Appendix H

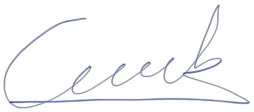
GEOTECHNICAL INVESTIGATION AND PAVEMENT DESIGN REPORT

VMC
Geotechnical Investigation And Pavement Design Report

Final
May 2025

DOWNTOWN vaughan METROPOLITAN CENTRE

Signatures and Disclaimers

Prepared by	Reviewed by
 Mohammed Kamala, P.Eng. PMP Pavement Engineer	 Atiqur Rahman, M.Eng., P.Eng., PMP Principal pavement Engineer

Client

Manager, Development Engineering (VMC), Policy Planning & Special Programs	Musa Deo
Transportation Project Manager	James Norris, P.Eng.

Project Personnel

Project Manager	Brett Sears
Report Preparation	Mohammed Kamala
Report Review	Atiqur Rahman

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1 General Data

1.1 Introduction

WSP Canada Inc. (WSP) was retained by City of Vaughan (Client) to provide a geotechnical investigation report for the proposed new construction of Millway Avenue from Highway 7 to Interchange Way, proposed rehabilitation of Interchange Way from 70 m west of Mable Smith Way to Jane Street and the proposed new construction of Interchange Way from Jane Street to Creditstone Road. In addition, geotechnical investigation and design recommendations are required at the Black Creek main tributary (east of Jane Street) which crosses the proposed Interchange Way extension to address the potential relocation of subsurface services and/or foundation design considerations.

A modified preferred alignment for Interchange Way was recently presented by the city to landowners; however, this update does not affect the current preferred design or require any additional field investigations for this report.

The purpose of this investigation was to obtain information on the general subsurface soil and groundwater conditions at the site by means of a limited number of boreholes. Based on our interpretation of the borehole data, this report provides a pavement design report and geotechnical information related to the design of the proposed culvert replacement.

1.2 Traffic Volumes

At the time of report writing, the traffic data was not available. The estimated 2024 two-way traffic volumes for Interchange Way and Millway Avenue are presented in Table 1

Table 1: Assumed Traffic Volumes

Location	Road Classification	AADT 2023	No. of Lanes	Growth Rate
Interchange Way	Local Urban – Residential	4000	2	2%

Location	Road Classification	AADT 2023	No. of Lanes	Growth Rate
Millway Avenue	Local Urban – Residential	3000	2	2%

1.3 Physiography

The physiography of site is generally characterized by bevelled till plains located within the Peel Plain. Underlying this, the relatively shallow bedrock generally consists of the Georgian Bay Formation of the Upper Ordovician period, which consists of shale, limestone, dolostone, and siltstone (The Physiography of Southern Ontario, Chapman, L.J. and Putnam, D.F., 1984 – Map P.2605).

2 Geotechnical Field Investigation

2.1 Borehole Investigation

The field investigation was carried between March 02, 2023, and March 08, 2023, during which time fifteen (15) boreholes, designated as BH-INT-01 to BH-INT-09, BH-MIL-01 to BH-MIL-05 and BH-BLC-01, were advanced within the project limits to depths ranging from 2.6 m to 10 m below ground surface (bgs).

WSP technical staff marked the location of each borehole, obtained utility public and private clearances, procured traffic control services, and supervised the daylighting, drilling, and soil logging activities. Due to the proximity of existing underground TTC tunnel, the areas surrounding boreholes BH-INT-03 and BH-MIL-01 to BH-MIL-05 were first daylighted with a hydro-vacuum truck to make sure no conflict within the TTC tunnel prior to drilling.

Boreholes were advanced using a truck-mounted rig equipped with 152 mm Outside Diameter (O.D.) solid stem augers. Soil samples were retrieved from auger cuttings as well as 51 mm O.D. split-spoon samplers. A qualified WSP geotechnical engineering technician supervised the drilling, logged and sampled the borehole in accordance with City standards. Soil samples were recovered and retained in labeled air-tight containers for subsequent review by the project engineer and laboratory testing, as required. Asphalt, base and subbase thicknesses of the roads were recorded. The borehole details are summarized in Table 2. These borehole locations are shown on plan view in **Appendix A**. The results of the geotechnical field investigation are summarized in the following sections. The Record of Boreholes are provided in **Appendix B**.

Table 2: Borehole Program

Borehole No.	Location	Latitude	Longitude	Borehole Depth (mbgs)	Monitoring Well Screen Bottom Depth (mbgs)
BH-INT-01	Interchange Way	43° 47' 19.7304"N	-79° 31' 44.0574"W	3.65	-

Borehole No.	Location	Latitude	Longitude	Borehole Depth (mbgs)	Monitoring Well Screen Bottom Depth (mbgs)
BH-INT-02	Interchange Way	43° 47' 20.5296"N	-79° 31' 39.7488"W	3.65	-
BH-INT-03	Interchange Way	43° 47' 21.7284"N	-79° 31' 36.2382"W	2.59	-
BH-INT-04W	Interchange Way	43° 47' 22.5996"N	-79° 31' 29.4882"W	4.57	4.57
BH-INT-05	Grass Area Northeast of Jane Street and Peelar Road	43° 47' 22.4586"N	-79° 31' 23.8506"W	4.41	-
BH-INT-06	NCI Vaughan Iceplex Front Parking	43° 47' 22.2108"N	-79° 31' 16.608"W	4.41	-
BH-INT-07W	Maplecrete Road	43° 47' 24.3312"N	-79° 31' 11.3808"W	4.41	4.41
BH-INT-08	Northeast Corner of 53 Maplecrete Road	43° 47' 24.5286"N	-79° 31' 6.4086"W	4.41	-
BH-INT-09	Creditstone Road	43° 47' 26.2494"N	-79° 30' 59.7774"W	4.41	-
BH-MIL-01	7540 Jane Street West of Parking Lot (South)	43° 47' 23.1894"N	-79° 31' 33.168"W	3.65	-
BH-MIL-02	7540 Jane Street West of Parking Lot (North)	43° 47' 26.0232"N	-79° 31' 34.2192"W	3.65	-
BH-MIL-03	Toromont CAT South lot (PCC)	43° 47' 28.3986"N	-79° 31' 34.7808"W	3.65	-
BH-MIL-04	Toromont CAT Entrance Driveway	43° 47' 32.7012"N	-79° 31' 35.6196"W	3.65	-
BH-MIL-05	Toromont CAT Entrance Driveway	43° 47' 35.4006"N	-79° 31' 35.8494"W	3.65	-
BH-BLC-01W	East of Peelar Road	43° 47' 21.609" N	-79° 31' 21.1512W	9.74	9.14

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations. Monitoring wells, consisting of 50 mm diameter PVC pipes and flush-mount casings, were installed in three (3) boreholes upon completion of drilling as summarized in Table 2. The remaining boreholes were backfilled with bentonite chips in general accordance with Ontario Regulation 903, as amended. The site conditions were restored following completion of the fieldwork.

2.2 Laboratory Testing

The granular base/subbase and subgrade soil samples obtained from boreholes were brought to WSP 's laboratory in Toronto for further examination and testing. Testing on selected samples was carried out in accordance with the procedures listed in MTO's "Laboratory Testing Manual." The tests included in-situ water content determination, sieve analysis, hydrometer and Atterberg Limits. The soil and granular samples tested under this assignment are listed in Table 3.

Table 3: Laboratory Testing Program for Granular and Subgrade Soils

Laboratory Testing	No. of Tests
Water Content	50
Sieve Analysis	11
Sieve and Hydrometer	13
Atterberg Limits	6

The laboratory results are included in the Record of Boreholes attached in **Appendix C**.

3 Soil And Pavement Data

The following provides a general description of the existing surficial conditions, pavement structures and major soil types encountered during the geotechnical investigation. It should be noted that the differences in soil types and changes between various soil strata are often gradational, as opposed to precise boundaries of geological change.

3.1 Existing Pavement Structure

Based on the results of the geotechnical field investigation, the pavement layer thicknesses encountered within the project limits are summarised in Table 4.

Table 4: Existing Pavement Structure

Borehole/Corehole No.	Asphalt Thickness (mm)	Concrete Thickness (mm)	Granular Base/ Subbase Thickness (mm)	Total Pavement Structure Thickness (mm)
Proposed Rehabilitation Of Interchange Way (70 m west of Mable Smith to Jane Street)				
BH-INT-01	140	-	550	690
BH-INT-02	130	-	550	680
BH-INT-03	140	-	550	690
BH-INT-04W	150	-	550	700
Range	130 - 150	-	-	680 – 700
Average	140	-	550	690
Proposed New Construction Of Interchange Way (Jane Street to Creditstone Road)				
BH-INT-06	60	-	250	310
BH-INT-07W	90	-	350	440
BH-INT-08	20	-	600	620
BH-INT-09	150	-	500	650
Range	20 - 150	-	250 - 600	270 - 750
Average	80	-	425	505
Proposed New Construction of Millway Avenue (Highway 7 To Interchange Way)				
BH-MIL-03	N/A	200	60	260
BH-MIL-05	130	-	200	330

3.2 Characteristics of Existing Granular base/ subbase Materials

Within the project limits, eleven (11) samples of the Granular Base/Subbase materials were tested for grain size analysis and the gradation results were compared against OPSS 1010 gradation requirements for Granular A and Granular B Type I.

Laboratory moisture content testing indicates a moisture content range between 4% and 9%, with an average of 6% in the granular base/subbase materials within the project limits.

The following Table 5 summarizes the results of this testing:

Table 5: Laboratory Testing Results of Granular Base/ Subbase Materials

Borehole No.	Sample	% Gravel	% Sand	% Fines	Material Description	Acceptability – OPSS Granular A	Acceptability – OPSS Granular B Type I
BH-INT-01	AS1	25	54	21	Gravelly sand, with fines	Not Acceptable	Not Acceptable
BH-INT-02	AS1	20	54	26	Gravelly sand, with fines	Not Acceptable	Not Acceptable
BH-INT-03	AS1	23	56	21	Gravelly sand, with fines	Not Acceptable	Not Acceptable
BH-INT-04W	AS1	32	54	14	Gravelly sand, some fines	Not Acceptable	Not Acceptable
BH-INT-06	AS1	21	61	18	Gravelly sand, some fines	Not Acceptable	Not Acceptable
BH-INT-07W	AS1	21	62	17	Gravelly sand, some fines	Not Acceptable	Not Acceptable
BH-INT-08	AS1A	16	81	3	Sand, trace gravel, Trace fines	Not Acceptable	Acceptable
BH-INT-08	AS1B	8	68	24	Sand, trace gravel, with fines	Not Acceptable	Not Acceptable
BH-INT-09	AS1A	30	62	8	Gravelly sand, trace fines	Not Acceptable	Acceptable
BH-INT-09	AS1B	26	53	21	Gravelly sand, with fines	Not Acceptable	Not Acceptable
BH-MIL-05	AS1	29	66	5	Gravelly sand, trace fines	Not Acceptable	Acceptable

Based on the laboratory testing results, none of the eleven samples tested meet OPSS 1010 gradation requirements for Granular A. Two out of eleven samples tested (BH-INT-08 and BH-INT09) meet OPSS 1010 gradation requirements for Granular B Type I. The laboratory testing results are presented in **Appendix C**.

3.3 Subgrade Soil Properties

Laboratory particle size distribution analysis was completed on thirteen (13) and Atterberg Limits test on six (6). The results according to the Unified Soil Classification System (USCS) are summarized in Table 6 and are shown on the Record of Boreholes in **Appendix C**.

Table 6: Subgrade Laboratory Testing Results

Borehole No.	Sample No.	Depth (mBGL)	Grain Size Distribution				Susceptibility To Frost Heaving	Atterberg Limits			Soil Type
			Gravel (%)	Sand (%)	Fines			Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	
					Silt (%)	Clay (%)					
BH-INT-1	SS5	0.76	3	41	45	11	38% (LSFH)	-			
BH-INT-1	SS5	3.05	2	29	53	16	45% (MSFH)	18	11	7	CL-ML
BH-INT-4W	SS5	3.05	1	34	47	18	40% (LSFH)	-			
BH-INT-5	SS2	0.76	1	27	56	16	38% (LSFH)	31	18	13	CL
BH-INT-7W	SS2	0.76	4	30	44	22	35% (LSFH)	-			
BH-INT-7W	SS6	3.81	1	27	64	8	56% (HSFH)	NV	NP	NP	ML
BH-INT-09	SS2	0.76	3	33	44	20	34% (LSFH)	19	11	8	CL
BH-INT-09	SS6	3.81	2	33	49	16	42% (MSFH)	-			
BH-MIL-02	SS2	0.76	4	33	44	19	34% (LSFH)	24	15	9	CL
BH-MIL-03	SS2	0.76	1	21	44	24	36% (LSFH)	-			
BH-MIL-05	SS5	3.05	0	2	88	10	73% (HSFH)	-			
BH-BLC-1W	SS2	0.76	3	32	44	21	33% (LSFH)	-			
BH-BLC-1W	SS6	3.81	0	24	49	28	40% (LSFH)	-			

3.3.1 Interchange Way (70 m west of Mable Smith to Jane Street)

A deposit of sand and silt, silty sand, and sandy silt was encountered below the granular base/subbase, extending to depths of 1.21 to 3.65 m below ground surface (bgs). The SPT N-values was 18 to 64 blows per 300 mm of penetration, indicating compact to very dense state of compactness.

A deposit of silty sandy clay to clayey silt was encountered in all boreholes except BH23-INT-2, extending to the maximum depth of the boreholes. The SPT N-values was 8 to 27 blows per 300 mm of penetration, indicating firm to very stiff state in consistency.

At the time of the field investigation, the soil was moist with water contents ranging from 9% to 14% with an average of 10%.

3.3.2 Interchange Way (Jane Street to Creditstone Road)

Earth fill of sand was encountered below the topsoil in BH-INT-05, extending to depths of 0.76 mbgs. The SPT N-value for sand was 11 blows per 300 mm of penetration, indicating compact state of compactness.

Earth fill of silty clay was encountered below the asphalt in BH-INT-06, extending to depths of 2.1 mbgs. The SPT N-value for silty clay was 10 to 15 blows per 300 mm of penetration, indicating this fill was stiff in consistency.

A deposit of silty clay to sandy silty, clayey silt, and sandy silt was encountered in all boreholes, extending to the maximum depth of the boreholes. The SPT N-values for silty clay to sandy silty clay and clayey silt was 8 to 31 blows per 300 mm of penetration, indicating stiff to very stiff state of compactness. The SPT N-values for sandy silt was 10 to 19 blows per 300 mm of penetration, indicating compact state of compactness and a water content ranging from 10 to 22 percent.

3.3.3 Millway Avenue (Highway 7 to Interchange Way)

Earth fill of sand and gravel was encountered below the topsoil in BH-MIL-04, extending to depths of 0.76 mbgs. The SPT N-value for sand and gravel was 23 blows per 300 mm of penetration, indicating compact state of compactness.

A cohesive deposit of sandy silty clay to silty clay, clayey silt to silt was encountered below the granular base/subbase/topsoil, extending to the maximum depth of the boreholes. The SPT N-values was 6 to 47 blows per 300 mm of penetration, indicating this deposit was in firm to hard in consistency.

A cohesionless layer of sand and silty sand was encountered at borehole BH-ML03 and BH-ML04 with the cohesive layer or just under the granular fill. The SPT N-values for sand to silty

sand was 10 to 16 blows per 300 mm of penetration, indicating compact state of compactness.

The water contents for these deposits ranging from 9% to 19% with an average of 14%.

3.3.4 Black Creek Main Tributary (East of Jane Street)

A deposit of sandy silty clay was encountered below the topsoil, extending to depths of 0.2 to 9.74 mbgs (termination depth of boreholes). The SPT N-values was 6 to 27 blows per 300 mm of penetration, indicating firm to very stiff state in consistency with water contents ranging from 13 to 26 percent.

3.4 Frost Penetration Depth

In accordance with OPSD-3090.101, Frost Penetration Depth of Southern Ontario, the frost depth in the project limit area is 1.4 metres.

The subgrade soil susceptibility to frost heave is assumed to be low (LSFH) to high (HSFH) with 33% to 73% of material passing 75 µm and retained on 5 µm. as outlined Table 7

Table 7: Susceptibility to Frost Heaving

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

3.5 Groundwater Conditions

The boreholes were noted to be dry and remained open and stable upon completion of drilling and removal of auger sampling equipment except borehole locations BH-INT-4W, BH-MIL-4 and BH-BLC-1W, where water was encountered at 2.4, 0.91 and 2.74 mBGL, respectively. Monitoring wells were installed in 3 boreholes as outlined in Table 2. The corresponding groundwater level readings are summarized in Table 8

Table 8: Summary of Groundwater Levels at monitoring Wells

Borehole No.	Monitoring Well Screen Bottom Depth (Mbgs)	Depth Of Groundwater (Mbgs)	Date Of Measurement
BH-INT-04W	4.57	2.4	07/03/2023
		2.25	21/12/2023
BH-INT-07W	4.41	Dry	06/03/2023
		2.7	21/12/2023
BH-BLC-01W	9.14	2.74	06/03/2023
		2.85	21/12/2023

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations as well as fluctuations in response to major weather events.

3.6 Topsoil

A total of one (1) borehole was advanced in the boulevard along the proposed new construction of Interchange Way, three (3) boreholes within the construction of Millway Avenue and one (1) within Black Creek Main Tributary. These boreholes encountered topsoil ranging in thicknesses from 130 to 300 mm, with an average thickness of 200 mm.

3.7 Pavement Structure Design

3.7.1 Existing Pavement Design Value for Rehabilitation Of Interchange Way (70 m west of Mable Smith to Jane Street)

Based on the values shown in Table 4, the chosen design values to represent the existing pavement structure are as follows:

- Asphalt Thickness: 140 mm
- Granular Fill Thickness: 550 mm
- Total Pavement Structure Thickness: 690 mm
- Subgrade Type: gravelly sand

It should be noted that the above design values are based on a limited investigation which included four (4) boreholes. Though the borehole location was chosen at what appeared, from the surface, to be representative conditions, the pavement structure and soil types within the site limits may differ from those expressed in this report. Any contractor performing rehabilitation activities on this roadway is advised to confirm and supplement the data presented herein.

Existing Structural Numbers

The existing pavement structure Structural Number (SN) for Interchange Way from Interchange Way to Jane Street was calculated using the following:

- Existing Asphalt: 0.24
- Existing Granular Fill: 0.09
- Drainage Coefficient for Base: 0.9

Using the design values presented above, the existing SN is 71 mm.

3.8 Equivalent Single Axle Loads

The equivalent single axle loads (ESALs) for the design lanes were calculated using the traffic data presented below. The input parameters for the design lane ESAL calculation were derived from MTO publication MI-183 'Adaptation and Verification of the AASHTO Pavement Design Guide for Ontario Conditions' and 'Procedures for Estimating Traffic Loads for Pavement Design, 1995'. The following Table 9 shows the estimates used to calculate the truck factor taken from MI-183 (Table D-3) for Urban Minor Arterial Roads with the required adjustment to capture the nature of traffic conditions at this location, as referenced above:

Table 9: Truck Factor

Truck Category	Average Truck Distribution (%)	Typical Truck Factor	Resultant Truck Factor Fraction
2 and 3-axle trucks	65	0.5	0.325
4-axle trucks	5	2.3	0.115
5-axle trucks	20	1.6	0.32
6-axle trucks	10	5.5	0.55
Total Truck Factor			1.31

Input parameters used to calculate ESALs for Interchange Way and Millway Avenue are presented in Table 10 below:

Table 10: ESAL Design Inputs

Road Name	Base year AADT[1]	Commercial[2] (%)	Avg. Truck Factor	DD[3]	Annual Traffic Growth (%)[4]	LD[5]	10-Yr ESAL's	15-Yr ESAL's	20-Yr ESAL's
Interchange Way	3000	5	1.31	0.5	2	0.9	354,000	559,000	785,000
Millway Avenue	4000	5	1.31	0.5	2	0.9	472,000	745,000	1,046,000

1. Base Year = 2024
2. Estimated Percent Truck Traffic
3. Directional Distribution
4. Annual Growth Rate Estimated
5. Lane Distribution Factor

The ESAL's calculation can be found in **Appendix D**.

3.9 AASHTO Design Method

The pavement design and analysis was carried out in accordance with the "1993 AASHTO Guide for Design of Pavement Structure" and the Ministry of Transportation's Pavement Design Manual. Input parameters are shown in Table 11 below, and the design output sheets are presented in **Appendix E**.

Table 11: Input Parameters for New Flexible Pavement Structure Calculations

		Interchange Way	Millway Avenue
Road Classification		Urban Minor Arterial	
Initial Serviceability		4.4	
Terminal Serviceability		2.2	
Reliability Level (%)		90	
Overall Standard Deviation		0.49	
Subgrade Resilient Modulus (MPa)		20 MPa	20 MPa
Layer Coefficient / Drainage Coefficient	New HMA	0.42/1.0	
	New Granular A	0.14/1.0	
	New Granular B, Type I	0.09/1.0	
	Existing HMA	0.24	N/A
	Existing Granular Base/Subbase	0.09/0.9	

The required SN values for the rehabilitation of the road section are based on the AASHTO design method for flexible pavement. Based on the input parameters listed in Table 11, the required SN is shown in Table 12 below:

Table 12: Required SN for Various Design Lives

Design Life	Required SN (mm)	
	Interchange Way	Millway Avenue
10 Years	102	106
15 Years	109	113
20 Years	114	118

Comparing the required SN value with the existing SN values Interchange Way from 70 m west of Mable Smith to Jane Street, there is a structural deficiency. The existing pavement structure is not structurally adequate to support the projected traffic volumes.

4 Recommendations

4.1 Rehabilitation of Interchange Way (70 m west of Mable Smith to Jane Street)

Two design options were considered for the rehabilitation of the existing Interchange Way (Interchange Way to Jane Street) pavement. To select the most feasible rehabilitation alternative, the following options were reviewed:

- **Option 1 – Full-Depth Asphalt Removal and Replacement:** Remove the existing asphalt in full-depth and pave with 140 mm of new hot mix asphalt. This strategy will address all the distresses in the asphalt layer and expose the granular base, which after proof-rolling, there would be an opportunity to identify soft areas that warrant repairs. This option provides a design life of approximately ten (10) years.
- **Option 2 – Full Depth Reconstruction:** Remove the existing asphalt and underlying granular materials to a depth of 650 mm below the finished grade, Proof-roll the exposed subgrade, repair soft-spots with Granular B, Type I and regrade as necessary, place 150 mm of new Granular A over 350 mm Granular B, Type II, and pave with 150 mm of new HMA. This option resolves all structural distress, improves drainage of the pavement structure and provides adequate structural capacity for approximately twenty (20) years of design life.

The proposed pavement structure for each option is presented in the Table 13 below. It is important to note that the estimated service lives consider timely routine and preventative maintenance (i.e. crack sealing and pot-hole filling).

Table 13: Flexible Pavement Rehabilitation Options for Interchange Way

	Option 1 Full Depth Asphalt placement	Option 2 Full Depth Reconstruction
Estimated Service Life	10 years	20 years
Hot-Mix Asphalt	40 mm SP 12.5 100 mm SP 19.0	50 mm SP12.5 100 mm SP19.0

	Option 1 Full Depth Asphalt placement	Option 2 Full Depth Reconstruction
Granular Base/Subbase	550 mm Existing (on average)	150 mm New Granular A 350 mm New Granular B Type II
Total Pavement Thickness	**690 mm**	**650 mm**
Estimated SN	**104 mm**	**116 mm**

The following minimum design requirements, outlined in Section 1.2.4.1 – Road Pavement Design Report of the City's road standards, are presented from the City of Vaughan for Industrial, Collector, and Arterial Roads for comparison purposes.

Table 14: City of Vaughan Minimum Thickness Requirements

COMPONENT	THICKNESS (mm)
Hot-Mix Asphalt	50 mm SP 12.5 75 mm SP 19.0
New Granular A Base	125 mm
New Granular Subbase	350 mm
Total Pavement Thickness	**600 mm**

The above pavement design results in a SN of 103 mm, which is less than the required SN of 116 mm shown above.

Therefore, we recommend the flexible pavement structure determine with AASHTO'93 analysis for Interchange Way over a 20-year design life is presented below in Table 15

Table 15: Recommended Pavement Profile for Interchange Way

Component	Material Thickness
New Surface Course	50 mm SP12.5B
New Binder Course	100 mm SP19.0 B
New Granular 'A' Base	150 mm
New Granular 'B' Type II Subbase	350 mm
Total	650 mm

4.2 Proposed New Construction Of Interchange Way (Jane Street to Creditstone Road)

We understand that Interchange way will extend from Jane Street to Creditstone Road. The following new pavement structure is required based on 20 years pavement design life.

The following Table 16 outlines the proposed pavement structure:

Table 16: Recommended Pavement Profile for Interchange Way (From Jain to Creditstone Road)

Component	Material Thickness
New Surface Course	50 mm SP12.5B
New Binder Course	100 mm SP19.0 B
New Granular 'A' Base	150 mm
New Granular 'B' Type II Subbase	350 mm
Total	650 mm

4.3 Preferred Pavement Rehabilitation and new construction of Interchange way (70 m west of Mable Smith to Creditstone Road)

Based on the findings from our investigation, the recommended rehabilitation strategy is Option 2: Full depth reconstruction. This option will address all the granular surface distresses and expose the subgrade material, which may identify soft areas that require improvement as follows

- Remove the existing asphalt and underlying materials to a depth 650 mm below the finished grade;
- Proof-roll the exposed subgrade, repair soft-spots with Granular 'A' and re-grade as necessary;

- Place 350 mm, or more as required of OPSS 1010 Granular B Type II followed by placing a minimum of 150 mm of OPSS 1010 Granular A. All granular materials should be placed in lift thicknesses of 150 mm or less and compacted to a minimum of 100 percent Standard Proctor Maximum Dry Density (SPMDD);
- place three lifts of hot-mix asphalt with 100 mm of SP 19.0 Cat B (PGAC 64-28) binder course in two lifts and 50 mm of SP 12.5 Cat B (PGAC 64-28) surface course in one lift;
- A light tack coat between the exposed concrete base and hot-mix asphalt courses; and
- The surface of the completed pavement should be provided with a minimum centre-to-edge cross-fall of 2 percent.

The new granular base/subbase materials should be placed in layers not exceeding 150mm (compacted thickness) and should be compacted to 100% of their respective SPMDD. The grading of the material should be conformed to current Ontario Provincial Standard Specifications.

It is recommended that geotechnical testing and inspections be carried out during construction operations to confirm construction is in accordance with the project specifications. Testing and inspections should include proof-rolling inspections on the subgrade prior to placing granular materials, compaction testing, monitoring of asphalt placement, etc.

The above pavement strategy assumes that the exposed subgrade has been adequately prepared. If localized soft areas are encountered, it may be necessary to sub-excavate and replace with additional granular fill. It is recommended that qualified geotechnical personnel be retained to complete an inspection of the subgrade and placement of new granular during construction prior to placement of any hot-mix asphalt. Soft areas should be repaired by sub-excavating a minimum depth of 300 mm and installing 300 mm Granular B Type I, compacted to 100% of the SPMDD. If necessary, geogrid may require strengthening soft soils.

4.4 Proposed New Construction of Millway Avenue (Highway 7 to Interchange Way)

For new constructions of Millway Avenue (from Highway 7 to Interchange Way) is recommended to be constructed as follows:

- Excavate full width to the required grade in order to accommodate 700 mm pavement structure (as below);
- Proof-roll the exposed subgrade, repair soft-spots with Granular 'A' and re-grade as necessary;
- Place 400 mm, or more as required of OPSS 1010 Granular B Type II followed by placing a minimum of 150 mm of OPSS 1010 Granular A. All granular materials should be placed in lift thicknesses of 150 mm or less and compacted to a minimum of 100 percent Standard Proctor Maximum Dry Density (SPMDD);
- place three lifts of hot-mix asphalt with 100 mm of SP 19.0 Cat B (PGAC 64-28) binder course in two lifts and 50 mm of SP 12.5 Cat B (PGAC 64-28) surface course;
- A light tack coat between the exposed concrete base and hot-mix asphalt courses; and
- The surface of the completed pavement should be provided with a minimum centre-to-edge cross-fall of 2 percent.

The following Table 17 outlines the proposed pavement structure:

Table 17: Recommended Pavement Profile for Interchange Way

Component	Material Thickness
New Surface Course	50 mm SP12.5 B
New Binder Course	100 mm SP19.0 B
New Granular 'A' Base	150 mm
New Granular 'B' Type II Subbase	400 mm
Total	700 mm

The new granular base/subbase materials should be placed in layers not exceeding 150mm (compacted thickness) and should be compacted to 100% of their respective SPMDD. The

grading of the material should be conformed to current Ontario Provincial Standard Specifications.

It is recommended that geotechnical testing and inspections be carried out during construction operations to confirm construction is in accordance with the project specifications. Testing and inspections should include proof-rolling inspections on the subgrade prior to placing granular materials, compaction testing, monitoring of asphalt placement, etc.

The above pavement strategy assumes that the exposed subgrade has been adequately prepared. If localized soft areas are encountered, it may be necessary to sub-excavate and replace with additional granular fill. It is recommended that qualified geotechnical personnel be retained to complete an inspection of the subgrade and placement of new granular during construction prior to placement of any hot-mix asphalt. Soft areas should be repaired by sub-excavating a minimum depth of 300 mm and installing 300 mm Granular B Type I, compacted to 100% of the SPMDD. If necessary, geogrid may require strengthening soft soils.

4.5 Erodibility at Culvert Location

The potential for erosion of the native soils has been determined using the Wischmeier Nomograph. The soil's silt, sand, and organic content, as well as the soil structure and permeability influence the erosion potential of soil. The Wischmeier Nomograph generates a K Factor between 0 and 1.0, which categorizes the erodibility of the soil; the higher the K value, the greater the erodibility. Highly erodible soils have a K factor exceeding 0.6, while relatively non-erodible soils have a K factor less than 0.2.

The two (2) subgrade soil samples tested at culvert location were classified as sandy clayey silt have moderate erodibility (with a K factor of 0.3 and 0.38).

4.6 Culvert Replacement

The native subgrade and fill material is generally considered to be a Type 3 soil in accordance with the Ontario Occupational Health and Safety Act. This classification is based on

observations during borehole drilling and data collected in the field and must be confirmed by qualified individuals as excavation proceeds and adjusted if necessary.

Temporary excavations should be carried out with a side slope no steeper than 1H:1V from the base of the excavation or be supported by a trench box. Newly placed granular fill can be considered a Type 2 soil provided it is adequately compacted. The frost depth along this section is estimated to be 1.2 m based on OPSD 3090.101. Based on the laboratory testing results, the subgrade soils encountered in the boreholes near the culvert location have low potential for frost heave.

The erodibility of the subgrade soils has been assessed using the Wischmeier Nomograph and the gradation test results. All of the materials yielded K values between 0.3 and 0.38 and therefore are generally considered to be moderately erodible. Erosion and sediment control should be provided throughout the project duration and vegetation should be re-established on disturbed slopes as soon as possible.

At the time of writing the report, information regarding the depth of cover for the culvert and its structure type was unavailable. It was assumed that the culvert is non-structural with a depth of cover equal to 1.5 meters.

The following table provides a breakdown of the frost susceptibility, soil erodibility values of the subgrade, pavement structure reinstatement recommendations as well as frost taper requirements:

Table 18: Non-Structural Culvert Replacement

Culvert Name	Depth of Cover	Frost Susceptibility	Soil Erodibility (K)	Frost Taper[1)]
Black Creek Main Tributary	1.5 m	LSFH	0.3-0.38	Required

1) Frost Tapers should be constructed in accordance with 803.030 or 803.031

4.7 Culvert Treatment Recommendations

The following generalized geotechnical recommendations are provided for the replacement of culverts within the project limits:

– Bedding for culvert should be in accordance with OPSD 802.010 and should consist of Granular A material.

– Culvert should be backfilled in accordance with the OPSD 802.010.

4.8 Drainage Improvements

Newly placed asphalt should be feathered towards the existing concrete curb in a manner that provides the required 2% crossfall toward drainage structures. The finished pavement surface and underlying granular and subgrade should be free of depressions and should be crowned and sloped (at a recommended minimum cross-fall of 2 % for both the pavement surface and repaired subgrade elements) to provide effective drainage. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas, considering that proper drainage systems are installed. Sub-drains must be installed (if not present) beneath the curb locations or, if present, brought to an acceptable service level to facilitate effective and assured drainage of the pavement structures. Subdrains are designed to intercept excess subsurface moisture and minimize subgrade softening.

Any new required subdrain will need to outlet to the storm sewer. The completed new asphalt surface should be monitored to ensure ponding due to poor surface grade or settlement of materials is not present.

4.9 Pipe Bedding And Cover

The bedding for the proposed services should be compatible with the size, type and class of pipe, the surrounding subsoils and anticipated loading conditions and should be designed in accordance with the Ontario Provincial Standard Specifications (OPSS) and any City of Vaughan standards.

The soils above the groundwater level, or properly dewatered if encountered below the groundwater level, will provide adequate support for the sewer pipes and allow the use of normal Class B type bedding. The recommended minimum thickness of granular bedding below the invert of the pipes is 150 mm. The thickness of the bedding may, however, must be increased depending on the pipe diameter or in accordance with local standards or if wet or weak subgrade conditions are encountered, especially when the soil at the trench base level consists of wet, dilatant silt.

The bedding material should consist of well graded granular material such as Granular 'A' or equivalent. The bedding material should be compacted to at least 98 percent of its SPMDD. After installing the pipe on the bedding, a granular surround of approved bedding material, which extends at least 300 mm above the obvert of the pipe, or as set out by the local authority or municipality, should be placed. It is recommended that WSP be on site during excavations to assess the suitability of the subgrade materials to support the pipes.

If localized wet trench conditions are encountered, a uniformly graded clear stone may be used provided a suitable, approved filter fabric (geotextile) is placed in conjunction with the clear stone. The geotextile must extend underneath the clear stone, along the sides of the trench, and wrapped on top of the clear stone such that the clear stone is fully wrapped by the geotextile. The geotextile must overlap for the entire width of the trench; alternatively stitching of the geotextile could be considered. WSP should be on site on a full-time basis if this method is being considered.

Localized, wet and unstable soils encountered within generally stable soil zones can be generally stabilized by 'punching' a 50 mm well graded crusher run limestone pad into the soft subgrade prior to bedding placement. The thickness of the 'pad' will depend on field conditions and should be examined by WSP personnel during the construction operations.

5 Other Design Considerations

5.1 Construction Joints Transition

Longitudinal and transverse joints should be constructed to key the new HMA into the existing pavement in accordance with OPSS.MUNI 310.

5.2 Reuse of Existing Granular Material

Based on the field investigation and laboratory test results, the existing granular base and subbase materials are not suitable for re-use in the pavement structure. The excavated granulars and subgrade soil may be re-used as acceptable earth fills or transported off site.

5.3 Asphalt Cement Grade

The asphalt cements should conform to OPSS.MUNI 1101 (November 2020). PGAC 64-28 is recommended for the surface and binder course mixes placed.

5.4 Topsoil and Organic Material

Topsoil, organic material and any other deleterious material present within the limits of the proposed temporary realignment should be removed regardless of depth. Based on the results of the investigation, the topsoil has an average thickness of 200 mm.

5.5 Construction Materials

SP12.5 is recommended for the surface course and SP19.0 for base course asphalt, alternatively HL3 for surface course and HL8 for base course instead of SP12.5 and SP19.0 can be used for this project. Superpave HMA material should meet the requirements of OPSS.MUNI 1151 (April 2021). The new granular base and subbase materials should meet the requirements of OPSS.MUNI 1010 (April 2013) for Granular A and Granular B, Type II

respectively. All granular materials should be uniformly compacted to 100% Standard Proctor Maximum Dry Density (SPMDD) in accordance with OPSS.MUNI 501 (November 2017). The HMA should be compacted in accordance with OPSS.MUNI 310.

5.6 Tack Coat

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

5.7 Conversion Factors

- Superpave 12.5 – 2.53 t/m3;
- Superpave 19.0 – 2.460 t/m3;
- Granular A – 2.2 t/m3; and,
- Granular B, Type II – 2.0 t/m3 .

5.8 Testing and Inspection

During construction, monitoring by a qualified technician should be carried out during any required trench backfill placement, as well as pipe bedding and cover. In addition, sufficient subgrade inspections and in situ materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes and to monitor conformance to the pertinent project specifications.

6 Limitations of Report

The comments given in this report are intended for the guidance of design engineers. It should be noted that the pavement design recommendations are based on the advancement of a limited number of boreholes without preliminary investigations. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., may be greater than has been carried out for current purposes. Contractors bidding on or undertaking the work shall, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them. Prior to construction of the pavement structure, it is recommended that a qualified geotechnical engineer or experienced engineering technician should inspect the condition of the exposed granular base.

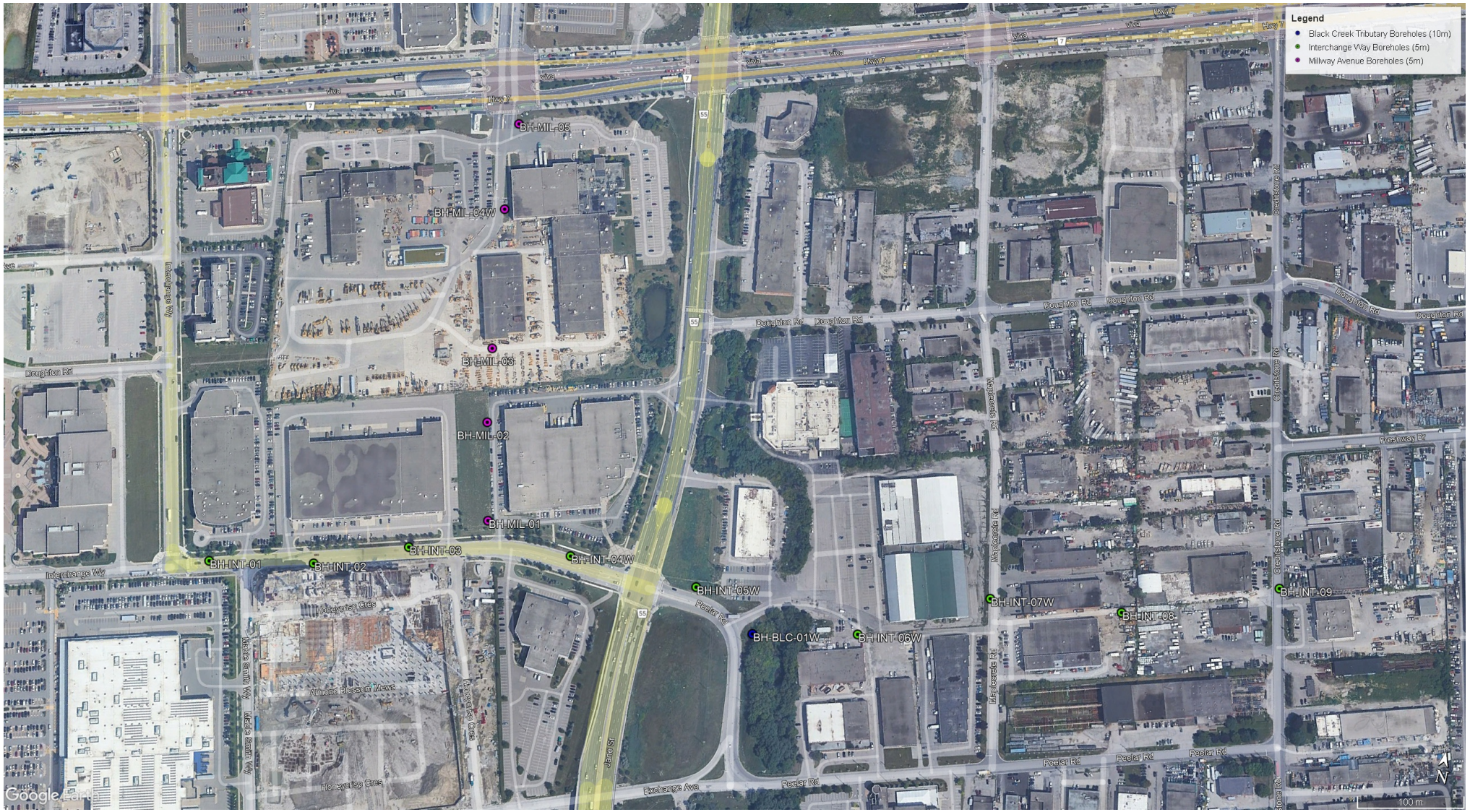
Prior to construction of the pavement structure, it is recommended that a qualified geotechnical engineer or experienced engineering technician should inspect the condition of the exposed granular base.

Some of the traffic data, including truck distribution, growth rate, and percentage of commercial traffic were estimated. The estimated values should be confirmed, and designs should be re-evaluated by a qualified Pavement Engineer.

Information in this report shall not be used by third parties without WSP's permission.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact us.

Appendix A
Borehole Location Plan



Client:	CITY OF VAUGHAN			Drawing No:	1
Drawn:	AA	Approved:		Title:	Borehole Location Plan
Date:	28-April-25	Scale:	N.T.S	Project:	Geotechnical Investigation - Vaughan Metropolitan Centre TMP
Original Size:	Letter	Rev:	N/A		wsp

Appendix B
Borehole Logs

LOG OF BOREHOLE BH-BLC-01W

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-06-2023 to Mar-06-2023
COMPILED BY MK
BH LOCATION: East of Peelar Road N 43°47'21.49"N E 79°31'21.00"W
CHECKED BY AR

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS "N" 0.3 m	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface					
0.00	**TOP SOIL (200 mm)**				Concrete	
0.20	dark brown **SANDY SILTY CLAY** trace gravel, brown, moist, firm to stiff	1	SS	7		
		2	SS	6		3 32 44 21
		3	SS	10		
	trace organic, grey	4	SS	9		
					W. L. 2.74 mBGL Mar 06, 2023	
		5	SS	6		
	dark grey	6	SS	10		0 24 49 28
					Sand	
	wet	7	SS	8		
					Screen	
	very stiff	8	SS	27		
	grey, firm	9	SS	6	Sand	
9.74	**END OF BOREHOLE** Notes: 1) Borehole was open and dry upon completion					

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-01

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-08-2023 to Mar-08-2023
COMPILED BY MK
BH LOCATION: Interchange Way N 43°47'19.98"N E 79°31'44.30"W
CHECKED BY AR

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface											
0.00	**ASPHALT (140 mm)**											
0.14	**GRANULAR BASE/ SUBBASE (550 mm)** gravelly sand, some fine material, brown, moist		1	AS					○			25 54 (21)
0.69	**SAND AND SILT** trace gravel, some clay, brown, moist, compact		2	SS	24							3 41 45 11
			3	SS	21							
2.12	**SILTY SANDY CLAY** trace gravel, grey, moist, very stiff		4	SS	27							
			5	SS	24				○			2 29 53 16
3.65	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-02

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-06-2023 to Mar-06-2023
COMPILED BY MK
BH LOCATION: Interchange Way N 43°47'20.61"N E 79°31'39.93"W
CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (kPa)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"							GR SA SI CL
	Ground Surface											
0.00	**ASPHALT (130 mm)**											
0.13	**GRANULAR BASE/ SUBBASE (550 mm)** gravelly sand, some fine material, brown, moist		1	AS					o			20 54 (26)
0.68	**SAND AND SILT** trace gravel, dark brown, moist, compact		2	SS	24							
1.36	**SANDY SILT** trace gravel, some clay, grey, moist, compact		3	SS	21							
	dense		4	SS	41							
	very dense		5	SS	64				o			
3.65	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-03

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-08-2023 to Mar-08-2023
COMPILED BY MK
BH LOCATION: Interchange Way N 43°47'21.74"N E 79°31'36.13"W
CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT (w_P w w_L) WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"							GR SA SI CL
0.00	**ASPHALT (140 mm)**											
0.14	**GRANULAR BASE/ SUBBASE (550 mm)** gravelly sand, some fine material, brown, moist		1	AS					○			23 56 (21)
0.69	**SANDY SILT** trace gravel, dark brown, moist, compact		2	SS	18							
1.21	**CLAYEY SILT** trace gravel, grey, moist, firm		3	SS	8							
			4	SS					⊖			
2.59	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion
2) encountered a concrete conduit at a depth of 3.04 m

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-04W

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-07-2023 to Mar-07-2023
COMPILED BY MK
BH LOCATION: Interchange Way N 43°47'22.56"N E 79°31'29.30"W
CHECKED BY AR

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface						
0.00	**ASPHALT (150 mm)**					Concrete	
0.15	**GRANULAR BASE/ SUBBASE (550 mm)** gravelly sand, some fine material, brown, moist	1	AS				32 54 (14)
0.70	**SANDY SILT** trace gravel, brown, moist, compact	2	SS	12			
1.21	**CLAYEY SILT** trace gravel, trace sand, dark brown, moist, stiff	3	SS	15		Bentonite	
2.29	**SANDY SILTY CLAY** trace gravel, grey, moist, stiff to hard	4	SS	14		W. L. 2.40 mBGL Mar 07, 2023	
	hard	5	SS	56		Sand	1 34 47 18
						Screen	
4.57	**END OF BOREHOLE**						

Notes:
1) WL encountered @ 2.4 m

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 10 20 30
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-05

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-08-2023 to Mar-08-2023
COMPILED BY MK
BH LOCATION: Grass area northeast of Jane St and Peelar Rd N 43°47'22.49"N E 79°31'23.78"W
CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (kPa)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m							
	Ground Surface											
0.00	**TOP SOIL (150 mm)** dark brown											
0.15	**FILL** sand, some gravel, brown, moist, compact		1	SS	11							
0.76	**SANDY SILTY CLAY** trace gravel, brown, moist, stiff		2	SS	12							1 27 56 16
			3	SS	11							
	very stiff		4	SS	27							
	stiff		5	SS	12							
	dark grey		6	SS	11							
4.41	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-06

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-07-2023 to Mar-07-2023
COMPILED BY MK
BH LOCATION: NCI Vaughan Iceplex front parking N 43°47'22.17"N E 79°31'16.65"W
CHECKED BY AR

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface											
0.00	**ASPHALT (60 mm)**											
0.06	**GRANULAR BASE/ SUBBASE (250 mm)** gravelly sand, some fine material, brown, moist		1	AS					○			21 61 (18)
0.31	**FILL** silty clay, trace gravel, trace sand, some organic, dark grey, moist, stiff		2	SS	10							
			3	SS	15							
2.12	**SILTY CLAY** trace gravel, some sand, grey, moist, stiff		4	SS	15							
	very stiff		5	SS	21				○			
	trace sand		6	SS	31				○			
4.41	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-07W

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-06-2023 to Mar-06-2023
COMPILED BY MK
BH LOCATION: Maplecrete Road N 43°47'24.12"N E 79°31'11.46"W
CHECKED BY AR

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
Ground Surface												
0.00	**ASPHALT (90 mm)**											
0.09	**GRANULAR BASE/ SUBBASE (350 mm)** gravelly sand, some fine material, brown, moist		1	AS			Concrete		○			21 62 (17)
0.44	**SANDY SILTY CLAY** trace gravel, brown, moist, stiff		2	SS	8		Bentonite					4 30 44 22
			3	SS	13							
			4	SS	8		Sand					
3.05	**SANDY SILT** trace gravel, trace clay, grey, moist, compact		5	SS	10		Screen					
			6	SS	19				○			1 27 64 8
4.41	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-08

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-07-2023 to Mar-07-2023
COMPILED BY MK
BH LOCATION: North East Corner of 53 Maplecrete Road N 43°47'24.59"N E 79°31'5.90"W
CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (kPa)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"			20 40 60 80 100	10 20 30			GR SA SI CL
Ground Surface												
0.00 / 0.02	**ASPHALT (20 mm)**											
	GRANULAR BASE/ SUBBASE (600 mm) sand, trace gravel, some fine material, brown, moist		1	AS								8 68 (24)
0.62	**CLAYEY SILT** trace gravel, some sand, brown, moist, firm		2	SS	6							
1	stiff		3	SS	8							
2			4	SS	16							
	dark grey		5	SS	12							
3	very stiff		6	SS	20							
4												
4.41	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-INT-09

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-07-2023 to Mar-07-2023
COMPILED BY MK
BH LOCATION: Creditstone Rd N 43°47'26.37"N E 79°30'59.53"W
CHECKED BY AR

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface											
0.00	**ASPHALT (150 mm)**											
0.15	**GRANULAR BASE/ SUBBASE (500 mm)** gravelly sand, some fine material, brown, moist		1A	AS					○			30 62 (8)
			1B	AS					○			26 53 (21)
0.65	**SANDY SILTY CLAY** trace gravel, brown, moist, stiff		2	SS	6							3 33 44 20
	firm		3	SS	8							
	redish brown, very stiff		4	SS	16							
	grey		5	SS	12							
			6	SS	20					○		2 33 49 16
4.41	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-MIL-01

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-06-2023 to Mar-06-2023
COMPILED BY MK
BH LOCATION: 7540 Jane Street West of Parking Lot (south) N 43°47'23.06"N E 79°31'33.10"W
CHECKED BY AR

SOIL PROFILE (m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
Ground Surface											
0.00	**TOP SOIL 200 mm)** dark brown										
0.20	**SANDY SILTY CLAY** trace gravel, trace sand, brown, moist, stiff		1	SS	10				○		
			2	SS	14						
			3	SS	12						
	grey, some sand, very stiff		4	SS	31						
	dark grey, hard		5	SS	37						
3.65	**END OF BOREHOLE**										

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-MIL-02

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-06-2023 to Mar-06-2023
COMPILED BY MK
BH LOCATION: 7540 Jane Street West of Parking Lot (north) N 43°47'26.04"N E 79°31'34.14"W
CHECKED BY AR

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface											
0.00	**TOP SOIL 200 mm)** dark brown											
0.20	**SANDY SILTY CLAY** trace gravel, some sand, brown, moist, stiff		1	SS	15							
			2	SS	10							4 33 44 19
	some gravel		3	SS	16							
			4	SS	13							
	dark grey, hard		5	SS	15							
3.65	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-MIL-03

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-06-2023 to Mar-06-2023
COMPILED BY MK
BH LOCATION: Toromont CAT South lot (PCC) N 43°47'28.32"N E 79°31'34.70"W
CHECKED BY AR

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Ground Surface											
0.00	**PORTLAND CEMENT CONCRETE (200 mm)**											
0.20	**GRANULAR BASE/ SUBBASE (60 mm)**		1	AS								
0.26	Sand and gravel, some fine material, brown, moist, compact											
	SANDY SILTY CLAY trace gravel, brown, moist, stiff		2	SS	14							1 21 44 24
1.52	**SAND** trace gravel, trace silt, trace clay, brown, very moist, compact		3	SS	10							
2.29	**CLAYEY SILT** trace gravel, some sand, grey, moist, very stiff		4	SS	17							
	stiff		5	SS	14							
3.65	**END OF BOREHOLE**											

Notes:
1) Borehole was open and dry upon completion

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-MIL-04

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-06-2023 to Mar-06-2023
COMPILED BY MK
BH LOCATION: Toromont CAT Entrance Driveway N 43°47'32.74"N E 79°31'35.65"W
CHECKED BY AR

SOIL PROFILE (m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
Ground Surface											
0.00	**TOP SOIL 300 mm)** dark brown										
0.30	**FILL** sand and gravel, grey, moist, compact		1	SS	23						
0.76	**SILTY CLAY** trace gravel, trace sand, dark grey, moist, firm		2	SS	8	▽	W. L. 0.91 mBGL Mar 06, 2023				
	wet		3	SS	6						
	very stiff		4	SS	23						
3.05	**CLAYEY SILT** trace gravel, some sand, dark grey, wet, stiff		5	SS	14						
3.65	**END OF BOREHOLE**										

Notes:
1) WL encountered @ 1.0 m

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH-MIL-05

PROJECT: Geotechnical Investigation
REF. NO.: 22532932
CLIENT: VMC EA Vaughan
Method: SOLID STEM AUGER
ENCL NO.:
PROJECT LOCATION: Vaughan, ON
Diameter: 152.4
ORIGINATED BY MM
DATUM: Geodetic
Date: Mar-06-2023 to Mar-06-2023
COMPILED BY MK
BH LOCATION: Toromont CAT Entrance Driveway N 43°47'35.55"N E 79°31'35.95"W
CHECKED BY AR

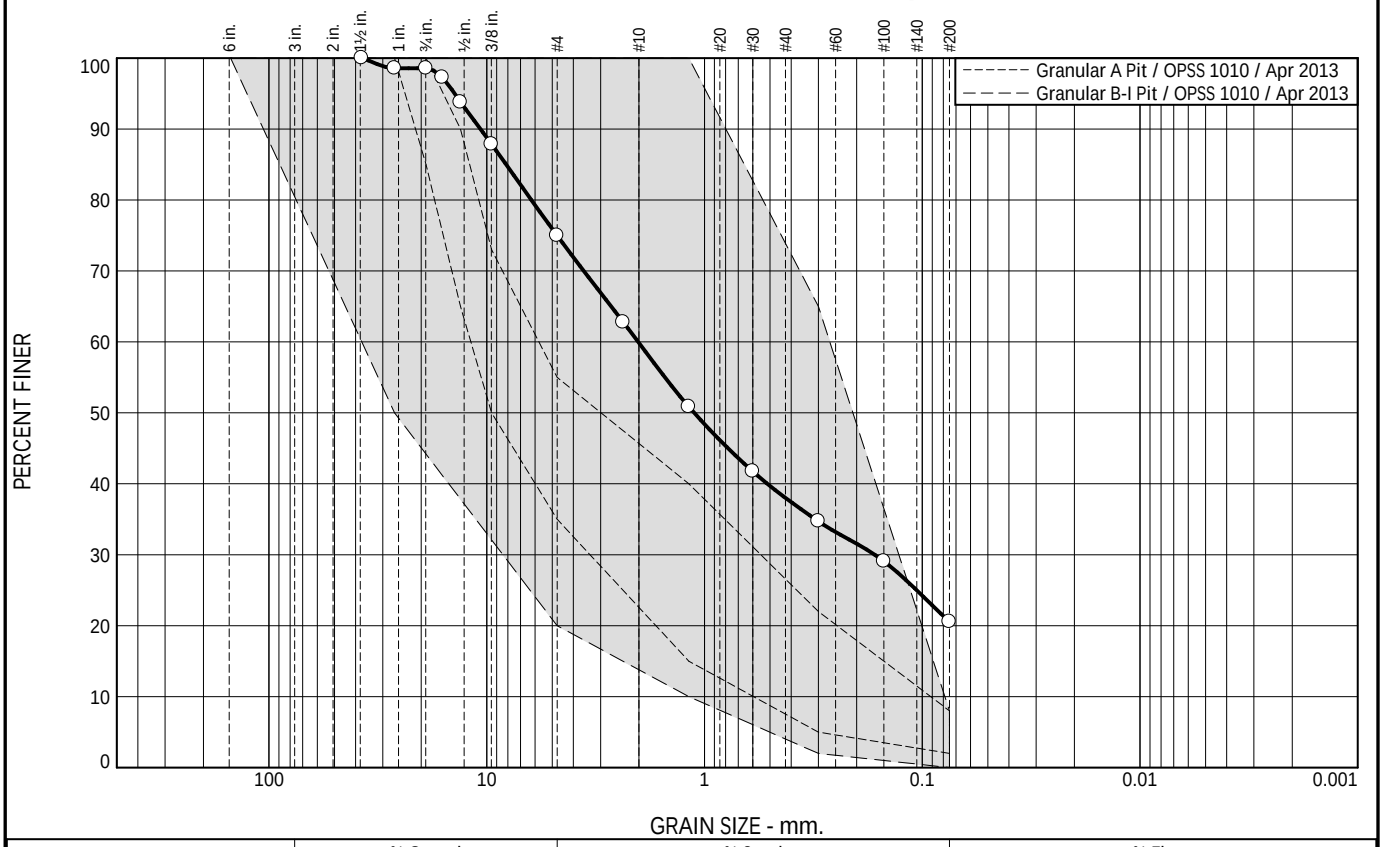
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (kPa)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"			20 40 60 80 100	10 20 30			GR SA SI CL
0.00	Ground Surface **ASPHALT (130 mm)**											
0.13	**GRANULAR BASE/ SUBBASE (200 mm)** gravelly sand, trace fine material, brown, moist		1	AS					o			29 66 (5)
0.33	**SILTY SAND** trace gravel, brown, moist, compact		2	SS	16				o			
1.52	**CLAYEY SILT** trace sand, brown, moist, very stiff		3	SS	19							
2.29	**SILT** trace sand, trace clay, grey to dark grey, moist, very stiff		4	SS	21							
	hard		5	SS	47				o			0 2 88 10
3.65	**END OF BOREHOLE** Notes: 1) Borehole was open and dry upon completion											

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

Appendix C
Lab Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.4	23.6	15.1	21.9	17.4	20.6	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
37.5mm	100.0		
26.5mm	98.6	100	X
19mm	98.6	85-100	
16mm	97.3		
13.2mm	93.8	65-90	X
9.5mm	87.9	50-73	X
4.75mm	75.0	35-55	X
2.36mm	62.8		
1.18mm	50.9	15-40	X
0.600mm	41.8		
0.300mm	34.7	5-22	X
0.150mm	29.1		
0.075mm	20.6	2-8	X

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 10.6912 D_{85}= 8.1408 D_{60}= 2.0162
D_{50}= 1.1149 D_{30}= 0.1653 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-01 AS1
Sample Number: R23-42-1

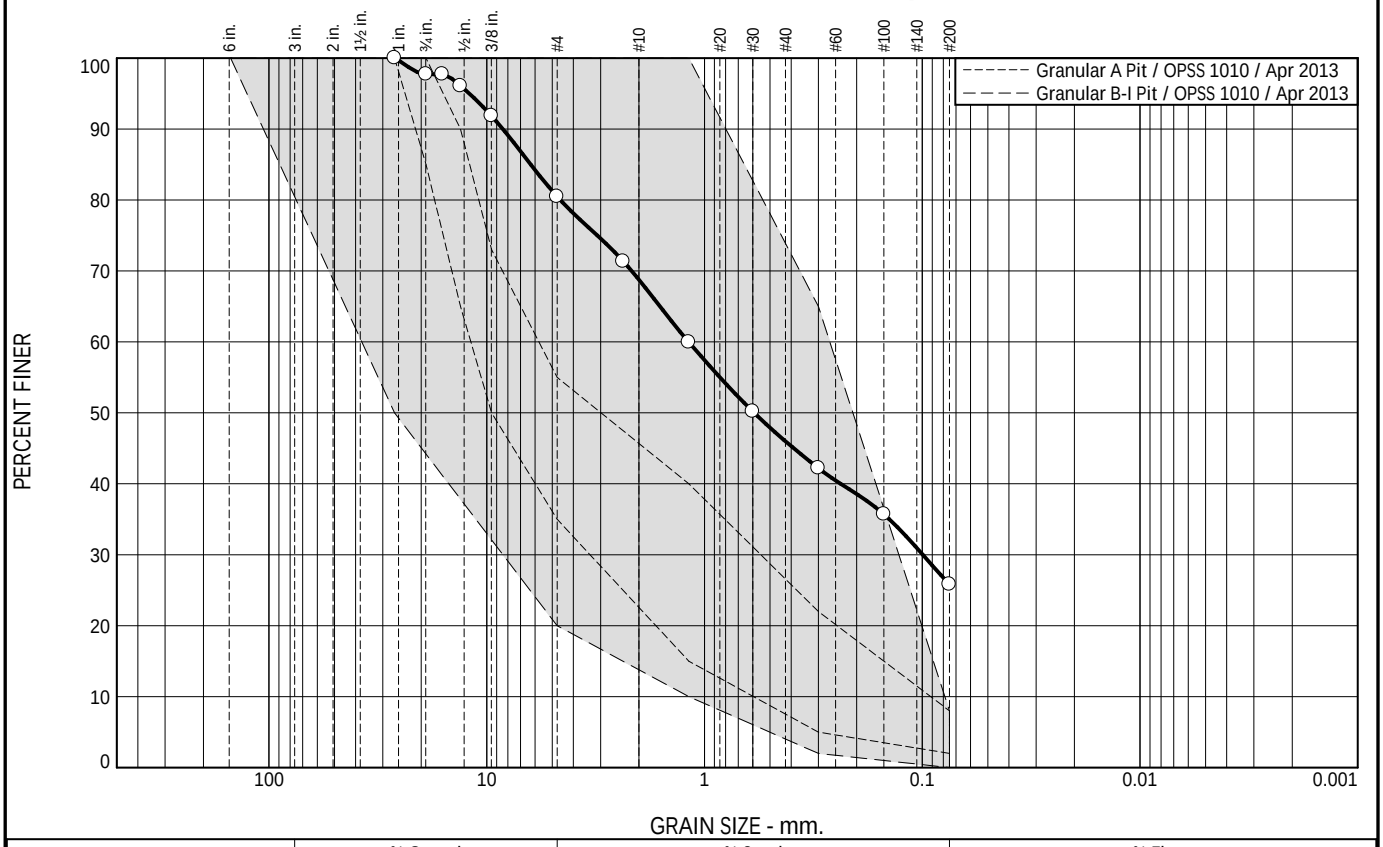
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.3	17.2	11.7	22.8	20.2	25.8	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.5mm	100.0	100	
19mm	97.7	85-100	
16mm	97.7		
13.2mm	96.1	65-90	X
9.5mm	91.8	50-73	X
4.75mm	80.5	35-55	X
2.36mm	71.3		
1.18mm	60.0	15-40	X
0.600mm	50.2		
0.300mm	42.2	5-22	X
0.150mm	35.7		
0.075mm	25.8	2-8	X

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 8.4292 D_{85}= 6.2752 D_{60}= 1.1833
D_{50}= 0.5911 D_{30}= 0.0994 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-02 AS1
Sample Number: R23-42-4

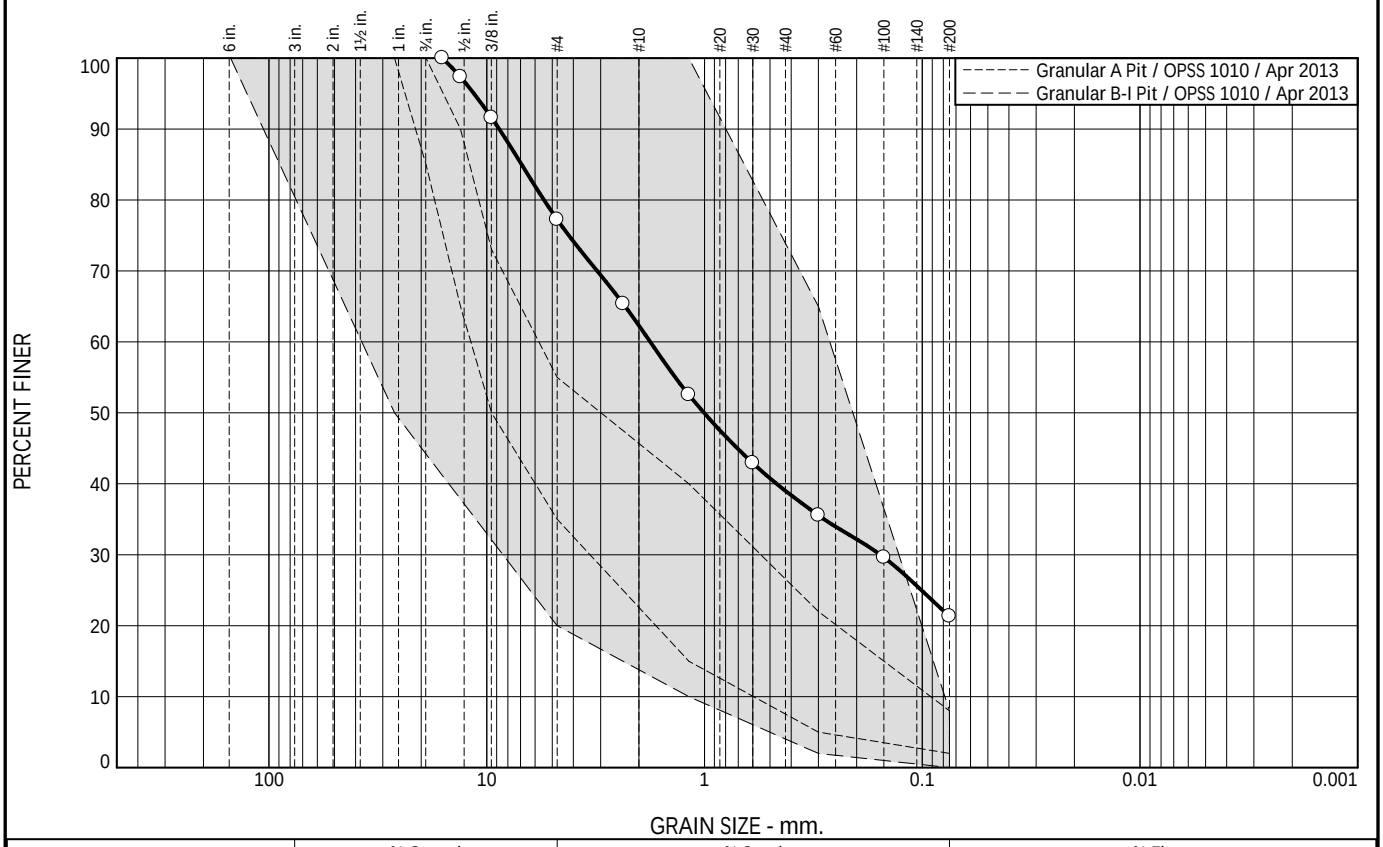
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	22.8	14.9	23.3	17.7	21.3	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16mm	100.0		
13.2mm	97.3	65-90	X
9.5mm	91.6	50-73	X
4.75mm	77.2	35-55	X
2.36mm	65.4		
1.18mm	52.5	15-40	X
0.600mm	42.9		
0.300mm	35.6	5-22	X
0.150mm	29.6		
0.075mm	21.3	2-8	X

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 8.7629 D_{85}= 6.9084 D_{60}= 1.7744
D_{50}= 1.0054 D_{30}= 0.1557 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-03 AS1
Sample Number: R23-42-5

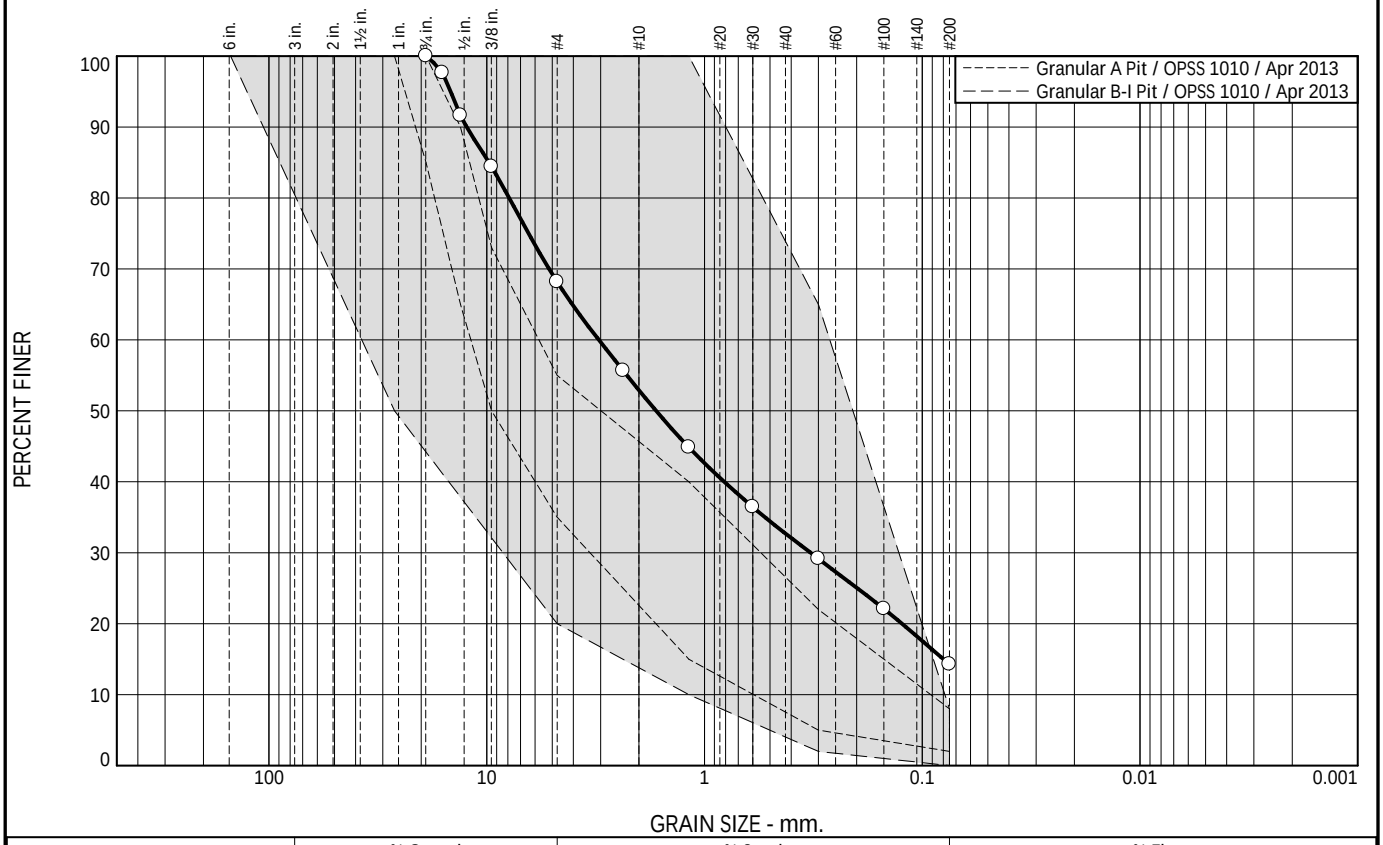
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	31.8	15.3	20.2	18.4	14.3	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
19mm	100.0	85-100	
16mm	97.6		
13.2mm	91.6	65-90	X
9.5mm	84.4	50-73	X
4.75mm	68.2	35-55	X
2.36mm	55.6		
1.18mm	44.9	15-40	X
0.600mm	36.4		
0.300mm	29.2	5-22	X
0.150mm	22.1		
0.075mm	14.3	2-8	X

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 12.3660 D_{85}= 9.7596 D_{60}= 3.0575
D_{50}= 1.6671 D_{30}= 0.3257 D_{15}= 0.0799
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-04W AS1
Sample Number: R23-42-6

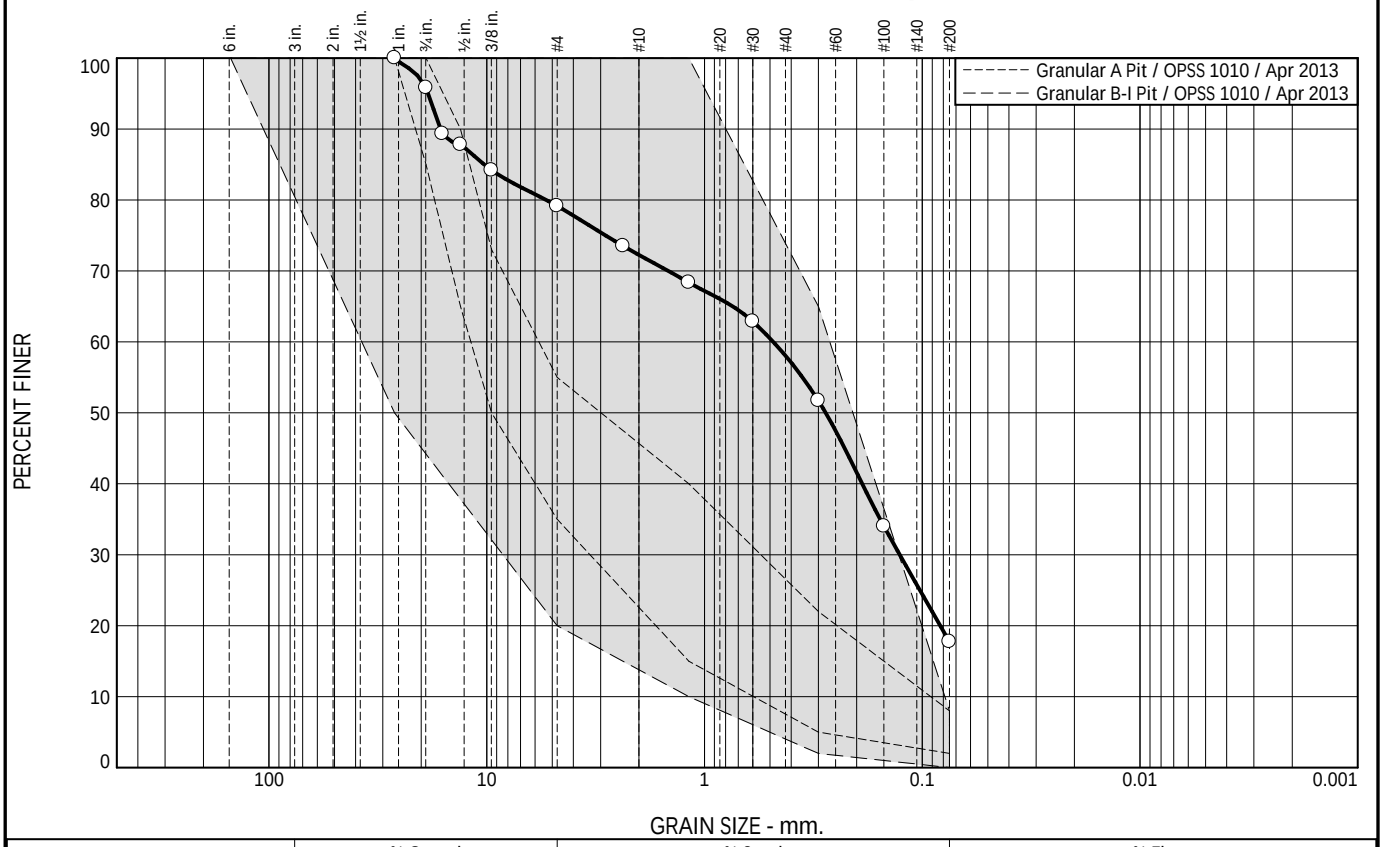
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.1	16.7	6.9	14.2	40.4	17.7	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.5mm	100.0	100	
19mm	95.8	85-100	
16mm	89.3		
13.2mm	87.8	65-90	
9.5mm	84.2	50-73	X
4.75mm	79.2	35-55	X
2.36mm	73.5		
1.18mm	68.4	15-40	X
0.600mm	62.9		
0.300mm	51.7	5-22	X
0.150mm	34.0		
0.075mm	17.7	2-8	X

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 16.3820 D_{85}= 10.2810 D_{60}= 0.4829
D_{50}= 0.2774 D_{30}= 0.1269 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-06 AS1
Sample Number: R23-42-9

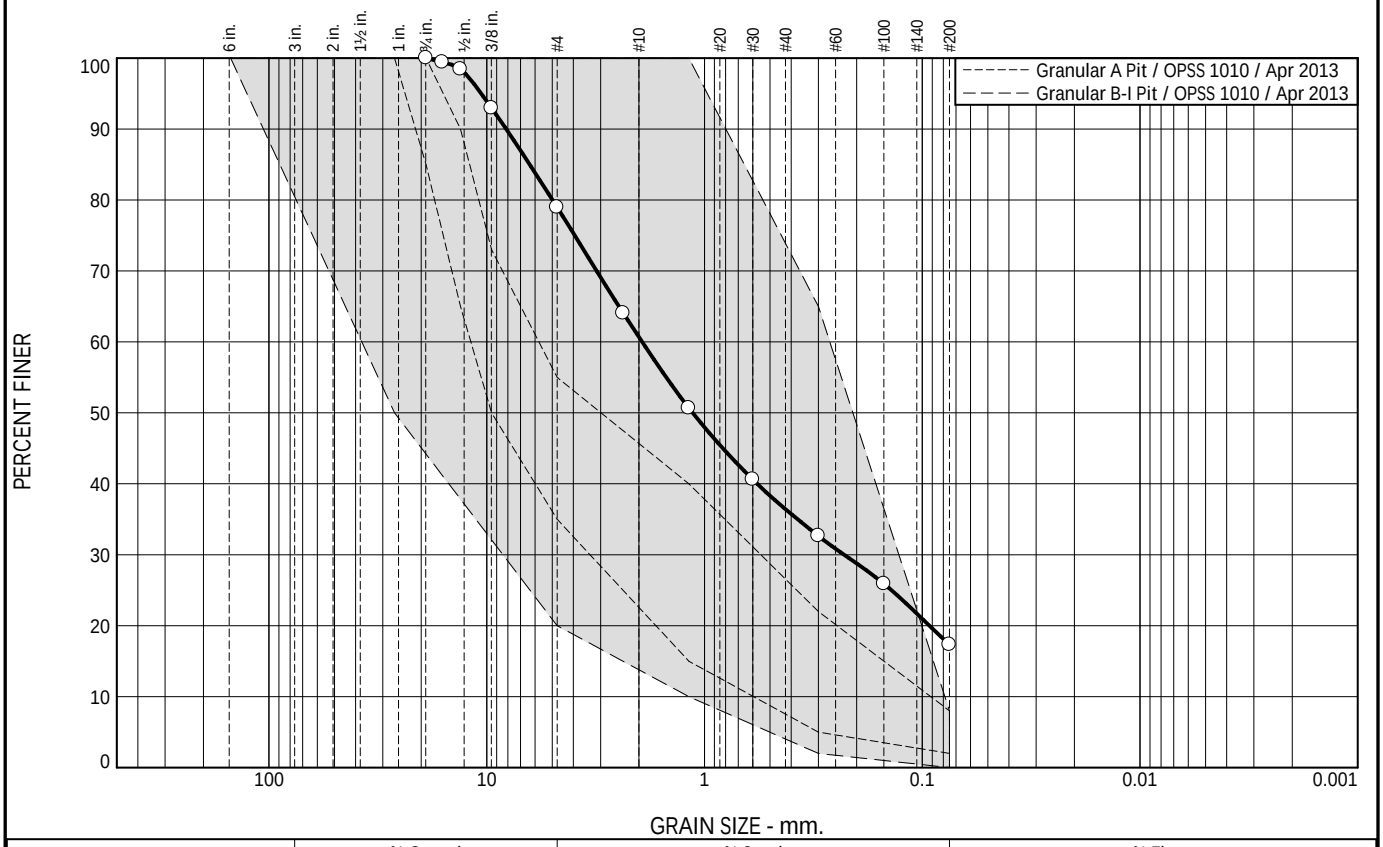
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	21.0	18.3	24.3	19.1	17.3	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
19mm	100.0	85-100	
16mm	99.4		
13.2mm	98.4	65-90	X
9.5mm	92.9	50-73	X
4.75mm	79.0	35-55	X
2.36mm	64.1		
1.18mm	50.7	15-40	X
0.600mm	40.6		
0.300mm	32.6	5-22	X
0.150mm	25.9		
0.075mm	17.3	2-8	X

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 8.1366 D_{85}= 6.3484 D_{60}= 1.9322
D_{50}= 1.1335 D_{30}= 0.2285 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-07W AS1
Sample Number: R23-42-10

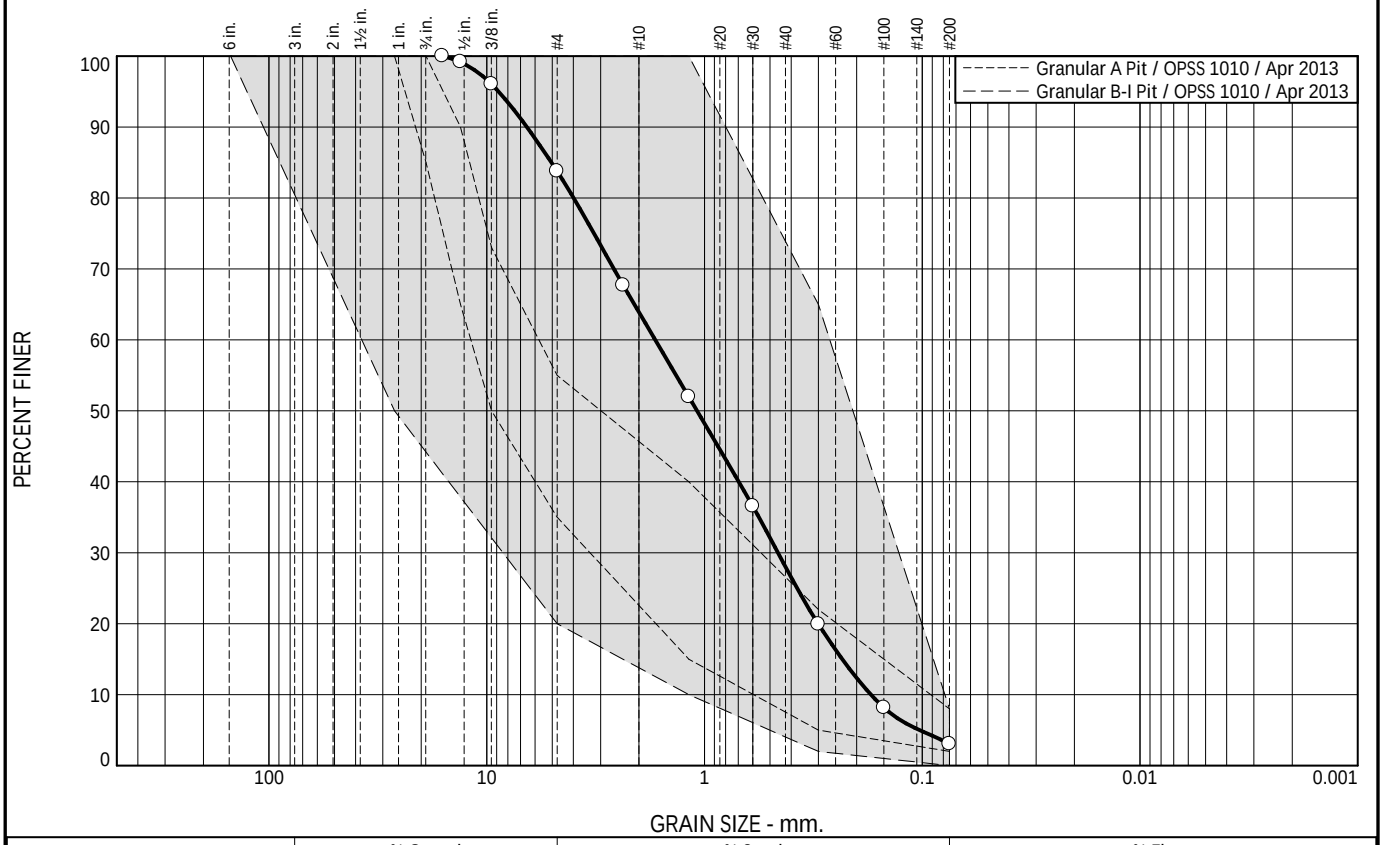
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	16.2	19.9	35.9	25.0	3.0	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16mm	100.0		
13.2mm	99.2	65-90	X
9.5mm	96.0	50-73	X
4.75mm	83.8	35-55	X
2.36mm	67.7		
1.18mm	52.0	15-40	X
0.600mm	36.6		
0.300mm	19.9	5-22	
0.150mm	8.2		
0.075mm	3.0	2-8	

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 6.5376 D_{85}= 5.0469 D_{60}= 1.6827
D_{50}= 1.0822 D_{30}= 0.4596 D_{15}= 0.2329
D_{10}= 0.1721 C_u= 9.78 C_c= 0.73

Classification

USCS= SP AASHTO=

Remarks

Location: BH-INT-08 AS1A
Sample Number: R23-42-13

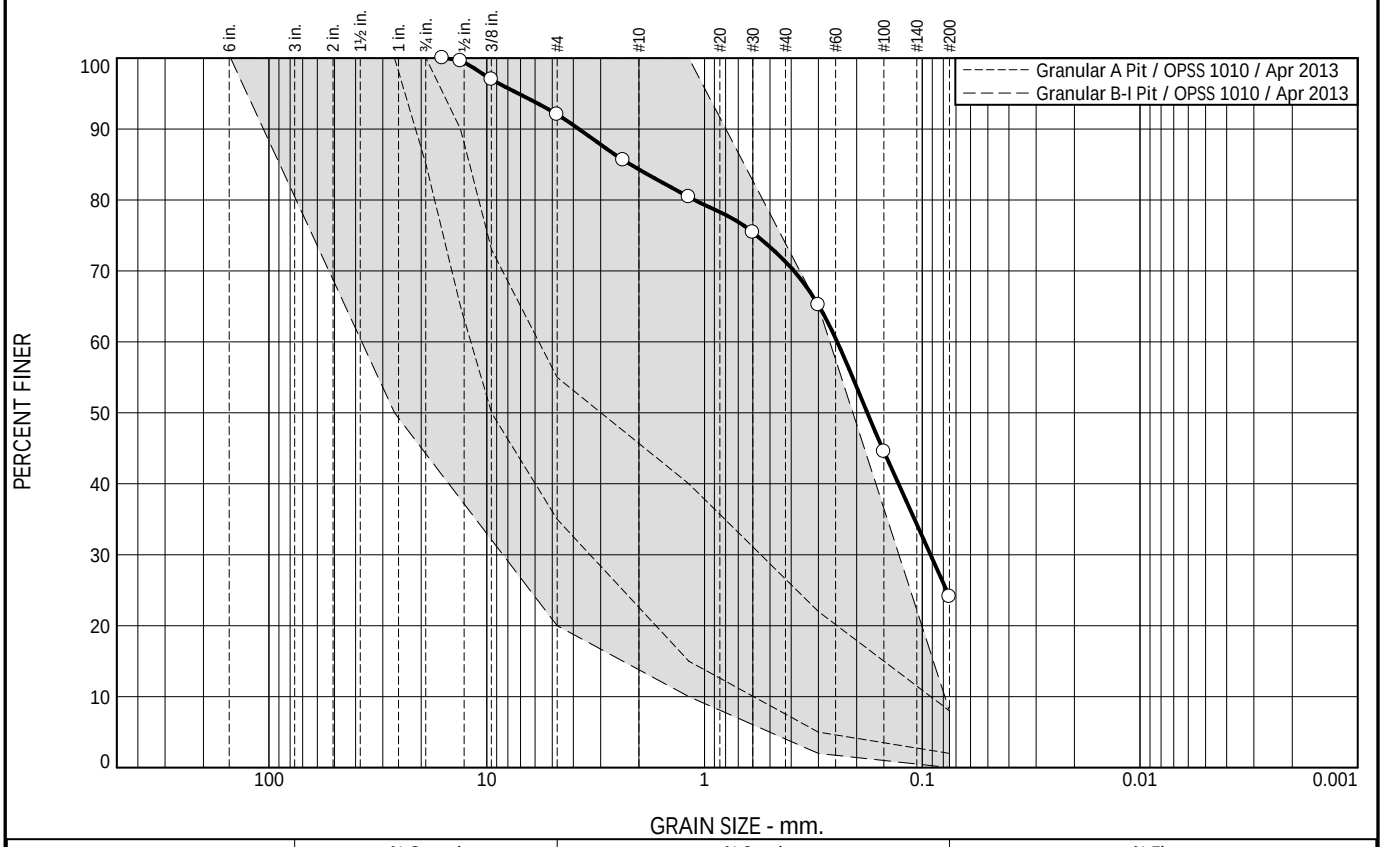
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.9	7.8	13.0	47.2	24.1	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16mm	100.0		
13.2mm	99.6	65-90	X
9.5mm	97.0	50-73	X
4.75mm	92.1	35-55	X
2.36mm	85.6		
1.18mm	80.4	15-40	X
0.600mm	75.4		
0.300mm	65.2	5-22	X
0.150mm	44.6		
0.075mm	24.1	2-8	X

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 3.7691 D_{85}= 2.1840 D_{60}= 0.2457
D_{50}= 0.1787 D_{30}= 0.0917 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-08 AS1B
Sample Number: R23-42-14

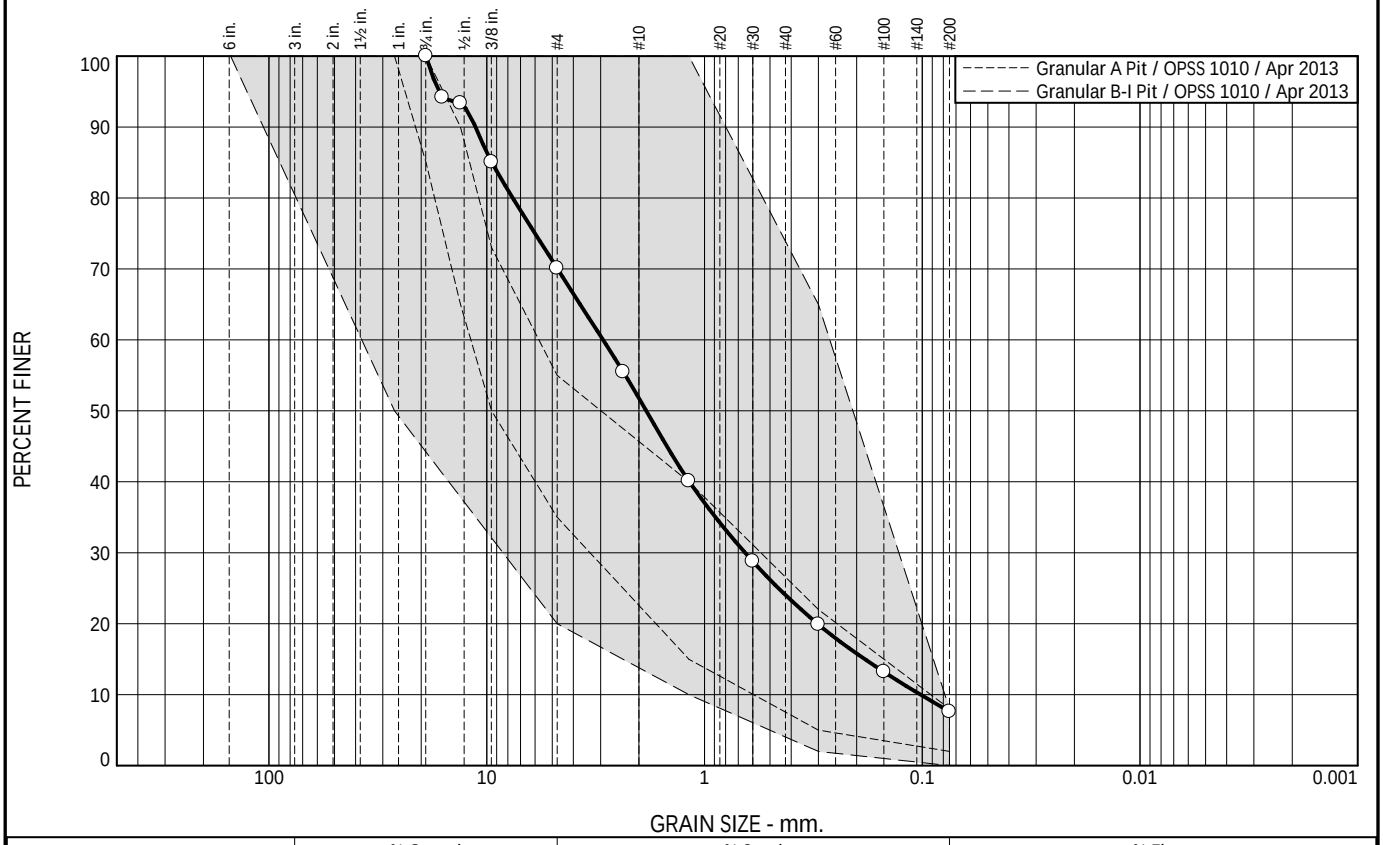
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	29.9	18.3	27.7	16.5	7.6	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
19mm	100.0	85-100	
16mm	94.2		
13.2mm	93.4	65-90	X
9.5mm	85.0	50-73	X
4.75mm	70.1	35-55	X
2.36mm	55.5		
1.18mm	40.1	15-40	X
0.600mm	28.8		
0.300mm	19.9	5-22	
0.150mm	13.2		
0.075mm	7.6	2-8	

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 11.2544 D_{85}= 9.4812 D_{60}= 2.9230
D_{50}= 1.8504 D_{30}= 0.6509 D_{15}= 0.1834
D_{10}= 0.1018 C_u= 28.73 C_c= 1.42

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-09 AS1A
Sample Number: R23-42-15

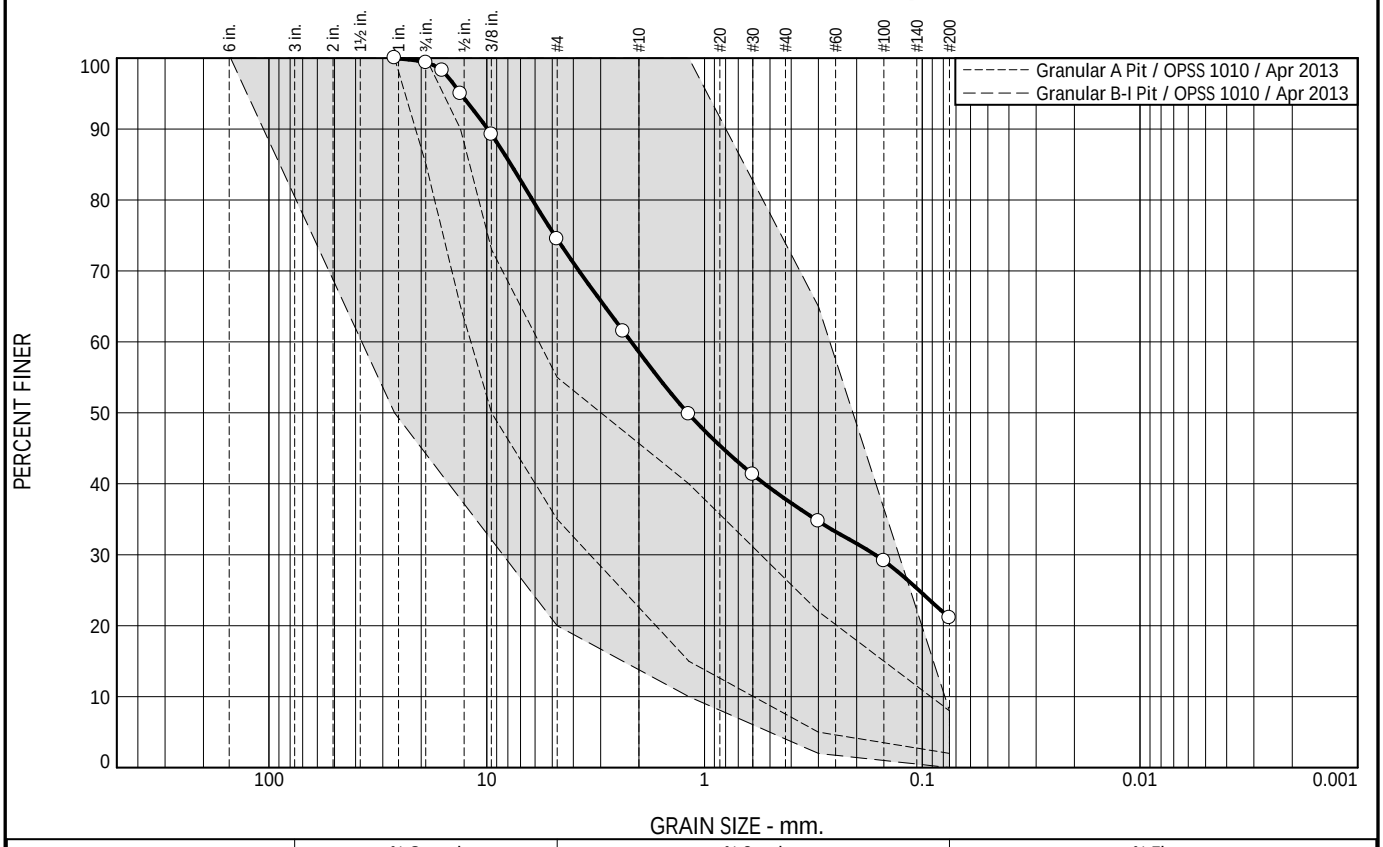
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.6	24.9	15.9	20.8	16.7	21.1	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.5mm	100.0	100	
19mm	99.4	85-100	
16mm	98.2		
13.2mm	95.0	65-90	X
9.5mm	89.2	50-73	X
4.75mm	74.5	35-55	X
2.36mm	61.5		
1.18mm	49.8	15-40	X
0.600mm	41.3		
0.300mm	34.7	5-22	X
0.150mm	29.1		
0.075mm	21.1	2-8	X

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 9.8970 D_{85}= 7.7395 D_{60}= 2.1685
D_{50}= 1.1946 D_{30}= 0.1646 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-09 AS1B
Sample Number: R23-42-16

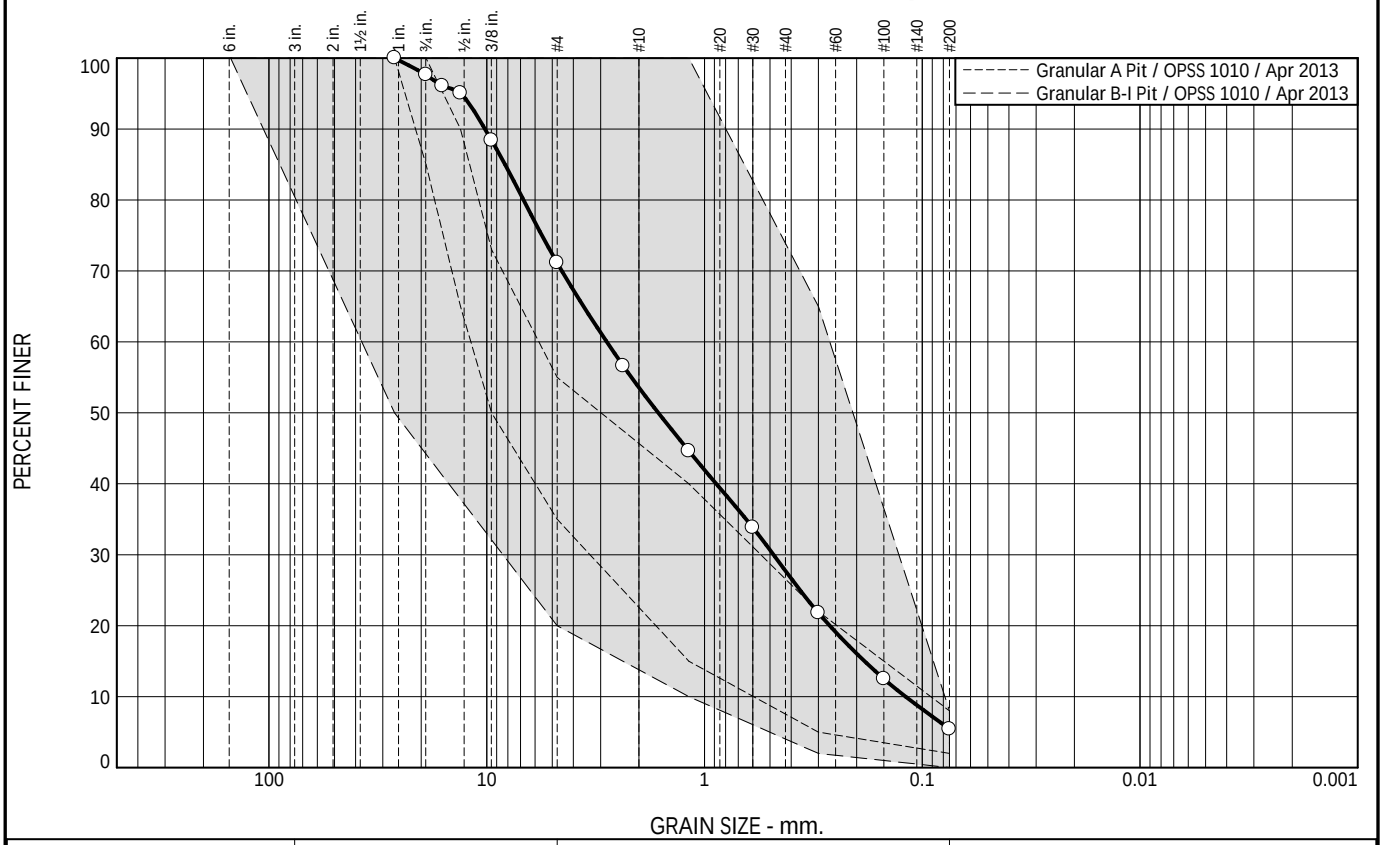
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.3	26.6	17.5	25.9	22.3	5.4	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
26.5mm	100.0	100	
19mm	97.6	85-100	
16mm	96.1		
13.2mm	95.0	65-90	X
9.5mm	88.4	50-73	X
4.75mm	71.1	35-55	X
2.36mm	56.6		
1.18mm	44.6	15-40	X
0.600mm	33.8		
0.300mm	21.8	5-22	
0.150mm	12.5		
0.075mm	5.4	2-8	

* Granular A Pit / OPSS 1010 / Apr 2013

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 10.1922 D_{85}= 8.2377 D_{60}= 2.8102
D_{50}= 1.6289 D_{30}= 0.4816 D_{15}= 0.1841
D_{10}= 0.1194 C_u= 23.53 C_c= 0.69

Classification

USCS= AASHTO=

Remarks

Location: BH-MIL-05 AS1
Sample Number: R23-42-21

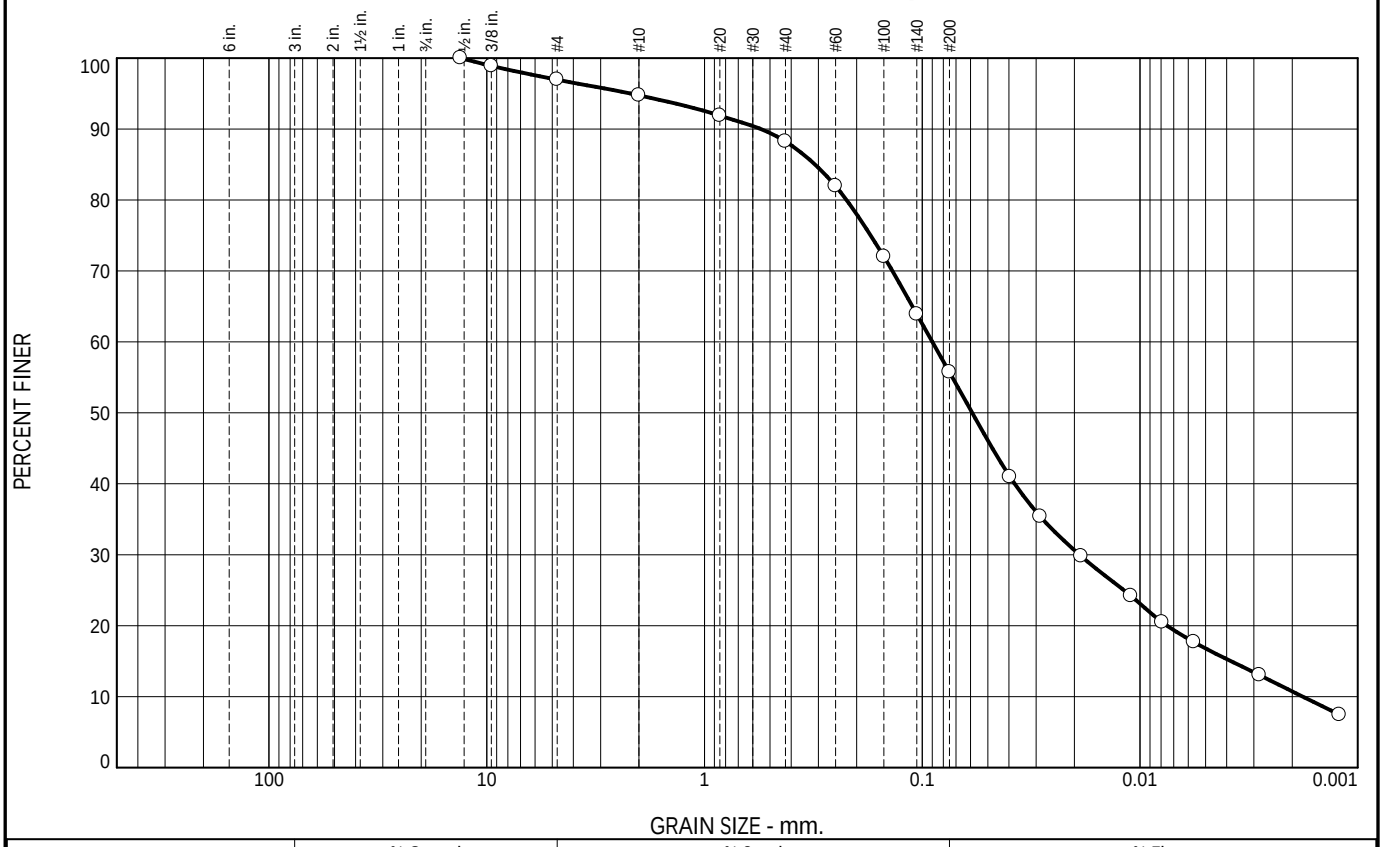
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.0	2.3	6.5	32.5	45.0	10.7

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.2mm	100.0		
9.5mm	98.9		
4.75mm	97.0		
2mm	94.7		
0.850mm	91.9		
0.425mm	88.2		
0.250mm	82.0		
0.150mm	72.0		
0.106mm	63.9		
0.075mm	55.7		
0.0396 mm.	41.0		
0.0287 mm.	35.4		
0.0186 mm.	29.8		
0.0110 mm.	24.2		
0.0079 mm.	20.5		
0.0057 mm.	17.7		
0.0028 mm.	13.0		
0.0012 mm.	7.4		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5505 D_{85}= 0.3108 D_{60}= 0.0899
D_{50}= 0.0590 D_{30}= 0.0189 D_{15}= 0.0038
D_{10}= 0.0018 C_u= 50.28 C_c= 2.23

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-01 SS2
Sample Number: R23-42-2

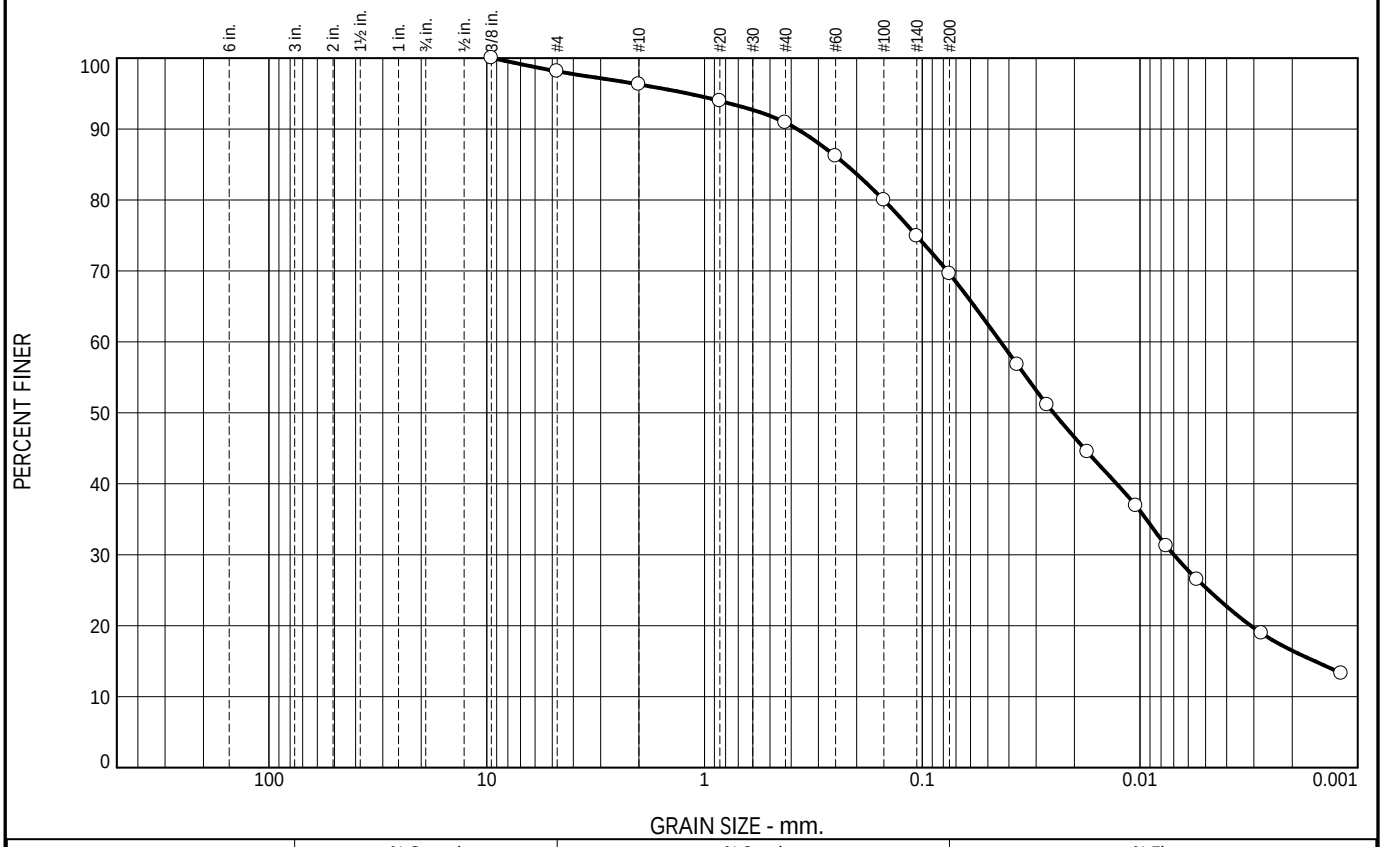
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.9	1.8	5.4	21.3	53.1	16.5

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	98.1		
2mm	96.3		
0.850mm	94.0		
0.425mm	90.9		
0.250mm	86.2		
0.150mm	80.0		
0.106mm	74.9		
0.075mm	69.6		
0.0366 mm.	56.8		
0.0267 mm.	51.1		
0.0174 mm.	44.5		
0.0104 mm.	36.9		
0.0076 mm.	31.2		
0.0055 mm.	26.5		
0.0028 mm.	18.9		
0.0012 mm.	13.3		

* (no specification provided)

Soil Description

Atterberg Limits

PL= 11 LL= 18 PI= 7

Coefficients

D_{90}= 0.3756 D_{85}= 0.2244 D_{60}= 0.0436
D_{50}= 0.0249 D_{30}= 0.0070 D_{15}= 0.0016
D_{10}= C_u= C_c=

Classification

USCS= CL-ML AASHTO= A-4(2)

Remarks

Location: BH-INT-01 SS5
Sample Number: R23-42-3

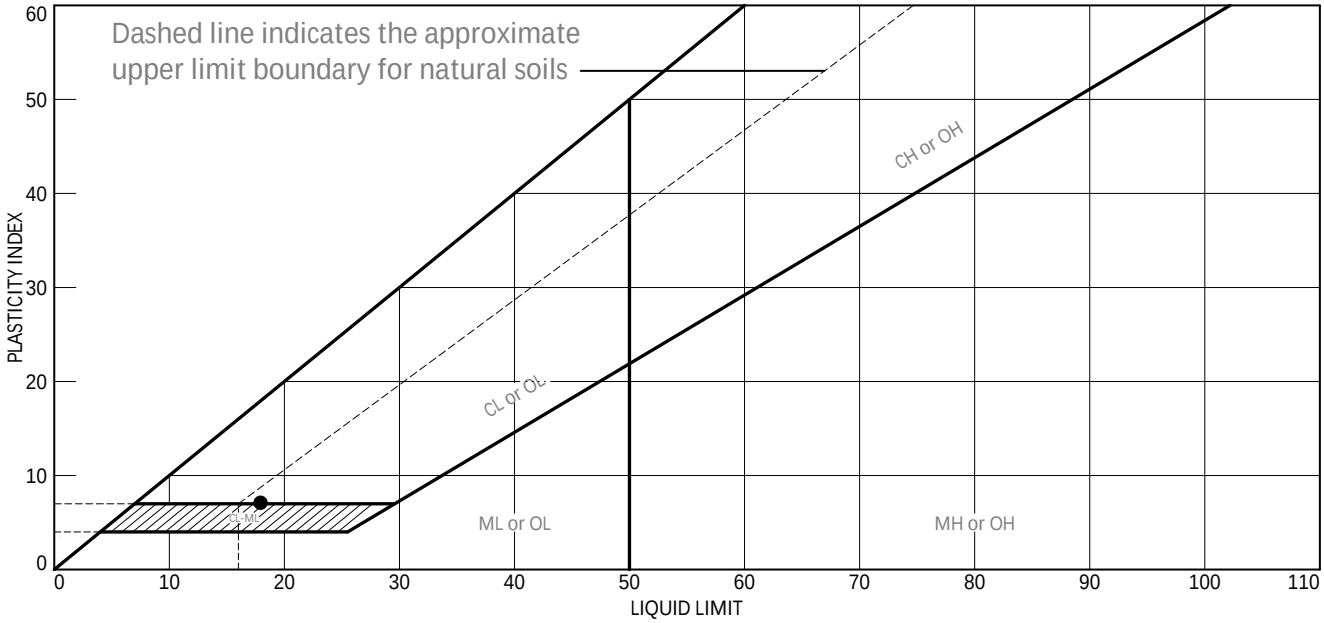
Date: 16/03/23

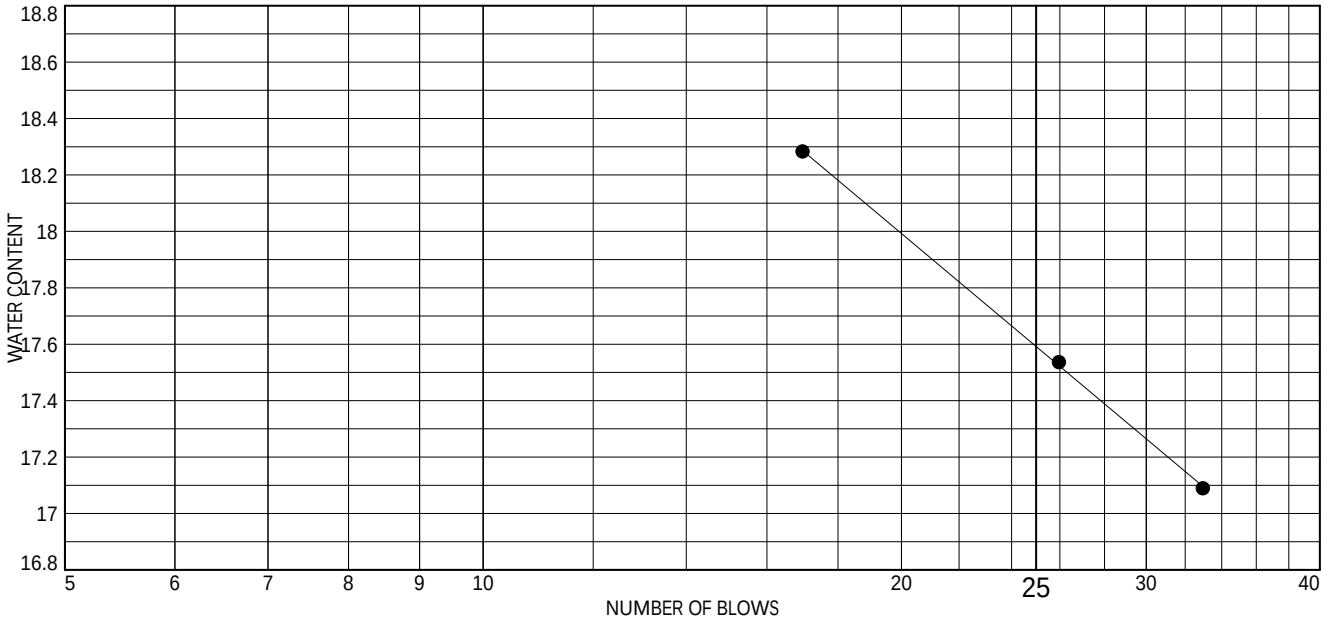
Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		18	11	7	90.9	69.6	CL-ML

Project No. 20M-01179-00/Subphase 480 Client: City of Vaughan

Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

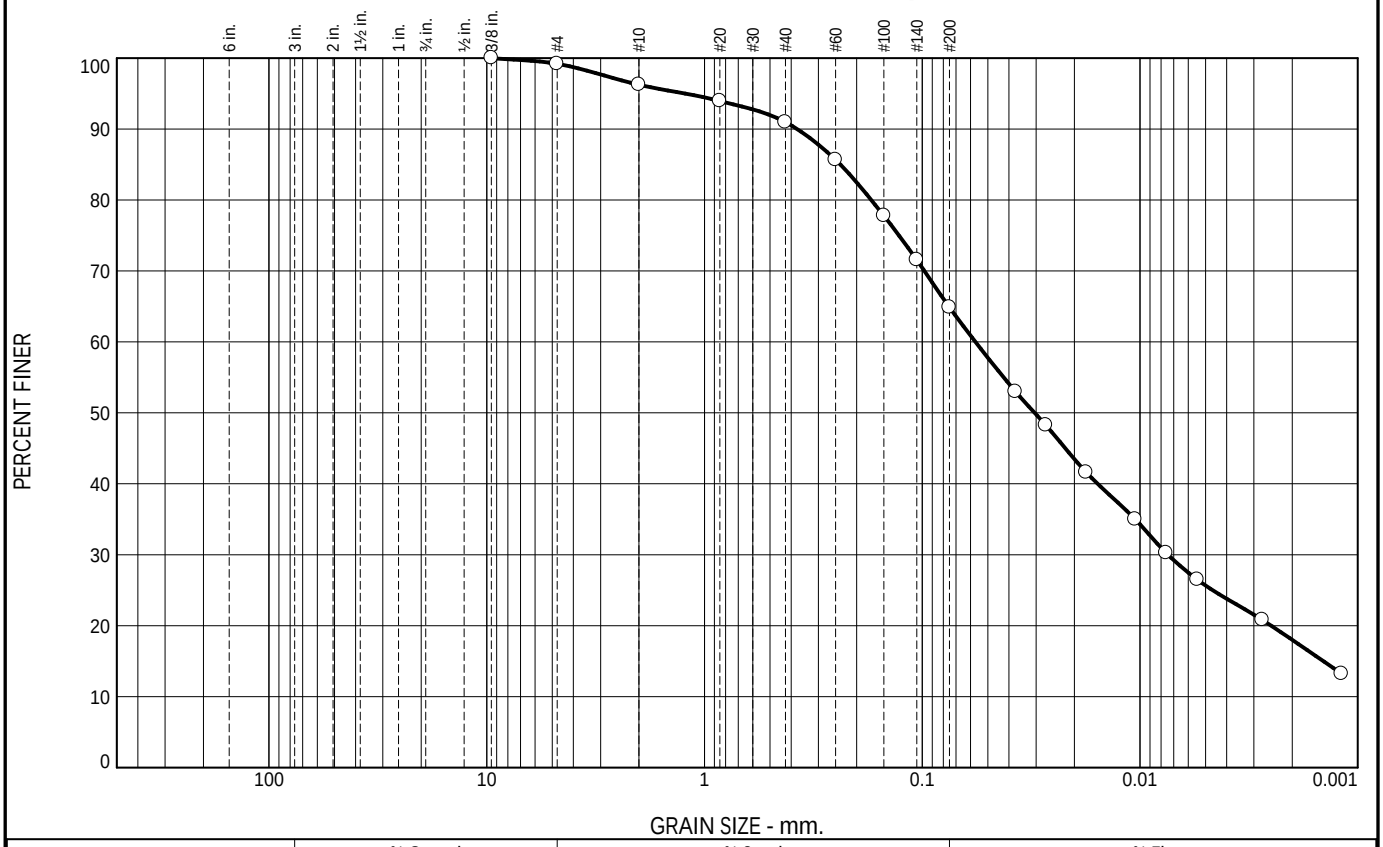
Location: BH-INT-01 SS5
Sample Number: R23-42-3

Remarks:

Figure

Tested By: Pavithra Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	3.0	5.2	26.1	46.9	18.0

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	99.2		
2mm	96.2		
0.850mm	94.0		
0.425mm	91.0		
0.250mm	85.7		
0.150mm	77.8		
0.106mm	71.5		
0.075mm	64.9		
0.0373 mm.	53.0		
0.0270 mm.	48.2		
0.0177 mm.	41.6		
0.0105 mm.	35.0		
0.0076 mm.	30.3		
0.0055 mm.	26.5		
0.0027 mm.	20.8		
0.0012 mm.	13.2		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3757 D_{85}= 0.2378 D_{60}= 0.0570
D_{50}= 0.0305 D_{30}= 0.0074 D_{15}= 0.0014
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-04W SS5
Sample Number: R23-42-7

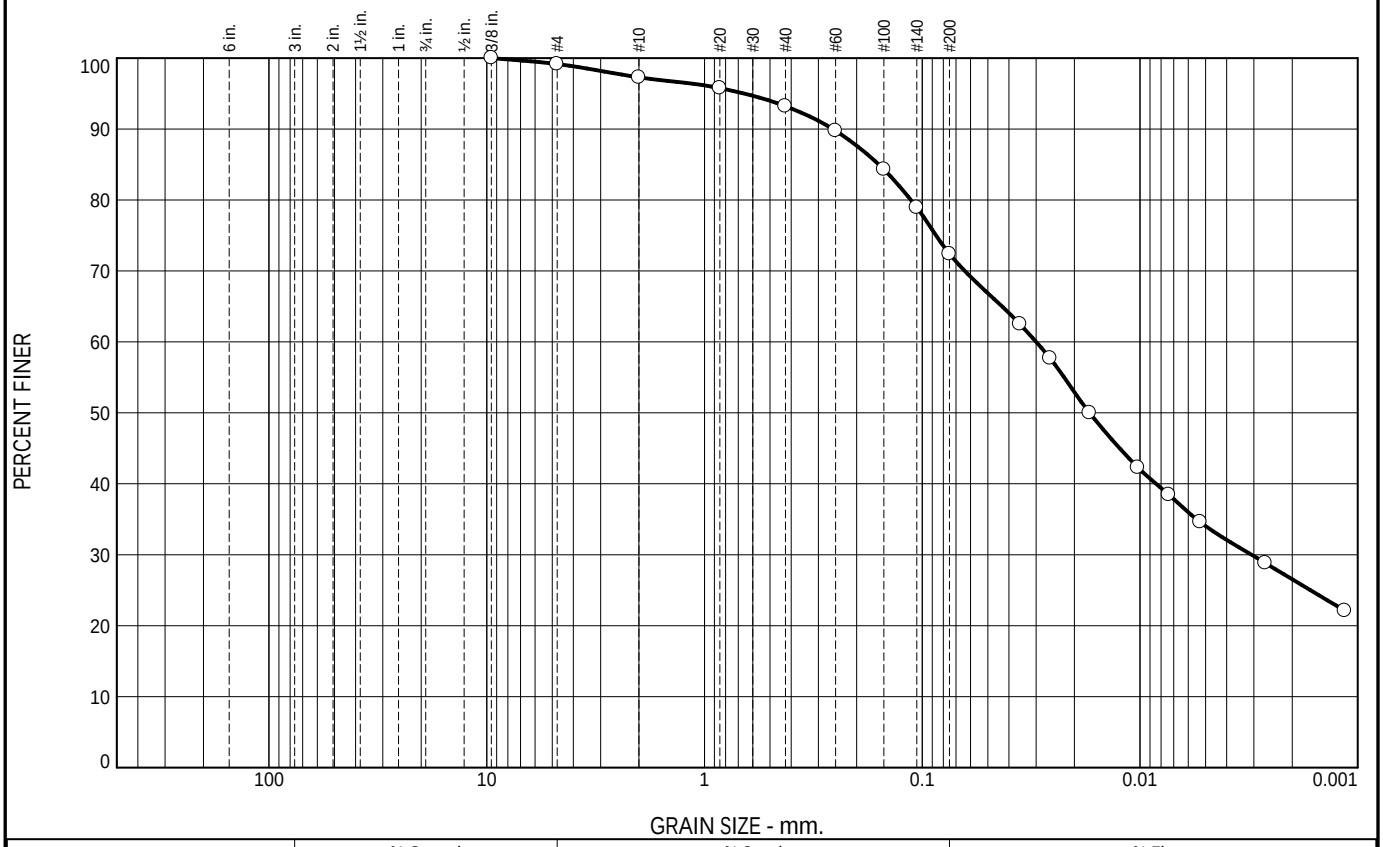
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.8	1.9	4.1	20.8	45.9	26.5

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	99.2		
2mm	97.3		
0.850mm	95.8		
0.425mm	93.2		
0.250mm	89.8		
0.150mm	84.3		
0.106mm	78.9		
0.075mm	72.4		
0.0356 mm.	62.5		
0.0259 mm.	57.7		
0.0170 mm.	50.0		
0.0102 mm.	42.3		
0.0074 mm.	38.5		
0.0053 mm.	34.6		
0.0027 mm.	28.8		
0.0011 mm.	22.1		

* (no specification provided)

Soil Description

Atterberg Limits

PL= 18 LL= 31 PI= 13

Coefficients

D_{90}= 0.2573 D_{85}= 0.1583 D_{60}= 0.0300
D_{50}= 0.0170 D_{30}= 0.0031 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(7)

Remarks

Location: BH-INT-05 SS2
Sample Number: R23-42-8

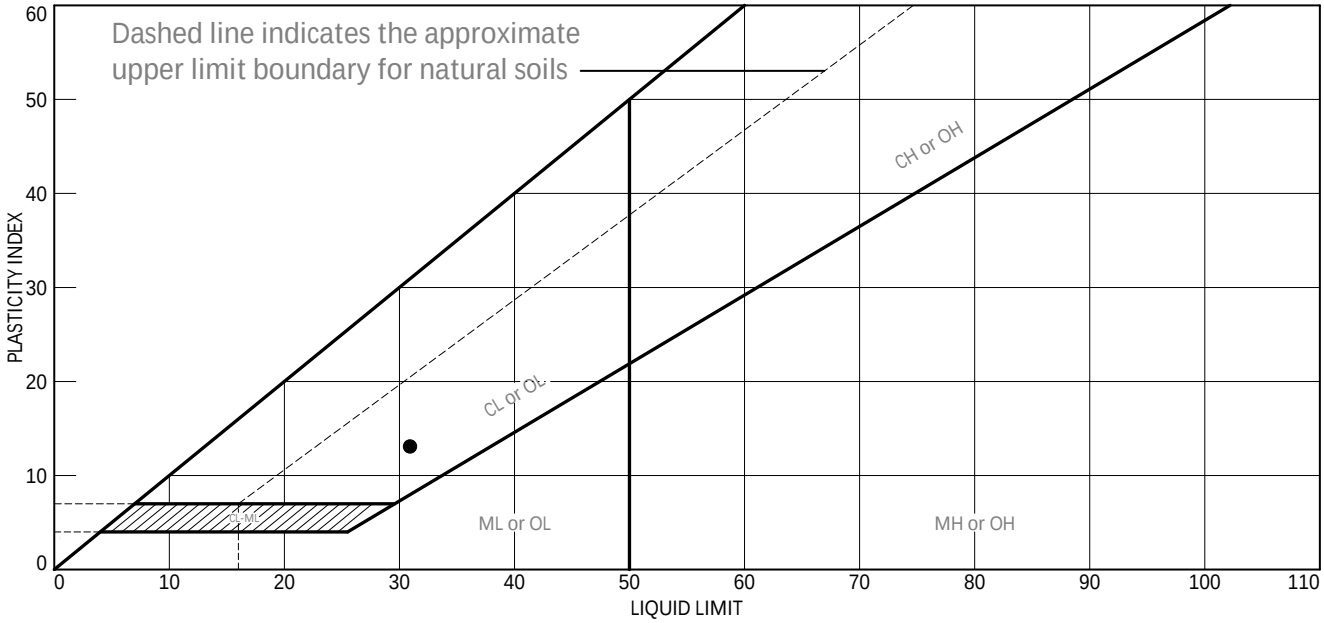
Date: 16/03/23

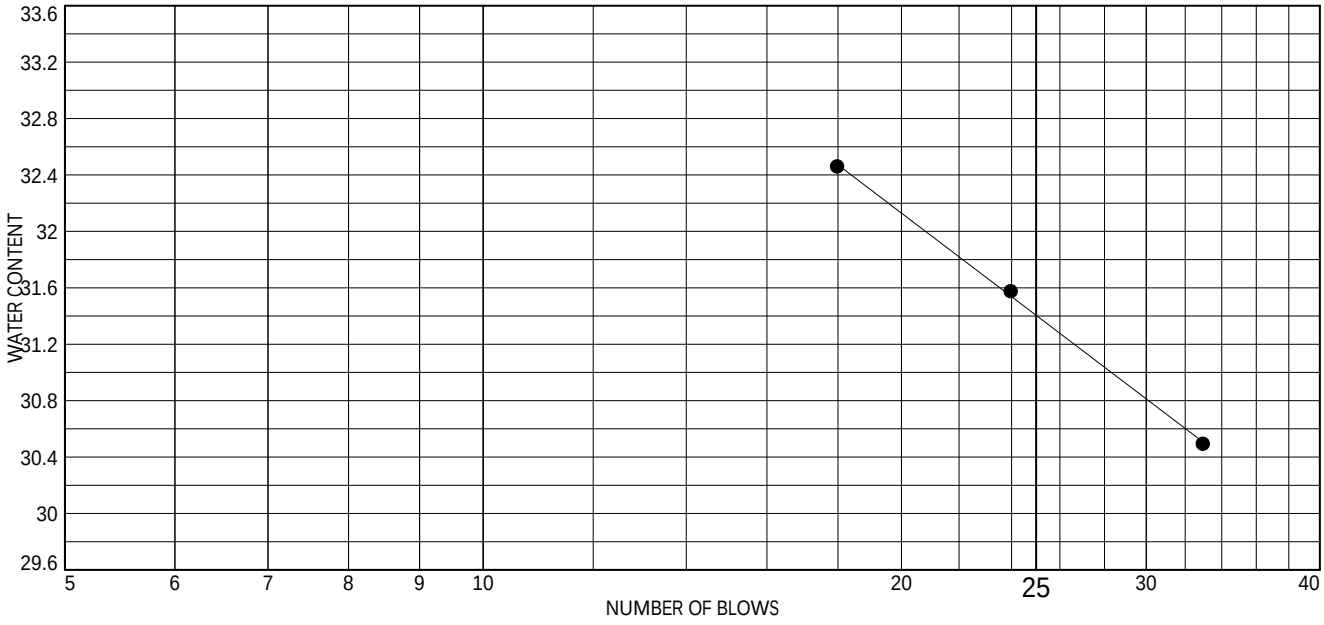
Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		31	18	13	93.2	72.4	CL

Project No. 20M-01179-00/Subphase 480 Client: City of Vaughan

Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

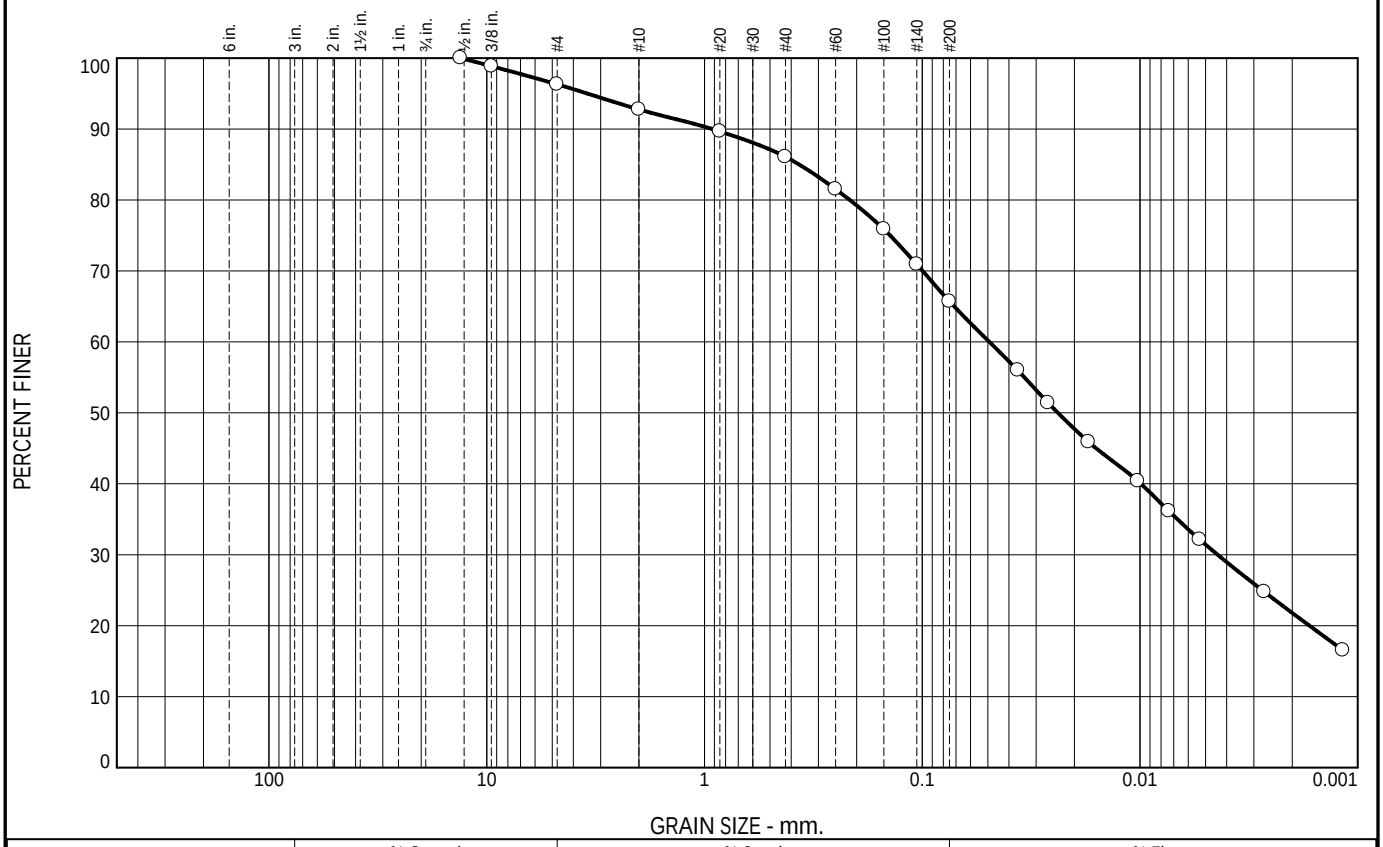
Location: BH-INT-05 SS2
Sample Number: R23-42-8

Remarks:

Figure

Tested By: Pavithra Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.7	3.5	6.7	20.4	43.9	21.8

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.2mm	100.0		
9.5mm	98.9		
4.75mm	96.3		
2mm	92.8		
0.850mm	89.7		
0.425mm	86.1		
0.250mm	81.5		
0.150mm	75.9		
0.106mm	70.9		
0.075mm	65.7		
0.0364 mm.	56.0		
0.0264 mm.	51.4		
0.0172 mm.	45.9		
0.0102 mm.	40.4		
0.0074 mm.	36.2		
0.0053 mm.	32.1		
0.0027 mm.	24.8		
0.0012 mm.	16.5		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.9207 D_{85}= 0.3676 D_{60}= 0.0492
D_{50}= 0.0238 D_{30}= 0.0044 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-07W SS2
Sample Number: R23-42-11

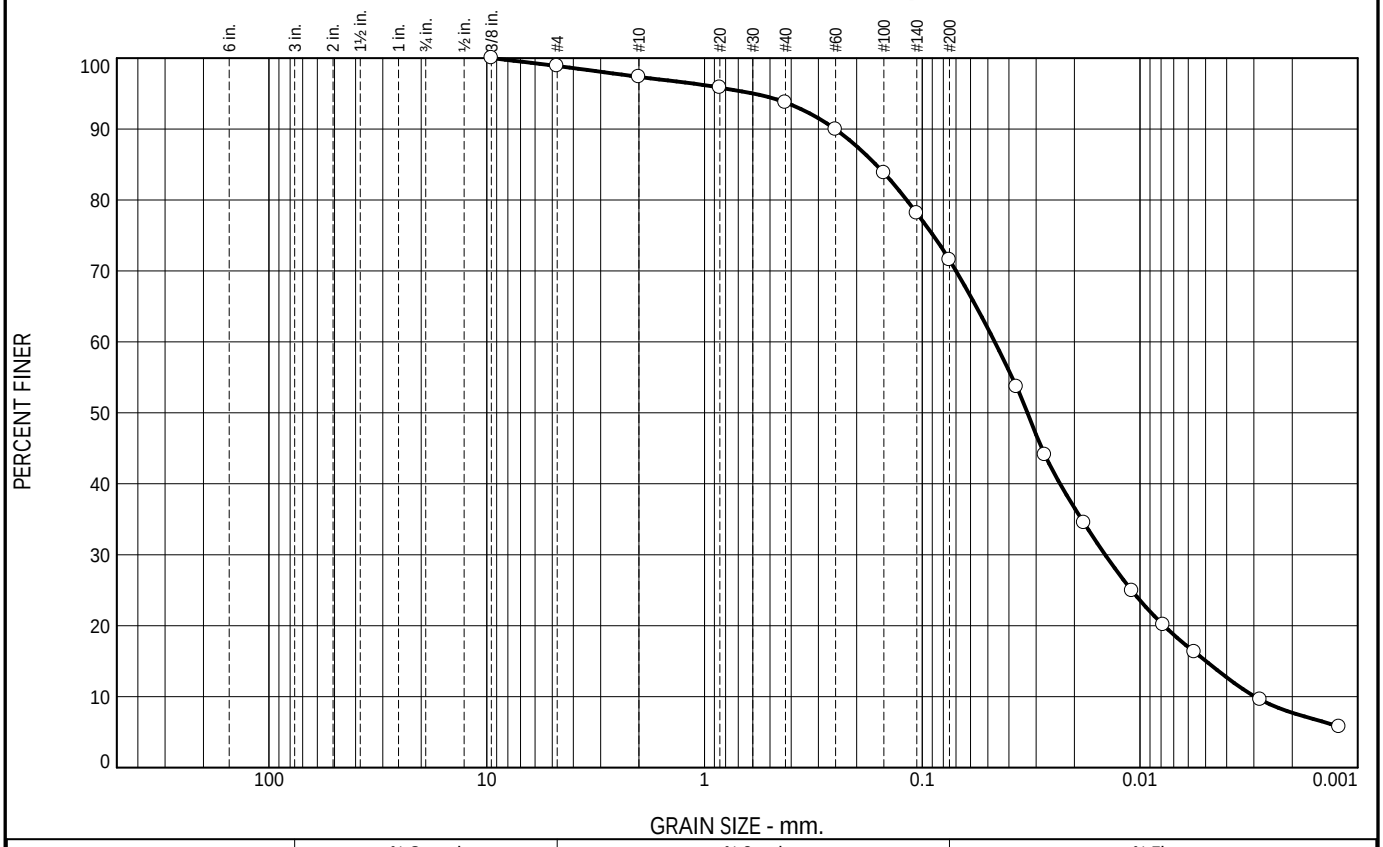
Date: 16/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.1	1.5	3.7	22.1	63.9	7.7

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	98.9		
2mm	97.4		
0.850mm	95.8		
0.425mm	93.7		
0.250mm	90.0		
0.150mm	83.8		
0.106mm	78.1		
0.075mm	71.6		
0.0369 mm.	53.7		
0.0274 mm.	44.1		
0.0181 mm.	34.5		
0.0109 mm.	24.9		
0.0078 mm.	20.1		
0.0056 mm.	16.3		
0.0028 mm.	9.6		
0.0012 mm.	5.8		

* (no specification provided)

Soil Description

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.2513 D_{85}= 0.1633 D_{60}= 0.0464
D_{50}= 0.0329 D_{30}= 0.0145 D_{15}= 0.0050
D_{10}= 0.0030 C_u= 15.66 C_c= 1.52

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Location: BH-INT-07W SS6
Sample Number: R23-42-12

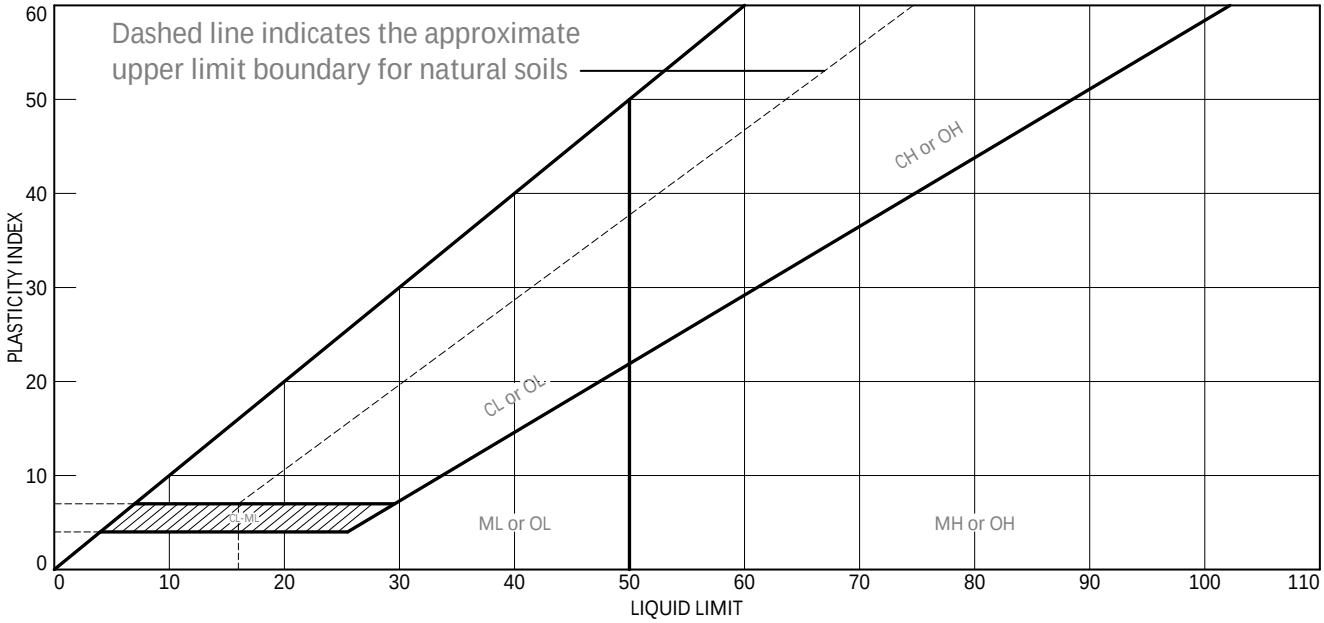
Date: 20/03/23

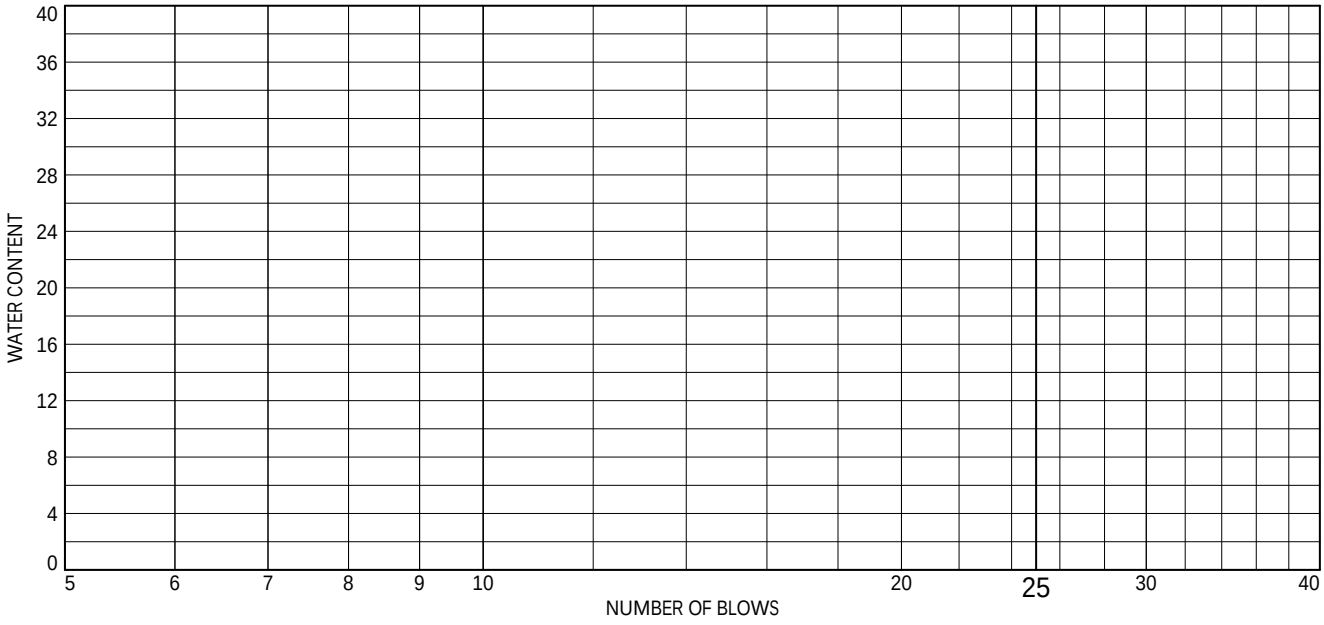
Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		NV	NP	NP	93.7	71.6	ML

Project No. 20M-01179-00/Subphase 480 Client: City of Vaughan

Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

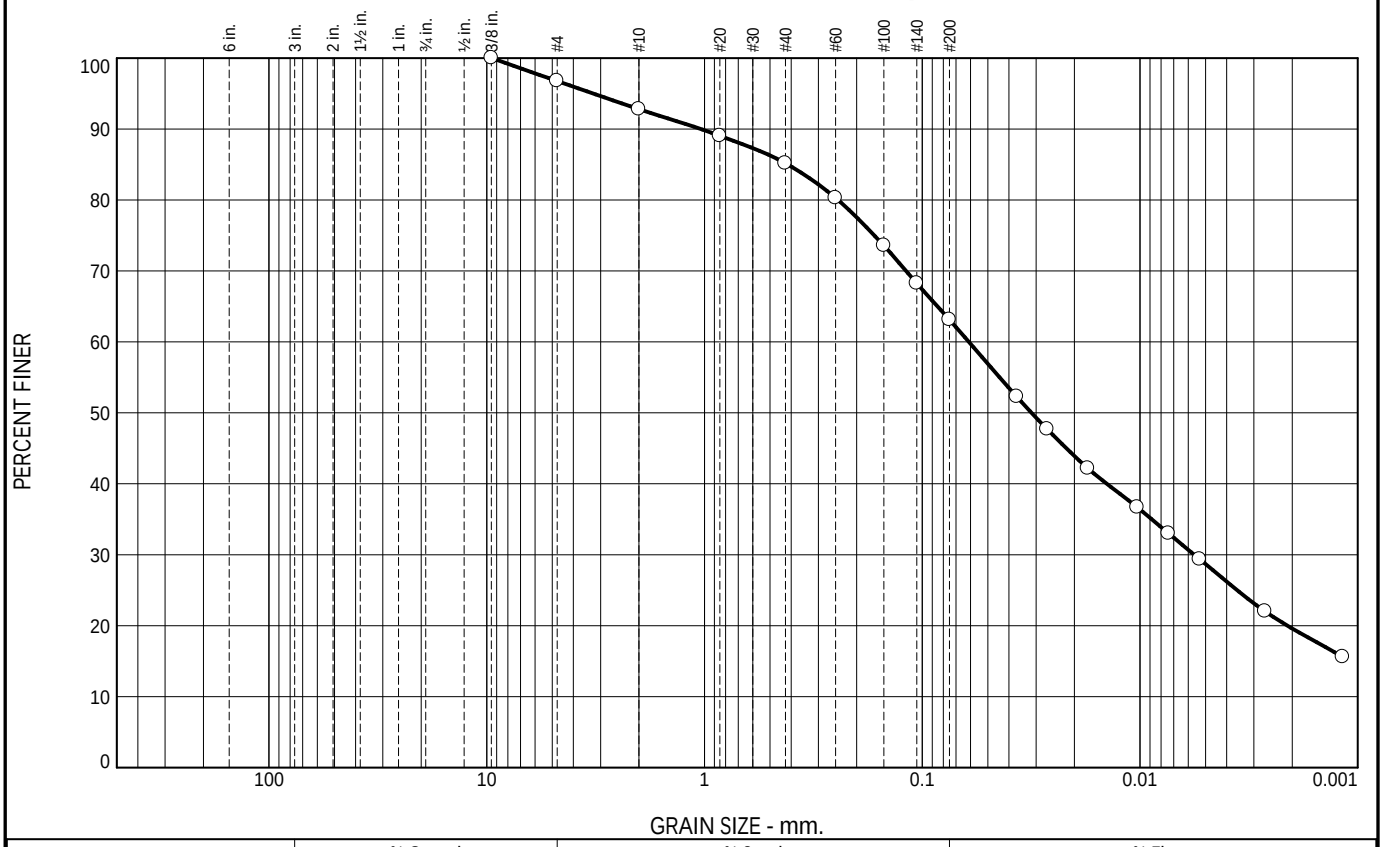
Location: BH-INT-07W SS6
Sample Number: R23-42-12

Remarks:

Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.2	4.0	7.6	22.1	43.5	19.6

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	96.8		
2mm	92.8		
0.850mm	89.1		
0.425mm	85.2		
0.250mm	80.3		
0.150mm	73.6		
0.106mm	68.2		
0.075mm	63.1		
0.0368 mm.	52.3		
0.0267 mm.	47.7		
0.0174 mm.	42.2		
0.0103 mm.	36.7		
0.0074 mm.	33.0		
0.0053 mm.	29.3		
0.0027 mm.	22.0		
0.0012 mm.	15.6		

* (no specification provided)

Soil Description

Atterberg Limits

PL= 11 LL= 19 PI= 8

Coefficients

D_{90}= 1.0393 D_{85}= 0.4153 D_{60}= 0.0611
D_{50}= 0.0315 D_{30}= 0.0056 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(2)

Remarks

Location: BH-INT-09 SS2
Sample Number: R23-42-17

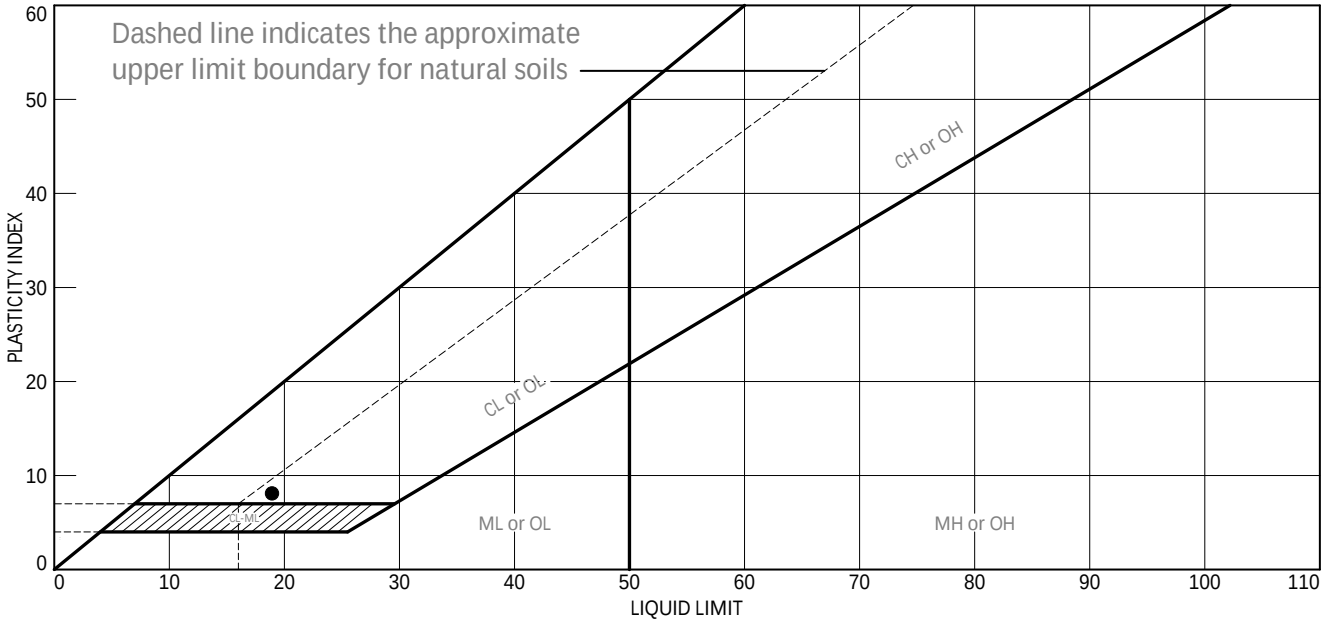
Date: 20/03/23

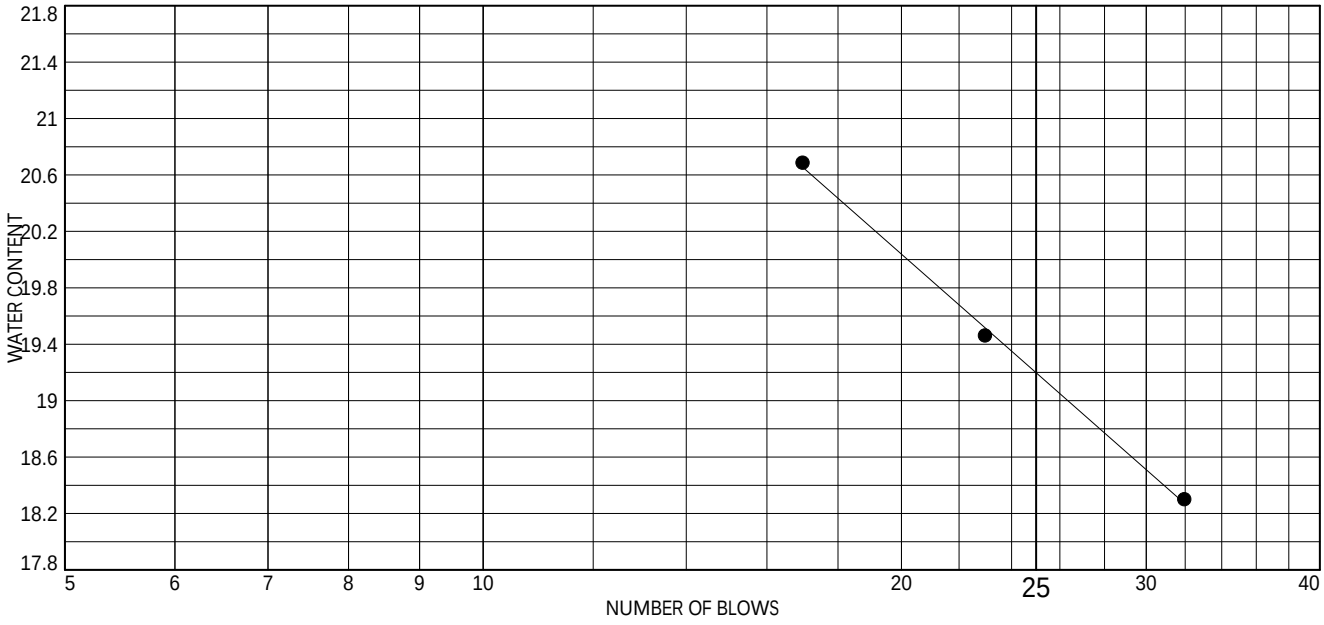
Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		19	11	8	85.2	63.1	CL

Project No. 20M-01179-00/Subphase 480 Client: City of Vaughan

Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

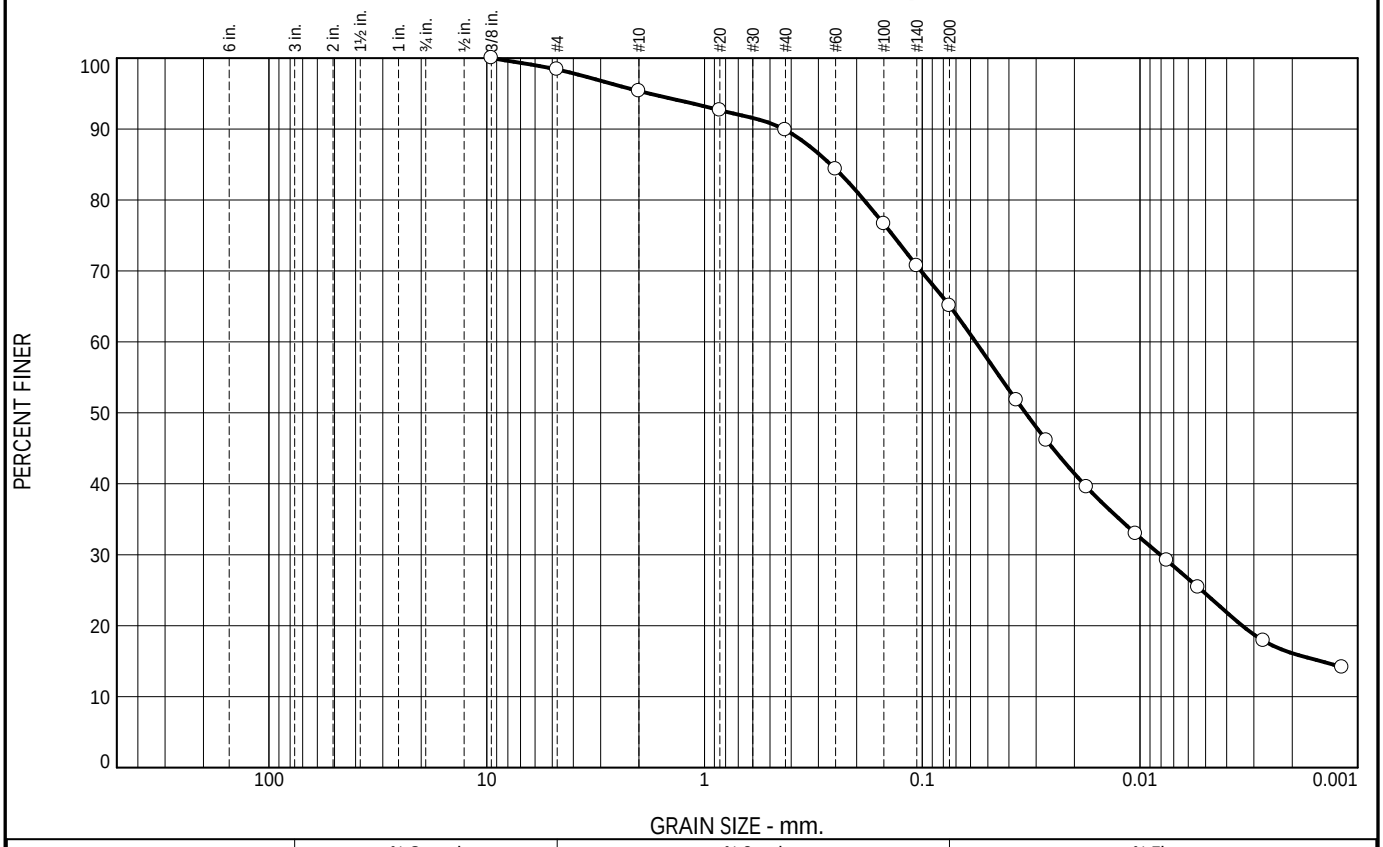
Location: BH-INT-09 SS2
Sample Number: R23-42-17

Remarks:

Figure

Tested By: Shireen Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.6	3.0	5.5	24.8	49.0	16.1

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	98.4		
2mm	95.4		
0.850mm	92.6		
0.425mm	89.9		
0.250mm	84.4		
0.150mm	76.6		
0.106mm	70.7		
0.075mm	65.1		
0.0369 mm.	51.8		
0.0269 mm.	46.2		
0.0176 mm.	39.6		
0.0105 mm.	33.0		
0.0075 mm.	29.2		
0.0054 mm.	25.4		
0.0027 mm.	17.9		
0.0012 mm.	14.1		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4333 D_{85}= 0.2632 D_{60}= 0.0569
D_{50}= 0.0335 D_{30}= 0.0081 D_{15}= 0.0015
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-INT-09 SS6
Sample Number: R23-42-18

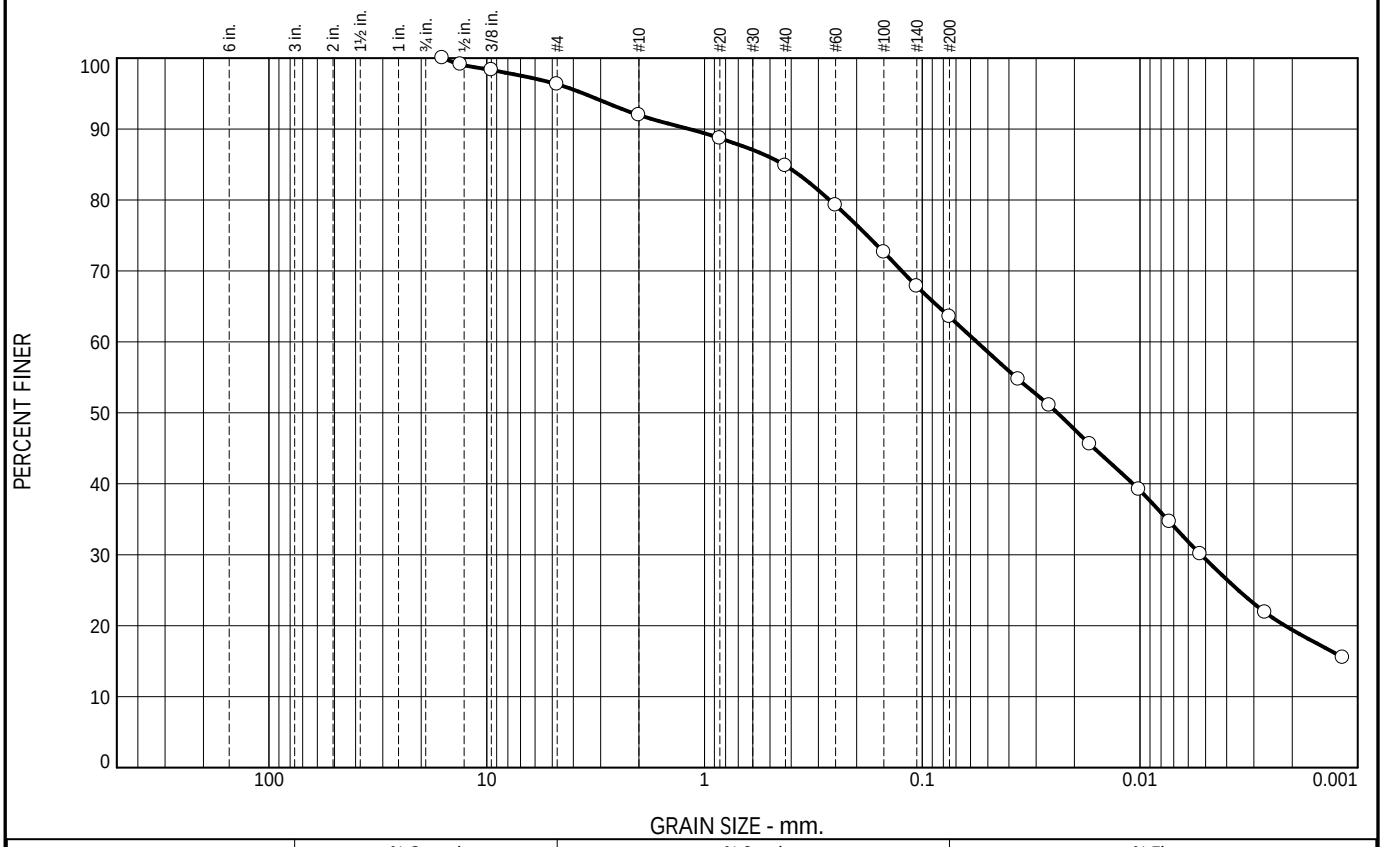
Date: 20/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.7	4.3	7.2	21.3	44.1	19.4

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
16mm	100.0		
13.2mm	99.1		
9.5mm	98.3		
4.75mm	96.3		
2mm	92.0		
0.850mm	88.7		
0.425mm	84.8		
0.250mm	79.3		
0.150mm	72.6		
0.106mm	67.8		
0.075mm	63.5		
0.0362 mm.	54.7		
0.0261 mm.	51.1		
0.0170 mm.	45.6		
0.0101 mm.	39.2		
0.0073 mm.	34.7		
0.0053 mm.	30.1		
0.0027 mm.	21.9		
0.0012 mm.	15.5		

* (no specification provided)

Soil Description

Atterberg Limits

PL= 15 LL= 24 PI= 9

Coefficients

D_{90}= 1.1744 D_{85}= 0.4334 D_{60}= 0.0562
D_{50}= 0.0240 D_{30}= 0.0052 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(3)

Remarks

Location: BH-MIL-02 SS2
Sample Number: R23-42-19

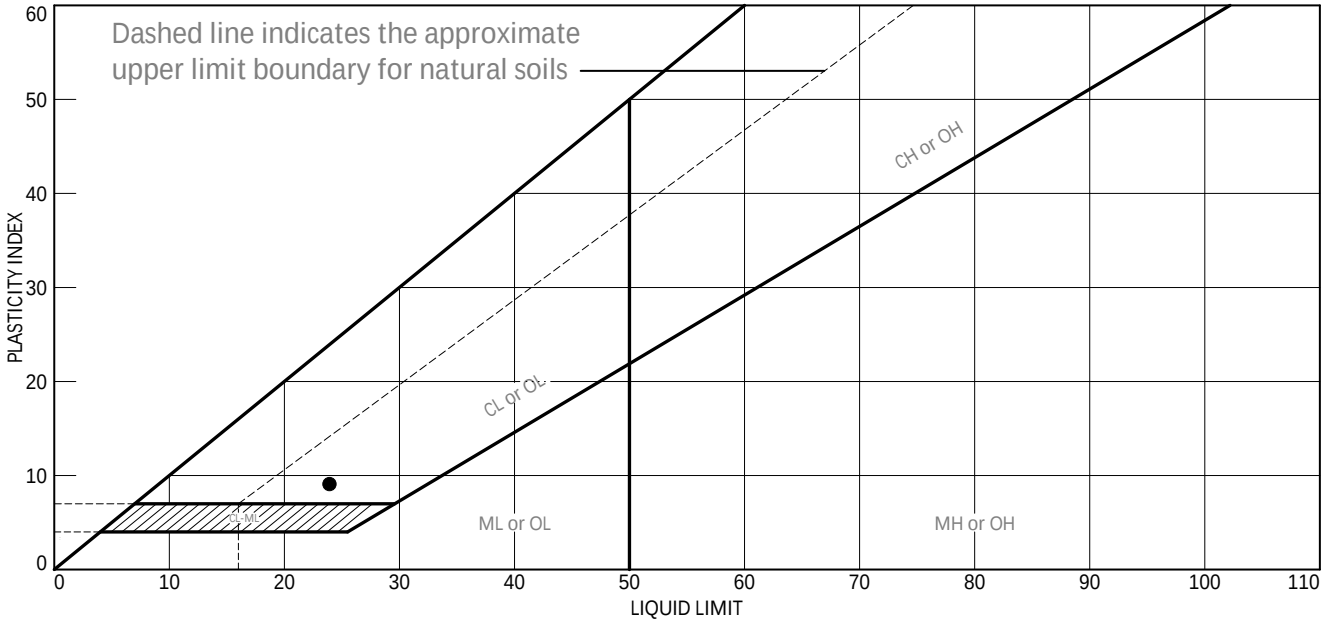
Date: 20/03/23

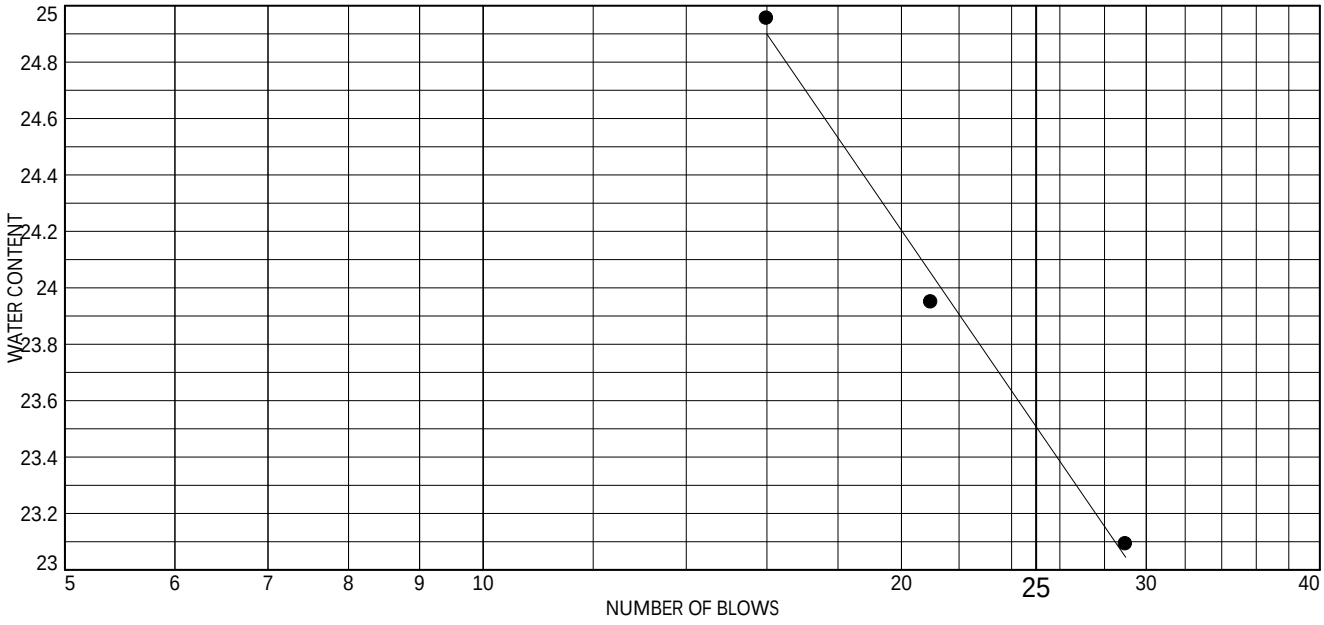
Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		24	15	9	84.8	63.5	CL

Project No. 20M-01179-00/Subphase 480 Client: City of Vaughan

Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

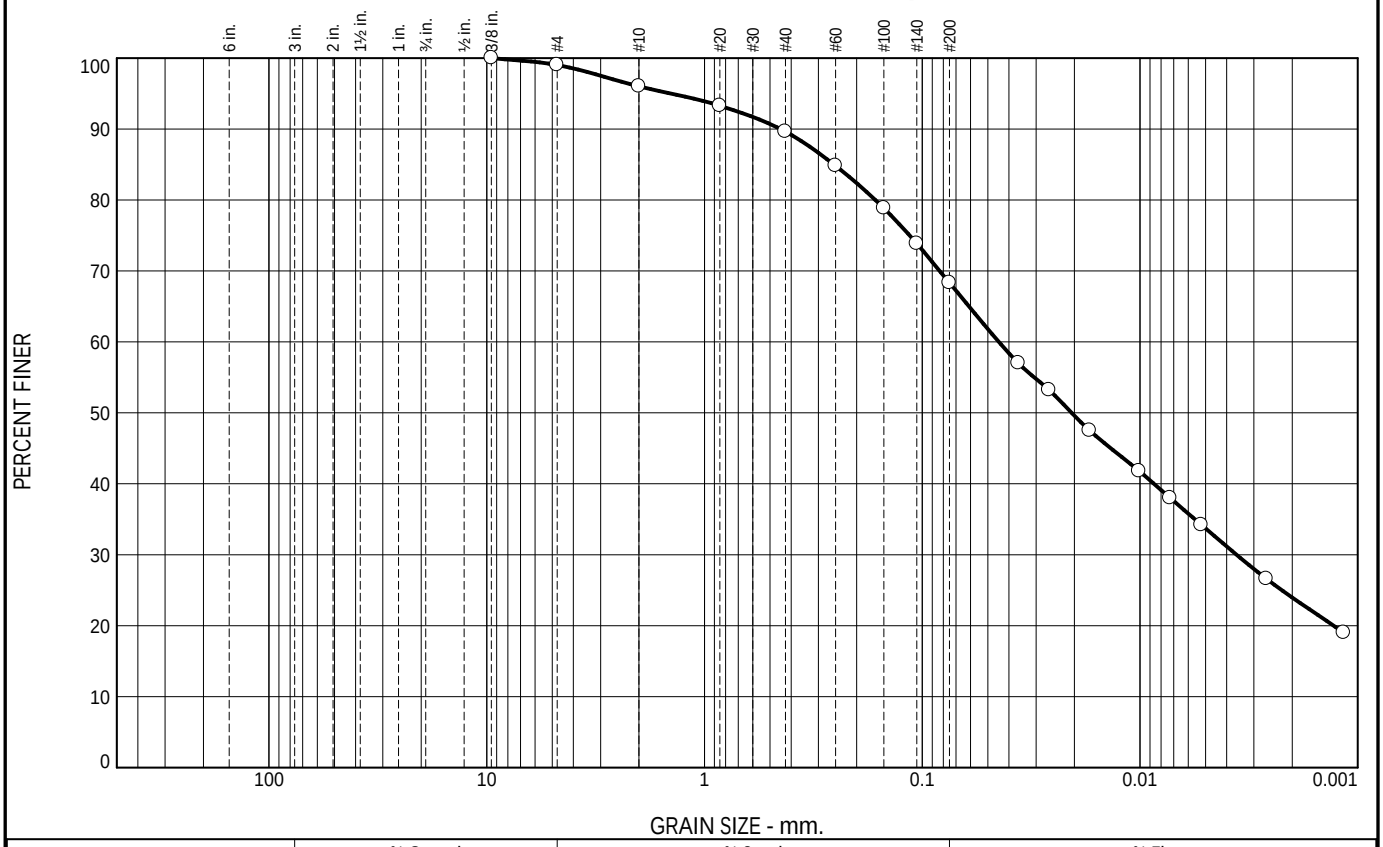
Location: BH-MIL-02 SS2
Sample Number: R23-42-19

Remarks:

Figure

Tested By: Pavithra Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.0	3.0	6.4	21.3	44.3	24.0

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	99.0		
2mm	96.0		
0.850mm	93.3		
0.425mm	89.6		
0.250mm	84.8		
0.150mm	78.8		
0.106mm	73.9		
0.075mm	68.3		
0.0362 mm.	57.0		
0.0261 mm.	53.2		
0.0170 mm.	47.5		
0.0101 mm.	41.8		
0.0073 mm.	38.0		
0.0052 mm.	34.2		
0.0026 mm.	26.6		
0.0012 mm.	19.0		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4477 D_{85}= 0.2544 D_{60}= 0.0445
D_{50}= 0.0206 D_{30}= 0.0036 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-MIL-03 SS2
Sample Number: R23-42-20

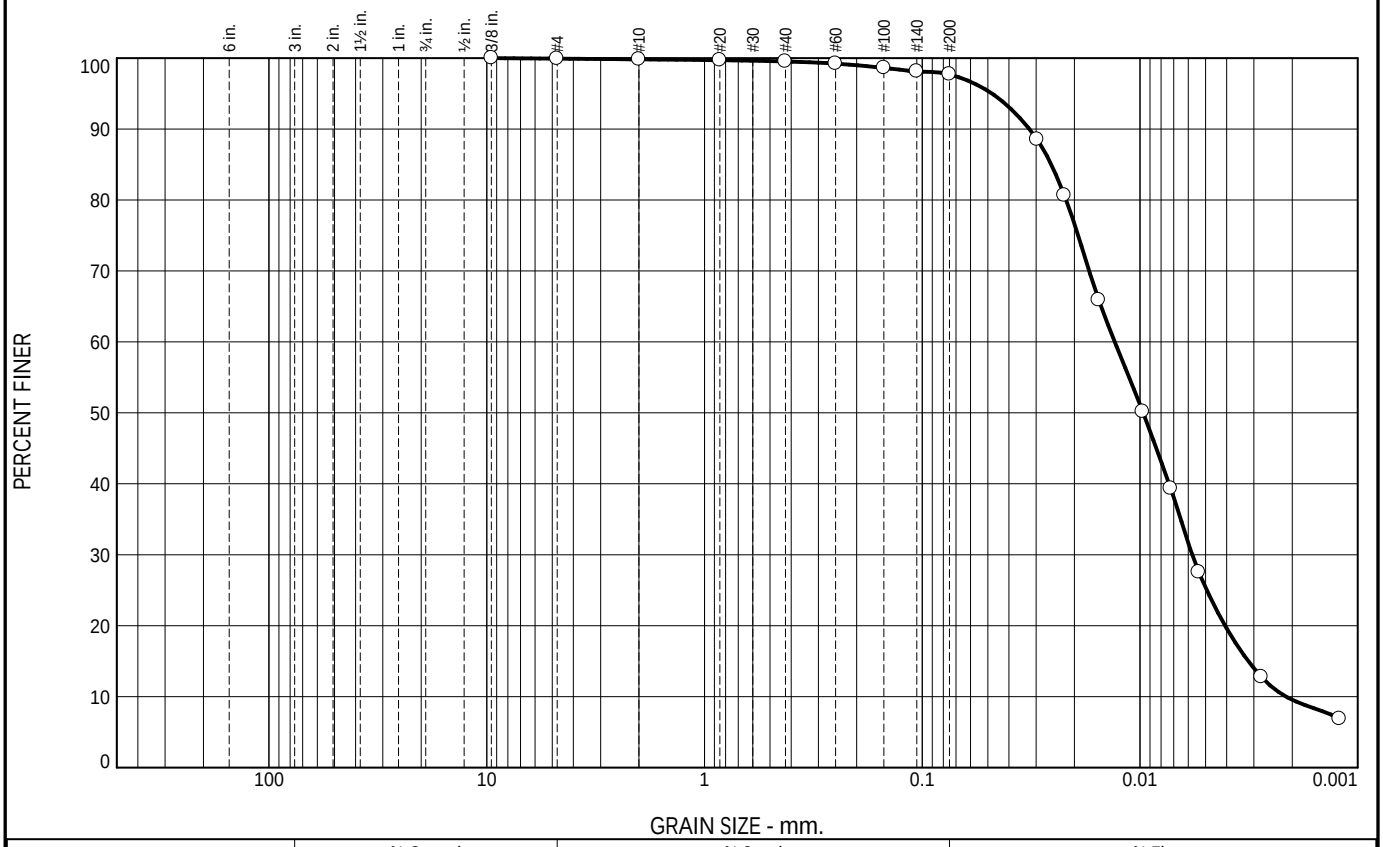
Date: 20/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.1	0.3	1.8	88.1	9.6

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	99.9		
2mm	99.8		
0.850mm	99.7		
0.425mm	99.5		
0.250mm	99.2		
0.150mm	98.6		
0.106mm	98.1		
0.075mm	97.7		
0.0297 mm.	88.5		
0.0222 mm.	80.6		
0.0155 mm.	65.9		
0.0097 mm.	50.2		
0.0072 mm.	39.3		
0.0054 mm.	27.5		
0.0028 mm.	12.8		
0.0012 mm.	6.9		

* (no specification provided)

Soil Description

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.0322 D_{85}= 0.0256 D_{60}= 0.0131
D_{50}= 0.0097 D_{30}= 0.0058 D_{15}= 0.0032
D_{10}= 0.0021 C_u= 6.12 C_c= 1.19

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Location: BH-MIL-05 SS5
Sample Number: R23-42-22

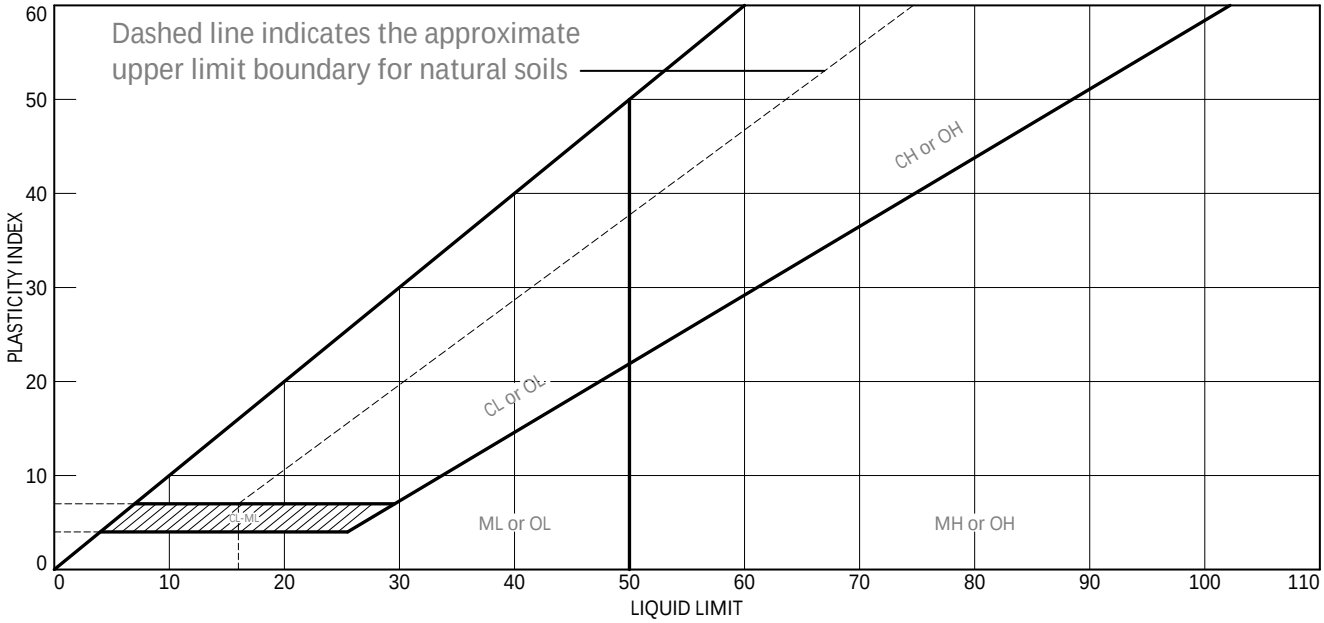
Date: 20/03/23

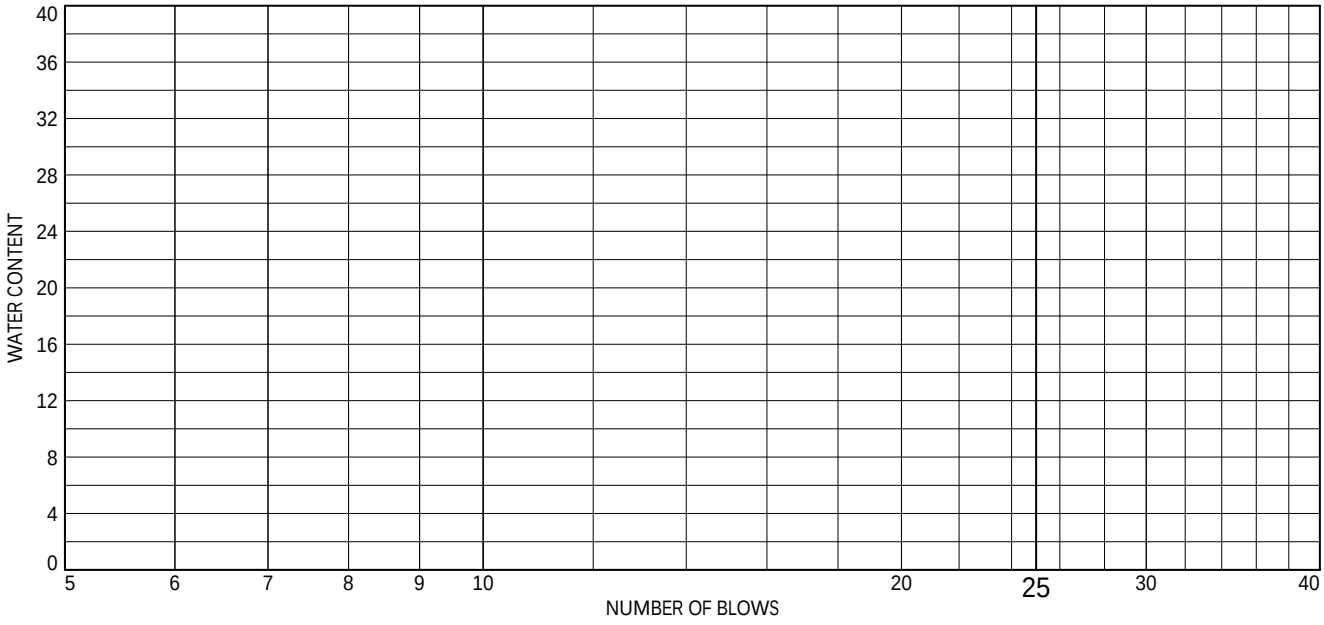
Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		NV	NP	NP	99.5	97.7	ML

Project No. 20M-01179-00/Subphase 480 Client: City of Vaughan

Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

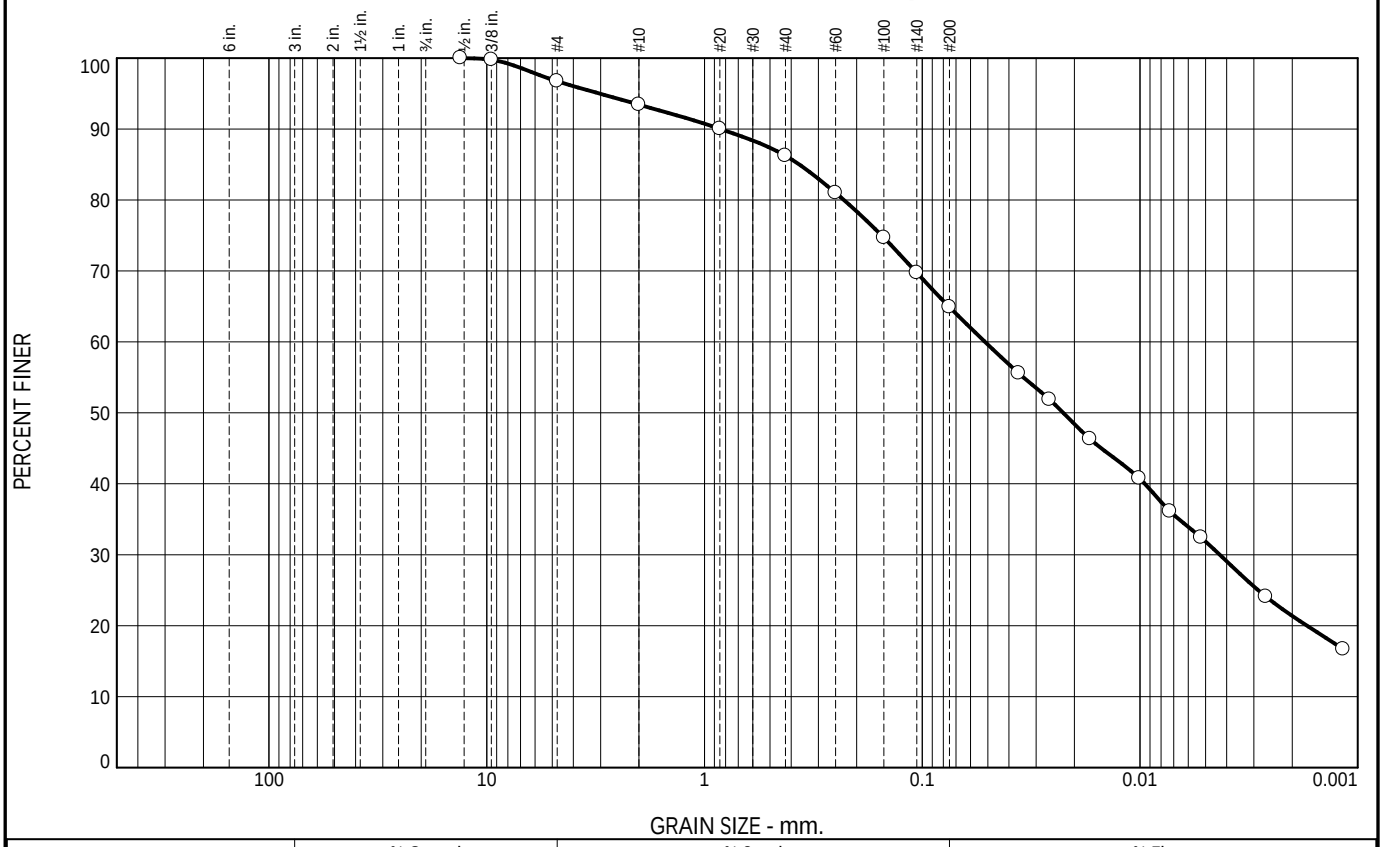
Location: BH-MIL-05 SS5
Sample Number: R23-42-22

Remarks:

Figure

Tested By: Pavithra Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.3	3.3	7.2	21.3	43.5	21.4

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.2mm	100.0		
9.5mm	99.8		
4.75mm	96.7		
2mm	93.4		
0.850mm	90.0		
0.425mm	86.2		
0.250mm	81.0		
0.150mm	74.7		
0.106mm	69.7		
0.075mm	64.9		
0.0361 mm.	55.6		
0.0260 mm.	51.9		
0.0170 mm.	46.3		
0.0101 mm.	40.7		
0.0073 mm.	36.1		
0.0052 mm.	32.4		
0.0026 mm.	24.1		
0.0012 mm.	16.7		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.8440 D_{85}= 0.3671 D_{60}= 0.0515
D_{50}= 0.0225 D_{30}= 0.0043 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-BLC-01W SS2
Sample Number: R23-42-23

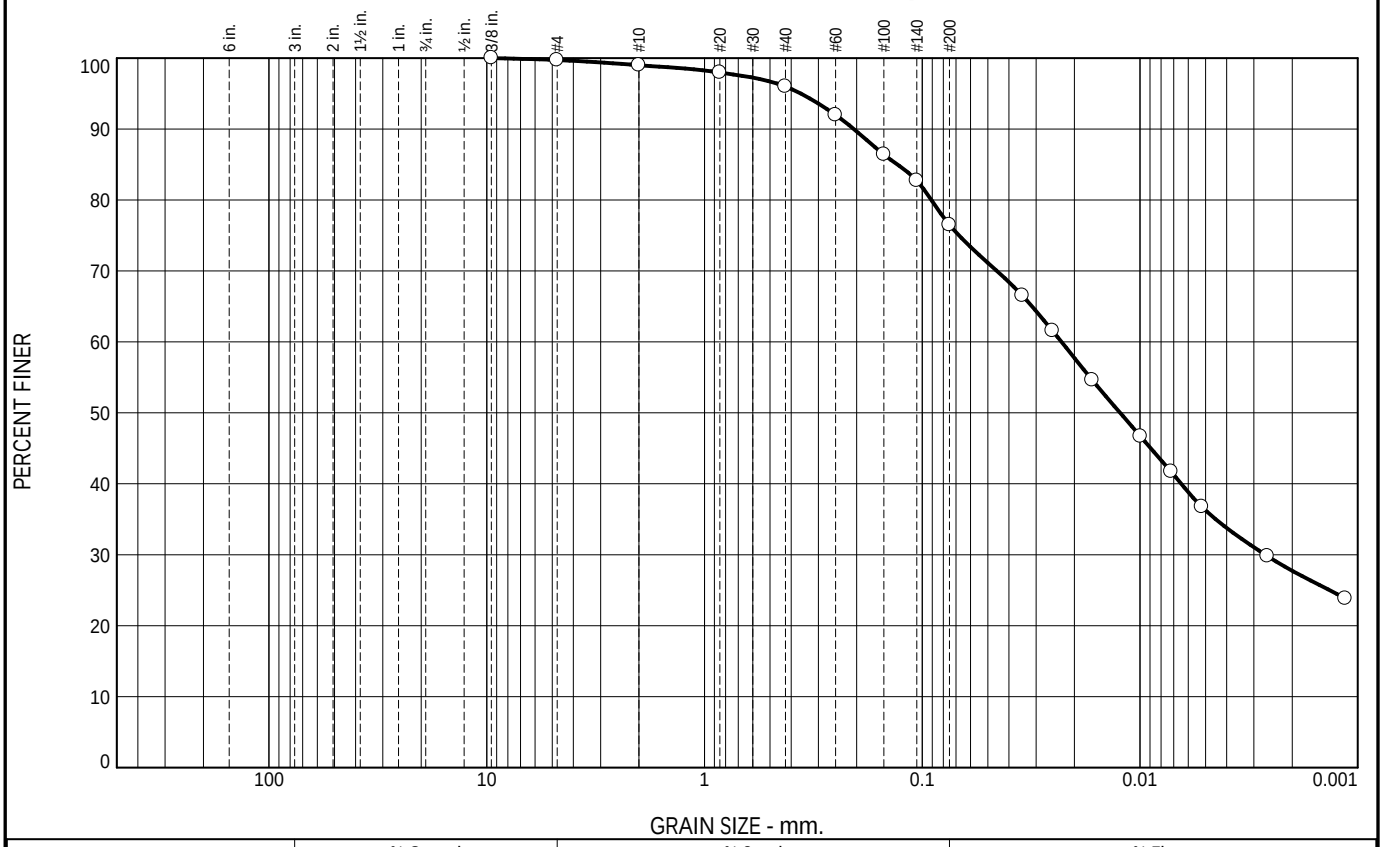
Date: 20/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	0.7	3.0	19.5	48.8	27.7

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	99.7		
2mm	99.0		
0.850mm	98.0		
0.425mm	96.0		
0.250mm	92.0		
0.150mm	86.4		
0.106mm	82.7		
0.075mm	76.5		
0.0347 mm.	66.5		
0.0252 mm.	61.6		
0.0166 mm.	54.6		
0.0100 mm.	46.7		
0.0072 mm.	41.7		
0.0052 mm.	36.7		
0.0026 mm.	29.8		
0.0011 mm.	23.8		

* (no specification provided)

Soil Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2062 D_{85}= 0.1299 D_{60}= 0.0229
D_{50}= 0.0123 D_{30}= 0.0027 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: BH-BLC-01W SS6
Sample Number: R23-42-24

Date: 20/03/23

Client: City of Vaughan
Project: 20M-01179-00 - Vaughan Metropolitan Centre TMP

Project No: 20M-01179-00/Subphase 480 Figure

Tested By: Shireen / Bonnie Checked By: Marjan

Appendix D
ESAL Calculations

Road Name: **Interchange Way, Vaughan, ON**

Project Name City of Vaughan

Date: April 28, 2025

Traffic Inputs

Provided AADT:	3000
Traffic Count Year	2024
AADT(Design Year)	3000
Commercial Traffic (%) (Note 1):	5
Average Truck Factor (Note 2):	1.31
Directional Distribution	0.5
Annual Traffic Growth Rate (%) (Note 3):	2
Lane Distribution"	0.9
Design Year	2024

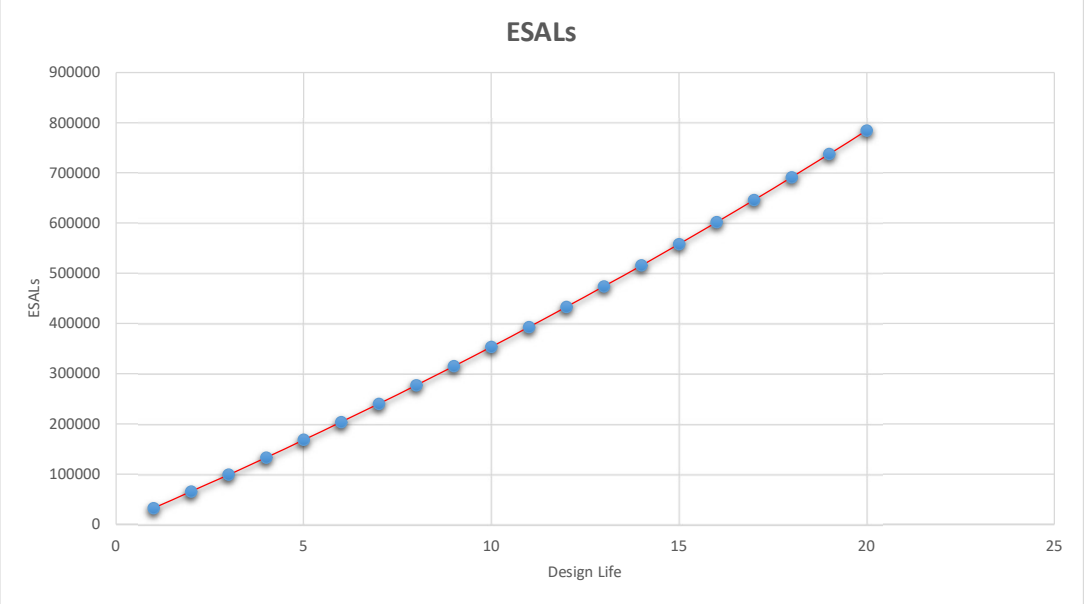
AADT (Design Year) = Current AADT x (1 + A/100)^(IY-MY)
A= Annual Traffic Growth Rate
IY = Year open to Traffic
MY = Year in which Current AADT is provided

Equivalent Single Axle Load (ESALs)
=Tf * T * G * D * L * 365 * Y

Tf = Truck Factor
T = Percent Trucks
G = Annual Traffic Growth Rate
D = Directional Distribution Factor
L = Lane Distribution Factor
Y = Design Period in Years

Design ESALS

5 Years	**=**	**168,000**
10 Years	**=**	**354,000**
15 Years	**=**	**559,000**
20 Years	**=**	**785,000**



Note 1: Assumed

Note 2: Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, March 2009 Table D-3

Note 3: Assumed

Prepared: Mohammed Kamala

Road Name: **Millway Avenue, Vaughan, ON**

Project Name City of Vaughan

Date: April 28, 2025

Traffic Inputs

Provided AADT:	4000
Traffic Count Year	2024
AADT(Design Year)	4000
Commercial Traffic (%) (Note 1):	5
Average Truck Factor (Note 2):	1.31
Directional Distribution	0.5
Annual Traffic Growth Rate (%) (Note 3):	2
Lane Distribution"	0.9
Design Year	2024

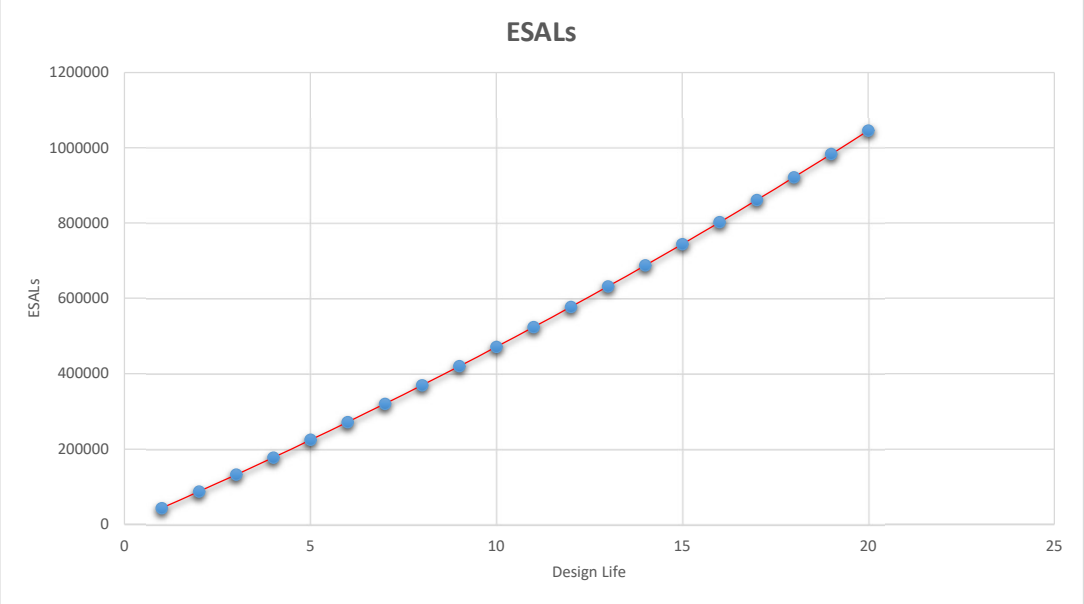
AADT (Design Year) = Current AADT x (1 + A/100)^(IY-MY)
A= Annual Traffic Growth Rate
IY = Year open to Traffic
MY = Year in which Current AADT is provided

Equivalent Single Axle Load (ESALs)
=Tf * T * G * D * L * 365 * Y

Tf = Truck Factor
T = Percent Trucks
G = Annual Traffic Growth Rate
D = Directional Distribution Factor
L = Lane Distribution Factor
Y = Design Period in Years

Design ESALS

5 Years	**=**	**224,000**
10 Years	**=**	**472,000**
15 Years	**=**	**745,000**
20 Years	**=**	**1,046,000**



Note 1: Assumed

Note 2: Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions, March 2009 Table D-3

Note 3: Assumed

Prepared: Mohammed Kamala

Appendix E
Design Outputs Sheets

Table E-1
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Rehabilitation of Interchange Way (70 m west of Mable Smith to Jane Street)
10-Year Design Life

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	354,000
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	20,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	102

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	140	140	59
2	New Granular B,Type I	0.09	0.90	550	550	45
Total	-	-	-	690	690	104

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	97	41
2	New Granular B,Type I	0.09	0.90	-	-	250,000	756	61
Total	-	-	-	-	-	-	853	102

-

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

New Construction of Interchange Way from 70 m west of Mable Smith to Jane Street
20-Year Design Life

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	785,000
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	20,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	114

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	150	150	63
2	New Granular A Base	0.14	1.00	150	150	21
3	New Granular B,Type I	0.09	1.00	350	350	32
Total	-	-	-	650	650	116

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	111	47
2	New Granular A Base	0.14	1.00	-	-	250,000	0	0
3	New Granular B,Type I	0.09	1.00	-	-	250,000	749	67
Total	-	-	-	-	-	-	860	114

-

Table E-3
PAVEMENT DESIGN AND ANALYSIS - FLEXIBLE STRUCTURAL DESIGN MODULE

Proposed New Construction of Millway Avenue
20-Year Design Life

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	1,046,000
Initial Serviceability	4.4
Terminal Serviceability	2.2
Reliability Level (%)	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	20,000 kPa
Stage Construction	1.0
Calculated Design Structural Number	118

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	150	150	63
2	New Granular A Base	0.14	1.00	150	150	21
3	New Granular B,Type I	0.09	1.00	400	400	36
Total	-	-	-	700	700	120

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	116	49
2	New Granular A Base	0.14	1.00	-	-	250,000	0	0
3	New Granular B,Type I	0.09	1.00	-	-	250,000	774	70
Total	-	-	-	-	-	-	891	119

-