohesive fill and the result is shown on Figure D5.

3.2.3.3 Silty Clay to Silty Clay and Sand

A cohesive deposit consisting of silty clay to silty clay and sand, containing trace to some gravel was encountered beneath the fill in Boreholes KP1, KP5, KP7, KP12, KS5, KS7, and KS8, extending to depths ranging from 1.4 m to 4.0 mbgs. However, in Boreholes KP1, KP5 and KP7, the thickness of the cohesive deposit was not fully penetrated. Oxidation staining was observed in Borehole KP1 within the cohesive deposit.

The SPT “N”-values measured within the cohesive deposit range from 7 blows to 24 blows per 0.3 m of penetration, indicating a firm to very stiff consistency.

Grain size distribution tests were carried out on two samples of the cohesive deposit and the results are shown on Figure D6. Atterberg limit testing was carried out on two samples of the cohesive deposit and the results indicate liquid limits of about 23 and 50 percent, plastic limits of about 12 and 20 percent, and plasticity indices of about 11 and 30 percent. These test results, which are plotted on a plasticity chart on Figure D7, indicate the cohesive deposit is classified as a silty clay of low to intermediate plasticity. Natural water contents measured on samples of the cohesive deposit range from about 10 percent to 23 percent.

3.2.3.4 Sandy Silt to Silty Sand to Silty Sand and Gravel

Non-cohesive deposits consisting of sandy silt, silty sand, some gravel, and silty sand and gravel were encountered in Boreholes KP4, KP12, KP13, KS2, KS4, KS6, KS7, KS9 and KS10, underlying fill, silty clay and non-cohesive till deposits.

The SPT “N”-values measured within these non-cohesive deposits range from 16 blows per 0.3 m of penetration to 50 blows for 0.13 m of penetration, indicating a compact to very dense compactness condition, but generally dense to very dense.

Grain size distribution tests were carried out on two samples of the non-cohesive deposits, the results are shown on Figures D8 and D9. It was observed that the silty sand encountered in most of these boreholes was described as ‘fine’ based on their grain size plotting between 0.075mm and 0.4mm. Natural water contents measured on samples of the non-cohesive deposits range from about 4 to 25 percent.

3.2.3.5 Glacial Till

Glacial till was encountered in Boreholes KP6, KS1 to KS3, KS6, KS8, KS9, and KS11. The glacial till consists of non-cohesive gravelly silty sand, silt and sand, some gravel, and cohesive silty clay and sand. The deposit generally extends to the borehole termination depths with the exception of Borehole KS6. Although cobbles and boulders were not noted during drilling through the till deposit at this site, cobbles and boulders are commonly encountered in glacially derived materials and should be expected within the glacial till. Further, the presence of cobbles and/or boulders can be inferred from auger grinding during drilling as well as the split-spoon sampler not advancing the full sample depth.

3.2.3.5.1 Silty Clay and Sand Till

The cohesive silty clay and sand till, containing some gravel was encountered in Boreholes KS1 to KS3, KS8, KS9, and KS11 underlying the cohesive fill, silty clay and sand, silty sand to silty sand and gravel, and non-cohesive till deposits.

The SPT “N”-values measured within the cohesive till range from 18 blows per 0.3 m of penetration to 50 blows per 0.07 m of penetration, indicating a very stiff to hard consistency, but the deposit is generally hard.

A grain size distribution test was carried out on one sample of the cohesive till and the result is shown on Figure D10. Atterberg limit testing was carried out on one sample of the cohesive till and the results indicate the liquid limit of about 19 percent, a plastic limit of about 11 percent, and a plasticity index of about 8 percent. The test results, which are plotted on a plasticity chart on Figure D11, indicate that the tested sample is classified as a silty clay of low plasticity. Natural water contents measured on samples of the silty clay and sand till range from about 4 to 13 percent, but generally less than 10 percent.

3.2.3.5.2 Silty Sand to Silt and Sand Till

The non-cohesive till was encountered in Boreholes KS2, KS3, KS6, KS9 and KP6 underlying the fill and cohesive till.

The SPT “N”-values measured within the non-cohesive till range from 19 blows per 0.3 m of penetration to 50 blows per 0.13 m of penetration, indicating a compact to very dense compactness condition, becoming dense to very dense with depth.

A grain size distribution test was carried out on one sample of the non-cohesive till and the result is shown on Figure D12. Natural water contents measured on four samples of non-cohesive till range from about 6 percent to 7 percent, with one water content measured at about 13 percent.

3.2.4 Groundwater

Groundwater observations during and upon completion of drilling ranged approximately between 0.9 mbgs and 7.6 mbgs, and dry in fifteen boreholes. Subsequently, groundwater levels were measured in the monitoring wells and ranged between approximately 1.7 mbgs and 7.8 mbgs (Elevations 202.0 m and 220.8 m) and are summarized in Table 3.

Table 3: Summary of Groundwater Levels

Monitoring Well	Ground Surface Elevation (m)	January 29, 2021	
		Depth (m)	Elevation (m)
KS1	204.0	2.0	202.0
KS2	209.3	1.7	207.6
KS3	214.7	7.7	206.9
KS4	218.7	6.6	211.6
KS7	223.0	2.2	220.8
KS8	223.5	4.1	219.4
KS9	222.9	7.0	215.9
KS10	223.2	7.8	215.4
KS11	218.7	2.5	216.2

It should be noted that these observations and measurements reflect the shallow groundwater conditions encountered in the boreholes during the time of the field investigation and that water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt.

3.2.5 Analytical Results

3.2.5.1 Environmental Quality

Analytical laboratory testing was carried out by AGAT Laboratories on select soil samples obtained from the current borehole investigation to assess environmental quality. The samples were submitted for analysis of metals, inorganics, PHCs and/or BTEX. For the purpose of this report, the analytical results for this testing were compared to the following (different standards may apply depending on the reuse location):

- Ontario Ministry of Environment, Conservations, and Park (MECP) (formerly Ministry of the Environment, MOE) *"Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act"*, April 15, 2011
  - Table 1 full depth background standards for residential / parkland / institutional / community / commercial / industrial land use, fine to medium soil texture; and

- Table 2 full depth standards for a potable groundwater situation and residential / parkland / institutional land use, fine to medium grained soil texture.

- MECP *"Rules for Soil Management and Excess Soil Quality Standards"*, 2020
  - Table 2.1 full depth volume independent standard for a potable groundwater situation and residential / parkland / institutional land use.

The laboratory certificate of analysis is provided in Appendix E and details of the sample submitted and parameter exceedances are summarized in Table 4.

Table 4: Summary of Analytical Results Exceeding MECP Table 1, Table 2 and Table 2.1 Standards

Borehole	Sample Depth (m)	Parameter Exceeding Table 1 Standards	Parameter Exceeding Table 2 Standards	Parameter Exceeding Table 2.1 Standards
KS1 Sa3	1.5 – 2.0	Electrical Conductivity (EC), Sodium Adsorption Ration (SAR)	EC, SAR	EC, SAR
KS4 Sa3	1.5 – 2.0	EC, SAR	EC, SAR	EC, SAR
KS7 Sa4	2.3 – 2.7	EC, SAR	EC, SAR	EC, SAR
KS9 Sa2	0.75 – 1.2	EC, SAR, Petroleum Hydrocarbon (PHC) Fractions F2, F3 and F4	EC, SAR	EC, SAR, PHC F2 and F3
KS10 Sa3	1.5 – 2.0	EC, SAR	EC, SAR	EC, SAR
KS11 Sa3	1.5 – 2.0	EC, SAR	EC, SAR	EC, SAR

In addition to the above, one soil sample was submitted for TCLP analysis of metals, inorganics, benzo(a)pyrene and benzene to assist with classification of the soil for disposal purposes. The results of this testing were compared to the Schedule 4 criteria set out in O.Reg. 347. No exceedances were detected indicating the tested soil would be classified as non-hazardous waste should disposal be required.

3.2.5.2 Corrosivity

A total of three selected soil samples from Boreholes KS1, KS4 and KS9 (represented as S1, S4 and S9 in the submitted Chain of Custody) were submitted to AGAT Laboratories for basic chemical analyses related to potential sulphate attack on buried concrete elements and potential corrosion of buried ferrous elements. The results of corrosivity testing are presented in Table 5 and Appendix E. Guidance on the impact of corrosion potential on substructures is contained in Section 4.3 of this report.

Table 5: Summary of Corrosivity Results

Borehole Number	Depth (m)	Chloride (µg/g)	Sulphate (µg/g)	pH	Resistivity (Ohm cm)
KS1	1.5 – 2.0	619	71	8.55	746
KS4	1.5 – 2.0	1990	123	7.70	287
KS9	0.8 – 1.2	618	58	9.17	685

Recommendation based on the laboratory test results have been provided in Section 4.3.

4.0 DISCUSSION AND RECOMMENDATIONS

This section of the report provides engineering information for the pavement / geotechnical design aspects of the project, based on our interpretation of the data obtained from Golder's field investigation and our understanding of the project requirements. The information in this portion of the report is provided for the guidance of the design engineers. Where comments are made on construction, they are provided only in order to highlight aspects of construction which could affect the design of the project. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

In performing our pavement design analysis, we have referred to the AASHTO 1993 (MTO's MI183 "*Adaptation and Verification of AASHTO Pavement Design Guide for Ontario conditions*", March 19, 2008), as well as the *York Region Road Design Guidelines*.

4.1 Pavement Design Analysis and Recommendations

4.1.1 Traffic Volumes

The traffic data provided by the Region in an email dated February 19, 2021, were used to carry out the analysis and develop pavement design strategies for the rehabilitation and widening of Kennedy Road. A summary of the relevant traffic information is presented in Table 6.

Table 6: Traffic Volumes

Location	AADT (2017)	AADT (2041)	% COMM
Kennedy Road	8,000 [1)]	33,000 [2)]	6

Notes:
1) Existing AADT (2 lanes)
2) Projected AADT (4 lanes)

4.1.2 ESAL Calculations

Pavement design for widening of Kennedy Road (new pavement) has been carried out for a 20-year design life, while the design life for the rehabilitation option for the existing lanes has been carried out for a service life of 15-years. Based on our discussions with staff from York Region, we understand that to improve drainage, significant grade revisions (~ up to 1m) will be required throughout the project limits. As such, reconstruction may be required for the majority of the pavements within the project limits.

The estimated Equivalent Single Axle Loads (ESALs) over the selected design period are shown in Table 7.

Table 7: Summary of Estimated ESALs

	Design/ Service Life	Estimated ESALs
Widening design	20 years	5.9×10^6
Rehabilitation Option for NB and SB lanes	15 years	3.85×10^6

4.1.3 Widening of Kennedy Road

It is understood that Kennedy Road will be widened from the existing two lanes (one lane in each direction) to four lanes and that the rural road cross section will be replaced with an urban cross section. New AT facilities are also proposed on both sides of the road.

The results of the field investigation indicate that the predominant subgrade soils within the project limits are silty clay, gravely silty clay and sand, and gravely silty clay / clayey silt and sand. Based on the condition of the subgrade soils and the MI-183 guidelines, we have assigned a subgrade resilient modulus of 25,000 kPa for the rehabilitation of the existing section of the road, and 20,000 kPa for the widening design.

The minimum pavement structure for a Regional Road as listed in York Region Road Design Guidelines (YRRDG) is as follows:

- 50 mm SP 12.5 Surface Course
- 100 mm SP 19.0 or SP 25.0 Base Course
- 150 mm Granular A Base Material
- 450 to 525 mm Granular B, Type I Subbase Material

Based on the AASHTO pavement design analysis, as well as the need to provide lateral drainage for the existing pavement, the following pavement structure is recommended for the widening of Kennedy Road:

New HMA	-200 mm
New Granular A Base	-150 mm
New Granular B, Type I Subbase	-750 mm
Total thickness	-1,100 mm

It should be noted that 500 mm of new Granular B Type I material is structurally sufficient; however, in order to ensure that the bottom of the new Granular B, Type I material matches the bottom of the granular subbase over at least 95 percent of the length of the pavements (to provide lateral drainage), the subbase thickness has been increased to 750 mm.

The structural capacity of the recommended widening design is more than the minimum required based on YRRDG, and it also satisfies the 20-year AASHTO design requirements.

The widening of Kennedy Road is recommended to be carried out as follows:

- Remove the existing northbound shoulder by saw cutting the HMA 100 mm from the pavement edge on the partially paved shoulder and excavate the underlying granular materials and subgrade soils to a depth of approximately 1,100 mm below existing pavement surface. Beyond the existing shoulder, strip the topsoil, organic material and any other deleterious material within the proposed widening area, and excavate or fill as required to match the subgrade elevation on the exposed section adjacent to the existing lane (note that the proposed rehabilitation strategy for the northbound lane will result in a 40 mm grade raise and this should be taken into consideration when excavating for the widening);
- All organic material and any other deleterious materials present within the limits of proposed widening should be removed regardless of depth;
- Heavily proof roll and inspect the existing subgrade prior to placing any new materials. If soft areas are encountered, remove and replace with new Granular B Type I material as directed by the geotechnical representative on-site;
- Place 750 mm of new OPSS Granular B Type I in lifts not exceeding 300 mm, and compact to 100 percent of the material's Standard Proctor Maximum Dry Density (SPMDD);
- Place 150 mm (compacted thickness) of new OPSS Granular A and compact to 100 percent of the material's SPMDD;
- Place and compact 100 mm of SP 25.0 asphalt (with PG 64-28 asphalt cement);
- Place and compact 60 mm of SP 19.0 asphalt (with PG 64-28 asphalt cement); and
- Place and compact 40 mm lift of SP 12.5 FC2 surface course asphalt (with PG 64-28 asphalt cement).

As the total pavement structure for the widening should match or exceed the depth of the existing adjacent pavement structure to provide lateral drainage, the 95-percentile value for the total pavement thickness was used in the design analysis.

It should be noted that the rehabilitation option for the NB lane will result in grade raise of 40 mm. If this option is selected, the Granular B Type I thickness should be increased by 40 mm.

As the SP 25.0 mix can have a coarse and/or open surface finish, it should not be used to support traffic. Two 50 mm lifts of SP 19.0 can be placed instead of one 100 mm lift of SP 25.0. It is recommended that the 40 mm surface course lift on the widened portion be placed at the same time as the 40 mm surface course lift (refer to section 4.1.4.1) for the rehabilitation of the existing northbound lane.

It should be noted that at the time of preparing this report, information regarding the final location of the proposed watermain and storm sewer, the plans showing details of the proposed road widening (symmetrical/asymmetrical) and information regarding the proposed type of construction (open cut or trenchless) were not available to provide more detailed recommendations for the widening or reconstruction of Kennedy Road.

4.1.4 Rehabilitation of Kennedy Road

As mentioned in Section 3.2.1, the HMA and total pavement thickness is significantly more in the northbound lane than in the southbound lane. As it is much weaker, partial or full depth reconstruction of the existing southbound lane will be required, compared to a mill and pave strategy for the existing northbound lane. Therefore, it is our

opinion that for ease of construction staging, it will be better to widen on the east side first (i.e. along the northbound lane).

4.1.4.1 Northbound Lane Rehabilitation

The proposed rehabilitation strategy for the northbound lane is as follows:

- Mill 60 mm of HMA and overlay with 100 mm of new HMA (mill one lift and pave two lifts). This strategy will provide approximately 15 years of service life and will have a 40 mm grade raise.

The 100 mm of new HMA should consist of following:

- 40 mm SP 12.5 FC2 surface course, and
- 60 mm SP 19.0 binder course.

Notes:

1) The 400 m long Section 1 in the northbound direction (starting from about 250 m south to about 150 m north of the intersection with Elgin Mills Road), which is in worse condition than the rest of the sections its, should be rehabilitated using the preferred rehabilitation option for the southbound lane given in Section 4.1.4.2. Less intrusive strategies may be considered for this section of the road, if additional boreholes are advanced and asphalt cores taken to evaluate the types and depths of existing cracks.
2) Where the proposed grade raise cannot be accommodated (such as the approximately 240 m, partially urbanized section north of Major Mackenzie Drive), it is recommended to use the following strategy: mill 160 mm of the existing pavement and pave with 160 mm of new HMA. The 160 mm of new HMA should consist of following:
   - 40 mm SP 12.5 FC2 surface course,
   - 2 x 60 mm SP 19.0 binder course.

4.1.4.2 Southbound Lane Rehabilitation

The southbound lane has significantly lower structural strength compared to the northbound lane. Therefore, the following two options were considered for the rehabilitation of the existing southbound lane:

- Option 1: Remove the existing HMA on the southbound lane full depth (an average of 160 mm) and the underlying existing granular base material to a depth of 300 mm below finished pavement surface (top of surface course); place minimum 100 mm of new Granular A base material and overlay with 200 mm of new HMA. The 200 mm of new HMA should consist of following:
  - 40 mm SP 12.5 FC2 surface course,
  - 60 mm SP 19.0 binder course, and
  - 100 mm SP 25 base course.

Note:

1) It is recommended that the 40 mm surface course be placed at the same time as the 40 mm surface course lift on the northbound rehabilitated section and widening sections.

2) Two 50 mm lifts of SP 19.0 can be placed instead of one 100 mm lift of SP 25.0.

This option will provide a service life of approximately 15 years and result in a grade raise of 40 mm.

- Option 2: Reconstruct the southbound lane using the same design as recommended for the widening in Section 4.1.3., as follows:

New HMA	-200 mm
New Granular A Base	-150 mm
New Granular B, Type I Subbase	-750 mm
Total thickness	-1,100 mm

This option will provide approximately 20 years of service life.

4.1.4.3 Life Cycle Cost Analysis for the two Southbound Lane Options

A 50-year Life Cycle Cost Analysis (LCCA) was carried out for the two pavement rehabilitation options evaluated for the southbound lane, and the results are summarized in Table 8. The details of the LCCA are provided in Appendix G, Tables G-1 to G-3. The LCCA is based on the "Life Cycle Cost 2006 Update, Final Report" dated August 2007, prepared by ARA and submitted to MTO, CAC and OHMPA.

Table 8: Summary of LCCA for Alternative Pavement Designs for Rehabilitation

	Option 1 Remove Existing HMA and 100 mm	Option 2 Full Reconstruction of SB lane using Widening design
Design Life	15 years	20 years
Initial Construction	$ 290 k	$ 640 k
50-year Life Cycle Cost	$ 405 k	$ 730 k
Ranking	1	2

Based on the analysis, the initial and life cycle costs are less for Option 1 than for Option 2. Therefore Option 1 is the preferred option for the rehabilitation of the southbound lane on Kennedy Road.

4.1.5 Reco

We understand that a grade raise will be required over the majority of the project length to improve drainage along Kennedy Avenue, and this may require the complete reconstruction of the existing lanes. If required, the existing lanes should be reconstructed as follows:

- Remove the existing HMA full depth (an average of 240 mm and 160 mm on NB and SB lanes respectively) and the underlying granular materials as required and place the following on top of the existing granular materials:
  - 200 mm New HMA
  - 150 mm New Granular A base material
  - Min 500 mm New Granular B subbase material or as needed to meet the required profile grade

- For New Pavement Widening:
  - Place engineered earth fill as needed to raise grade to 1.2 m (85% of frost depth) below the final grade, and place the following on top of the engineered fill:
  - 200 mm New HMA
  - 150 mm New Granular A base material
  - 850 mm New Granular B subbase material

4.1.6 Off-road Active Transportation Facilities

It is understood that off-road AT facilities will be added on both sides of the road. It is assumed that the AT facilities will primarily serve bicycle traffic with occasional usage by snow removal/ maintenance vehicles. The recommended preliminary pavement design for the AT facilities is as follows:

- 40 mm SP 12.5
- 50 mm SP 19.0
- 300 mm Granular A Base material

Over competent subgrade material.

It should be noted that at the time of preparing this report, plans showing the locations of the proposed AT facilities were not available for us to provide detailed pavement design recommendations for the AT facilities.

To facilitate positive lateral drainage, it is recommended that subgrade under the proposed AT facilities be sloped towards the subdrains along the adjacent road.

The preliminary pavement design provided in this report for the AT facilities should be confirmed once the location and elevation of the AT facilities are finalized.

4.1.7 Reuse of Existing Granular Material

The existing granular base and subbase material removed from the widening sections can be re-used on site as acceptable earth fill under the granular subbase layer. It should be noted that any on-site material that is to be re-used, should be kept free of contamination from topsoil and organic material. Care should be taken during excavation to ensure that the existing and new granular materials are not contaminated by subgrade soils or by construction traffic tracking mud, etc.

4.1.8 Drainage

It is understood that the road profile will be urbanized, and new off-road AT facilities will be added on both sides of the road's right-of-way. Therefore, a proper drainage system should be installed along the edges of the new pavement, immediately below the proposed subgrade elevation. The drainage system should consist of a 150 mm diameter perforated pipes, placed inside a 300 mm by 300 mm trench and surrounded by concrete sand. The trench should be lined with a suitable geotextile prior to placing the concrete sand. At the top of the trench, the geotextile should overlap a minimum of 300 mm. The geotextile should conform to OPSS 1860, Class II and be non-woven with a F.O.S. in the range of 75 to 150 micron. The subdrain inverts should be approximately 250 mm below the bottom of the finished granular subbase elevation.

4.1.9 Hot Mix Asphalt Types and Construction

The SP 19.0 and SP 25.0 asphalt mixes should be compacted to a minimum of 91 percent, and the SP 12.5 FC2 should be compacted to a minimum of 92 percent of their respective Maximum Relative Densities (MRD). HMA material and placement requirements should be in accordance with OPSS 310 and OPSS 1150, as amended by the applicable Regional standards.

4.1.10 Transitions

Transverses and longitudinal joints should be saw cut, cleaned, and tack coated prior to placing new HMA. Where the new pavement abuts the existing pavement (e.g., at tie-ins to existing pavement), proper longitudinal lap joints should be constructed to key the new HMA surface course into the existing pavement in accordance with OPSS 310. The existing HMA should be sawcut to provide a vertical face prior to keying-in the new HMA surface course. Any undermined or broken edges resulting from the construction activities should be removed by the sawcut.

4.1.11 Tack Coat

It is recommended that tack coat be applied between all new lifts of HMA. Tack coat should conform to the requirements of Ontario Provincial Standard Specification OPSS.PROV 308 (April 2012) and SSP 308F02 (February 2017).

4.1.12 Performance Graded Asphalt Cement (PGAC)

It is recommended that PG 64-28 asphalt cement be used for all the HMA mixes in accordance with OPSS.MUNI 1101.

4.2 Watermain and Storm Sewer Recommendations

4.2.1 Settlement

Based on the anticipated maximum trench depth of 6 m below final road grade, the proposed watermain and storm sewers may likely be founded within the native firm to stiff gravelly silty clay and sand, compact to very dense silty sand, very dense sand, and very dense/hard glacial till. Soft silty clay and sand was encountered in Borehole KS11 between depths of 2.0 mbgs and 4.0 mbgs (Elevations 214.7 m and 216.7 m).

The soft silty clay and sand is highly compressible and subject to long term settlement depending on the thickness of the compacted backfill. Although soft silty clay and sand was only encountered in Borehole KS11, firm to stiff silty clay was encountered in other boreholes. Therefore, the extent and thicknesses of the compressible soils are unknown beyond the borehole they were encountered and should be expected between and beyond the boreholes.

Therefore, to reduce the potential for differential settlement because of the varying founding materials supporting the proposed watermain, the soft soils, where present below the invert, known to be in the vicinity of Borehole KS11, should be removed and replaced with approved, properly placed and compacted engineered fill or unshrinkable fill, where required. The exposed soils should be confirmed to be competent by Golder prior to backfilling with engineered fill to founding level.

4.2.2 Excavations

Based on the assumed storm sewer and watermain inverts of up to a maximum depth of 6 m below existing road grade, the anticipated native founding soils will generally consist of soft to stiff gravelly silty clay and sand, compact to very dense silty sand, very dense sand, and very dense/hard glacial till. These soils are generally considered suitable for support of the pipes with the exception of the soft gravelly silty clay and sand deposit encountered in Borehole KS11. The suitability of the founding soils to support the pipe should be confirmed by Golder at the time of excavation.

It is anticipated that the excavations will likely consist of conventional temporary open cuts. All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. Based on the OHSA, the very dense sand and compact to very dense silty sand deposits are classified as a Type 3 soil and all excavations in excess of 1.2 m in depth through these soils should be sloped no steeper than 1 horizontal to 1 vertical for excavation above the groundwater level. These deposits are classified as a Type 4 soil below the groundwater level and these soils should be sloped no steeper than 3 horizontal to 1 vertical. The dense to very dense/hard glacial till is generally classified as Type 2 soils with a 1 horizontal to 1 vertical to 1.2 m or less from its bottom above the groundwater level, and Type 3 soils if excavating below the ground water level. Depending upon the construction procedures adopted by the contractor, the success of the contractor's groundwater control methods and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required.

To maintain temporary excavation stability, excavated materials must be placed away from the edge of the excavation a distance equal to the depth of the excavation or greater. In addition, stockpiling of the material should be prohibited adjacent to the excavation to minimize surcharge loading near the excavation crest. Where sufficient space is not available to stockpile the excavated material at the site, off-site disposal of the excavated material intended for reuse would need to be arranged.

We understand that trench boxes are frequently used for this type of construction to protect the construction personnel and minimize the size of the excavation. It must be emphasized that a trench liner box provides protection for construction personnel but does not restrict movement of the excavation walls or prevent granular soils from flowing under the influence of groundwater, which may be the case at this site. Any voids between the excavation wall and the trench liner box should be filled immediately to minimize the potential for loss of ground and support of adjacent utilities, roadway pavements and the like. Furthermore, it is recommended that the trench excavation be carried out in short sections with the support system installed immediately upon completion of excavation and, as a minimum, backfilled at the end of each working day. It is imperative that any underground services adjacent to the excavations be accurately located prior to construction and adequate support be provided where required.

If a shored excavation is required to support adjacent utilities or structures, the shoring should be designed and constructed in accordance with Ontario Provincial Standard Specification (OPSS) 539 (Temporary Protection Systems), including an evaluation of base stability, soil squeezing stability and the hydraulic uplift stability as defined in the Canadian Foundation Engineering Manual (2006). Design of temporary works, including dewatering, will be entirely the responsibility of the contractor.

4.2.3 Groundwater Control

Groundwater levels were measured at depths ranging between about 1.7 mbgs and 7.8 mbgs (Elevations 202.0 m and 220.8 m). It has been assumed that excavations for site servicing (including approximately 0.2 m of

bedding material) are anticipated to extend to a maximum depth of 6 m below final road grade. As such, depending on the proposed storm sewer and watermain profile, the excavations will extend up to about 4.5 m below the groundwater level in most areas with some locations (vicinity of Boreholes KS3, KS4 and KS11) being above the measured groundwater levels.

Due to the low hydraulic conductivity of the glacial till, it is anticipated that groundwater seepage into the trenches will not be significant and that any localized seepage can most likely be controlled by pumping from filtered sumps installed within the trenches. However, we recommend that trench excavations should be left open for as short a duration as possible to reduce the potential for water accumulation both from potential seepage and from precipitation. Based on the groundwater levels, it appears that an upward hydraulic gradient exists which increases from south to north along Kennedy Avenue and that the wet silty sand and sand deposits encountered within some boreholes may be pressurized. As such, a significant amount of groundwater may be generated where excavation extends into this deposit. It is therefore anticipated that proactive dewatering/depressurization of the silty sand and sand deposits will likely be required.

The actual rate of groundwater inflow to the excavations will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, the number of working areas being excavated at one time, and the time of year at which the excavation is made. Also, there may be instances where significant volumes of precipitation, surface runoff and / or groundwater may collect in an open excavation and must be pumped out. Care should be taken at all times to ensure trenching operations adhere to OHSA requirements at a minimum. Surface water runoff should be directed away from open excavations. In case of the need for active dewatering, the groundwater level should be drawn down to at least 1 m below the bottom of the trench.

Groundwater control measures that extract more than 50,000 L/day of water are subject to regulation by the Ontario Ministry of the Environment, Conservation and Parks (MECP). Certain takings of groundwater and stormwater for construction dewatering purposes with a combined total less than 400,000 L/day qualify for self-registration on the MECP's Environmental Activity and Sector Registry (EASR). Registry on the EASR replaces the need to obtain a Permit to take Water (PTTW) for water taking and a Section 53 approval for discharge of water to the environment. A "Water Taking Plan" and a "Discharge Plan" are required by the MECP if water is taken in accordance with an EASR. In all cases, discharge under the EASR must be in accordance with a Discharge Plan (to be developed by a qualified professional). A Category 3 PTTW would be required for water takings in excess of 400,000 L/day.

An accurate prediction of the groundwater pumping volumes cannot be made at this time, as the flow rate would be dependent on construction methods adopted by the contractor and the final inverts. A hydrogeological study may be warranted in support of an EASR or PTTW depending on invert levels, construction methods and equipment used. Pumping discharges should also conform to any requirements from the local municipalities and conservation agencies. It is anticipated that an EASR will likely be required at this site for the trench excavations. Golder can be retained to carry out a detailed hydrogeological assessment once the details of the proposed storm sewer and watermain profile are made available.

4.2.4 Pipe Bedding and Cover

The bedding for watermains and sewers should be compatible with the size, type, and class of pipe, surrounding soil and loading conditions and should be designed in accordance with the Provincial, York Region and City of Markham standards. Where granular bedding is deemed to be acceptable, it should consist of at least 150 mm of OPSS Granular 'A' or 19 mm crusher run limestone material. Thicker bedding in the order of 300 mm to 450 mm,

may be required where soft soils are encountered during construction. Clear stone should not be used as bedding material or to stabilize the base at this site. Sand cover may be used from the spring line to 300 mm above the obvert of the pipes. All bedding material and cover should be placed in maximum 150 mm loose lifts and uniformly compacted to a minimum of 100 percent of the material's SPMDD.

4.2.5 Trench Backfill

The excavated materials will generally consist of fill material, silty clay with varying amounts of sand, sandy silt to silty sand with varying amounts of gravel and glacial till. The excavated materials at suitable water contents may be reused as trench backfill provided, they are free of significant amounts of organics, or other deleterious material and are placed and compacted as outlined below. However, the cohesive fill and silty clay materials encountered within the site should not be used as backfill material due to their high compressibility and high water contents. These soils should be separated and disposed off-site.

All oversized cobbles and boulders (i.e. greater than 150 mm in size), if encountered, should be removed from the backfill. The excavated soils are expected to be near and above their estimated optimum water contents for compaction, and therefore some drying prior to reuse as trench backfill may be required. All trench backfill from the top of the cover material to 1.0 m below subgrade elevation should be uniformly compacted to at least 95 percent of the materials SPMDD. From 1.0 m below subgrade to the subgrade elevation, the materials should be placed in maximum 300 mm loose lifts and uniformly compacted to at least 98 percent of material's SPMDD. Effort will be required to break down the cohesive till materials to reduce clod size, the presence of voids, and the associated potential for future settlements. Backfilling operations during cold weather should avoid inclusions of frozen lumps of material, snow, and ice. All pipes should be protected with a minimum of 1.4 m of earth cover, or equivalent insulation, for frost protection.

Alternatively, if soil water contents at the time of construction are too high, or if there is a shortage of suitable in-situ material, then an approved imported granular material which meets the requirements for OPSS.PROV 1010 Select Subgrade Material (SSM) could be used, placed, and compacted as described above. If strict control of backfill settlement is required, the trenches may be backfilled with unshrinkable fill.

Normal post-construction settlement of the compacted trench backfill should be anticipated, with the majority of such settlement taking place within about six months following the completion of trench backfilling operations. This settlement will be reflected at the surface of any new pavement placed over trenched sections. If the asphalt binder course is placed shortly following the completion of trench backfilling operations, any settlement that may be reflected by subsidence of the surface of the binder asphalt should be compensated for by placing an additional thickness of binder asphalt or by padding. Post-construction settlement of the restored ground surface in the off-road trench areas is also expected and should be topped-up and re-landscaped, as required.

It should be noted that in some cases, even though the compaction requirements have been met, the subgrade strength in the trench backfill areas may not be adequate to support heavy construction loading, especially during wet weather or where backfill materials wet of optimum have been placed. In any event, the subgrade should be proof-rolled and inspected by Golder prior to placing granular material for road reconstruction, as required, consistent with the prevailing weather conditions and anticipated use by construction traffic.

It is recommended that, where the utility trench encounters high permeability non-cohesive soils (if any), trench plugs should be constructed to prevent preferential water flow through the granular bedding and trench backfill. For preliminary purposes, these low permeability plugs could be constructed using excavated cohesive material or concrete, typically spaced at every 50 m to 100 m. The need for and frequency of trench plugs must be evaluated

in the field during construction and/or once the servicing details are known. As such, it should be included in the contract as a provisional item.

4.3 Soil Corrosivity

The corrosivity results were compared to Table 2 values obtained from a guideline entitled, "*Performance Guideline for Buried Steel Structures, Durability of Structural Plate Corrugated Steel Pipe and Deep Corrugated Structural Plate Structures*", dated February 2012.

The soil aggressiveness to concrete was evaluated by analytical testing for soluble sulphate concentrations in selected soil samples to the Canadian Standards Association (CSA) A23.1 (Table 1 and 3) Standard, "*Concrete materials and methods of concrete construction*". Based on the analytical results, the sulphate concentration in the soils is non-aggressive to concrete.

The electrical resistivity ranged between 287 and 746 ohm-cm which indicates that the soil corrosiveness is high (<5000 ohm-cm) as per Table A1.1 of CSA A23.2:19. The chloride concentration measured in the native soils ranged between 618 and 1990 µg/g (or mg/L), which is high indicating that the soil is very aggressive (i.e. >200 mg/L).

The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a high potential for corrosion of exposed ferrous metal, which should be considered during the design of the substructure.

These recommendations are provided as guidance only; the structural designer should take the results of the laboratory testing, the potential for corrosion and the ultimate selection of materials into consideration.

4.4 Soil Reuse / Excess Soil Disposal

Based on the results of the environmental testing and comparison to selected criteria (see above), the following comments are provided regarding the management of excavated and excess soil:

On-site Reuse of Excavated Soil

Based on the above limited testing, the soil associated with the depths and locations investigated has been impacted by the application of de-icing salt. Excavated soil resulting from the construction work can be reused on-site subject to the following:

- Soil screening, consisting of visual inspection for consistency of soil type, presence of debris, odours or staining, should be carried out during excavation and prior to reuse. Should any unexpected soil conditions be encountered, or any potential environmental issues be detected either during excavation or placement of the soil, reuse of the material should cease, and the soil be reassessed.
- Reuse of soil should be limited to the locations and depths for which testing was conducted. Additional testing would be required if material from different locations or depths is proposed for reuse.
- Reuse is subject to the geotechnical suitability of the material.
- The reuse of EC and SAR impacted soil is subject to acceptance and approval from the property owner. Its reuse should generally be limited to the project area associated with the proposed construction work and where there will be continued application of de-icing salt. EC and SAR impacted soil should not be reused within 30 m of a water body or 100 m of a potable water well.

Off-site Reuse of Excess Soil

As of January 1, 2021, the new Excess Soil Quality Standards, under O.Reg. 406/19, came into effect. A preliminary review of the data collected as part of this investigation suggests that the soil (except in the vicinity of borehole KS9) would be suitable for off-site reuse (based on the comparison standard and associated land use noted above) subject to the requirements relating to salt-impacted excess soil. Specifically, in addition to the requirements relating to on-site reuse (see above), the following would also be required:

- The reuse of EC and SAR impacted soil is subject to acceptance and approval from the receiver/property owner. Its reuse should generally be limited to a road allowance (where there will be continued application of de-icing salt) or within a commercial/industrial property to which the non-potable standards apply or at a depth of at least 1.5 m below ground surface. The material should not be reused within 30 m of a water body, within 100 m of a potable water well or on land that will be used for growing crops or pasturing livestock unless the excess soil is placed 1.5 m or greater below the soil surface.
- Soil collected from borehole KS9 (at a depth of approximately 0.8 to 1.2 mbgs) exceeded the Table 2.1 Excess Soil Quality Standard for PHC F2 and F3. Material in the vicinity of this test location is not suitable for reuse based on the comparison standard and land use noted above. Additional testing should be considered to further characterize soil quality at this location prior to reuse.

It is noted that this assessment was conducted for preliminary planning only and is not intended to meet the requirements of O.Reg. 406/19. This regulation should be reviewed in conjunction with the proposed construction work including construction schedule, locations from which excess soil will be generated, soil volumes, proposed soil management options and reuse location. There are additional requirements of the regulation that take effect in 2022 for which pre-planning will be required and which should be considered in conjunction with the work including the preparation of an assessment of past uses report, sampling and analysis plan, excess soil characterization report, soil destination report and a soil tracking program. There are also several timing extensions and exemptions provided in the regulation for infrastructure projects which should be reviewed in light of the proposed work. The reuse/receiving site may have specific acceptance criteria which should be determined as part of the construction planning process. Furthermore, movement of soil to a site that has a Record of Site Condition on file with the MECP may require that specific testing protocols be followed and that the materials must satisfy site specific standards.

Off-site Soil Disposal

In the event that excess soil cannot be reused on- or off-site, the excess soil may require management at a MECP approved receiving or waste management facility. The receiving facility will have specific acceptance criteria which would need to be addressed in conjunction with the project planning.

4.5 Monitoring Well Decommissioning

Nine groundwater monitoring wells (Boreholes KS1 to KS4, and KS7 to KS11) were installed to permit monitoring of the groundwater level at the site. Ontario Regulation (O.Reg.) 903 amended by O.Reg. 128/03 of the Ontario Water Resources Act requires that monitoring wells are properly abandoned/decommissioned by qualified personnel. We recommend that the decommissioning of the monitoring wells be carried out as part of the construction activities at the site so that water level measurements can be taken immediately prior to construction. If requested, Golder could provide assistance in arranging for the decommissioning of the monitoring wells by a licensed water well drilling contractor.

4.6 Construction Monitoring and Inspections

The geotechnical aspects of the final design drawings and specifications should be reviewed by Golder prior to tendering and construction to confirm that the intent of this report has been met. During construction, full time inspections should be carried out by Golder to confirm that the conditions exposed are consistent with those encountered in the boreholes and in-situ materials testing should be carried out to monitor conformance to the pertinent project specifications. HMA and granular materials testing should be carried out in CCIL and CSA certified laboratories.

5.0 CLOSURE

We trust that this report provides sufficient information for you to proceed with the detailed design of the project. If you have any questions regarding the contents of this report, please contact our office.

Signature Page

Golder Associates Ltd.

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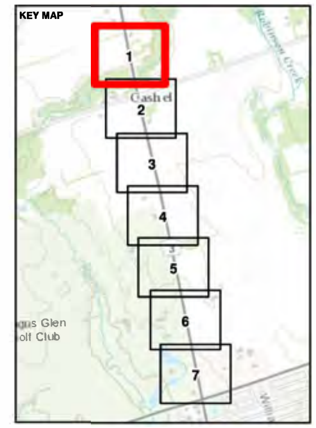
TO/IM/ACB/SEMP/ljv

LEGEND

- APPROXIMATE BOREHOLE LOCATION – ROAD LANE
- APPROXIMATE BOREHOLE LOCATION – ROAD SHOULDER
- APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION



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REFERENCE(S)
1. BASE DATA - MNRF 2020
2. BASE IMAGERY - SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS,

CLIENT
THE REGIONAL MUNICIPALITY OF YORK

PROJECT
PROPOSED ROAD IMPROVMENTS OF KENNEDY AVENUE, MARKHAM ONTARIO

TITLE
BOREHOLE LOCATION PLAN

CONSULTANT: GOLDER

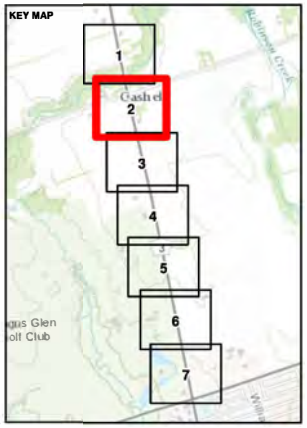
YYYY-MM-DD	2021-04-05
DESIGNED	CGE
PREPARED	CGE
REVIEWED	AP
APPROVED	SEMP

PROJECT NO.	CONTROL	REV.	FIGURE
20146456	0001	-	1

LEGEND

- APPROXIMATE BOREHOLE LOCATION – ROAD LANE
- APPROXIMATE BOREHOLE LOCATION – ROAD SHOULDER
- APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION

KEY MAP



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REFERENCE(S)

1. BASE DATA - MNRF 2020
2. BASE IMAGERY - SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS,

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PROJECT
PROPOSED ROAD IMPROVMENTS OF KENNEDY AVENUE, MARKHAM ONTARIO

TITLE
BOREHOLE LOCATION PLAN

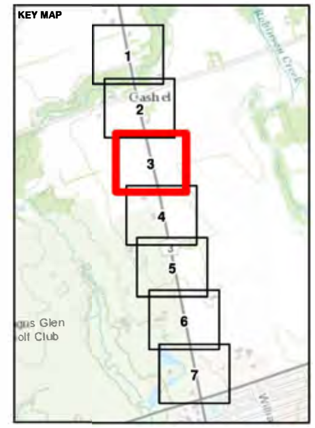
CONSULTANT
GOLDER

YYYY-MM-DD	2021-04-05
DESIGNED	CGE
PREPARED	CGE
REVIEWED	AP
APPROVED	SEMP

PROJECT NO.	CONTROL	REV.	FIGURE
20146456	0001	-	2

LEGEND

APPROXIMATE BOREHOLE LOCATION – ROAD LANE
APPROXIMATE BOREHOLE LOCATION – ROAD SHOULDER
APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION



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REFERENCE(S)
1. BASE DATA - MNRF 2020
2. BASE IMAGERY - SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS,

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PROJECT NO.	CONTROL	REV.	FIGURE
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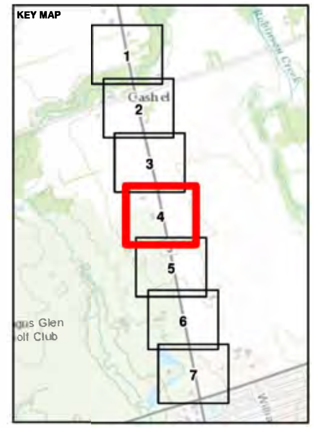
LEGEND

- APPROXIMATE BOREHOLE LOCATION – ROAD LANE
- APPROXIMATE BOREHOLE LOCATION – ROAD SHOULDER
- APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION



0 50 100

1:1,500 METRES

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APPROVED	SEMP

PROJECT NO.	CONTROL	REV.	FIGURE
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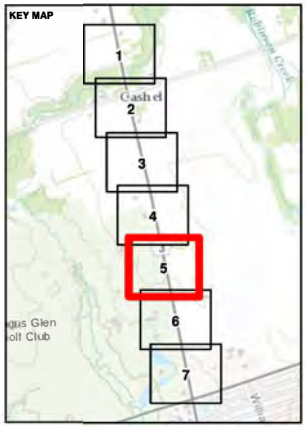
LEGEND

- APPROXIMATE BOREHOLE LOCATION – ROAD LANE
- APPROXIMATE BOREHOLE LOCATION – ROAD SHOULDER
- APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION



0 50 100

1:1,500 METRES

REFERENCE(S)

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2. BASE IMAGERY - SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS,

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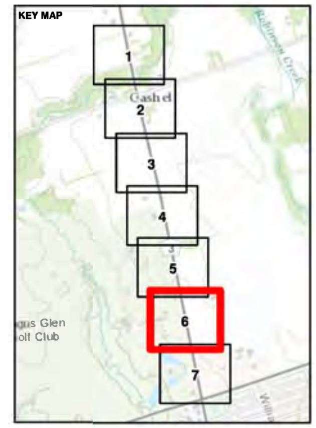
LEGEND

- APPROXIMATE BOREHOLE LOCATION – ROAD LANE
- APPROXIMATE BOREHOLE LOCATION – ROAD SHOULDER
- APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION



0 50 100

1:1,500 METRES

REFERENCE(S)
1. BASE DATA - MNRF 2020
2. BASE IMAGERY - SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS,

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PROJECT NO.	CONTROL	REV.	FIGURE
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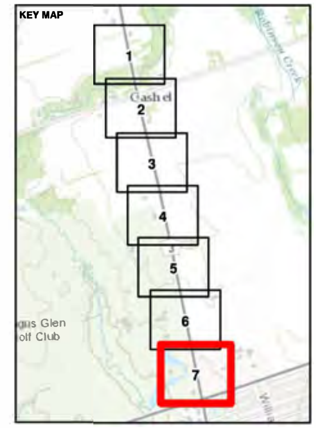
LEGEND

- APPROXIMATE BOREHOLE LOCATION – ROAD LANE
- APPROXIMATE BOREHOLE LOCATION – ROAD SHOULDER
- APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION



0 50 100
1:1,500 METRES

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PROJECT NO.	CONTROL	REV.	FIGURE
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Section 2 – Sealed cracks

Section 2 – Typical sealed cracks

Section 2 – Typical sealed cracks

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YYYY-MM-DD	22021-03-09
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CHECKED BY	ACB

PROJECT
Geotechnical Investigation
Proposed Road Improvements of Kennedy Avenue, Markham, Ontario

TITLE
Site Photographs

PROJECT No. 20146456

Section 2 – Asphalt surface near the construction site

Section 2 – Asphalt surface near the construction site

Section 1 – Transverse crack

Section 1 – Map cracking

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CHECKED BY ACB

PROJECT
Geotechnical Investigation
Proposed Road Improvements of Kennedy Avenue, Markham, Ontario

TITLE
Site Photographs

PROJECT No. 20146456

Section 1 – Longitudinal cracking

Section 1 – Typical cracking

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PROJECT
Geotechnical Investigation
Proposed Road Improvements of Kennedy Avenue, Markham, Ontario

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TITLE
Site Photographs

GOLDER

PROJECT No. 20146456

APPENDIX A

Important Information and Limitations of This Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

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.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

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.

APPENDIX B

Pavement Condition Survey Sheets

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kennedy Road **Location From** 250 m south of intersection with Elgin Mills Road **To** 150 m north of intersection with Elgin Mills Road

Section Length 0.4 (Km) **Survey Date** March 9, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. **Work Project No.** 20146456 **Class** A (F: Freeway, C: Connecting Link, A: Major Arterial, M: Minor Arterial, R: Residential)

Pavement Condition Rating (PCR) 40-45 **Riding Condition Rating (RCR)** 5 **Evaluated by** IM

Riding Condition Rating (At Posted Speed)

10	8	6	4	2	0
Excellent	Good	Fair	Poor	Very Poor	
Smooth and Pleasant	Comfort-able	Uncomfort-able	Very Rough and Bumpy	Dangerous at Posted Speed	

Pavement Distress Manifestation			Severity of Distress: Slight	Moderate	Severe	Density of Distress % (Extent of Occurrence): Intermittent	Frequent	Extensive
			1	2	3	< 20	20-50	> 50
						1	2	3
Surface Defects	Ravelling	1	X				X	
	Flushing	2						
	Potholes	3	X			X		
	Pavement Edge Breaks	4	X			X		
	Manholes and Catchbasins	5						
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7		X				X
	Distortion	8	X				X	
	Utility Trenches	9						
Cracking	Longitudinal	10		X				X
	Transverse	11		X			X	
	Pavement Edge	12	X			X		
	Map	13		X				X
	Alligator	14		X		X		

Distress Comments (Items not covered above)

The section from approx. 250 m south of Elgin Mills to approximately 150 m north of the intersections with Elgin Mills Road is in worse condition then the rest of the project limits.

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli	Right Mod	Right Sev	Left Sli	Left Mod	Left Sev	Density of Distress % Extent of Occurrence: Right <20	Right 20-50	Right >50	Left <20	Left 20-50	Left >50
			1	2	3	1	2	3	1	2	3	1	2	3
Paved Full		Pavement Edge												
		Paved Shoulder												
		Separation												
Paved Partial	X	Edge Cracking	X			X			X			X		
		Breakup and Potholes												
Surface Treated														
		Distortion												
Primed		Pavement Edge Curb Sepatation												

Maitenance Treatment: Pavement	Extent of Occurrence % <20	20-50	>50	Shoulder	Extent of Occurrence % <20	20-50	>50
	1	2	3		1	2	3
Manual Patching				Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM (MUNICIPALITIES)

Road No. (Street) Kennedy Road **Location From** Major Mackenzie Drive **To** 400 m north of Elgin Mills Road

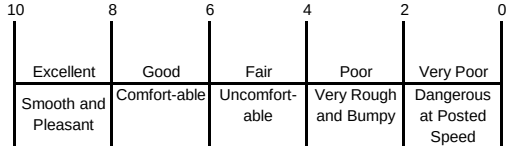
Excluding 400 m long Section 1

Section Length 2.0 (Km) **Survey Date** March 9, 2021 **Traffic Direction** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound)

Contract No. **Work Project No.** 20146456 **Class** A (F: Freeway, C: Connecting Link, A: Major Artierial, M: Minor Artierial, R: Residential)

Pavement Condition Rating (PCR) 50 **Riding Condition Rating (RCR)** 6 **Evaluated by** IM

Riding Condition Rating (At Posted Speed)



Pavement Distress Manifestation			Severity of Distress: Slight (1)	Moderate (2)	Severe (3)	Density of Distress % Extent of Occurrence: Intermittent (< 20, 1)	Frequent (20-50, 2)	Extensive (> 50, 3)
Surface Defects	Ravelling	1	X				X	
	Flushing	2						
	Potholes	3	X			X		
	Pavement Edge Breaks	4	X			X		
	Manholes and Catchbasins	5						
Surface Deformation	Rippling and Shoving	6						
	Wheel Track Rutting	7	X					X
	Distortion	8	X			X		
	Utility Trenches	9						
Cracking	Longitudinal	10	X				X	
	Transverse	11		X		X		
	Pavement Edge	12	X			X		
	Map	13	X			X		
	Alligator	14	X			X		

Distress Comments (Items not covered above) Most of the cracks are sealed. Ditches generaly well maintained.

Recommendation by Evaluator

Shoulder Distress Manifestation			Severity of Distress: Right Sli (1)	Right Mod (2)	Right Sev (3)	Left Sli (1)	Left Mod (2)	Left Sev (3)	Density of Distress % Extent of Occurrence: Right <20 (1)	Right 20-50 (2)	Right >50 (3)	Left <20 (1)	Left 20-50 (2)	Left >50 (3)
Paved Full		Pavement Edge Paved Shoulder Separation												
Paved Partial	X	Edge Cracking	X			X			X			X		
Surface Treated		Breakup and Potholes												
Primed		Distortion												
		Pavement Edge Curb Sepatation												

Maitenance Treatment								
Pavement	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)	Shoulder	Extent of Occurrence % <20 (1)	20-50 (2)	>50 (3)
Manual Patching				Manual patching			
Machine Patching				Manual Spray Patching			
Manual Spray patching				Manual Chip Seal			
Manual Chip Seal				Crack Rout and Seal			
Machine Chip Seal							
Fog Seal							
Surface Treatment							
Manual Burn & Seal							
Crack Rout and Seal							

APPENDIX C

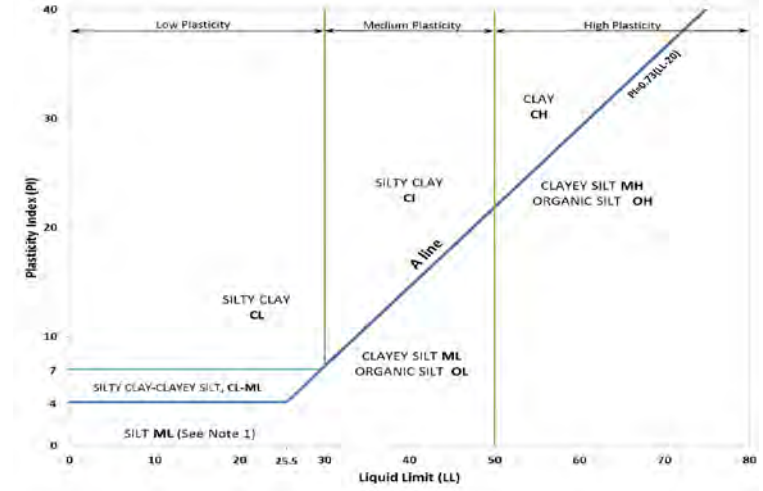
Borehole Records

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 ($\phi = 0$ 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: 20146456

LOCATION: N 4861996.50; E 634983.99

RECORD OF BOREHOLE: KP1

SHEET 1 OF 1

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		204.50									
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	ASPHALT (140 mm thick)		0.00									
		Crushed granular; brown		0.14 / 204.05	1A	AS	-						
		FILL - (SP-SM) SAND, trace gravel, some fines; brown; non-cohesive, moist		0.45 / 203.80	1B								
1		(CI) SILTY CLAY, some sand; brown, oxidation staining; cohesive, w<PL, very stiff		0.70	2	SS	15				W	MH	
					3	SS	15						
2		END OF BOREHOLE		202.52 / 1.98									
		NOTES:											
		1. Borehole caved to a depth of 1.3 m upon completion of drilling.											
		2. Borehole was dry upon completion of drilling.											
3													
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP2

SHEET 1 OF 1

LOCATION: N 4862126.14; E 634957.69

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		207.80							
0	B57 Truck Mount; 150 mm O.D. Hollow Stem Auger	ASPHALT (160 mm thick)		0.00							
		Crushed granular with RAP; brown		0.16 / 207.37	1A	AS	-				
		FILL- (SP-SM) SAND, trace gravel, some fines; brown; non-cohesive, moist		0.43 / 207.04	1B						
1		FILL - (CL-ML) gravelly SILTY CLAY-CLAYEY SILT and SAND, brown; cohesive, w>PL, stiff to very stiff		0.76	2	SS	11		⊢⊖⊣	MH	
					3	SS	18				
2				205.82							
		END OF BOREHOLE		1.98							

NOTES:

1. Borehole caved to a depth of 1.5 m upon completion of drilling.

2. Borehole was dry upon completion of drilling.

3. RAP = Recycled asphalt pavement

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP3

SHEET 1 OF 1

LOCATION: N 4862283.37; E 634927.65

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		212.00									
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00 / 211.60	1A	AS	-						
		FILL - (SM) SILTY SAND, trace gravel: brown; non-cohesive, moist		0.40 / 211.24	1B								
1		FILL - (CL) SILTY CLAY, some sand; dark grey and black, organic inclusions; cohesive, w~PL, stiff		0.76 / 210.63	2	SS	11						
		(CL) SILTY CLAY and SAND, some gravel; brown; cohesive, w<PL, very stiff		1.37 / 210.02	3	SS	20						
2		END OF BOREHOLE		1.98									
3		NOTES: 1. Borehole caved to a depth of 1.2 m upon completion of drilling. 2. Borehole was dry upon completion of drilling.											
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP4

SHEET 1 OF 1

LOCATION: N 4862501.24; E 634887.30

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		217.50							
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	ASPHALT (120 mm thick)		0.00							
		Crushed granular with RAP; brown		0.12 / 217.15	1A	AS	-				
		FILL - (SM) SILTY SAND, trace gravel: brown; non-cohesive, moist		0.35 / 216.75	1B						
1		FILL - (CL-ML) gravelly SILTY CLAY-CLAYEY SILT and SAND, brown; cohesive, w>PL, stiff		0.75 / 216.13	2	SS	13		○		
		(SM) SILTY SAND, some gravel; brown; non-cohesive, moist, compact		1.37 / 215.52	3	SS	16				
2		END OF BOREHOLE		1.98							

NOTES:

1. Borehole caved to a depth of 1.5 m upon completion of drilling.

2. Borehole was dry upon completion of drilling.

3. RAP = Recycled asphalt pavement

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP5

SHEET 1 OF 1

LOCATION: N 4862688.03; E 634846.61

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		219.80									
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00	1A								
				219.41									
		FILL - (SP) SAND, some gravel, trace fines: brown; non-cohesive, moist		0.39		AS	-						
		Recycled asphalt pavement		0.55 / 219.02	1B								
1		FILL - (CL) SILTY CLAY, some sand; dark brown; cohesive, w>PL, stiff		0.78	2	SS	9						
				218.43									
		(CL) SILTY CLAY and SAND, some gravel; brown; cohesive, w<PL, stiff		1.37	3	SS	8				○		
2				217.82									
		END OF BOREHOLE		1.98									

NOTES:

1. Borehole caved to a depth of 1.2 m upon completion of drilling.

2. Borehole was dry upon completion of drilling

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP6

SHEET 1 OF 1

LOCATION: N 4862905.53; E 634805.64

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		221.80									
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	ASPHALT (200 mm thick)		0.00 / 221.60									
		Crushed granular; brown		0.20 / 221.40	1A	AS	-					M	
		FILL - (SP) SAND, some gravel, trace fines; brown; non-cohesive, moist		0.40 / 220.98	1B / 2A								
1		FILL - (CL) SILTY CLAY, some sand; dark brown; cohesive, w>PL, stiff		0.82 / 220.43	2B	SS	8				○		
		(SM) gravelly SILTY SAND; brown (TILL); non-cohesive, moist, compact		1.37 / 219.82	3	SS	28						
2		END OF BOREHOLE		1.98									
		NOTES: 1. Borehole caved to a depth of 1.3 m upon completion of drilling. 2. Borehole was dry upon completion of drilling.											
3													
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JL
CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP7

SHEET 1 OF 1

LOCATION: N 4863105.31; E 634761.62

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, 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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		222.80									
0	B57 Truck Mount; 150 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00	1A								
				222.25									
		FILL - (SP) SAND, some gravel, trace fines: brown; non-cohesive, moist		0.55	1B	AS	-						
				0.65									
1		FILL - (SM) SILTY SAND and GRAVEL with RAP; brown; non-cohesive, moist, compact		221.83	2A	SS	18				○	M	
				0.97	2B								
		FILL - (SM) SILTY SAND and GRAVEL; brown; non-cohesive, moist, compact		221.43									
				1.37									
		(CI) SILTY CLAY, trace sand; brown; cohesive, w>PL, very stiff			3	SS	15				○		
				220.82									
2		END OF BOREHOLE		1.98									
		NOTES:											
		1. Borehole caved to a depth of 1.3 m upon completion of drilling.											
		2. Borehole was dry upon completion of drilling.											
		3. RAP = Recycled asphalt pavement											
3													
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP8

SHEET 1 OF 1

LOCATION: N 4863330.56; E 634715.76

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		223.40									
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	ASPHALT (120 mm thick)		0.00									
		Crushed granular; brown		0.12 / 223.02	1A	AS	-						
		FILL - (SP) SAND, some gravel, trace fines: brown; non-cohesive, moist		0.38 / 222.78	1B								
		ASPHALT (260 mm)		0.62 / 222.52	2A	SS	69/ 0.18*						
1		FILL - (CL) gravelly SILTY CLAY and SAND, grey; cohesive, w>PL, hard to stiff		0.88	2B						○		
		- Auger grinding at a depth of 1.1 m			3	SS	11						
2		END OF BOREHOLE		221.42 / 1.98									

NOTES:

1. Borehole caved to a depth of 1.4 m upon completion of drilling.

2. Borehole was dry upon completion of drilling.

3. *N value may not be representative of the soil's consistency due to obstructions encountered.

3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP9

SHEET 1 OF 1

LOCATION: N 4863498.29; E 634672.80

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		223.20									
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00 / 222.80	1A	AS	-						
		FILL - (SP) SAND, some gravel, trace fines: brown; non-cohesive, moist		0.40 / 222.30	1B, 2A								
1		FILL - (CL) gravelly SILTY CLAY and SAND, dark brown; cohesive, w<PL, stiff to very stiff		0.90 / 221.22	2B, 3	SS	14, 15						
2		END OF BOREHOLE		1.98									
		NOTES:											
		1. Borehole caved to a depth of 1.2 m upon completion of drilling.											
		2. Borehole was dry upon completion of drilling.											
3													
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4863698.71; E 634626.76

RECORD OF BOREHOLE: KP10

SHEET 1 OF 1

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		223.50									
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	ASPHALT (180 mm thick)		0.00 / 223.32									
		Crushed granular; brown		0.18 / 223.14	1A	AS	-						
		FILL - (SP-SM) gravelly SAND, some fines: brown; non-cohesive, moist		0.36 / 222.75	1B						○	M	
1		FILL - (CL) gravelly SILTY CLAY and SAND, dark brown, organic inclusions; cohesive, w>PL, stiff		0.75	2	SS	12						
					3	SS	12				○		
2		END OF BOREHOLE		221.52 / 1.98									
		NOTES: 1. Borehole caved to a depth of 1.3 m upon completion of drilling. 2. Borehole was dry upon completion of drilling.											
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6													
7													
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10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4863918.31; E 634575.98

RECORD OF BOREHOLE: KP11

SHEET 1 OF 1

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		221.20							
0	B57 Truck Mount; 150 mm O.D. Hollow Stem Auger	ASPHALT (180 mm thick)		0.00 / 221.02							
		Crushed granular; brown		0.18	1A	AS	-				
		FILL - (SP-SM) gravelly SAND, some fines: brown; non-cohesive, moist		0.34 / 220.62	1B						
		FILL - (CL) gravelly SILTY CLAY and SAND; dark brown, organic inclusions; cohesive, w<PL, very stiff to hard		0.58	2	SS	18		W	MH	
2		- Auger resistance between a depth of 1.8 m and 1.9 m		219.22	3	SS	61*				
		END OF BOREHOLE		1.98							

NOTES:

1. Borehole caved to a depth of 1.2 m upon completion of drilling.

2. Borehole was dry upon completion of drilling.

3. *N value may not be representative of the soil's consistency due to obstructions encountered

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KP12

SHEET 1 OF 1

LOCATION: N 4864147.22; E 634531.61

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		220.10									
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00	1A								
				219.65									
		FILL - (SP-SM) gravelly SAND, some fines: brown; non-cohesive, moist		0.45	1B	AS	-						
				219.28									
1		(CI) SILTY CLAY, some sand, some gravel; brown; cohesive, w>PL, stiff		0.82	2	SS	8						
				218.73									
		(ML) sandy SILT; brown; non-cohesive, wet, compact		1.37	3	SS	22				○	MH	
				218.12									
2		END OF BOREHOLE		1.98									
		NOTES:											
		1. Borehole caved to a depth of 1.3 m upon completion of drilling.											
		2. Borehole was dry upon completion of drilling.											
3													
4													
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6													
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8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4864251.68; E 634519.69

RECORD OF BOREHOLE: KP13

SHEET 1 OF 1

BORING DATE: January 21, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		222.80									
0	B57 Truck Mount; 150 mm O.D. Hollow Stem Auger	ASPHALT (240 mm thick)		0.00 / 222.56									
		Crushed granular; brown		0.24	1A	AS	-						
		FILL - (SP-SM) gravelly SAND, some fines; brown; non-cohesive, moist, compact		0.40	1B								
1				221.75	2A								
		FILL - (SM) SILTY SAND and GRAVEL; brown; non-cohesive, moist, compact		1.05 / 221.43	2B	SS	15				○		
		(ML) sandy SILT, some gravel, brown; non-cohesive, moist, compact		1.37	3	SS	19						
2				220.82									
		END OF BOREHOLE		1.98									
		NOTE:											
		1. Borehole open and dry upon completion of drilling.											
3													
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS1

SHEET 1 OF 2

LOCATION: N 4861907.72; E 635019.68

BORING DATE: January 20, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		204.00							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	ASPHALT (265 mm thick)		0.00	1A	AS	-				
				203.74							
		Crushed granular; brown		0.26	1B						
				203.49							
		FILL - (SP-SM) gravelly SAND, some fines; brown; non-cohesive, moist, compact		0.51							
1					2	SS	12				
				202.63							
		FILL - (CL-ML) gravelly SILTY CLAY-CLAYEY SILT and SAND; brown, containing asphalt pieces; cohesive, w>PL, stiff		1.37							
					3	SS	11		○		
2											January 29, 2021 ▽
					4	SS	15				
				201.10							
3		(CL) SILTY CLAY and SAND, some gravel; grey (TILL); cohesive, w~PL to w<PL, very stiff to hard		2.90	5	SS	21		⊕—⊣	MH	
											Bentonite
4		- Auger grinding between depths of 4.3 m and 4.4 m			6	SS	50/ 0.13				
5											
6					7	SS	56		○		
7											Sand
					8	SS	49				
8											Screen
9											
					9	SS	70		○		Sand
				194.25							
		END OF BOREHOLE		9.75							
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE
1 : 50

GOLDER

LOGGED: YS
CHECKED: TO

PROJECT: 20146456

RECORD OF BOREHOLE: KS1

SHEET 2 OF 2

LOCATION: N 4861907.72; E 635019.68

BORING DATE: January 20, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
		NOTES: 1. Water encountered at a depth of 9.0 m during drilling. 2. Groundwater level was measured in monitoring well at a depth of 2.0 mbgs (El. 202m) on January 29, 2021.									
11											
12											
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18											
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20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4862189.80; E 634962.05

RECORD OF BOREHOLE: KS2

SHEET 1 OF 2

BORING DATE: January 4, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○)	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		209.30							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00 / 208.95	1A	AS	-				
		FILL - (SM) SILTY SAND, trace gravel: brown; non-cohesive, moist		0.35 / 208.54	1B						
1		FILL - (CL-ML) gravelly SILTY CLAY-CLAYEY SILT and SAND; brown; cohesive, w<PL, stiff		0.76 / 207.93	2	SS	8		○		
		FILL - (ML) sandy SILT; brown; non-cohesive, wet, compact		1.37 / 207.17	3	SS	14				▽ January 29, 2021
2		(ML) SILT and SAND, trace gravel; brown (TILL); non-cohesive, moist, very dense		2.13 / 205.26	4	SS	65		○	MH	Bentonite
3					5	SS	85				
4		(CL) SILTY CLAY and SAND, some gravel; grey (TILL); cohesive, w<PL, hard		4.04	6	SS	54		○		
5											
6					7	SS	91				Sand
7											
8					8	SS	92		○		Screen
9				200.03	9	SS	50/0.13				Sand
		END OF BOREHOLE		9.27							
		NOTES: 1. Borehole was open and dry upon completion of drilling.									
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS2

SHEET 2 OF 2

LOCATION: N 4862189.80; E 634962.05

BORING DATE: January 4, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
		2. Groundwater level was measured in monitoring well at a depth of 1.7 mbgs (El. 207.6m) on January 29, 2021.									
11											
12											
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14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4862378.69; E 634920.57

RECORD OF BOREHOLE: KS3

BORING DATE: January 4, 2021

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		214.70							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00	1A						
				214.29		AS	-				
		FILL - (SM) SILTY SAND, trace gravel; brown; non-cohesive, moist		0.41	1B				○	M	
				214.00							
		FILL - (CL) SILTY CLAY and SAND, some gravel; dark brown; cohesive, w>PL, firm		0.70							
1					2	SS	7				
				213.33							
		(CL) SILTY CLAY and SAND, some gravel; grey (TILL); cohesive, w<PL, very stiff to hard		1.37							
					3	SS	27		○		
2											
					4	SS	60				
				211.80							Bentonite
3		(SM) SILTY SAND, some gravel; brown (TILL); non-cohesive, moist, very dense		2.90							
					5	SS	50/ 0.13		○		
				210.66							
4		(CL) SILTY CLAY and SAND, some gravel; grey (TILL); cohesive, w<PL, hard		4.04							
					6	SS	96/ 0.25				
5											
6											Sand
					7	SS	50/ 0.13		○		
7											Screen
					8	SS	50/ 0.13				Sand
				206.80							▽ January 29, 2021
8		END OF BOREHOLE		7.90							
		NOTES:									
		1. Borehole was open and dry upon completion of drilling.									
9		2. Groundwater level was measured in monitoring well at a depth of 7.7 mbgs (El. 206.9m) on January 29, 2021.									
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS4

SHEET 1 OF 2

LOCATION: N 4862601.12; E 634875.39

BORING DATE: January 18, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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 WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		218.70							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00	1	AS	-				
				218.28							
		FILL - (SM) SILTY SAND, trace gravel; brown; non-cohesive, moist, loose		0.42							
1					2	SS	6				
				217.33							
		FILL - (CI) SILTY CLAY, some sand; brown; cohesive, w>PL, firm		1.37							
					3	SS	7		W		
2				216.57							
		FILL - (SM) SILTY SAND, tarce gravel; brown; non-cohesive, moist, loose		2.13							
					4	SS	6				
				215.80							
3		(SM) SILTY SAND, fine; brown; non-cohesive, moist to wet, very dense		2.90							
					5	SS	61			MH	
4											
					6	SS	50/ 0.15				
5											Bentonite
6											
					7	SS	73				
											▽ January 29, 2021
7		- 0.3m thick sand blowout was observed at 7.6 m									
					8	SS	50				
8											
9		- 0.9m thick sand blowout was observed at 9.1 m									
					9	SS	50/ 0.13				
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS4

SHEET 2 OF 2

LOCATION: N 4862601.12; E 634875.39

BORING DATE: January 18, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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 WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	B57 Truck Mount 200 mm O.D. Hollow Stem Auger	(SM) SILTY SAND, fine; brown; non-cohesive, moist to wet, very dense - 1.5m thick sand blowout was observed at 10.7 m			10	SS	50				
11											
12					11	SS	65		○		Bentonite
13											
14					12	SS	50/0.13				
15											Sand
16					13	SS	90		○		Screen
				201.94							
		END OF BOREHOLE		16.76							
17		NOTES: 1. Water was encountered at a depth of 4.6 m during drillling. 2. Sand blowout was cleaned out using water prior to advancing augers. 3. Groundwater level was measured in monitoring well at a depth of 6.6 mbgs (El. 211.6m) on January 29, 2021. 4. SPT N-value could not be carried out at 16.7mbgs due to a 1.5m sand blowout. The sand could not be completely cleaned out during drilling.									
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4862815.63; E 634829.53

RECORD OF BOREHOLE: KS5

SHEET 1 OF 1

BORING DATE: January 15, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		221.30							
0	B57 Truck Mount, 150 mm O.D. Hollow Stem Auger	ASPHALT (280 mm thick)		0.00 / 221.02							
		Crushed granular; brown		0.28	1A	AS	-				
		FILL - (SP) SAND, some gravel, trace fines; brown; non-cohesive, moist		0.41 / 220.54	1B						
1		(Cl) SILTY CLAY, some sand; brown; cohesive, w>PL, stiff to very stiff		0.76	2	SS	9		○		
					3	SS	24				
2				219.17							
		(SP) SAND, trace fines; brown; non-cohesive, moist to wet, very dense		2.13	4	SS	65		○		
3					5	SS	56				
4					6	SS	83		○		
5											
6					7	SS	50/ 0.13				
7											
				213.43	8	SS	50/ 0.10		○		
8		END OF BOREHOLE		7.87							
		NOTE:									
		1. Borehole was open and dry upon completion of drilling.									
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS6

SHEET 1 OF 1

LOCATION: N 4863022.33; E 634786.84

BORING DATE: January 22, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, 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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		222.30							
0	B57 Truck Mount; 150 mm O.D. Hollow Stem Auger	ASPHALT (140 mm thick)		0.00							
		Crushed granular with RAP; brown		0.14 / 221.88	1A						
		FILL - (SP) SAND, some gravel, trace fines: brown; non-cohesive, moist		0.42	1B	AS	-				
				221.45	2A	SS	13				
1		FILL - (CL) SILTY CLAY, some sand; brown; cohesive, w>PL, stiff		0.85	2B						
				220.93							
		(ML) SILT and SAND, some gravel; brown (TILL); non-cohesive, moist, compact to dense		1.37	3	SS	19		○		
2					4	SS	37				
3					5	SS	37		○	MH	
4				218.26							
		(SM) SILTY SAND, some gravel; brown; non-cohesive, moist, very dense		4.04	6	SS	84				
5											
6					7	SS	70		○		
7											
				214.40	8	SS	50/0.13				
8		END OF BOREHOLE		7.90							
		NOTE:									
		1. Borehole was open and dry upon completion fo drilling.									
		2. RAP = Recycled asphalt pavement									
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4863216.48; E 634749.77

RECORD OF BOREHOLE: KS7

BORING DATE: January 19, 2021

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		223.00							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00	1	AS	-				
				222.43							
		FILL - (SP) SAND, some gravel, trace fines: brown; non-cohesive, moist, dense		0.57							
1					2	SS	32		○		
				221.63							
		FILL - (CL) gravelly SILTY CLAY and SAND; dark grey and brown, organic inclusions; cohesive, w>PL, stiff		1.37							
					3	SS	11				
2				220.87							
		(CL) SILTY CLAY and SAND, some gravel; brown; cohesive, w>PL, stiff		2.13							▽ January 29, 2021
					4	SS	10		○		
3											Bentonite
					5	SS	11				
4				218.96							
		(SM) SILTY SAND; brown; non-cohesive, wet, very dense		4.04							
					6	SS	58		○		
5											
6											Sand
					7	SS	89				
											Screen
7											
				215.10	8	SS	50/ 0.13		○		Sand
8		END OF BOREHOLE		7.90							
		NOTES:									
		1. Water was encountered at a depth of 4.6 m during drilling.									
		2. Groundwater level was measured in monitoring well at a depth of 2.2 mbgs (El. 220.8m) on January 29, 2021.									
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS8

SHEET 1 OF 2

LOCATION: N 4863405.94; E 634706.26

BORING DATE: January 22, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		223.50							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00	1A						Sand
				223.02		AS	-				
		FILL - (SP) SAND, some gravel, trace fines; brown; non-cohesive, moist		0.48	1B						
				222.65	2A						
1		FILL - (CI) SILTY CLAY, some sand, trace gravel; dark grey and brown, organic inclusions; cohesive, w>PL, stiff to firm		0.85	2B	SS	13				
					3	SS	9				
2											
					4	SS	7				Bentonite
				220.60							
3		(CL) SILTY CLAY and SAND, trace gravel; brown; cohesive, w>PL, firm		2.90	5	SS	7			MH	
4				219.46							▽ January 29, 2021
		(CL) SILTY CLAY and SAND, some gravel; brown to grey (TILL); cohesive, w<PL, hard		4.04	6	SS	40				
5											
		- Becoming grey at a depth of 5.6 m									
6					7	SS	80				
7											Grout
8					8	SS	48				
9											
					9	SS	31				
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4863405.94; E 634706.26

RECORD OF BOREHOLE: KS8

SHEET 2 OF 2

BORING DATE: January 22, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	(CL) SILTY CLAY and SAND, some gravel; brown to grey (TILL); cohesive, w<PL, hard									
11					10	SS	80/ 0.28				Grout
12					11	SS	50/ 0.07		○		
13											Bentonite
14					12	SS	50/ 0.07				
15											Sand
15					13	SS	75		○		
16											Screen
17				206.41	14	SS	130/ 0.18				Sand
		END OF BOREHOLE		17.09							
18		NOTES:									
19		1. Water was encountered at a depth of 7.0 m during drilling.									
20		2. Groundwater level was measured in monitoring well at a depth of 4.1 mbgs (El. 219.4m) on January 29, 2021.									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JL

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS9

SHEET 1 OF 2

LOCATION: N 4863597.66; E 634660.05

BORING DATE: January 28, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○)	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		222.90							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00	1A	AS	-				
				222.48							
		FILL - (SP) SAND, some gravel, trace fines; brown; non-cohesive, moist		0.42	1B						
				222.17							
1		FILL - (CL) gravelly SILTY CLAY and SAND; brown and black, organic inclusions; cohesive, w<PL, stiff to very stiff		0.73	2	SS	28		○		
					3	SS	10				
2				220.77							
		(SM) SILTY SAND; brown; non-cohesive, moist to wet, compact to dense		2.13	4	SS	19		○		
3					5	SS	29				
4											
					6	SS	42		○		
5											Bentonite
6											
					7	SS	35				
7											▽ January 29, 2021
					8	SS	31		○		
8				214.29							
		(CL) SILTY CLAY and SAND, some gravel; grey (TILL); cohesive, w>PL, very stiff		8.61							
9					9	SS	19				
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS9

SHEET 2 OF 2

LOCATION: N 4863597.66; E 634660.05

BORING DATE: January 28, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	(CL) SILTY CLAY and SAND, some gravel; grey (TILL); cohesive, w>PL, very stiff		211.24							
11					10	SS	18		○		
		(ML) SILT and SAND, some gravel; grey (TILL); non-cohesive, moist, compact		11.66							Bentonite
12					11	SS	25				
13				209.72							
		(SM) SILTY SAND and GRAVEL; grey; non-cohesive, wet, very dense		13.18							Sand
14					12	SS	52		○		Screen
				208.19							
15		(CL) SILTY CLAY and SAND, some gravel; grey (TILL); cohesive, w<PL, hard		14.71							
					13	SS	50/ 0.13				Sand
				207.38							
		END OF BOREHOLE		15.52							
16		NOTES:									
		1. Water was encountered at a depth of 6.1 m during drilling									
		2. Groundwater level was measured in monitoring well at a depth of 7.0 mbgs (El. 215.9m) on January 29, 2021									
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4863803.25; E 634615.91

RECORD OF BOREHOLE: KS10

SHEET 1 OF 2

BORING DATE: January 20, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		223.20							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	ASPHALT (265 mm thick)		0.00 / 222.94							
		Crushed granular; brown		0.26 / 222.75	1	AS	-				
		FILL - (SP) SAND, some gravel, trace fines; brown; non-cohesive, moist, compact		0.45							
1					2	SS	11		○		
				221.94							
		FILL - (CL) gravelly SILTY CLAY and SAND, brown; cohesive, w>PL, firm		1.26							
2					3	SS	5				
					4	SS	7		○		
				220.30							
3		(SM) SILTY SAND, fine; brown; non-cohesive, moist to wet, compact to dense		2.90	5	SS	25				Bentonite
4											
					6	SS	47		○	MH	
5											
6											
					7	SS	32				
7											Sand
					8	SS	26		○		January 29, 2021
8											Screen
9											
					9	SS	21				Sand
				213.60							
		END OF BOREHOLE		9.60							
		NOTES:									
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

RECORD OF BOREHOLE: KS10

SHEET 2 OF 2

LOCATION: N 4863803.25; E 634615.91

BORING DATE: January 20, 2021

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, 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	PIEZOMETER OR STANDPIPE INSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
		1. Water was encountered at a depth of 7.6 m during drilling. 2. Groundwater level was measured in monitoring well at a depth of 7.8 mbgs (El. 215.4m) on January 29, 2021									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

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PROJECT: 20146456

LOCATION: N 4864045.36; E 634563.11

RECORD OF BOREHOLE: KS11

BORING DATE: January 20, 2021

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	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 WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		218.70							
0	B57 Truck Mount; 200 mm O.D. Hollow Stem Auger	Crushed granular; brown		0.00 / 218.40	1A	AS	-		○	M	
		FILL - (SP) SAND, some gravel, trace fines; brown; non-cohesive, moist		0.30 / 218.19	1B						
		ASPHALT (240 mm thick)		0.51 / 217.95							
1		FILL - (CL) gravelly SILTY CLAY and SAND, black and brown, containing rootlets and organic inclusions; cohesive, w~PL to w>PL, stiff to soft		0.75	2	SS	12				
					3	SS	13		○		
2					4	SS	3				▽ January 29, 2021
3					5	SS	4		○		Bentonite
4				214.66							
		(CL) SILTY CLAY and SAND, some gravel; grey (TILL); cohesive, w<PL, hard		4.04	6	SS	39				
5											
6					7	SS	50/ 0.07		○		Sand
7											Screen
				210.98	8	SS	50/ 0.10				Sand
		END OF BOREHOLE		7.72							
8		NOTES:									
		1. Water was encountered at a depth of 2.3 m during drilling.									
		2. Groundwater level was measured in monitoring well at a depth of 2.5mbgs (El. 216.2m) on January 29, 2021									
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: YS

CHECKED: TO

GTA-BHS 001 S:\CLIENTS\REGION_OF_YORK\MAJOR_MACKENZIE_DRIVE\02_DATA\GINTMARKHAM_WARDEN&KENNEDY_RD.GPJ GAL-MIS.GDT 4/5/21

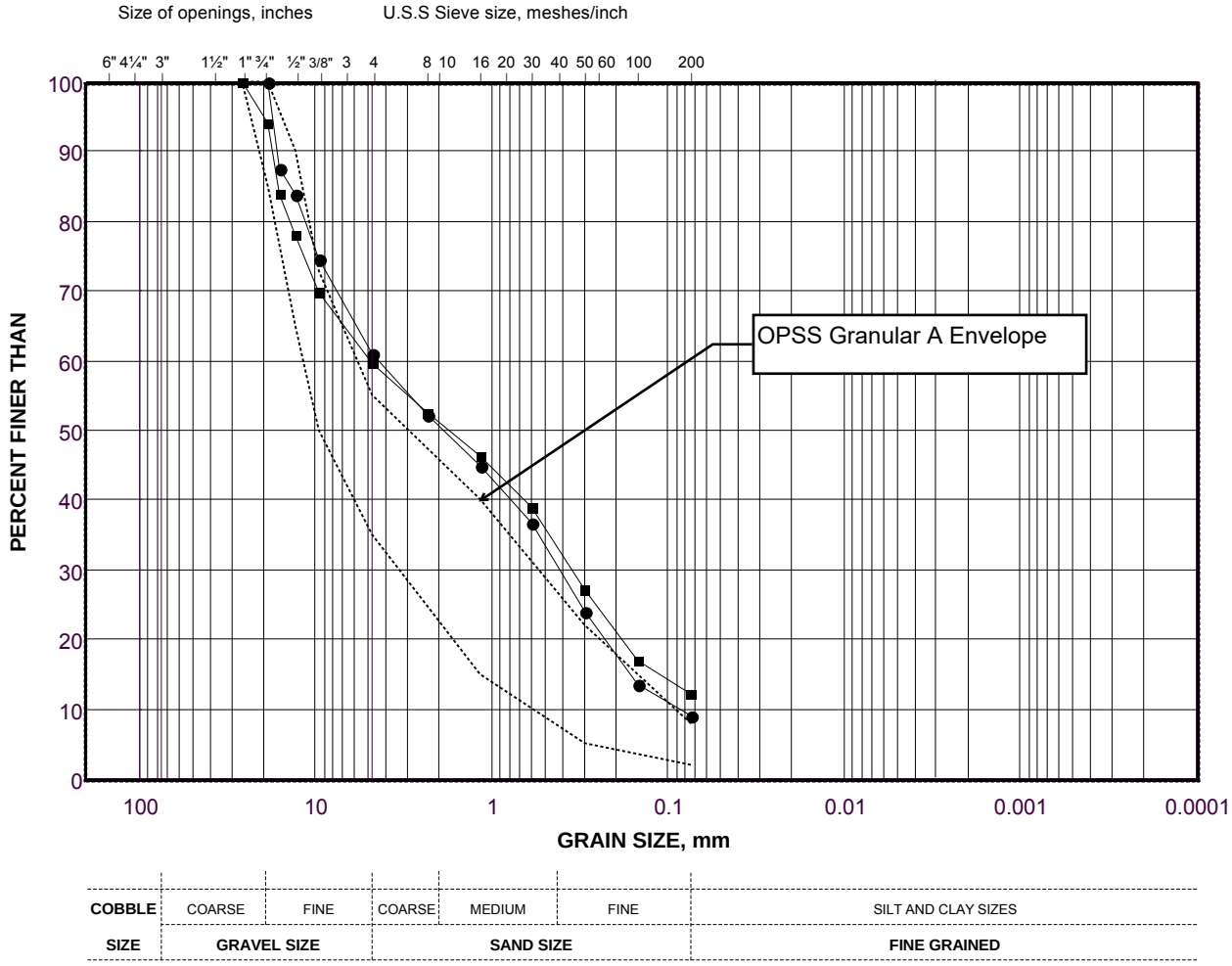
APPENDIX D

S

GRAIN SIZE DISTRIBUTION

Typical Base Material

FIGURE D1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KP 6	1A	0.2 - 0.4
■	KS 11	1A	0.0 - 0.3

Project Number: 20146456

Checked By: TO

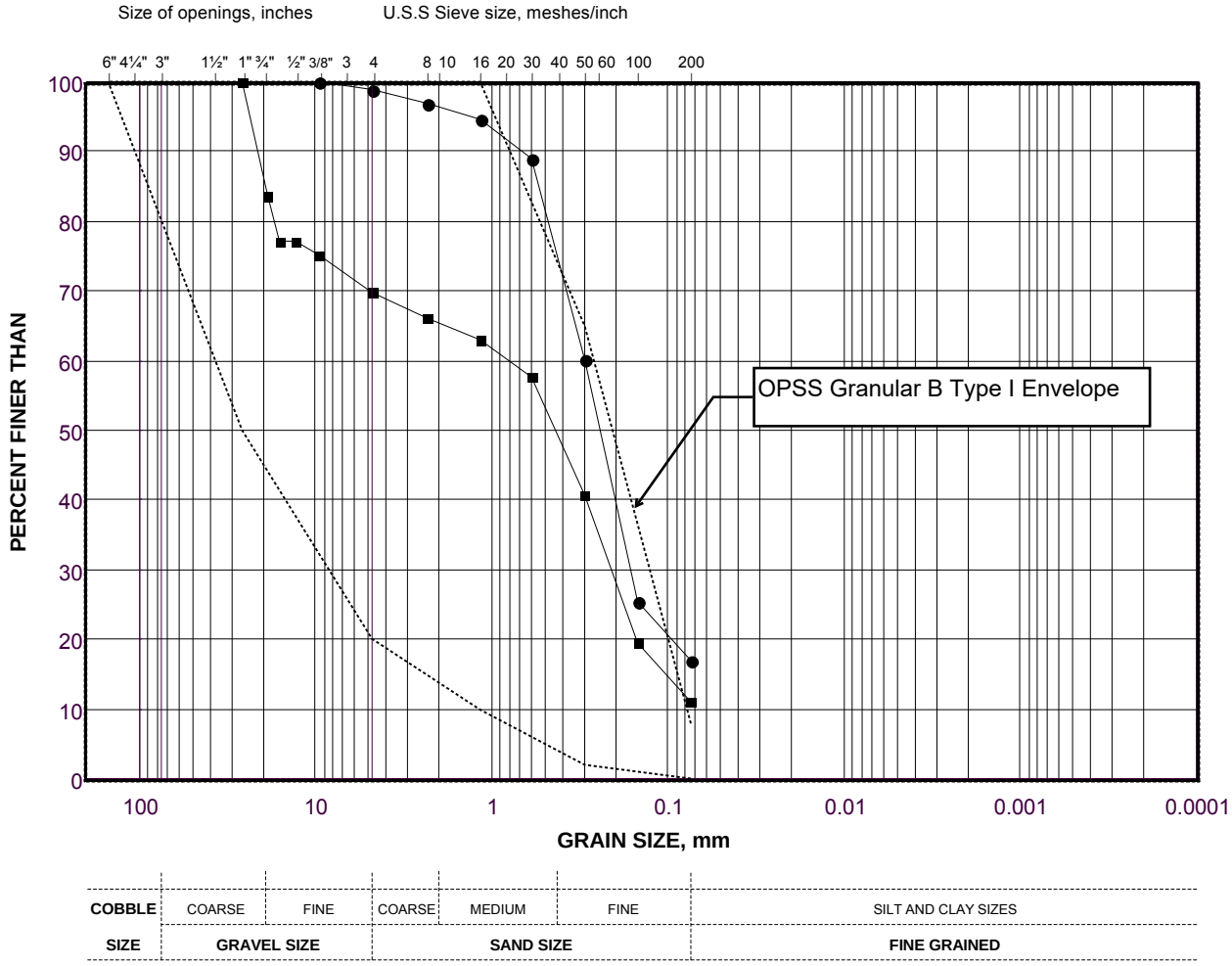
Golder Associates

Date: 26-Feb-21

GRAIN SIZE DISTRIBUTION

Typical Subbase Material

FIGURE D2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KS 3	1B	0.4 - 0.7
■	KP 10	1B	0.4 - 0.8

Project Number: 20146456

Checked By: TO

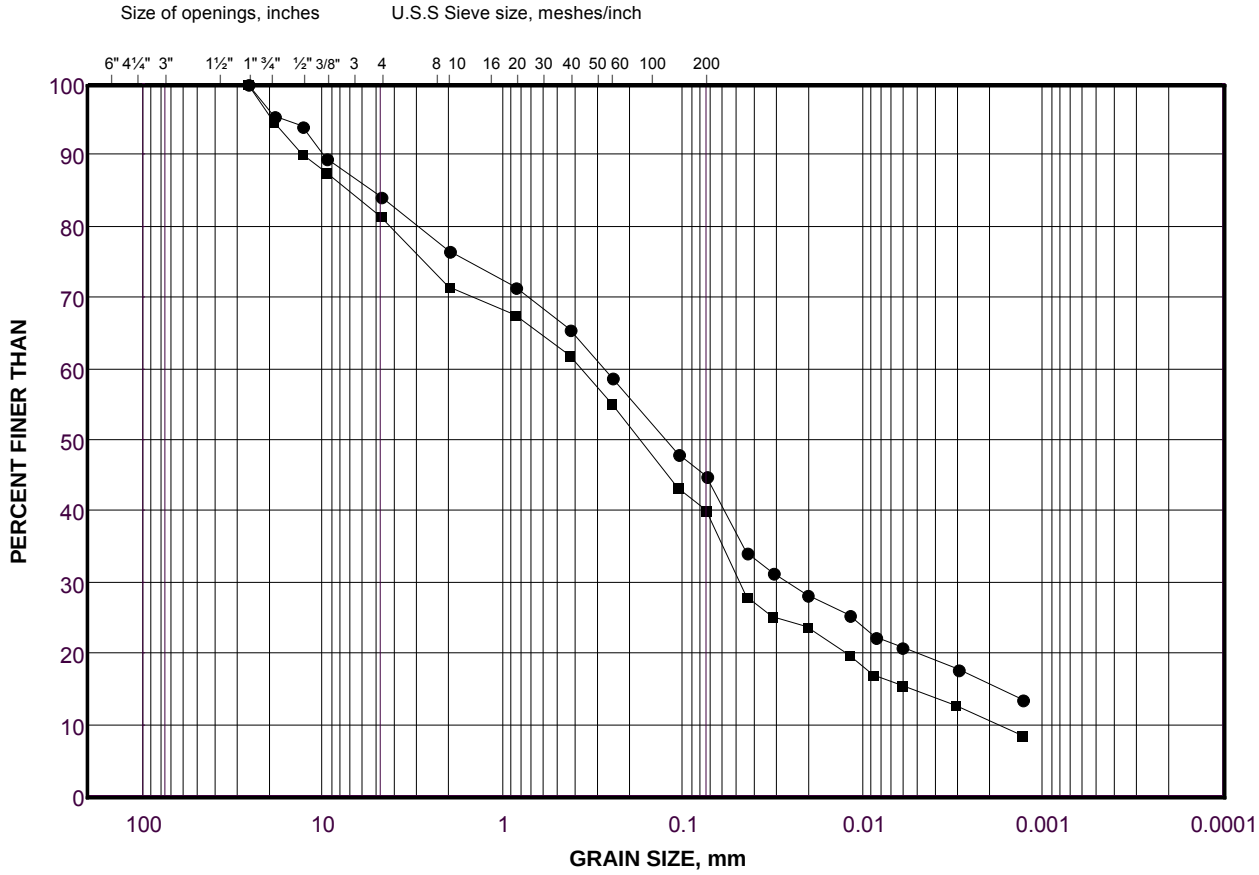
Golder Associates

Date: 26-Feb-21

GRAIN SIZE DISTRIBUTION

FILL- (CL-ML) gravelly SILTY CLAY-CLAYEY SILT and SAND to (CL) gravelly SILTY SAND

FIGURE D3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KP 11	2	0.8 - 1.2
■	KP 2	2	0.8 - 1.2

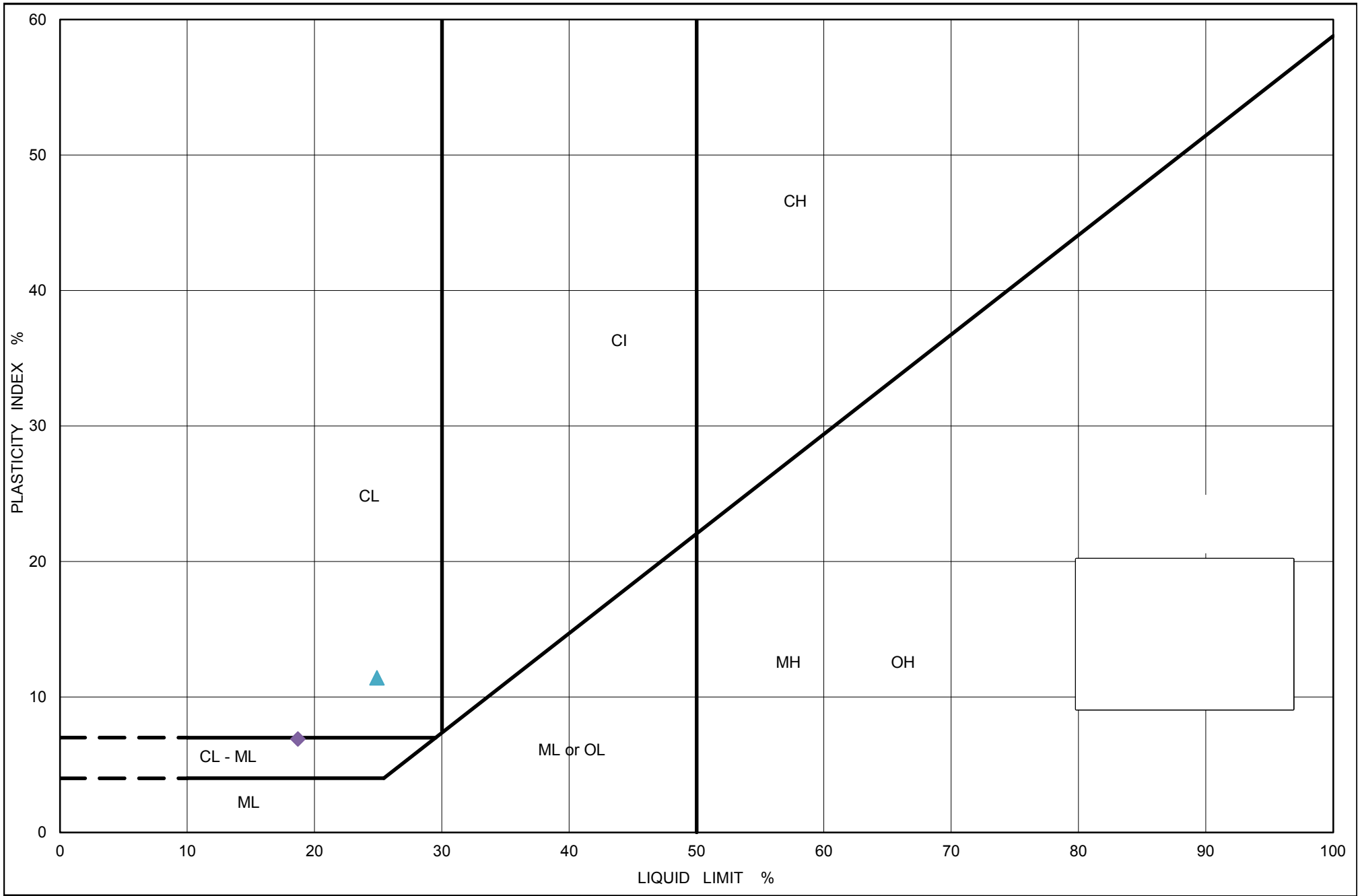
Project Number: 20146456

Checked By: TO

Golder Associates

Date: 26-Feb-21

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

FILL - (CL-ML) gravelly SILTY CLAY-CLAYEY SILT and SAND to (CL) gravelly SILTY CLAY and SAND

Figure No.: D4

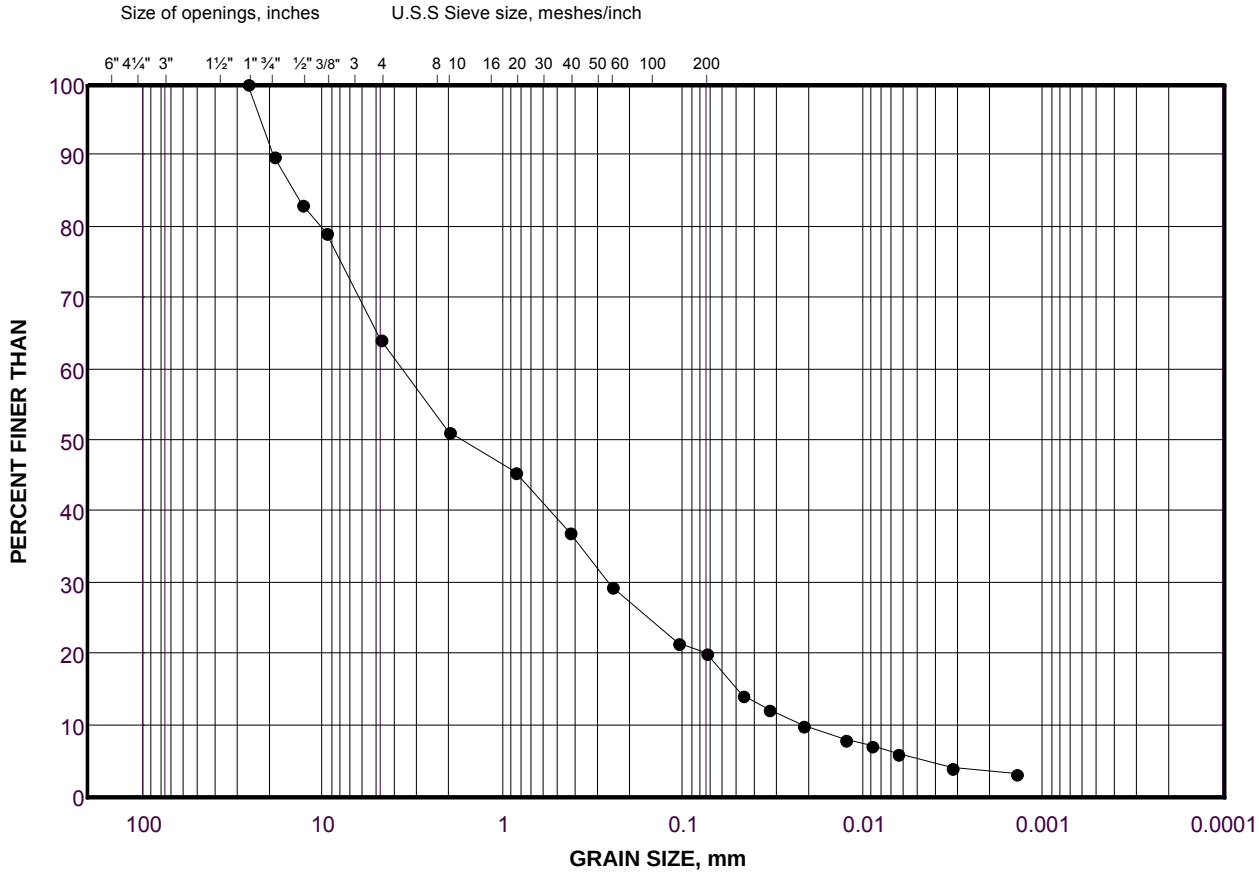
Project No.: 20146456

Checked By: TO

GRAIN SIZE DISTRIBUTION

FILL - (SM) SILTY SAND and GRAVEL

FIGURE D5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KP 7	2	0.8 - 1.2

Project Number: 20146456

Checked By: TO

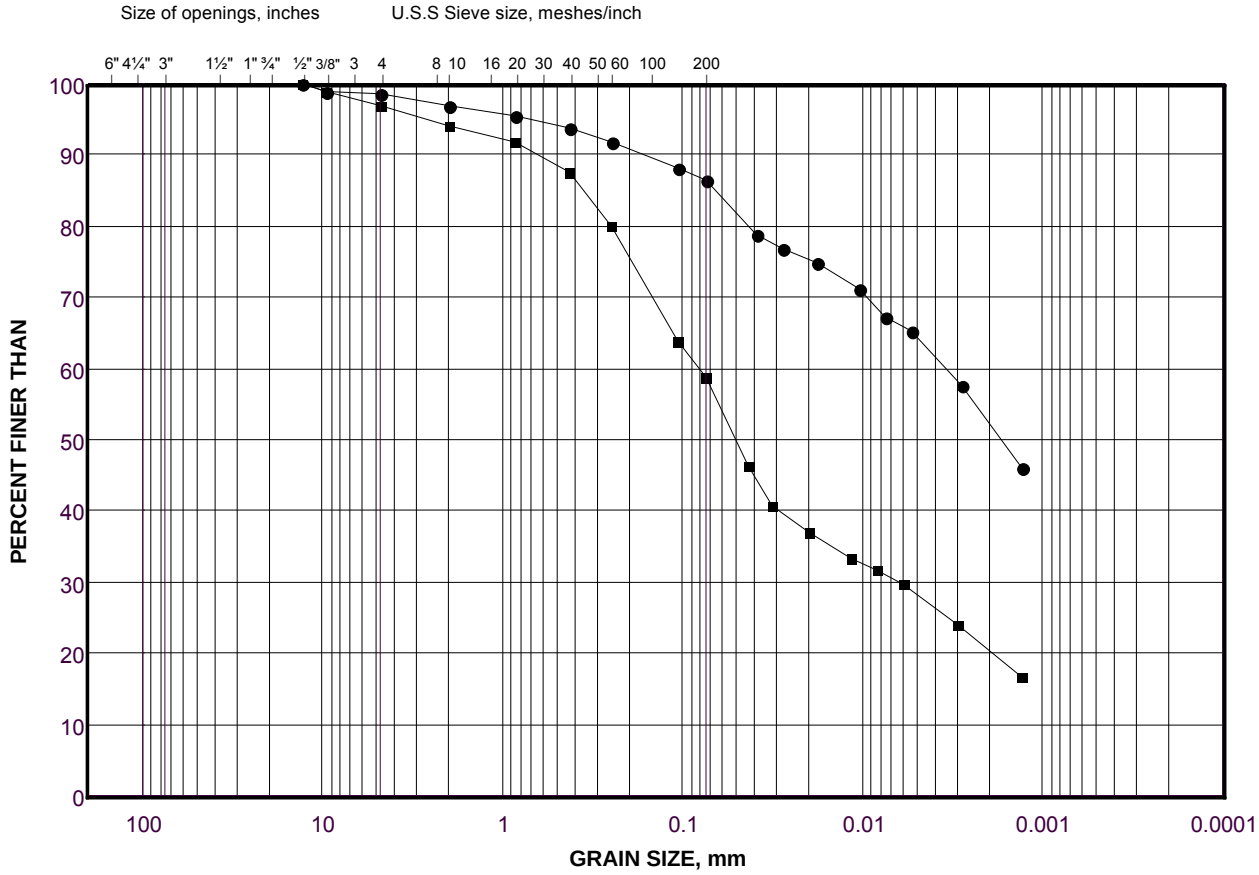
Golder Associates

Date: 26-Feb-21

GRAIN SIZE DISTRIBUTION

(CI) SILTY CLAY to (CL) SILTY CLAY and SAND

FIGURE D6



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KP 1	2	0.8 - 1.2
■	KS 8	5	3.0 - 3.5

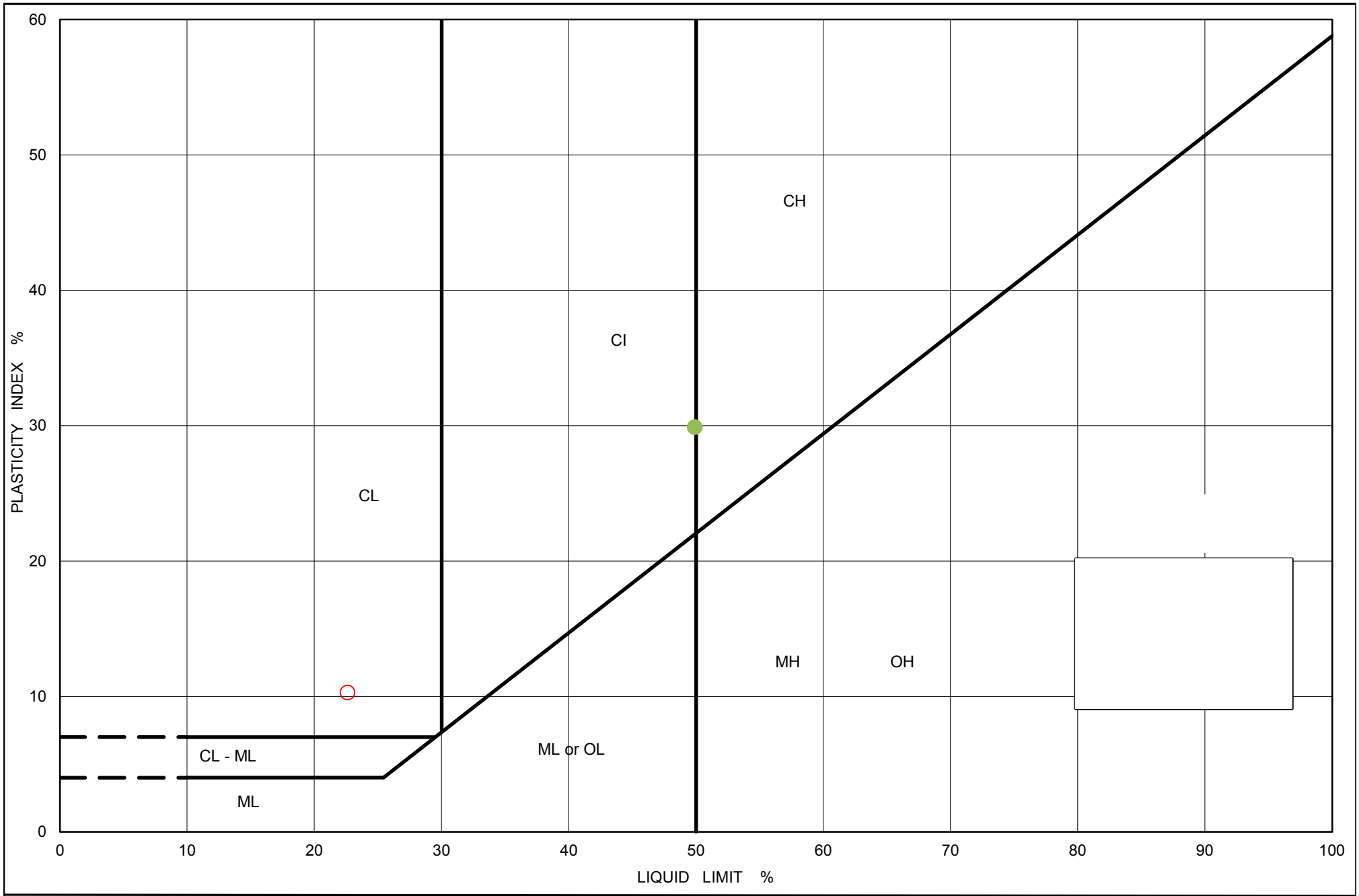
Project Number: 20146456

Checked By: TO

Golder Associates

Date: 26-Feb-21

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

(CI) SILTY CLAY to (CL) SILTY CLAY and SAND

Figure No.: D7

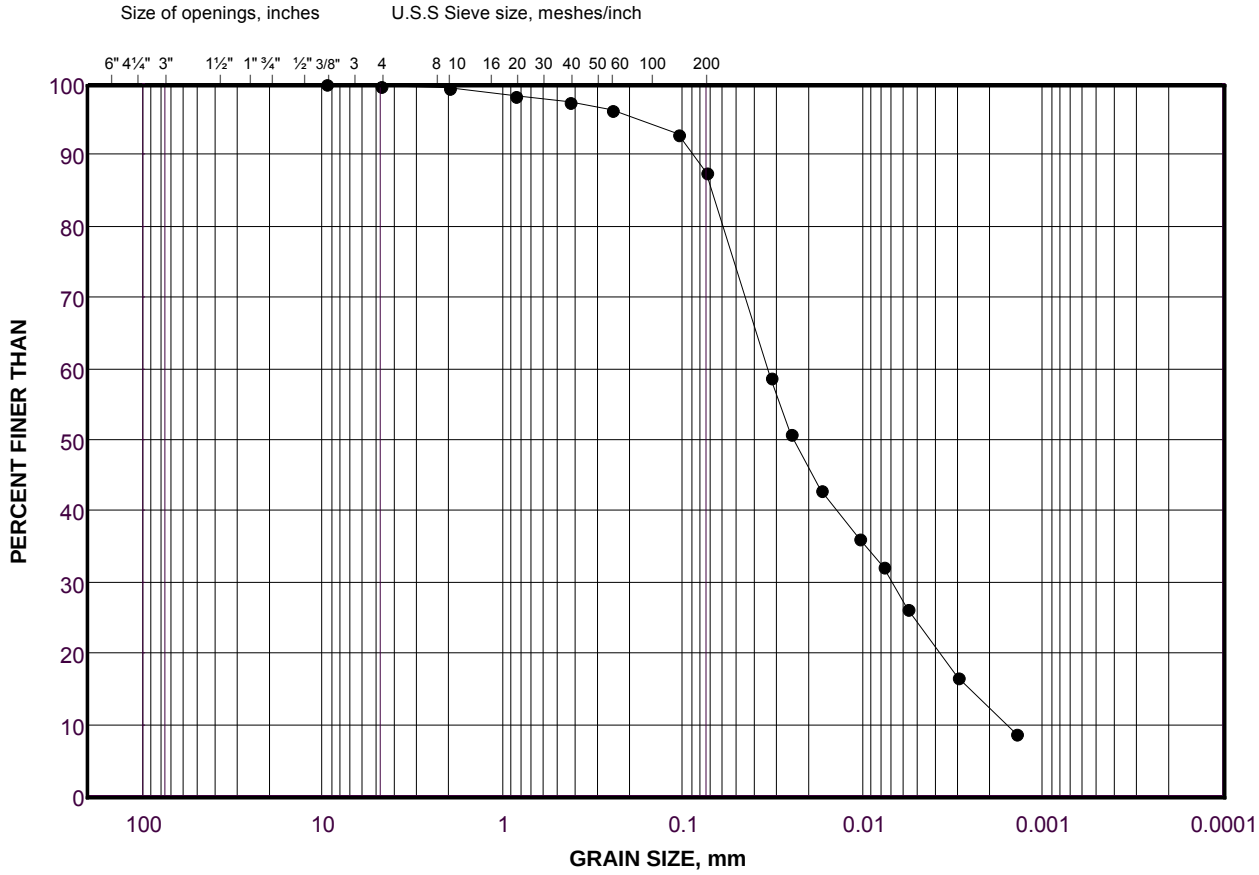
Project No.: 20146456

Checked By: TO

GRAIN SIZE DISTRIBUTION

(ML) sandy SILT

FIGURE D8



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KP 12	3	1.5 - 2.0

Project Number: 20146456

Checked By: TO

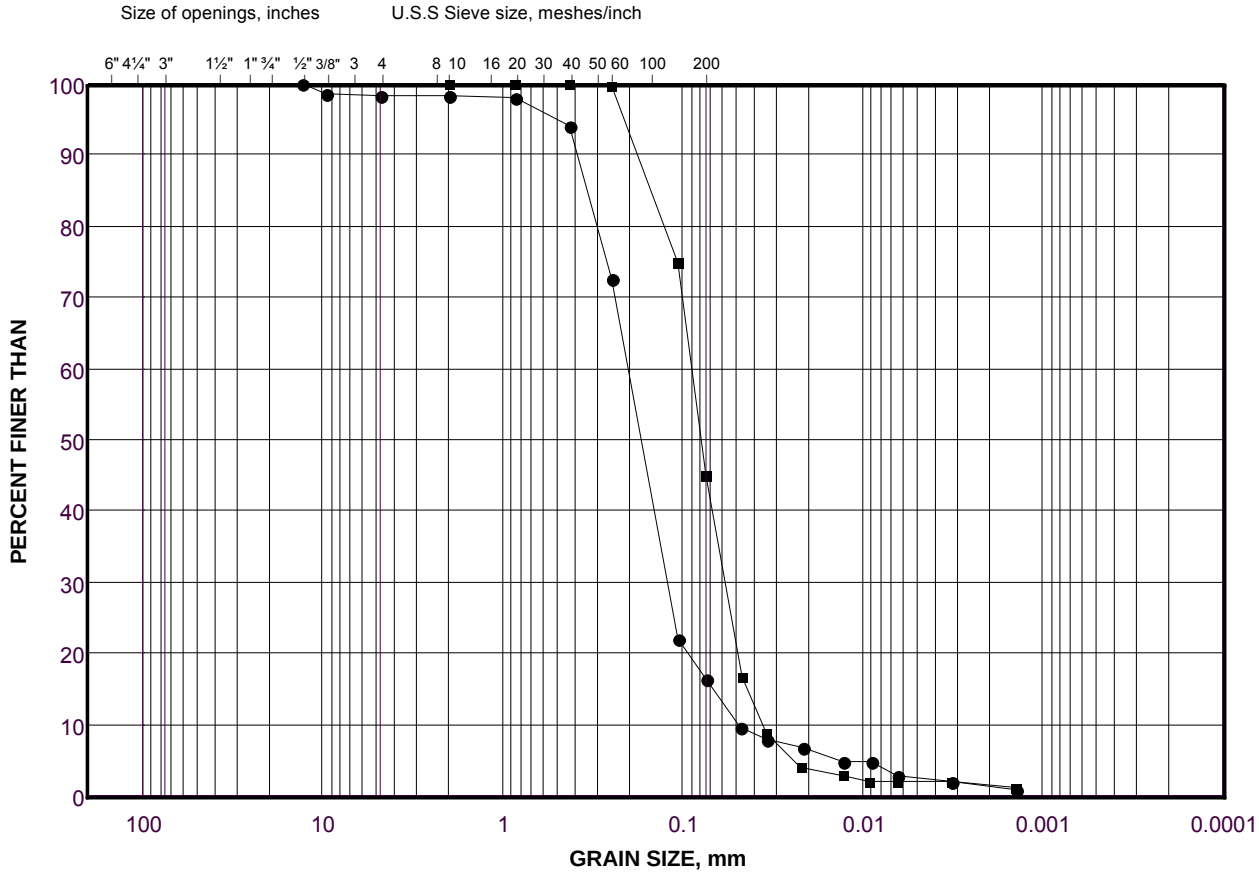
Golder Associates

Date: 26-Feb-21

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND, fine

FIGURE D9



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KS 4	5	3.0 - 3.5
■	KS 10	6	4.5 - 5.0

Project Number: 20146456

Checked By: TO

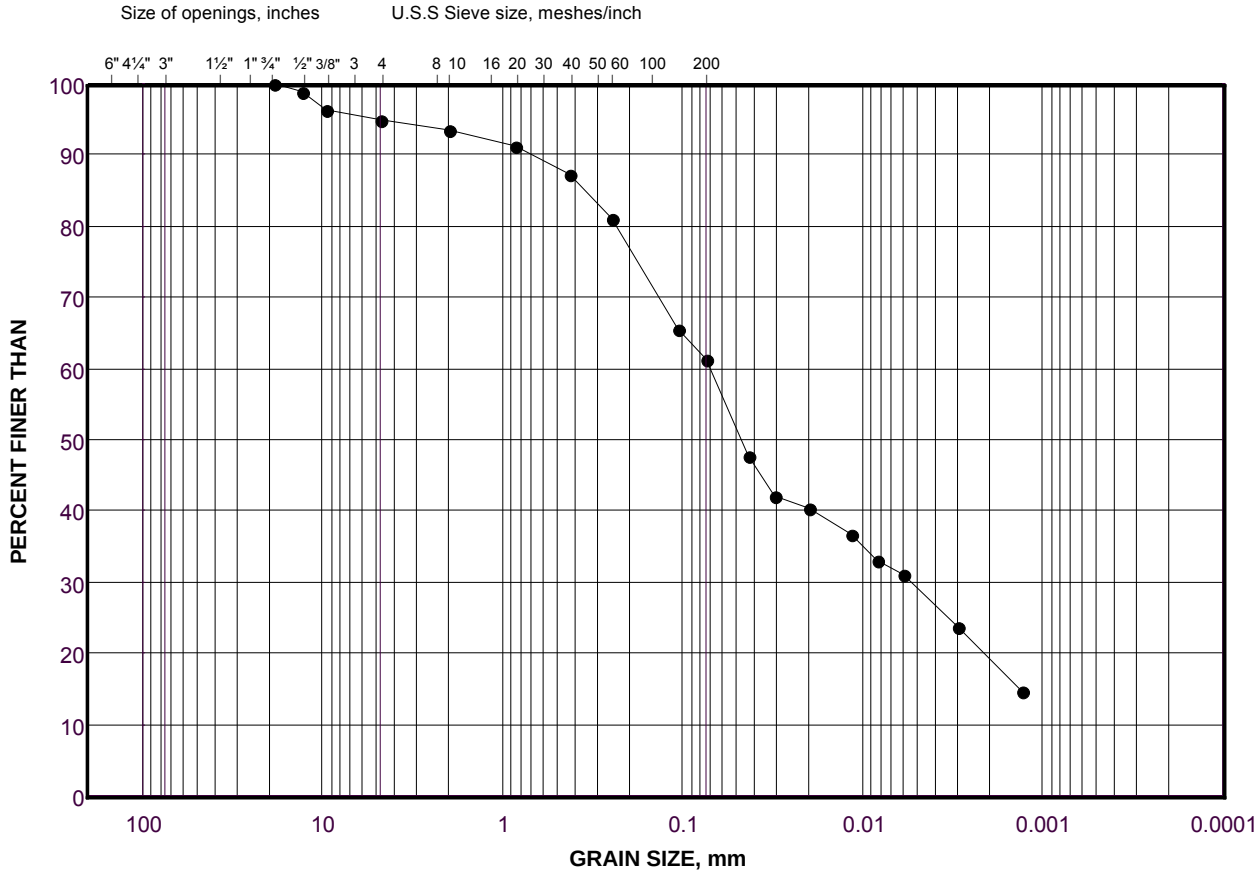
Golder Associates

Date: 26-Feb-21

GRAIN SIZE DISTRIBUTION

(CL) SILTY CLAY and SAND (TILL)

FIGURE D10



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KS 1	5	3.0 - 3.5

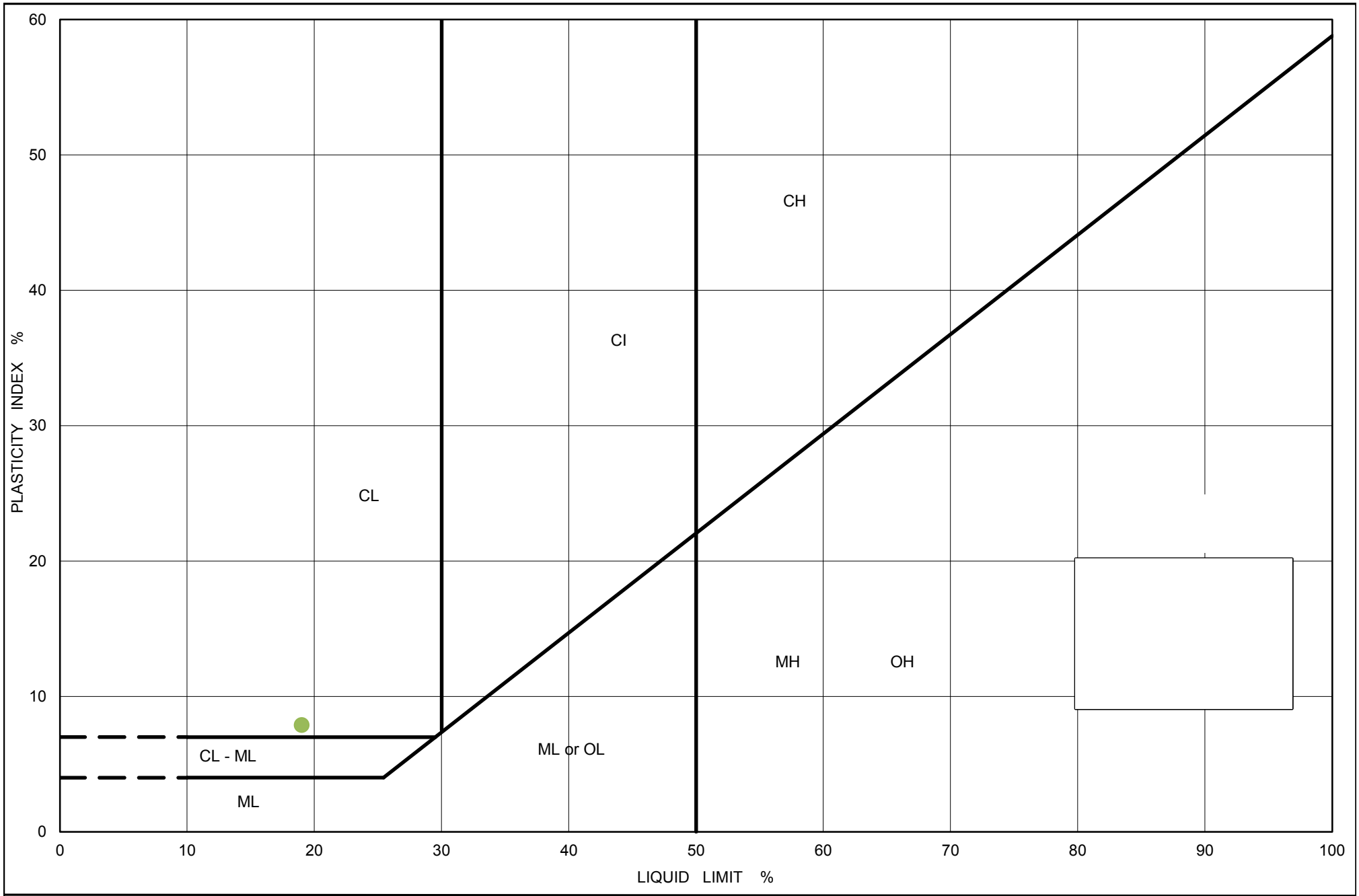
Project Number: 20146456

Checked By: TO

Golder Associates

Date: 26-Feb-21

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

(CL) SILTY CLAY and SAND (TILL)

Figure No.: D11

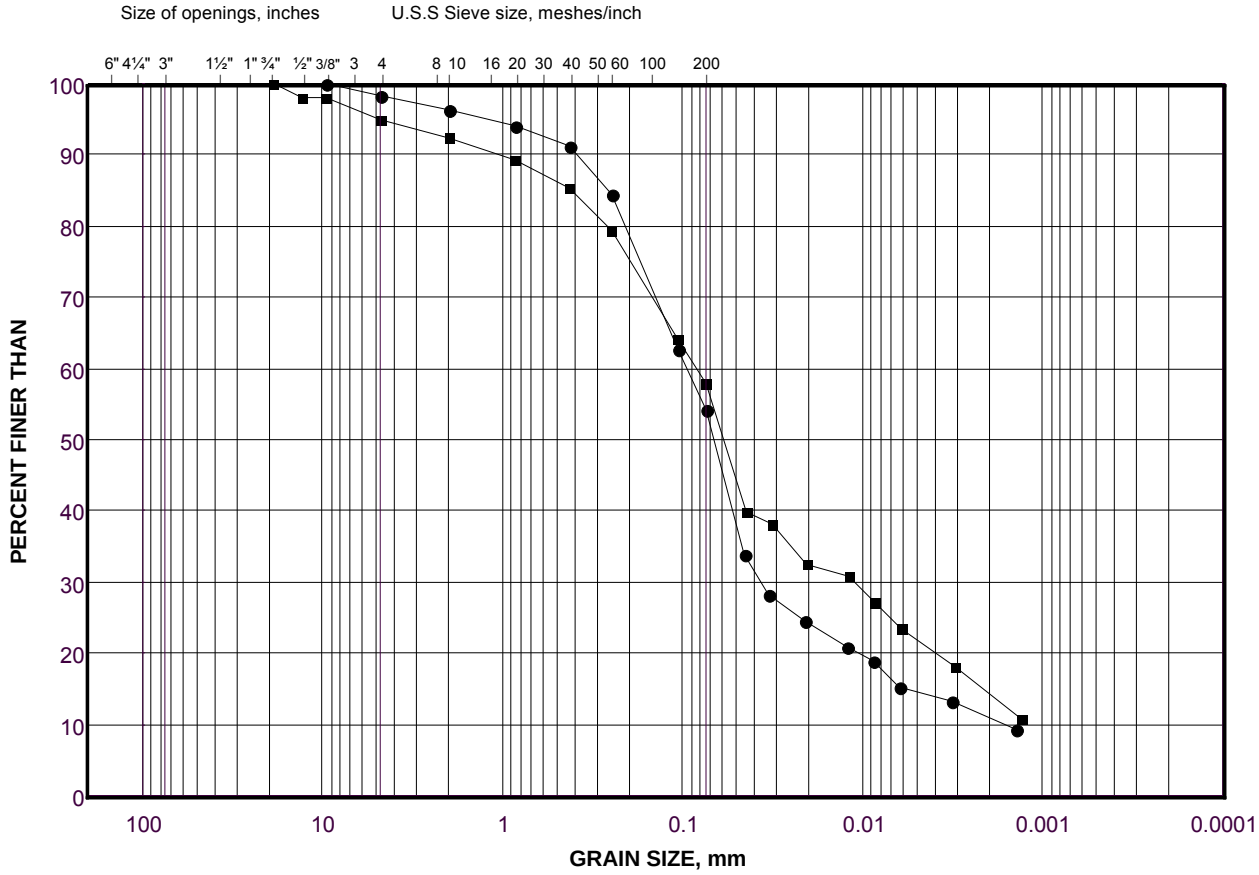
Project No.: 20146456

Checked By: John Taylor, Laboratory Supervisor

GRAIN SIZE DISTRIBUTION

(ML) SILT and SAND (TILL)

FIGURE D12



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	KS 2	4	2.3 - 2.7
■	KS 6	5	3.0 - 3.5

Project Number: 20146456

Checked By: TO

Golder Associates

Date: 26-Feb-21

APPENDIX E

Analytical Laboratory Results

AGAT Laboratories

5835 COOPERS AVENUE
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FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD.
100 SCOTIA COURT
WHITBY, ON L1N8Y6
(905) 723-2727

ATTENTION TO: Yusuf Soliman

PROJECT: 20146456

AGAT WORK ORDER: 21T705996

SOIL ANALYSIS REVIEWED BY: Jacky Zhu, Spectroscopy Technician

TRACE ORGANICS REVIEWED BY: Neli Popnikolova, Senior Chemist

DATE REPORTED: Feb 12, 2021

PAGES (INCLUDING COVER): 17

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.

AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2021-02-01

DATE REPORTED: 2021-02-12

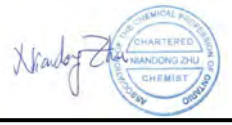
				SAMPLE DESCRIPTION:	S4 Sa3		S9 Sa2	S1 Sa3
				SAMPLE TYPE:	Soil		Soil	Soil
				DATE SAMPLED:	2021-01-19 09:00		2021-01-28 11:00	2021-01-20 11:00
Parameter	Unit	G / S	RDL	2036904	RDL	2036946	2036949	
Chloride (2:1)	µg/g	NA	8	1990	4	618	619	
Sulphate (2:1)	µg/g		8	123	4	58	71	
pH (2:1)	pH Units		NA	7.70	NA	9.17	8.55	
Electrical Conductivity (2:1)	mS/cm	0.57	0.005	3.49	0.005	1.46	1.34	
Resistivity (2:1) (Calculated)	ohm.cm		1	287	1	685	746	
Redox Potential 1	mV		NA	442	NA	342	368	
Redox Potential 2	mV		NA	447	NA	343	369	
Redox Potential 3	mV		NA	455	NA	343	370	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

2036904-2036949 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.
Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.
Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.
Dilution required, RDL has been increased accordingly.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



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Certificate of Analysis

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

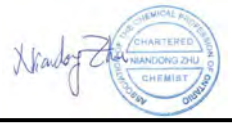
O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2021-02-01

DATE REPORTED: 2021-02-12

SAMPLE DESCRIPTION:				S4 Sa3	S9 Sa2	S1 Sa3	S10 Sa3	S7 Sa4	S11 Sa3
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2021-01-19 09:00	2021-01-28 11:00	2021-01-20 11:00	2021-01-29 10:00	2021-01-19 13:00	2021-01-20 15:00
Parameter	Unit	G / S	RDL	2036904	2036946	2036949	2036950	2036953	2036954
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	4	3	4	3	3	3
Barium	µg/g	220	2.0	209	30.4	31.6	57.4	129	116
Beryllium	µg/g	2.5	0.4	1.3	<0.4	<0.4	0.6	0.8	1.0
Boron	µg/g	36	5	15	18	<5	7	13	12
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.19	0.35	0.31	0.19	<0.10	0.24
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	70	5	43	12	10	16	25	30
Cobalt	µg/g	21	0.5	14.1	3.9	3.4	6.4	7.6	9.8
Copper	µg/g	92	1.0	25.3	10.5	7.6	12.9	15.2	17.7
Lead	µg/g	120	1	15	58	4	11	7	15
Molybdenum	µg/g	2	0.5	<0.5	0.8	1.0	<0.5	<0.5	<0.5
Nickel	µg/g	82	1	33	10	7	15	17	21
Selenium	µg/g	1.5	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Silver	µg/g	0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Thallium	µg/g	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Uranium	µg/g	2.5	0.50	0.63	<0.50	<0.50	<0.50	0.51	0.56
Vanadium	µg/g	86	0.4	56.0	18.6	21.7	27.7	36.5	43.6
Zinc	µg/g	290	5	82	140	40	83	39	60
Chromium, Hexavalent	µg/g	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide, Free	µg/g	0.051	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity (2:1)	mS/cm	0.57	0.005	3.49	1.46	1.34	2.51	1.17	1.57
Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	N/A	22.1	19.0	14.1	21.7	11.4	10.6
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.69	7.88	7.79	8.07	7.76	7.74

Certified By:



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Certificate of Analysis

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2021-02-01

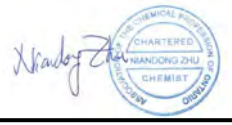
DATE REPORTED: 2021-02-12

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

2036904-2036954 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



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Certificate of Analysis

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

O. Reg. 558 Metals and Inorganics

DATE RECEIVED: 2021-02-01

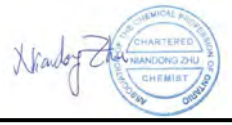
DATE REPORTED: 2021-02-12

		SAMPLE DESCRIPTION:		S4 TCLP
		SAMPLE TYPE:		Soil
		DATE SAMPLED:		2021-01-19 12:00
Parameter	Unit	G / S	RDL	2036899
Arsenic Leachate	mg/L	2.5	0.010	<0.010
Barium Leachate	mg/L	100	0.100	0.187
Boron Leachate	mg/L	500	0.050	<0.050
Cadmium Leachate	mg/L	0.5	0.010	<0.010
Chromium Leachate	mg/L	5	0.010	<0.010
Lead Leachate	mg/L	5	0.010	<0.010
Mercury Leachate	mg/L	0.1	0.01	<0.01
Selenium Leachate	mg/L	1	0.010	<0.010
Silver Leachate	mg/L	5	0.010	<0.010
Uranium Leachate	mg/L	10	0.050	<0.050
Fluoride Leachate	mg/L	150	0.05	0.28
Cyanide Leachate	mg/L	20	0.05	<0.05
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	<0.70

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



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AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

O. Reg. 153(511) - PHCs F1 - F4 (Soil)

DATE RECEIVED: 2021-02-01

DATE REPORTED: 2021-02-12

				SAMPLE DESCRIPTION:	S4 Sa3	S9 Sa2
				SAMPLE TYPE:	Soil	Soil
				DATE SAMPLED:	2021-01-19 09:00	2021-01-28 11:00
Parameter	Unit	G / S	RDL		2036904	2036946
Benzene	µg/g	0.02	0.02		<0.02	<0.02
Toluene	µg/g	0.2	0.05		<0.05	<0.05
Ethylbenzene	µg/g	0.05	0.05		<0.05	<0.05
m & p-Xylene	µg/g		0.05		<0.05	<0.05
o-Xylene	µg/g		0.05		<0.05	<0.05
Xylenes (Total)	µg/g	0.05	0.05		<0.05	<0.05
F1 (C6 to C10)	µg/g	25	5		<5	<5
F1 (C6 to C10) minus BTEX	µg/g	25	5		<5	<5
F2 (C10 to C16)	µg/g	10	10		<10	44
F3 (C16 to C34)	µg/g	240	50		<50	950
F4 (C34 to C50)	µg/g	120	50		<50	290
Gravimetric Heavy Hydrocarbons	µg/g	120	50		NA	NA
Moisture Content	%		0.1		21.4	7.6
Surrogate	Unit	Acceptable Limits				
Toluene-d8	% Recovery	50-140			89	82
Terphenyl	%	60-140			103	130

Certified By:

AGAT Laboratories

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FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

O. Reg. 153(511) - PHCs F1 - F4 (Soil)

DATE RECEIVED: 2021-02-01

DATE REPORTED: 2021-02-12

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

2036904-2036946 Results are based on sample dry weight.
The C6-C10 fraction is calculated using Toluene response factor.
Xylenes is a calculated parameter. The calculated value is the sum of m&p-Xylene and o-Xylene.
C6–C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX.
The calculated parameters are non-accredited. The parameters that are components of the calculation are accredited.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
The chromatogram has returned to baseline by the retention time of nC50.
Total C6 - C50 results are corrected for BTEX contribution.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 + nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.
Fractions 1-4 are quantified with the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.
Quality Control Data is available upon request.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

O. Reg. 558 - Benzene

DATE RECEIVED: 2021-02-01

DATE REPORTED: 2021-02-12

				SAMPLE DESCRIPTION:	S4 TCLP
				SAMPLE TYPE:	Soil
				DATE SAMPLED:	2021-01-19 12:00
Parameter	Unit	G / S	RDL	2036899	
Benzene	mg/L	0.5	0.020	<0.020	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

2036899 Surrogate Recovery for Toluene-d8: %
Surrogate recovery for 4-Bromofluorobenzene: %
Sample was prepared using Regulation 558 protocol and a zero headspace extractor.
Results relate only to the items tested.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

O. Reg. 558 - Benzo(a) pyrene

DATE RECEIVED: 2021-02-01

DATE REPORTED: 2021-02-12

		SAMPLE DESCRIPTION:		S4 TCLP
		SAMPLE TYPE:		Soil
		DATE SAMPLED:		2021-01-19 12:00
Parameter	Unit	G / S	RDL	2036899
Benzo(a)pyrene	mg/L	0.001	0.001	<0.001
Surrogate	Unit	Acceptable Limits		
Naphthalene-d8	%	50-140		88
Acenaphthene-d10	%	50-140		93
Chrysene-d12	%	50-140		73

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to O. Reg. 558 - Schedule IV Leachate Quality Criteria
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

2036899 The sample was leached according to Regulation 558 protocol. Analysis was performed on the leachate.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

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Exceedance Summary

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
2036904	S4 Sa3	ON T1 S RPI/ICC	Corrosivity Package	Electrical Conductivity (2:1)	mS/cm	0.57	3.49
2036904	S4 Sa3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	3.49
2036904	S4 Sa3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.)	N/A	2.4	22.1
2036946	S9 Sa2	ON T1 S RPI/ICC	Corrosivity Package	Electrical Conductivity (2:1)	mS/cm	0.57	1.46
2036946	S9 Sa2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	1.46
2036946	S9 Sa2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.	N/A	2.4	19.0
2036946	S9 Sa2	ON T1 S RPI/ICC	O. Reg. 153(511) - PHCs F1 - F4 (Soil)	F2 (C10 to C16)	µg/g	10	44
2036946	S9 Sa2	ON T1 S RPI/ICC	O. Reg. 153(511) - PHCs F1 - F4 (Soil)	F3 (C16 to C34)	µg/g	240	950
2036946	S9 Sa2	ON T1 S RPI/ICC	O. Reg. 153(511) - PHCs F1 - F4 (Soil)	F4 (C34 to C50)	µg/g	120	290
2036949	S1 Sa3	ON T1 S RPI/ICC	Corrosivity Package	Electrical Conductivity (2:1)	mS/cm	0.57	1.34
2036949	S1 Sa3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	1.34
2036949	S1 Sa3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.	N/A	2.4	14.1
2036950	S10 Sa3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	2.51
2036950	S10 Sa3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.	N/A	2.4	21.7
2036953	S7 Sa4	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	1.17
2036953	S7 Sa4	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.	N/A	2.4	11.4
2036954	S11 Sa3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity (2:1)	mS/cm	0.57	1.57
2036954	S11 Sa3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio (2:1) (Calc.	N/A	2.4	10.6

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Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.
AGAT WORK ORDER: 21T705996
PROJECT: 20146456
ATTENTION TO: Yusuf Soliman
SAMPLING SITE:
SAMPLED BY:

Soil Analysis

RPT Date: Feb 12, 2021

PARAMETER	Batch	Sample Id	DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
			Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	2036904	2036904	<0.8	<0.8	NA	< 0.8	115%	70%	130%	103%	80%	120%	103%	70%	130%
Arsenic	2036904	2036904	4	4	NA	< 1	121%	70%	130%	103%	80%	120%	107%	70%	130%
Barium	2036904	2036904	209	175	17.7%	< 2.0	99%	70%	130%	99%	80%	120%	94%	70%	130%
Beryllium	2036904	2036904	1.3	1.1	NA	< 0.4	123%	70%	130%	103%	80%	120%	95%	70%	130%
Boron	2036904	2036904	15	13	NA	< 5	93%	70%	130%	112%	80%	120%	72%	70%	130%
Boron (Hot Water Soluble)	2036904	2036904	0.19	0.20	NA	< 0.10	105%	60%	140%	104%	70%	130%	104%	60%	140%
Cadmium	2036904	2036904	<0.5	<0.5	NA	< 0.5	107%	70%	130%	100%	80%	120%	98%	70%	130%
Chromium	2036904	2036904	43	39	9.8%	< 5	108%	70%	130%	99%	80%	120%	96%	70%	130%
Cobalt	2036904	2036904	14.1	13.0	8.1%	< 0.5	105%	70%	130%	97%	80%	120%	95%	70%	130%
Copper	2036904	2036904	25.3	23.5	7.4%	< 1.0	95%	70%	130%	101%	80%	120%	96%	70%	130%
Lead	2036904	2036904	15	15	0.0%	< 1	103%	70%	130%	102%	80%	120%	92%	70%	130%
Molybdenum	2036904	2036904	<0.5	<0.5	NA	< 0.5	108%	70%	130%	102%	80%	120%	100%	70%	130%
Nickel	2036904	2036904	33	30	9.5%	< 1	108%	70%	130%	99%	80%	120%	91%	70%	130%
Selenium	2036904	2036904	<0.8	<0.8	NA	< 0.8	101%	70%	130%	104%	80%	120%	101%	70%	130%
Silver	2036904	2036904	<0.5	<0.5	NA	< 0.5	134%	70%	130%	97%	80%	120%	90%	70%	130%
Thallium	2036904	2036904	<0.5	<0.5	NA	< 0.5	100%	70%	130%	97%	80%	120%	93%	70%	130%
Uranium	2036904	2036904	0.63	0.59	NA	< 0.50	100%	70%	130%	100%	80%	120%	95%	70%	130%
Vanadium	2036904	2036904	56.0	51.2	9.0%	< 0.4	115%	70%	130%	95%	80%	120%	92%	70%	130%
Zinc	2036904	2036904	82	77	6.3%	< 5	108%	70%	130%	102%	80%	120%	104%	70%	130%
Chromium, Hexavalent	2050443		<0.2	<0.2	NA	< 0.2	97%	70%	130%	92%	80%	120%	85%	70%	130%
Cyanide, Free	2023868		<0.040	<0.040	NA	< 0.040	91%	70%	130%	93%	80%	120%	119%	70%	130%
Mercury	2036904	2036904	<0.10	<0.10	NA	< 0.10	111%	70%	130%	102%	80%	120%	99%	70%	130%
Electrical Conductivity (2:1)	2036904	2036904	3.49	3.66	4.8%	< 0.005	109%	80%	120%						
Sodium Adsorption Ratio (2:1) (Calc.)	2036904	2036904	22.1	23.2	4.9%	NA									
pH, 2:1 CaCl2 Extraction	2036950	2036950	8.07	8.08	0.1%	NA	101%	80%	120%						

Comments: For a multi-element scan for lab control standards and matrix spikes, up to 10% of analytes may exceed the quoted limits by up to 10% absolute and it is considered acceptable.

O. Reg. 558 Metals and Inorganics															
Arsenic Leachate	2019326		<0.010	<0.010	NA	< 0.010	100%	70%	130%	98%	80%	120%	110%	70%	130%
Barium Leachate	2019326		0.825	0.843	2.2%	< 0.100	100%	70%	130%	100%	80%	120%	116%	70%	130%
Boron Leachate	2019326		0.058	0.060	NA	< 0.050	100%	70%	130%	109%	80%	120%	97%	70%	130%
Cadmium Leachate	2019326		<0.010	<0.010	NA	< 0.010	100%	70%	130%	102%	80%	120%	97%	70%	130%
Chromium Leachate	2019326		<0.010	<0.010	NA	< 0.010	101%	70%	130%	101%	80%	120%	108%	70%	130%
Lead Leachate	2019326		<0.010	<0.010	NA	< 0.010	98%	70%	130%	99%	80%	120%	86%	70%	130%
Mercury Leachate	2019326		<0.01	<0.01	NA	< 0.01	102%	70%	130%	101%	80%	120%	93%	70%	130%
Selenium Leachate	2019326		<0.010	<0.010	NA	< 0.010	101%	70%	130%	100%	80%	120%	109%	70%	130%
Silver Leachate	2019326		<0.010	<0.010	NA	< 0.010	99%	70%	130%	104%	80%	120%	87%	70%	130%
Uranium Leachate	2019326		<0.050	<0.050	NA	< 0.050	98%	70%	130%	101%	80%	120%	88%	70%	130%

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Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

Soil Analysis (Continued)

RPT Date: Feb 12, 2021			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Fluoride Leachate	2019326		0.23	0.24	NA	< 0.05	105%	90%	110%	107%	90%	110%	106%	70%	130%
Cyanide Leachate	2019326		<0.05	<0.05	NA	< 0.05	90%	70%	130%	91%	80%	120%	107%	70%	130%
(Nitrate + Nitrite) as N Leachate	2019326		<0.70	<0.70	NA	< 0.70	104%	80%	120%	97%	80%	120%	98%	70%	130%
Corrosivity Package															
Chloride (2:1)	2038857		70	71	1.4%	< 2	97%	70%	130%	104%	80%	120%	103%	70%	130%
Sulphate (2:1)	2038857		22	23	4.4%	< 2	92%	70%	130%	102%	80%	120%	105%	70%	130%
pH (2:1)	2036904	2036904	7.70	7.72	0.3%	NA	100%	90%	110%						
Electrical Conductivity (2:1)	2036904	2036904	3.49	3.66	4.8%	< 0.005	109%	80%	120%						
Redox Potential 1	1						100%	90%	110%						

Comments: NA signifies Not Applicable.
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.
Duplicate NA: results are under 5X the RDL and will not be calculated.

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Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

Trace Organics Analysis

RPT Date: Feb 12, 2021			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - PHCs F1 - F4 (Soil)															
Benzene	2039311		< 0.02	< 0.02	NA	< 0.02	80%	50%	140%	104%	60%	130%	114%	50%	140%
Toluene	2039311		< 0.05	< 0.05	NA	< 0.05	102%	50%	140%	88%	60%	130%	115%	50%	140%
Ethylbenzene	2039311		< 0.05	< 0.05	NA	< 0.05	87%	50%	140%	103%	60%	130%	111%	50%	140%
m & p-Xylene	2039311		< 0.05	< 0.05	NA	< 0.05	88%	50%	140%	106%	60%	130%	111%	50%	140%
o-Xylene	2039311		< 0.05	< 0.05	NA	< 0.05	87%	50%	140%	101%	60%	130%	81%	50%	140%
Xylenes (Total)	2039311		< 0.05	< 0.05	NA	< 0.05	88%	50%	140%	103%	60%	130%	96%	50%	140%
F1 (C6 to C10)	2039311		< 5	< 5	NA	< 5	99%	60%	140%	110%	60%	140%	90%	60%	140%
F2 (C10 to C16)	2036904	2036904	< 10	< 10	NA	< 10	106%	60%	140%	100%	60%	140%	86%	60%	140%
F3 (C16 to C34)	2036904	2036904	< 50	< 50	NA	< 50	104%	60%	140%	94%	60%	140%	87%	60%	140%
F4 (C34 to C50)	2036904	2036904	< 50	< 50	NA	< 50	92%	60%	140%	114%	60%	140%	91%	60%	140%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

O. Reg. 558 - Benzene															
Benzene	2036899	2036899	<0.020	<0.020	NA	< 0.020	109%	50%	140%	94%	50%	140%	73%	60%	130%
O. Reg. 558 - Benzo(a) pyrene															
Benzo(a)pyrene	2019052		< 0.001	< 0.001	NA	< 0.001	77%	50%	140%	66%	50%	140%	75%	50%	140%

Certified By:

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QA Violation

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

ATTENTION TO: Yusuf Soliman

RPT Date: Feb 12, 2021

PARAMETER	Sample Id	Sample Description	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
			Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
				Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)											
Silver	2036904	S4 Sa3	134%	70%	130%	97%	80%	120%	90%	70%	130%

Comments: For a multi-element scan for lab control standards and matrix spikes, up to 10% of analytes may exceed the quoted limits by up to 10% absolute and it is considered acceptable.

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Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	modified from MSA PART 3, CH 14 and SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	modified G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Antimony	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Arsenic	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Barium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Beryllium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Boron	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	modified from EPA 6010D and MSA PART 3, CH 21	ICP/OES
Cadmium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Chromium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Cobalt	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Copper	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Lead	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Molybdenum	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Nickel	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Selenium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Silver	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Thallium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Uranium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Vanadium	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Zinc	MET 93 -6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS
Chromium, Hexavalent	INOR-93-6068	modified from EPA 3060 and EPA 7196	SPECTROPHOTOMETER
Cyanide, Free	INOR-93-6052	modified from ON MOECC E3015, SM 4500-CN- I, G-387	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	modified from EPA 3050B and EPA 6020B and ON MOECC	ICP-MS

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Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 21T705996

PROJECT: 20146456

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Sodium Adsorption Ratio (2:1) (Calc.)	INOR-93-6007	modified from EPA 6010D & Analytical Protocol	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Arsenic Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Barium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Boron Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Cadmium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Chromium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Lead Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Mercury Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Selenium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Silver Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Uranium Leachate	MET-93-6103	EPA 1311 & modified from EPA 6020B	ICP-MS
Fluoride Leachate	INOR-93-6018	EPA 1311 & modified from SM4500-F-C	ION SELECTIVE ELECTRODE
Cyanide Leachate	INOR-93-6052	EPA 1311 modified from MOE 3015 SM 4500 CN-I,G387	TECHNICON AUTO ANALYZER
(Nitrate + Nitrite) as N Leachate	INOR-93-6053	EPA SW 846-1311 & modified from SM 4500 - NO3- I	LACHAT FIA
Trace Organics Analysis			
Benzene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Toluene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Ethylbenzene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
m & p-Xylene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
o-Xylene	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
Xylenes (Total)	VOL-91-5009	modified from CCME Tier 1 Method	(P&T)GC/MS
F1 (C6 to C10)	VOL-91-5009	modified from CCME Tier 1 Method	P&T GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	modified from CCME Tier 1 Method	P&T GC/FID
Toluene-d8	VOL-91-5009	modified from EPA SW-846 5030C & 8260D	(P&T)GC/MS
F2 (C10 to C16)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F3 (C16 to C34)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
F4 (C34 to C50)	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	VOL-91-5009	modified from CCME Tier 1 Method	BALANCE
Moisture Content	VOL-91-5009	Tier 1 Method	BALANCE
Terphenyl	VOL-91-5009	modified from CCME Tier 1 Method	GC/FID
Benzene	VOL-91-5001	EPA 1311, EPA 8260D	(P&T)GC/MS
Benzo(a)pyrene	ORG-91-5105	modified from EPA 3510C and EPA 8270E	GC/MS
Naphthalene-d8	ORG-91-5105	modified from EPA 3510C and EPA 8270E	GC/MS
Acenaphthene-d10	ORG-91-5105	modified from EPA 3510C and EPA 8270E	GC/MS
Chrysene-d12	ORG-91-5105	modified from EPA 3541 and EPA 8270E	GC/MS

AGAT Laboratories

1 LG

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 21T705996

Cooler Quantity:

Arrival Temperatures: 2.9 | 4.8 | 3.4
8.4 | 9.1 | 8.6

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes: FREE ICE

Report Information:

Company: Golder Associates Ltd.
Contact: Yusuf Soliman
Address: 100 Scotia Court
Whitby ON, L1N 8Y6
Phone: 289 356 6235 Fax:
Reports to be sent to:
1. Email: ysoliman@golder.com
2. Email: Anastasia_Poliacik@golder.com

Regulatory Requirements:

(Please check all applicable boxes)

☑ Regulation 153/04
Table 1 (Indicate One)
☑ Ind/Com
☐ Res/Park
☐ Agriculture
Soil Texture (Check One)
☐ Coarse
☐ Fine

☐ Excess Soils R406
Table ____ (Indicate One)

☐ Regulation 558

☐ CCME

☐ Sewer Use
☐ Sanitary ☐ Storm
____ (Region)

☐ Prov. Water Quality Objectives (PWQO)

☐ Other
____ (Indicate One)

Is this submission for a **Record of Site Condition?** ☐ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 20146456
Site Location: Kennedy Rd, Markham
Sampled By:
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☑ No ☐

Company:
Contact:
Address:
Email:

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC (Y/N)	O. Reg 153: Metals & Inorganics	O. Reg 153: Metals - ☐ CrVI, ☐ Hg, ☐ HWSB	O. Reg 153: BTEX, F1-F4 PHCs	O. Reg 153: Analyze F4G if required ☐ Yes ☐ No	O. Reg 153: PAHs	O. Reg 153: PCBs	O. Reg 153: VOC	O. Reg 558: Landfill Disposal Characterization TCLP: ☒ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	O. Reg 406: Excess Soils SPLP Rainwater Leach SPLP: ☐ Metals ☐ VOCs ☐ SVOCs	O. Reg 406: Excess Soils Characterization Package	Salt - EC/SAR	TCLP - Benzene	TCLP - Benzo(a)pyrene	Corrosivity					Potentially Hazardous or High Concentration (Y/N)
S4 TCLP	Jan 19/21	12 AM/PM	3	Soil										X				X	X						
S4 SA3	Jan 19/21	9 AM/PM	3				X		X											X					
S9 SA2	Jan 28/21	11 AM/PM	3				X		X											X					
S1 SA3	Jan 20/21	11 AM/PM	1				X													X					
S10 SA3	Jan 29/21	10 AM/PM	1				X																		
S7 SA4	Jan 19/21	1 AM/PM	1				X																		
S11 SA3	Jan 20/21	3 AM/PM	1				X																		
		AM/PM																							
		AM/PM																							
		AM/PM																							
		AM/PM																							

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
Yusuf Soliman	Jan 31/21	7PM			
	Feb 1/21	2:37		Feb 01/21	1:00

Page ____ of ____

N°: 112218

AGAT Laboratories

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD.
100 SCOTIA COURT
WHITBY, ON L1N8Y6
(905) 723-2727

ATTENTION TO: Yusuf Soliman

PROJECT: 21T705996

AGAT WORK ORDER: 21T707684

SOLID ANALYSIS REVIEWED BY: Sherin Moussa, Senior Technician

DATE REPORTED: Feb 12, 2021

PAGES (INCLUDING COVER): 5

Should you require any information regarding this analysis please contact your client services representative at (905) 501-9998

*NOTES

All samples are stored at no charge for 90 days. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

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CANADA L4Z 1N9
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FAX (905)501-0589
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 21T707684
PROJECT: 21T705996

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

(201-042) Sulfide

DATE SAMPLED: Feb 04, 2021 | DATE RECEIVED: Feb 05, 2021 | DATE REPORTED: Feb 12, 2021 | SAMPLE TYPE: Other

Analyte:	Sulfide
Unit:	%
Sample ID (AGAT ID) RDL:	0.05
S4 Sa3-2036904 (2054225)	<0.05
S4 Sa3-2036904-DUP (2054226)	<0.05
S9 Sa2-2036946 (2054227)	0.17
S1 Sa3-2036949 (2054228)	0.10

Comments: RDL - Reported Detection Limit

Analysis performed at AGAT 5623 McAdam Rd., Mississauga, ON (unless marked by *)

Certified By: Sherin Moussa

AGAT Laboratories

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MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
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FAX (905)501-0589
http://www.agatlabs.com

Quality Assurance - Replicate

AGAT WORK ORDER: 21T707684

PROJECT: 21T705996

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

(201-042) Sulfide

	REPLICATE #1				REPLICATE #2											
Parameter	Sample ID	Original	Replicate	RPD	Sample ID	Original	Replicate	RPD								
S	2054225	0.036	0.038	5.4%	2054228	0.101	0.108	6.7%								
Sulfate	2054225	< 0.01	< 0.01	0.0%	2054228	< 0.01	< 0.01	0.0%								
Sulfide	2054225	< 0.05	< 0.05	0.0%	2054228	0.10	0.11	9.5%								

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http://www.agatlabs.com

Quality Assurance - Certified Reference materials

AGAT WORK ORDER: 21T707684

PROJECT: 21T705996

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

(201-042) Sulfide

	CRM #1				CRM #2											
Parameter	Expect	Actual	Recovery	Limits	Expect	Actual	Recovery	Limits								
S	0.80	0.79	98%	90% - 110%	0.80	0.81	101%	90% - 110%								
Sulfate	0.01	0.01	100%	90% - 110%	0.01	0.01	100%	90% - 110%								
Sulfide	0.80	0.78	97%	90% - 110%	0.80	0.80	100%	90% - 110%								

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Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 21T707684

PROJECT: 21T705996

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Solid Analysis			
Sulfide	MIN-200-12037		LECO

APPENDIX F

AASHTO Design Sheets

Table F-1
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Kennedy Road - Widening design 20 years

1) Traffic Analysis

Traffic Data Year	2017		2041		2050
Design Year	**2023**				
Traffic Analysis Period		24		9	
Average Annual Daily Traffic (AADT)	8,000		33,000		55,755
Average Rate of Increase in Traffic (%)		6.08		6.00	
Truck Fraction of Total Traffic (%)	6		6		6
Average Rate of Increase in Truck Fraction (%)		0.00		0.00	
Number of Lanes in One Direction	1		2		2
Directional Factor	0.5		0.5		0.5
Lane Distribution Factor	1		0.8		0.8
Daily Truck Volume	**342**		**792**		**1,338**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2023	2041	2050
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	222	515	870
	Class 2	17	40	67
	Class 3	68	158	268
	Class 4	34	79	134
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	111	257	435
	Class 2	39	91	154
	Class 3	109	253	428
	Class 4	188	436	736
Total Daily ESALs in Design Lane		**448**	**1,038**	**1,753**

3) Total ESALs for Base Year

Base Year	2023	2041	2050
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**163,543**	**378,695**	**639,827**

4) Cumulative ESALs for the Design Period

Design Period (Years)		**20**	
Span of Design Periods	2023 to 2041	2041 to 2043	
Average Rate of Increase in Truck Volume (%)	4.78	6.00	
Years of Design Periods	18	2	
Growth Factor	31.15	2.06	
ESALs for the Design Periods	5,094,000	780,000	
Cumulative ESALs for the Design Period		**5,874,058**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table F-2
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Kennedy Road - Widening design 20 years

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	5,900,000
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level (%)	90
Overall Standard Deviation	0.47
Roadbed Soil Resilient Modulus	20,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	148

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	200	200	84
2	New Granular A Base	0.14	1.00	150	150	21
3	New Granular B,Type I	0.09	1.00	500	500	45
Total	-	-	-	850	850	150

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	154	65
2	New Granular A Base	0.14	1.00	-	-	240,000	129	18
3	New Granular B,Type I	0.09	1.00	-	-	120,000	723	65
Total	-	-	-	-	-	-	1006	148

-

Table F-3
EQUIVALENT SINGLE AXLE LOAD CALCULATION

Kennedy Road - Rehabilitation design
15 year ESALs

1) Traffic Analysis

Traffic Data Year		2017		2041	2050
Design Year		**2023**			
Traffic Analysis Period			24	9	
Average Annual Daily Traffic (AADT)		8,000		33,000	55,755
Average Rate of Increase in Traffic (%)			6.08	6.00	
Truck Fraction of Total Traffic (%)		6		6	6
Average Rate of Increase in Truck Fraction (%)			0.00	0.00	
Number of Lanes in One Direction		1		2	2
Directional Factor		0.5		0.5	0.5
Lane Distribution Factor		1		0.8	0.8
Daily Truck Volume		**342**		**792**	**1,338**

2) Daily ESALs Analysis

Road Classification		***Urban Minor Arterial***		
Traffic Analysis Base Year		2023	2041	2050
Breakdown of Truck Proportions (%)	Class 1	65		
	Class 2	5		
	Class 3	20		
	Class 4	10		
Daily Truck Volumes for 4 Classes	Class 1	222	515	870
	Class 2	17	40	67
	Class 3	68	158	268
	Class 4	34	79	134
Truck Factors for 4 Classes of Truck	Class 1	0.5		
	Class 2	2.3		
	Class 3	1.6		
	Class 4	5.5		
Weighted Average Truck Factor			**1.310**	
Daily ESALs per Truck Class	Class 1	111	257	435
	Class 2	39	91	154
	Class 3	109	253	428
	Class 4	188	436	736
Total Daily ESALs in Design Lane		**448**	**1,038**	**1,753**

3) Total ESALs for Base Year

Base Year	2023	2041	2050
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**163,543**	**378,695**	**639,827**

4) Cumulative ESALs for the Design Period

Design Period (Years)	**15**	
Span of Design Periods	2023 to 2038	
Average Rate of Increase in Truck Volume (%)	4.78	
Years of Design Periods	15	
Growth Factor	23.42	
ESALs for the Design Periods	3,831,000	
Cumulative ESALs for the Design Period	**3,830,547**	

Note: The ESAL calculations are baesd on the guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", March 19, 2008.

Table F-4
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Kennedy Road - NB Lane Rehabilitation- 15 year design
Mill 60 mm / Pave 100 mm
(40 mm grade raise)

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	3,850,000
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level (%)	90
Overall Standard Deviation	0.47
Roadbed Soil Resilient Modulus	25,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	131

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	100	100	42
2	Existing Hot Mix Asphalt	0.25	1.00	180	180	45
3	Existing Granular Base	0.10	0.90	200	200	18
4	Existing Granuar Subbase	0.07	0.90	620	620	39
Total	-	-	-	1100	1100	144

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	53	22
2	Existing Hot Mix Asphalt	0.25	1.00	-	-	2,500,000	161	40
3	Existing Granular Base	0.10	0.90	-	-	220,000	195	18
4	Existing Granuar Subbase	0.07	0.90	-	-	110,000	803	51
Total	-	-	-	-	-	-	1213	131

-

Table F-5
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Kennedy Road - SB lane - 15 year Rehabilitation design
Remove existing HMA (ave. 160mm) and 100 mm of existing gran base / place 100 mm new Gran A + Pave 200 mm HMA (40 mm grade raise)

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	3,850,000
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level (%)	90
Overall Standard Deviation	0.47
Roadbed Soil Resilient Modulus	25,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	131

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Required Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	200	200	84
2	New Granular A	0.14	1.00	100	100	14
3	Existing Granular Base	0.10	0.90	130	130	12
4	Existing Granuar Subbase	0.07	0.90	360	360	23
Total	-	-	-	790	790	133

Layered Thickness Design

Thickness precision

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Actual Spec Thickness (Di) (mm)	Actual Min Thickness (Di) (mm)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1.00	-	-	2,750,000	144	61
2	New Granular A	0.14	1.00	-	-	240,000	14	2
3	Existing Granular Base	0.10	0.90	-	-	220,000	195	18
4	Existing Granuar Subbase	0.07	0.90	-	-	110,000	803	51
Total	-	-	-	-	-	-	1157	132

APPENDIX G

Life Cycle Cost Analysis

Table G-1

REHABILITATION COST ANALYSIS (Per Lane, Per Kilometre)

Kennedy Road SB Lane Rehabilitation Options

SUMMARY OF LIFE COST ANALYSIS

OPTIONS	STRATEGY DESCRIPTION	INITIAL COST	MAIN'T COST	50 YEAR LCC	RANKING
Option 1	**Remove Existing HMA & 100 mm gran.base/Pave 200mm HMA over**	$291,038	$113,958	$404,996	**1**
Option 2	**Reconstruction (20-year)**	$637,538	$92,571	$730,108	**2**

Length	**1,000**	m
Width	**3.75**	m
Area	**3750**	sq.m

Option 1 Remove Existing HMA & 100 mm gran.base/Pave 200mm HMA over 100 mm new Gran.A (15-year)

	%	Thickness (mm)	Unit Weight	Quantity	Unit	Unit Price	Cost
Removal of existing HMA	100%	160	-	3,750	sq.m	12.00	45,000
Earth excavation	100%	100	2.40	375	m3	50.00	18,750
SP 12.5 FC2	100%	40	2.50	375	t	130.00	48,750
SP 19.0	100%	60	2.45	551	t	110.00	60,638
SP 25.0	100%	100	2.47	926	t	120.00	111,150
Tack Coat	300%	-	-	11,250	sq.m	0.60	6,750
New Granular A Base	100%	100	2.40	900	t	40.00	36,000
						TOTAL	**291,038**

Option 2 Reconstruction (20-year)

	%	Thickness (mm)	Unit Weight	Quantity	Unit	Unit Price	Cost
Removal of existing HMA	100%	160	-	3,750	sq.m	12.00	45,000
Earth excavation	100%	940	2.40	3,525	m3	50.00	176,250
SP 12.5 FC2	100%	40	2.50	375	t	130.00	48,750
SP 19.0	100%	60	2.45	551	t	110.00	60,638
SP 25.0	100%	100	2.47	926	t	120.00	111,150
Tack Coat	300%	-	-	11,250	sq.m	0.60	6,750
New Granular A Base	100%	150	2.40	1,350	t	40.00	54,000
New Granular B, Type I SubbBase	100%	750	2.40	6,750	t	20.00	135,000
						TOTAL	**637,538**

Table G-2
50 YEAR LIFE CYCLE COST ANALYSIS

(Per Lane, Per Kilometer, 5.0 % Discount Rate)

Kennedy Road SB Lane Rehabilitation Options

Remove Existing HMA & 100 mm gran.base/Pave 200mm HMA over 100 mm new Gran.A (15-year)

OPTION 1

Scheduled Maint/Rehab Year	Maintenance/Rehabilitation Treatment	Work %	Quantities (Per C/L km)	Pay Item Price ($)	Cost (Per C/L km)	Maint/Rehab Cost (Per C/L km)	Net Present Worth $
0	**Initial Construction Cost**						**$291,038**
3	Rout and Seal Cracks		120 m	$12.00	$1,440	$1,440	$1,244
9	Rout and Seal Cracks		240 m	$12.00	$2,880	$2,880	$1,856
9	Mill 50 mm and Patch 50 mm		150 sq.m	$17.50	$2,625	$2,625	$1,692
15	**Mill 50 mm asphalt pavement**	100%	3,750 sq.m	$6.20	$23,250	**$86,438**	**$41,578**
	Resurface SP 12.5 FC2 - 50 mm	100%	469 t	$130.00	$60,938		
	Tack Coat - 1 layer	100%	3,750 sq.m	$0.60	$2,250		
18	Rout and Seal Cracks		120 m	$12.00	$1,440	$1,440	$598
21	Rout and Seal Cracks		240 m	$12.00	$2,880	$5,505	$1,976
	Mill 50 mm and Patch 50 mm		150 sq.m	$17.50	$2,625		
24	**Mill 90 mm asphalt pavement**	100%	3,750 sq.m	$6.20	$23,250	**$127,031**	**$39,388**
	Resurface SP 12.5 FC2 - 40 mm	100%	375 t	$130.00	$48,750		
	SP 19.0 - 50 mm	100%	459 t	$110.00	$50,531		
	Tack Coat - 2 layers	200%	7,500 sq.m	$0.60	$4,500		
27	Rout and Seal Cracks		150 m	$12.00	$1,800	$1,800	$482
32	Rout and Seal Cracks		250 m	$12.00	$3,000	$5,800	$1,217
	Mill 50 mm and Patch 50 mm		160 sq.m	$17.50	$2,800		
36	**Mill 50 mm asphalt pavement**	100%	3,750 sq.m	$6.20	$23,250	**$86,438**	**$14,924**
	Resurface SP 12.5 FC2 - 50 mm	100%	469 t	$130.00	$60,938		
	Tack Coat - 1 layer	100%	3,750 sq.m	$0.60	$2,250		
39	Rout and Seal Cracks		150 m	$12.00	$1,800	$1,800	$268
42	Rout and Seal Cracks		280 m	$12.00	$3,360	$3,360	$433
42	Mill 50 mm and Patch 50 mm		200 sq.m	$17.50	$3,500	$3,500	$451
45	**Mill 90 mm asphalt pavement**	100%	3,750 sq.m	$6.20	$23,250	**$127,031**	**$14,138**
	Resurface SP 12.5 FC2 - 40 mm	100%	375 t	$130.00	$48,750		
	SP 19.0 - 50 mm	100%	459 t	$110.00	$50,531		
	Tack Coat - 2 layers	200%	7,500 sq.m	$0.60	$4,500		
48	Rout and Seal Cracks		150 m	$12.00	$1,800	$1,800	$173
50	**Salvage Value**				-$74,102	**-$74,102**	**-$6,462**
						Subtotal	$113,958
						Initial Cost	$291,038
						TOTAL	**$404,996**

Table G-3
50 YEAR LIFE CYCLE COST ANALYSIS

(Per Lane, Per Kilometer, 5.0 % Discount Rate)

Kennedy Road SB Lane Rehabilitation Options

Reconstruction (20-year)

OPTION 2

Scheduled Maint/Rehab Year	Maintenance/Rehabilitation Treatment	Work %	Quantities (Per C/L km)	Pay Item Price ($)	Cost (Per C/L km)	Maint/Rehab Cost (Per C/L km)	Net Present Worth $
0	**Initial Construction Cost**						**$637,538**
3	Rout and Seal Cracks		120 m	$12.00	$1,440	$1,440	$1,244
9	Rout and Seal Cracks		240 m	$12.00	$2,880	$2,880	$1,856
9	Mill 50 mm and Patch 50 mm		150 sq.m	$17.50	$2,625	$2,625	$1,692
15	Rout and Seal Cracks		300 m	$12.00	$3,600	$3,600	$1,732
15	Mill 50 mm and Patch 50 mm		200 sq.m	$17.50	$3,500	$3,500	$1,684
20	**Mill 90 mm asphalt pavement**	100%	3,750 sq.m	$6.20	$23,250	**$127,031**	**$47,877**
	Resurface SP 12.5 FC2 - 40 mm	100%	375 t	$130.00	$48,750		
	SP 19.0 - 50 mm	100%	459 t	$110.00	$50,531		
	Tack Coat - 2 layers	200%	7,500 sq.m	$0.60	$4,500		
23	Rout and Seal Cracks		150 m	$12.00	$1,800	$1,800	$586
28	Rout and Seal Cracks		250 m	$12.00	$3,000	$5,800	$1,480
	Mill 50 mm and Patch 50 mm		160 sq.m	$17.50	$2,800		
32	**Mill 50 mm asphalt pavement**	100%	3,750 sq.m	$6.20	$23,250	**$86,438**	**$18,140**
	Resurface SP 12.5 FC2 - 50 mm	100%	469 t	$130.00	$60,938		
	Tack Coat - 1 layer	100%	3,750 sq.m	$0.60	$2,250		
35	Rout and Seal Cracks		120 m	$12.00	$1,440	$1,440	$261
38	Rout and Seal Cracks		240 m	$12.00	$2,880	$2,880	$451
38	Mill 50 mm and Patch 50 mm		150 sq.m	$17.50	$2,625	$2,625	$411
41	**Mill 90 mm asphalt pavement**	100%	3,750 sq.m	$6.20	$23,250	**$127,031**	**$17,185**
	Resurface SP 12.5 FC2 - 40 mm	100%	375 t	$130.00	$48,750		
	SP 19.0 - 50 mm	100%	459 t	$110.00	$50,531		
	Tack Coat - 2 layers	200%	7,500 sq.m	$0.60	$4,500		
44	Rout and Seal Cracks		150 m	$12.00	$1,800	$1,800	$210
49	Rout and Seal Cracks		250 m	$12.00	$3,000	$3,000	$275
49	Mill 50 mm and Patch 50 mm		160 sq.m	$17.50	$2,800	$2,800	$256
50	**Salvage Value**				-$31,758	**-$31,758**	**-$2,769**
						Subtotal	$92,571
						Initial Cost	$637,538
						TOTAL	**$730,108**

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