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Project name:
AMZL DYT3 Ottawa

Project ref:
60634622

From:
Jack Yu Guo, and Taesang Ahn

Date:
September 27, 2022

Technical Memorandum

Subject: 60634622 Supplementary Geotechnical Investigation at DYT3 Ottawa, Ontario

The DYT3 site (the site) is located at 2625 Sheffield Road in Ottawa, Ontario. A supplementary geotechnical field investigation program was carried out at the site between March 14 and March 15, 2022, under the full-time supervision of AECOM staff. A total of four (4) boreholes, two (2) sampled boreholes and two (2) Dynamic Core Penetration Tests (DCPTs), were advanced near the existing structure, and the borehole locations and logs are provided in **Appendix A**. The laboratory test results are provided in **Appendix B**.

Subsurface Conditions at the Borehole Locations

A granular fill layer was encountered in Boreholes BH-S1/MW and BH-S2/MW beneath the asphalt. The thickness of granular fill ranged from 76 to 180 mm. This granular fill extended to 66.92 to 66.72 metres above sea level (mASL).

A layer of sand fill underlain by a layer of granular fill was encountered in Boreholes BH-S1/MW and BH-S2/MW. The thickness of sand fill ranged from 1.2 to 1.3 m. The sand fill was encountered at the elevations ranged from 66.2 to 66.72 mASL and extended to 65.5 mASL. Standard Penetration Testing (SPT) N blow counts ranged from 10 to over 50 blows per 0.3 m of penetration, indicating a compact to very dense soil.

The native silty clay to clayey silt underlain by the layers of fill was encountered in Boreholes BH-S1/MW and BH-S2/MW. The silty clay was encountered at elevation 62.5 mASL and extended to 58.0 to 56.3 mASL. Standard Penetration Testing (SPT) N values ranged from Weight Hammer (WH) to 10 blows per 0.3 m of penetration, indicating a very soft to stiff cohesive soil. The sand seams were present within the clay layer at about 62.3mASL. According to the field vane tests at 7mbgs, the undisturbed and remolded shear strength was 34.1 kPa and 8.5kP, respectively. The sensitivity ratio was about 4. This clay was medium to very sensitive and significant settlement would be expected under loading conditions. The natural water content for the very soft clay (w=about 53.5%) was higher than the liquid limit (LL=40%), indicating a highly flocculent quick clay, i.e., the clay would liquefy when it is remolded.

The native silty clay till was underlain by a layer of native silty clay in Borehole BH-S1/MW. The silty clay till was encountered at the elevation of 58.0 mASL and it extended to 56.0 mASL. Standard Penetration Testing (SPT) N values were over 50 blows per 0.3 m of penetration, indicating a hard cohesive soil.

Bedrock was encountered in Borehole BH-S2/MW below the native silty clay materials and also in DCPT-1 and DCPT-2. The bedrock surface was encountered at elevations ranging from 57.3 to 56.3 mASL. Bedrock coring was carried out in BH-S2/MW. The bedrock is comprised of Carlsbad formation shale, which is highly weathered and in dark grey in colour with horizontal bedding. The vertical and inclined open joints were infilled with clay as were observed in the core samples. The top 2m of the shale bedrock was highly weathered with an RQD of 0% and a fracture index of about 10.

The groundwater level was observed at a depth of 4.27 mbgs at the time of drilling in the open hole. Monitoring wells were installed in Boreholes BH-S1/MW and BH-S2/MW to allow for long-term groundwater monitoring at these two locations.

Foundation Options and Recommendations

According to the historical foundation design of the building, shallow foundations have been used to support the old building. Therefore, it is feasible to use the spread footings and strip footings as the foundation design option.

Shallow Foundations

Typically, shallow foundations are not suitable for heavily to moderately loaded structures based on the compressible soils encountered at the site. Loading of the sensitive clay would cause significant post-construction settlement. Since the existing building is supported by shallow foundations, the soil under the existing building footprint has been consolidated. But additional loading due to an increase in building structural load will still generate some settlement. It is recommended to increase the design settlement criteria to 50mm in the Ottawa region where substantial soft soils are existing. The bearing capacities are evaluated with the detailed foundation location plan.

Based on the above considerations, the recommended option from a geotechnical/foundations perspective is to support the proposed building on spread and strip footings with a foundation depth of 1.5mbgs.

Foundation Design Capacities

Shallow foundations

The bearing capacity at the ultimate limit state (ULS) is estimated based on the two-layer method proposed by Meyerhof and Hanna (1978) and Meyerhof (1974). The bearing capacity at the service limit state (SLS) is estimated via numerical software Settle 3 by Rocscience inc. The footings should be placed at a minimum of 1.5 m below the ground surface.

The soil layers considered in the analysis were divided into five(5) sublayers, as seen in **Table 1**. The consolidation test results are shown in **Appendix B**. The settlement analysis via Settle 3D is shown in **Appendix C**.

Table 1 Soil layers for bearing capacity analysis

Soil Layer	Thickness (m)	Compactness/Consistency	Unit Weight (kN/m ³)	S _u (kPa)	Φ (°)	E (MPa)	Consolidation Settlement Parameter					
							C _c	C _r	OC R	P _c (kPa)	e ₀	C _v (cm ² /s)
Fill	1.5	Dense to very dense	21	-	-	52.5	-	-	-	-	-	-
Top silty clay with sand	1.5	Stiff to firm	20	-	-	40.0	-	-	-	-	-	-
Silty Clay	3	Very soft	20	35*	-	-	0.33 9	0.03 3	1	-	1.4	7.45E-4
Silty Clay Bottom	1	Firm to Stiff	20	-	-	-	0.33 9	0.03 3	-	110	0.55	7.45E-4
Silty Clay/Clayey Silt Till	2	Very stiff to hard	20	-	-	40.0	-	-	-	-	-	-
Engineered Fill	-	100% SPMDD	21	-	36	62.5	-	-	-	-	-	-
*Weighted average value												

Based on the subsurface soil conditions described in Table 1, the bearing capacity in terms of the ULS and SLS estimated for the different size of spread footing is shown in Table 2. It should be noted that the footing is generally ULS controlled because the founding soil layer is stiff to firm silty clay underlain by the very soft silty clay. The ULS could be increased by subexcavating the clay and replaced with compacted engineered fill.

Table 2 ULS and SLS for Shallow Foundation Option

Footing size	Factored Geotechnical Resistance at ULS (kPa)	Geotechnical Reaction at SLS* (kPa)
Strip footing 1.5m wide	110	90
2m x 2m	130	200
3m x 3m	120	150
4m x 4m	110	100

Note: * The SLS is calculated based on the settlement of 50mm at 15-year design life.

Please note that a smaller capacity (ULS or SLS) should be used for the foundation design.

Subgrade modulus

The vertical modulus of subgrade reaction ($K_{0.3}$) on the engineered fill of 30 MPa/m to 50 MPa/m (for square plate 30 x 30 cm or 30 cm wide strip resting on pre-compressed layers) may be used for the design. It should be noted that reduction of $K_{0.3}$ due to shape and size of foundations (i.e., K_s) should be considered.

Table 3 Subgrade Reaction Modulus

Size of slab	K_s		
	Min. $K_{0.3}= 30$ Mpa/m	Max. $K_{0.3}= 50$ Mpa/m	Mean $K_{0.3}=40$ MPa/m
2m x 2m	10.0	16.5	13.2
3m x 3m	9.1	15.1	12.1
4m x 4m	8.7	13.4	11.6

Seismic Site Classification

Table 4 summarizes the site classification based on the soil properties in the top 20 m of the subsurface. Considering the undrained shear strength and SPT values of the very soft to stiff silty clay to clayey silt encountered, a seismic site classification of the building and proposed canopy area is **Site Class E**.

Table 4 Site Classification for Seismic Site Response (CFEM 2006)

Site Class	Ground Profile Name	Shear Wave Velocity \bar{V}_s (m/s)	Standard Penetration Resistance \bar{N}_{60}	Soil Undrained Shear Strength s_u (kPa)
A	Hard Rock	$\bar{V}_s > 1500$	Not Applicable	Not Applicable
B	Rock	$760 < \bar{V}_s \leq 1500$	Not Applicable	Not Applicable
C	Very Dense Soil and Soft Rock	$360 < \bar{V}_s \leq 760$	$\bar{N}_{60} > 50$	$s_u > 100$
D	Stiff Soil	$180 < \bar{V}_s \leq 360$	$15 \leq \bar{N}_{60} \leq 50$	$50 < s_u \leq 100$
E	Soft Soil	$\bar{V}_s \leq 180$	$\bar{N}_{60} < 15$	$s_u < 50$
		Any profile with more than 3m of soil with the following characteristics: <ul style="list-style-type: none"> • Plasticity Index $PI > 20$; • Moisture Content $w \geq 40\%$; and • Undrained Shear Strength $s_u < 25$ kPa 		
F	Other Soil	Site Specific Evaluation Required		

Spectral accelerations and PGA values given in **Table 5** should be adjusted using Tables 4.2 to 4.9 in CHBDC S6-14. The design PGA and $S_a(T)$, should be selected based on project-specific requirements as described in the minimum performance level in CHBDC S6-14. Seismic earth pressures acting on the structure may be estimated using Mononobe-Okabe or Wood methods depending on the rigidity or tolerable movement of the structures.

Table 5 Spectral Acceleration $S_a(T)$ and PGA (CHBDC S6-14)

2%/50 years (0.000404 per annum) probability				
Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.465	0.248	0.122	0.058	0.297 g
5%/50 years (0.001 per annum)				
Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.269	0.144	0.072	0.033	0.172 g
10%/50 years (0.001 per annum)				
Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.169	0.091	0.045	0.021	0.107 g
40%/50 years (0.001 per annum)				
Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.057	0.032	0.015	0.006	0.034 g

Liquefaction Consideration

To delineate liquefaction susceptibility, this memo has adopted the empirical criteria recommended in the Canadian Foundation Engineering Manual:

- $w/w_L \geq 0.85$ and $I_p \leq 12$: Susceptible to liquefaction or cyclic mobility;
- $w/w_L \geq 0.80$ and $10 \leq I_p \leq 12$: Moderately susceptible to liquefaction;
- $w/w_L < 0.85$ and $I_p \geq 12$: No liquefaction or cyclic mobility.

Where w is the in-situ soil water content, w_L is the liquid limit of the soil and I_p is the plasticity index of the soil.

The clay present on site is susceptible to liquefaction as the natural water content is higher than its liquid limit.

Minimum Insulation Calculation

A design methodology for insulated foundations has been presented by Robinsky and Besspflug (1973). Summaries of their design charts for heated and unheated structures are shown in Figure 1 and Figure 2, respectively (CFEM, 2006).

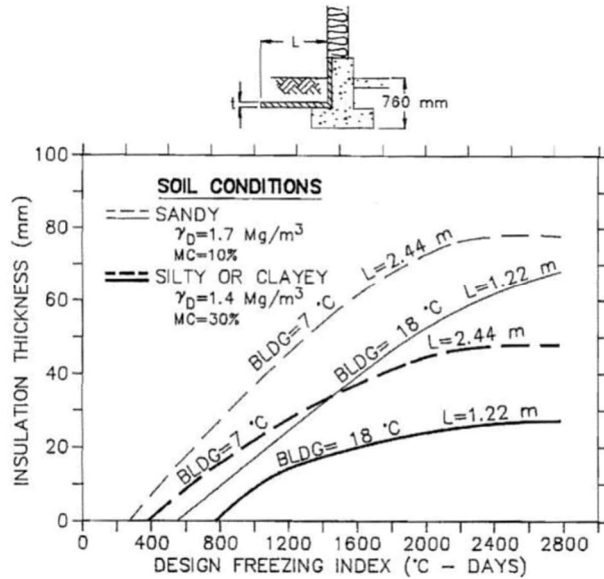


Figure 1 Design curves for minimum insulation requirements for heated structures (adapted from Robinsky and Bespflug, 1973)

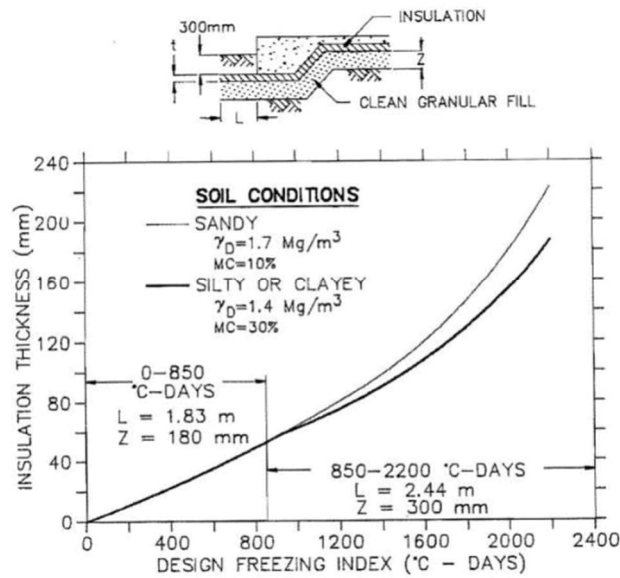


Figure 2 Design curves for minimum insulation requirements for unheated structures (adapted from Robinsky and Bespflug, 1973)

Design freezing Index of Ottawa is around 2350°C. As the footings will be founded on granular materials and all the backfill materials are granular materials, the sandy soil conditions are adopted while using the figures. When the building temperature of 18°C is to be maintained, Insulation should be placed with minimum soil covers of 300 mm and extend at least 1.22 m from the edge of the building. For the heated structures, the minimum installation thickness is about 60 mm according to **Figure 1**.

Closure

We trust that this meets your expectations. If you have any questions or need clarification, please do not hesitate to contact the undersigned.

AECOM Canada Ltd.



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Encl.



Appendix A Borehole Location and Borehole Logs



LEGEND

- Geotechnical Borehole - 20 m Depth
- DCPT - 20 m Depth
- Geotechnical Borehole - AECOM, 2020 Investigation

NOTES:

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REFERENCE DRAWINGS				
NO.	DATE	DESCRIPTION		
REVISIONS				
0	2022.03.03	BH Plan	JH	TA
REV.	DATE	DESCRIPTION	BY	CHK

CLIENT NAME: AMAZON LOGISTICS	PROJECT LOCATION: 2625 Sheffield Rd, Ottawa ON PROJECT NUMBER: 60634622
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PROPOSED BOREHOLE LOCATION PLAN

DRAWN BY: JH	SCALE: 1:1500	DRAWING No. 1
CHECKED: TA	DATE: MAR 2022	REVISION 0

TERMINOLOGY USED IN BOREHOLE LOGS

Topsoil: Mixture of soil and humus capable of supporting good vegetative growth.

Peat: A mass of organic matter usually fibrous in texture in various stages of decomposition, generally dark brown to black in colour and of spongy consistency.

Fill: The term fill has been used to describe materials which have been placed by non-natural processes. Fills can often be heterogeneous in nature and those relying on this report should expect them to contain deleterious materials. Such materials can include wood, bricks, slag, porcelain, organics, and obstructions such as scrap metal, storage tanks, and abandoned concrete/steel structures.

Due to the uncertainty of the placement method of the material, the boring samples obtained for this report are not expected to represent other materials at any horizontal or vertical distance from where the sample was obtained.

Fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill site. Unless specifically stated, the fill on this site has not been tested for contaminants that can be considered toxic or hazardous. Testing to determine the toxicity of fill materials can be conducted, if requested.

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

Terminology describing soil structure

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

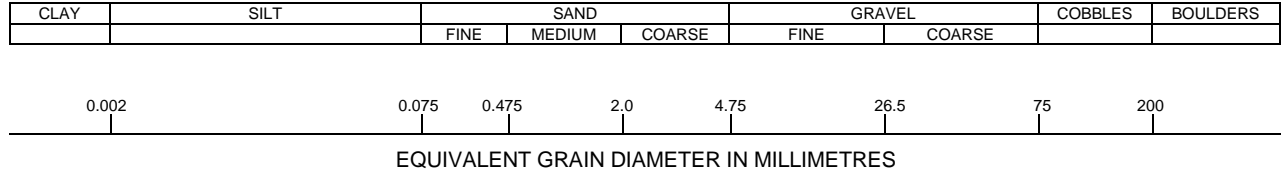
Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

Residual: completed weathered sedimentary rock mixed with native soils.

All soil sample descriptions included in this report generally follow the Canadian Foundations Engineering Manual and the Unified Soil Classification System. These systems follow the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by AECOM follow the same system. Note that, with exception of those samples where a grain size distribution analysis has been completed, all samples have been classified by visual inspection. Visual inspection classification is not sufficient to provide exact grain sizing.

ISSMFE / USCS SOIL CLASSIFICATION



The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by in-situ vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis. Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils.

The standard terminology to describe cohesionless soils includes the compactness condition as determined by the Standard Penetration Test 'N' value.

Cohesionless Soils		Cohesive Soils			Composition	
Compactness Condition	SPT N-Index (blows per 0.3 m)	Consistency	Undrained Shear Strength (kPa)	SPT N-Index (blows per 0.3 m)	Term	Criteria
Very loose	0 – 4	Very soft	< 12	< 2	Trace	1% - 10%
Loose	4 – 10	Soft	12 - 25	2 – 4	Some	10% - 20%
Compact	10 – 30	Firm	25 – 50	4 – 8	Adjective	20% - 35%
Dense	30 – 50	Stiff	50 – 100	8 – 15	And	> 35%
Very Dense	> 50	Very Stiff	100 - 200	15 – 30	Noun	> 35% & largest fraction
		Hard	> 200	> 30		

Standard Penetration Test (SPT):

The number of blows required to drive a 50 mm (2 in.) open split spoon sampler from a depth of 150 mm (6 in.) to 450 mm (18 in.) in undisturbed soil. Each blow is driven by a 63.6 kg (140 lb.) hammer free falling a distance of 0.76 m (30 in.).

Sample & Soil Abbreviations	Contaminant Abbreviations	Strata/Graphic Plot
CORE Rock core sample	BNAE base/neutral/acid extractables	
AS Auger sample	BTEX benzene, toluene, ethylbenzene, xylenes	
FV Field vane	OCP organochlorine pesticides	
PP Pocket penetrometer	MI metals & inorganics	
SG Specific Gravity	PAH polycyclic aromatic hydrocarbons	
GS Grab sample	PCB polychlorinated biphenyls	
SS Split spoon sample	PHC CCME petroleum hydrocarbons (fractions 1 – 4)	
DCPT Dynamic cone penetration test	VOC volatile organic compounds (includes BTEX)	
GR Gravel	Plasticity Description	
SA Sand	Low $w_l < 30$	
SI Silt	Medium $30 < w_l < 50$	
CL Clay	High $50 < w_l$	

Explanatory Sheet To Rock Core Log

Column No.	Description
1.	Elevation and Depth of Geotechnical Boundary in Borehole
2.	Drilling Method Used
3.	General Description of Geotechnical Unit: Quantitative description including rock type (s), percentage of rock types, frequency and sizes of interbeds, colour, texture, weathering, strength and general joint spacing
	Hardness
	H1 Extremely Hard Cannot be scratched with a pocket knife or sharp pick. Can only be chipped with repeated heavy hammer blows
	H2 Very Hard Cannot be scratched with a pocket knife or sharp pick. Breaks with repeated heavy hammer blows
	H3 Hard Can be scratched with a pocket knife or sharp pick with difficulty (heavy pressure) Breaks with heavy hammer blows
	H4 Moderately Hard Can be scratched with a pocket knife or sharp pick with light or moderate pressure. Breaks with moderate hammer blows
	H5 Moderately Soft Can be grooved 1.6 mm (1/16 in) with a pocket knife or sharp pick
	H6 Soft Can be grooved or gouged easily with a pocket knife or sharp pick with slight pressure, can be scratch with a finger nail. Breaks with light or moderate manual pressure
	H7 Very Soft Can readily be indented, grooved or gouged with a finger nail, or Carved with pocket knife. Breaks with light manual pressure
	Strength (from ISRM) Approx UCS
	Svh Very High Strength >200 MPa
	Sh High Strength 50 to 200 MPa
	Sm Medium Strength 15 to 50 MPa
	Sl Low Strength 4 to 15 MPa
	Svl Very Low Strength 1 to 4 MPa
4.	Geological Symbol for Rock or Soil Material
5.	Elevation of Geotechnical Boundary
6.	Run Number: Drill run number
7.	Penetration Rate: meters per min
8.	Colour & Return Percentage:
9.	Core Recovery: Core recovery is the total length of core pieces, irrespective of their individual lengths, obtained in a core run and expressed as a percentage of the length of that core run.
10.	Rock Quality Designation (RQD): The total length of those pieces of sound core which are 10 cm (4 inches) or greater in length in a core run expressed as a percentage of the total length of that core run. Sound pieces of rock are those pieces separated by natural breaks and not machine breaks or subsequent artificial breaks.
	0 - 25 percent Very Poor Quality
	25 - 40 percent Poor Quality
	40 - 75 percent Fair Quality
	75 - 90 percent Good Quality
	90 - 100 percent Very Good Quality
11.	Fracturing:
	Fu Unfractured No Fractures
	Fvs Very Slightly Fractured Core length greater than 0.9 m (3 ft)
	Fsl Slightly Fractured Core length from 0.3 to 0.9 m (1 to 3 ft)
	Fm Moderately Fractured Core length from 0.1 to 0.3 m (4 in. to 1 ft)
	Fi Intensely Fractured Core lengths from 0.25 to 0.1 m (1 in. to 4 in.)
	Fvi Very Intensely Fractured Mostly chips and fragments
12.	Degreed of dip of discontinuity measured from the axis of rock core.

13.

Discontinuity Description

Fracture Width (FW)

FWt	Tight	No visible separation
FWs	Slightly Open	$FW < 0.8 \text{ mm (1/32 in.)}$
FWm	Moderately Open	$0.8 \text{ mm (1/32 in.)} \leq FW < 3.2 \text{ mm (1/8 in.)}$
FWo	Open	$3.2 \text{ mm (1/8 in.)} \leq FW < 9.7 \text{ mm (3/8 in.)}$
FWmw	Moderately Wide	$9.7 \text{ mm (3/8 in.)} \leq FW < 25.4 \text{ mm (1 in.)}$
FWw	Wide	$FW \geq 25.4 \text{ mm (1 in.)}$

Fracture Filling or Coating Thickness (FF)

FFc	Clean	No film coating
FFvt	Very Thin	$FF < 0.8 \text{ mm (1/32 in.)}$
FFm	Moderately Thin	$0.8 \text{ mm (1/32 in.)} \leq FF < 3.2 \text{ mm (1/8 in.)}$
FFt	Thin	$3.2 \text{ mm (1/8 in.)} \leq FF < 9.7 \text{ mm (3/8 in.)}$
FFmt	Moderately Thick	$9.7 \text{ mm (3/8 in.)} \leq FF < 25.4 \text{ mm (1 in.)}$
FFw	Thick	$FF \geq 25.4 \text{ mm (1 in.)}$

Roughness

Rst	Stepped	Near normal steps and ridges occur on the fracture surface
Rr	Rough	Large angular asperities can be seen
Rm	Moderately Rough	Asperities are cleanly visible and fracture surface feels abrasive
Rs	Slightly Rough	Small asperities on the fracture surface are visible and can be felt
Rsm	Smooth	No asperities, smooth to the touch

Bedding Spacing (Sb)

Bm	Massive	$\leq Sb > 3 \text{ m (10 ft)}$
Bvt	Very Thickly Bedded	$0.9 \text{ m (3 ft)} \leq Sb \leq 3 \text{ m (10 ft)}$
Bt	Thickly Bedded	$0.3 \text{ m (1 ft)} \leq Sb \leq 0.9 \text{ m (3 ft)}$
Bm	Moderately Bedded	$0.1 \text{ m (4 in.)} \leq Sb \leq 0.3 \text{ m (1 ft)}$
Bt	Thinly Bedded	$25 \text{ mm (1 in.)} \leq Sb \leq 0.1 \text{ m (4 in.)}$
Bvt	Very Thinly Bedded	$6 \text{ mm (1/4 in.)} \leq Sb \leq 25 \text{ mm (1 in.)}$
Bl	Laminated	$SB \leq 6 \text{ mm (1/4 in.)}$

Orientation

Of	Flat	$= 0 - 20^\circ$
Od	Dipping	$= 20 - 50^\circ$
Ov	Vertical	$= 50 - 90^\circ$

Surface Shape

Planar	Flat surface
Wavy	Undulating surface

Fracture Type:

B	Bedding
J	Fault
C	Joint
F	Foliation
S	Shear Plane
M	Mechanical Breaks

14.

Hydraulic Conductivity (cm/sec)

15.

Point Load Index:

Extremely Strong	> 10
Very Strong	4 - 10
Strong	2 - 4
Medium Strong	1 - 2

PROJECT: DYT3 - Ottawa
 LOCATION: 2625 Sheffield Rd
 COORDINATES: N 5028171.5; E 452674.6
 DATUM: Geodetic
 AECOM PROJECT #: 60634622
 CLIENT: Amazon Logistics

RECORD OF BOREHOLE: BH-S1/MW

SHEET 1 OF 2

START DATE: Mar 14, 2022
 END DATE: Mar 15, 2022
 BORING METHOD: 200 mm O.D. Hollow Stem Auger
 CONTRACTOR: Canadian Environmental Drilling
 PENETRATION TEST HAMMER, 64kg; DROP, 760mm
 SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE		SAMPLES			Dynamic Cone Penetration Testing (blows/0.3m)				SHEAR STRENGTH Cu, kPa				ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	N VALUE	20	40	60	80	20	40	60			80	
0	Power Auger Drilling 200 mm O.D. Hollow Stem Auger	PAVEMENT		67.00														
		ASPHALT: 100 mm thick		0.00														
		FILL: sand and gravel, 76 mm thick, some rock pieces, brown, moist, very dense		0.10	1	SS	50/150mm											
		FILL: sand, occasional cobbles, trace gravel, brown, moist, very dense		0.20														
1					2	SS	50/150mm										18	57 (25)
2		SILTY CLAY: trace gravel, some sand, brown to grey, moist to wet, stiff to firm	65.50	3	SS	8												
		firm	1.50	4	SS	5									2	39 59		
3				5	SS	4												
4																		
5		Sand Seam		1	TW													
				1	TW													
6				6	SS	5												
7				7	SS	5									7	46 33 14		
8																		
9		SILTY CLAY TILL: trace gravel, some sand, grey, wet, hard	58.00	8	SS	50/76mm												
			9.00															
10																		

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE

1 : 50



LOGGED: BK

CHECKED: TA

AECOM_BH_001_60634622 - DYT3 OTTAWA 2022_04_12.GPJ GAL-MISS.GDT 22-10-11

2022.03.15

PROJECT: DYT3 - Ottawa
 LOCATION: 2625 Sheffield Rd
 COORDINATES: N 5028171.5; E 452674.6
 DATUM: Geodetic
 AECOM PROJECT #: 60634622
 CLIENT: Amazon Logistics

RECORD OF BOREHOLE: BH-S1/MW

SHEET 2 OF 2

START DATE: Mar 14, 2022
 END DATE: Mar 15, 2022
 BORING METHOD: 200 mm O.D. Hollow Stem Auger
 CONTRACTOR: Canadian Environmental Drilling
 PENETRATION TEST HAMMER, 64kg; DROP, 760mm
 SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE		SAMPLES			Dynamic Cone Penetration Testing (blows/0.3m)				SHEAR STRENGTH Cu, kPa				ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	N VALUE	20	40	60	80	20	40	60		
		CONTINUED FROM PREVIOUS PAGE														
10	Power Auger Drilling	SILTY CLAY TILL: trace gravel, some sand, grey, wet, hard														
11		AUGER REFUSAL END OF BOREHOLE Notes: 1. This log is to be read with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. No abnormal odour or staining was observed unless otherwise indicated. 4. The groundwater was observed at the depth of 4.27 mbgs in the open hole. 5. The monitoring well was installed upon the completion of drilling.		56.03 10.97	9	SS	50/76mm									
12																
13																
14																
15																
16																
17																
18																
19																
20																

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE

1 : 50



LOGGED: BK

CHECKED: TA

AECOM_BH_001_60634622 - DYT3 OITAWA 2022_04_12.GPJ GAL-MISS.GDT 22-10-11

PROJECT: DYT3 - Ottawa
 LOCATION: 2625 Sheffield Rd
 COORDINATES: N 5027916.8; E 452712.8
 DATUM: Geodetic
 AECOM PROJECT #: 60634622
 CLIENT: Amazon Logistics

RECORD OF BOREHOLE: BH-S2/MW

SHEET 1 OF 3

START DATE: Mar 15, 2022
 END DATE: Mar 15, 2022
 BORING METHOD: 200 mm O.D. Hollow Stem Auger
 CONTRACTOR: Canadian Environmental Drilling
 PENETRATION TEST HAMMER, 64kg; DROP, 760mm
 SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE		SAMPLES			Dynamic Cone Penetration Testing (blows/0.3m)				SHEAR STRENGTH Cu, kPa				ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	N VALUE	20	40	60	80	20	40	60			80	
0	Power Auger Drilling 200 mm O.D. Hollow Stem Auger	PAVEMENT		67.00														
		ASPHALT: 100 mm thick		0.00														
		FILL: sand and gravel, 180 mm thick, some rock pieces, brown, moist, compact		0.10	1	SS	11											
		FILL: sand, trace gravel, brown, moist, compact		0.28														
1						2	SS	10										11 63 (26)
					65.50													
		SILTY CLAY: trace gravel, some sand, brown to grey, moist to wet, very soft to stiff		1.50	3	SS	5											
2																		
						4	SS	3										
3																		
					5	SS	WH										52.86 1 9 44 46	
4																		
					6	SS	WH										59.34	
5																		
					1	TW											0 1 56 43	
6																		
7																		
8					7	SS	10											
9																		
10					2	TW												

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE

1 : 50



LOGGED: BK

CHECKED: TA

AECOM_BH_001_60634622 - DYT3 OTTAWA 2022_04_12.GPJ GAL-MISS.GDT 22-10-11

PROJECT: DYT3 - Ottawa
 LOCATION: 2625 Sheffield Rd
 COORDINATES: N 5027916.8; E 452712.8
 DATUM: Geodetic
 AECOM PROJECT #: 60634622
 CLIENT: Amazon Logistics

RECORD OF BOREHOLE: BH-S2/MW

SHEET 2 OF 3

START DATE: Mar 15, 2022
 END DATE: Mar 15, 2022
 BORING METHOD: 200 mm O.D. Hollow Stem Auger
 CONTRACTOR: Canadian Environmental Drilling
 PENETRATION TEST HAMMER, 64kg; DROP, 760mm
 SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE		SAMPLES			Dynamic Cone Penetration Testing (blows/0.3m)				SHEAR STRENGTH Cu, kPa				ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	N VALUE	20 40 60 80				20 40 60 80					
								100 200 300 400				10 20 30 40					
10		CONTINUED FROM PREVIOUS PAGE													GR SA SI CL		
		SILTY CLAY: trace gravel, some sand, brown to grey, moist to wet, very soft to stiff															
11	Coring Coring	SHALE BEDROCK: Refer to RECORD OF DRILLHOLE: BH-S2/MW Highly weathered, grey, horizontal bedding, vertical and inclined open joints, clay infilling RUN 1 10.67-10.98 TCR=100%, SCR=42%, RQD=0%, FI=9 RUN 2 10.98-12.50 TCR=93%, SCR=27%, RQD=0%, FI=10 RUN 3 12.50-12.80 TCR=100%, SCR=13%, RQD=0%, FI=9		56.33 10.67													
12																	
13		END OF BOREHOLE Notes: 1. This log is to be read with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. No abnormal odour or staining was observed unless otherwise indicated. 4. The groundwater was observed at the depth of 4.27 mbgs in the open hole. 5. The monitoring well was installed upon the completion of drilling.		54.20 12.80													
14																	
15																	
16																	
17																	
18																	
19																	
20																	

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE

1 : 50



LOGGED: BK

CHECKED: TA

AECOM_BH_001_60634622 - DYT3 OTTAWA 2022_04_12.GPJ GAL-MISS.GDT 22-10-11

PROJECT: DYT3 - Ottawa
 LOCATION: 2625 Sheffield Rd
 COORDINATES: N 5027916.8; E 452712.8
 DATUM: Geodetic
 AECOM PROJECT #: 60634622
 CLIENT: Amazon Logistics

RECORD OF DRILLHOLE: BH-S2/MW

SHEET 3 OF 3

START DATE: Mar 15, 2022
 END DATE: Mar 15, 2022
 DRILLING METHOD:

CONTRACTOR: Canadian Environmental Drilling INCLINATION: -90° AZIMUTH: --

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR	% RETURN	FR/FX-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	BC-BROKEN CORE	WELL INSTALLATION AND WATER LEVELS
										CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK	
										SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY	B-BEDDING	
										VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED		
RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY			DIAMETRAL POINT LOAD INDEX (MPa)						
TOTAL CORE %	SOLID CORE %		DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	10 ⁻⁶ K _v cm ² /sec	10 ⁻⁴	10 ⁻²								
11		ASPHALT		56.33											
		Highly weathered, grey, horizontal bedding, open joints, clay infilling SHALE		10.67	1										36.2
		45° inclined joints and vertical joints		56.02											
				10.98											10.3
12					2										
				54.50											
				12.50											
				54.20											
13		END OF BOREHOLE		12.80	3										
		Notes: 1. This log is to be read with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. No abnormal odour or staining was observed unless otherwise indicated. 4. The groundwater was observed at the depth of 4.27 mbgs in the open hole. 5. The monitoring well was installed upon the completion of drilling.													
14															
15															
16															
17															
18															
19															
20															

AECOM_RCK_001_60634622 - DYT3 OTTAWA 2022_04_12.GPJ GAL-MISS.GDT 22-10-11

DEPTH SCALE

1 : 50



LOGGED: BK

CHECKED: TA

PROJECT: DYT3 - Ottawa
 LOCATION: 2625 Sheffield Rd
 COORDINATES: N 5028091.4; E 452590.1
 DATUM: Geodetic
 AECOM PROJECT #: 60634622
 CLIENT: Amazon Logistics

RECORD OF BOREHOLE: DCPT-1

SHEET 1 OF 1

START DATE: Mar 14, 2022
 END DATE: Mar 14, 2022
 BORING METHOD: 50.8 mm diameter CPT
 CONTRACTOR: Canadian Environmental Drilling
 PENETRATION TEST HAMMER, 64kg; DROP, 760mm
 SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE		SAMPLES			Dynamic Cone Penetration Testing (blows/0.3m)		SHEAR STRENGTH Cu, kPa		ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	N VALUE	20	40	60			80
		PAVEMENT		67.00									
		ASPHALT: 50 mm thick											
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
10				9.75									
11													
12													
13													
14													
15													

END OF BOREHOLE
 Notes:
 1. This log is to be read with the subject report and project number as presented above.
 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project.
 3. No abnormal odour or staining was observed unless otherwise indicated.
 4. The groundwater was observed at the depth of 4.27 mbgs in the open hole.

AECOM_BH_001_60634622 - DYT3 OTTAWA 2022_04_12.GPJ GAL-MISS.GDT 22-10-11

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE

1 : 75



LOGGED: BK

CHECKED: TA

▽
2022.03.14

PROJECT: DYT3 - Ottawa
 LOCATION: 2625 Sheffield Rd
 COORDINATES: N 5028025.2; E 452766.4
 DATUM: Geodetic
 AECOM PROJECT #: 60634622
 CLIENT: Amazon Logistics

RECORD OF BOREHOLE: DCPT-2

SHEET 1 OF 1

START DATE: Mar 14, 2022
 END DATE: Mar 14, 2022
 BORING METHOD: 50.8 mm diameter CPT
 CONTRACTOR: Canadian Environmental Drilling

PENETRATION TEST HAMMER, 64kg; DROP, 760mm
 SAMPLER HAMMER, 64kg; DROP, 760mm

DEPTH SCALE (METRES)	BORING METHOD	SOIL PROFILE		SAMPLES			Dynamic Cone Penetration Testing (blows/0.3m)		SHEAR STRENGTH Cu, kPa		ADDITIONAL LAB. TESTING & GRAIN SIZE DISTRIBUTION (%)	WELL INSTALLATION AND WATER LEVELS	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	N VALUE	20	40	60			80
0		PAVEMENT		67.50									
		ASPHALT: 40 mm thick											
1	Dynamic Cone Penetration Testing 50.8 mm diameter CPT												
2													
3													
4													
5													
6													
7													
8													
9													
10													
11		END OF BOREHOLE		10.67									
12		Notes: 1. This log is to be read with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. No abnormal odour or staining was observed unless otherwise indicated. 4. The groundwater was observed at the depth of 4.57 mbgs in the open hole.											
13													
14													
15													

2022.03.14

AECOM_BH_001_60634622 - DYT3 OTTAWA 2022_04_12.GPJ GAL-MISS.GDT 22-10-11

(LOG TO BE READ IN CONJUNCTION WITH REPORT)

DEPTH SCALE

1 : 75



LOGGED: BK

CHECKED: TA

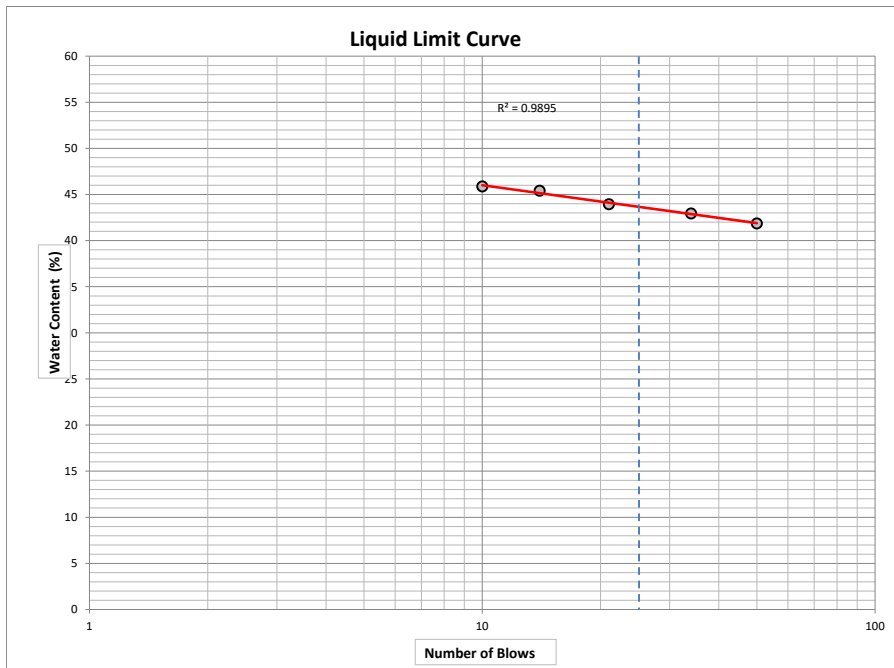
Appendix B Laboratory Results

MOISTURE CONTENT DETERMINATION

CLIENT				AECOM			DATE		March 28, 2022	
PROJECT NUMBER				60634622			TESTED BY		SAM/DHARMIK	
PROJECT NAME				DYT3			REVIEWED BY		Ramana M	
LOCATION				2625 Sheffield Rd, Ottawa, ON						
Borehole Name	Sample Id	Depth (feet)	Can Id	Observations			Formula			
				Weight of Empty Can (g) W ₁	Weight of Wet Soil + Can (g) W ₂	Weight of Dry Soil + Can (g) W ₃	Weight of Water (g) W _w = (W ₂ -W ₃)	Weight of Dry soil (g) W _s = (W ₃ -W ₁)	Moisture Content (%) w = (W _w /W _s)*100	
S1MW	SS1		114	13.40	71.64	66.49	5.15	53.09	9.70	
	SS2		174	13.66	83.21	78.18	5.03	64.52	7.80	
	SS3		87	13.68	64.32	52.02	12.30	38.34	32.08	
	SS4		148	13.47	58.60	46.23	12.37	32.76	37.76	
	SS6		111	13.58	83.02	64.70	18.32	51.12	35.84	
	SS7		105	13.85	95.34	87.63	7.71	73.78	10.45	
	SS8		63	13.49	81.09	74.80	6.29	61.31	10.26	
	SS9		132	13.72	69.74	62.13	7.61	48.41	15.72	
	S2MW	SS1		82	13.47	72.24	70.18	2.06	56.71	3.63
SS2			161	13.48	86.74	75.35	11.39	61.87	18.41	
SS3			173	13.45	82.40	69.36	13.04	55.91	23.32	
SS4			165	13.71	64.42	47.84	16.58	34.13	48.58	
SS5			134	13.69	74.97	53.78	21.19	40.09	52.86	
SS6			181	13.60	91.34	62.39	28.95	48.79	59.34	
SS8			144	13.66	102.50	84.24	18.26	70.58	25.87	
S1MW		TW1-1(TOP)	78'	56	13.56	39.96	32.26	7.70	18.70	41.18
	TW1-2	78'	106	13.51	75.01	70.41	4.60	56.90	8.08	
S2MW	TW2(TOP)		116	13.74	111.35	95.93	15.42	82.19	18.76	
	SS9		168	13.62	94.40	86.68	7.72	73.06	10.57	

Total Samples 19

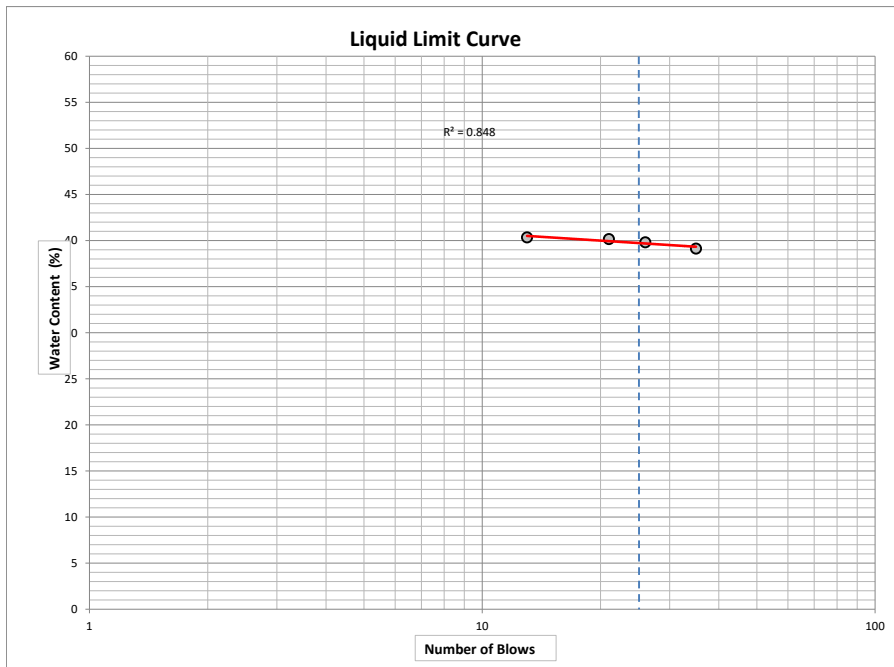
AECOM CANADA LTD.		AECOM					
DETERMINATION OF LIQUID LIMIT							
Client	AECOM	Project Number	60634662		Date	April 3, 2022	
Project Name	Sheffield Rd			Tested By	Ian P		
Location	Ottawa			Reviewed By	Ramana M		
Borehole Number	S1/MW	Sample Id	SS7	Depth (feet)	20-22	Lab Number	202204003S
Description	Formula	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Container Number		134	175	146	149	136	
Weight of Empty Container (g) W_1		13.69	13.68	13.77	13.64	13.83	
Weight of Container + Wet Soil (g) W_2		19.70	21.64	21.68	20.73	22.64	
Weight of Container + Dry Soil(g) W_3		17.81	19.21	19.21	18.60	20.04	
Weight of Water (g) W_w	$W_w = W_2 - W_3$	1.89	2.43	2.47	2.13	2.60	
Weight of Dry Soil (g) W_s	$W_s = W_3 - W_1$	4.12	5.53	5.44	4.96	6.21	
Water Content (%)	$w = (W_w / W_s) * 100$	45.87	43.94	45.40	42.94	41.87	
Number of Blows		10	21	14	34	50	
Liquid Limit (%) From Graph		43.7					



AECOM CANADA LTD. AECOM							
DETERMINATION OF PLASTIC LIMIT							
Client	AECOM	Project Number	60634662	Date	April 3, 2022		
Project Name	Sheffield Rd			Tested By	Ian P		
Location	Ottawa			Reviewed By	Ramana M		
Borehole Number	S1/MW	Sample Id	SS7	Depth (feet)	20-22	Lab Number	202204003S
Description	Formula	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Container Number		156	132	64			
Weight of Empty Container (g) W_1		13.41	13.70	13.48			
Weight of Container + Wet Soil (g) W_2		14.34	14.98	14.63			
Weight of Container + Dry Soil (g) W_3		14.14	14.70	14.38			
Weight of Water (g) W_w	$W_w = W_2 - W_3$	0.20	0.28	0.25			
Weight of Dry Soil (g) W_s	$W_s = W_3 - W_1$	0.73	1.00	0.90			
Plastic Limit (%)	$w = (W_w / W_s) * 100$	27.40	28.00	27.78			
Average Plastic Limit (%) w_p		27.73					

Result Summary	
Liquid Limit (%)	44
Plastic Limit (%)	28
Plasticity Index (%)	16
Sample status	Plastic

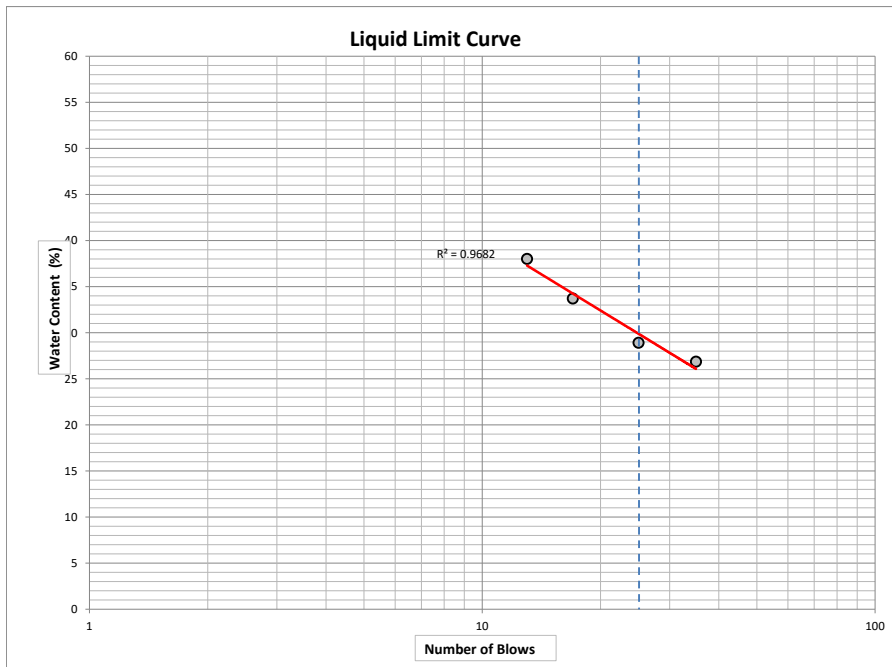
AECOM CANADA LTD.		AECOM					
DETERMINATION OF LIQUID LIMIT							
Client	AECOM	Project Number	60634662		Date	April 3, 2022	
Project Name	Sheffield Rd				Tested By		
Location	Ottawa				Reviewed By	Ramana M	
Borehole Number	S2/MW	Sample Id	SS5	Depth (feet)	10-12	Lab Number	202204005S
Description	Formula	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Container Number		283	229	33	223		
Weight of Empty Container (g) W_1		12.40	12.40	12.00	12.50		
Weight of Container + Wet Soil (g) W_2		20.40	22.00	22.50	22.90		
Weight of Container + Dry Soil(g) W_3		18.10	19.30	19.51	19.92		
Weight of Water (g) W_w	$W_w = W_2 - W_3$	2.30	2.70	2.99	2.98		
Weight of Dry Soil (g) W_s	$W_s = W_3 - W_1$	5.70	6.90	7.51	7.42		
Water Content (%)	$w = (W_w / W_s) * 100$	40.35	39.13	39.81	40.16		
Number of Blows		13	35	26	21		
Liquid Limit (%) From Graph		39.7					



AECOM CANADA LTD. AECOM							
DETERMINATION OF PLASTIC LIMIT							
Client	AECOM	Project Number	60634662	Date	April 3, 2022		
Project Name	Sheffield Rd			Tested By	0		
Location	Ottawa			Reviewed By	Ramana M		
Borehole Number	SZ/MW	Sample Id	SS5	Depth (feet)	10-12	Lab Number	202204005S
Description	Formula	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Container Number		196	255	22			
Weight of Empty Container (g) W_1		12.4	12.50	12.00			
Weight of Container + Wet Soil (g) W_2		19.6	19.30	20.30			
Weight of Container + Dry Soil(g) W_3		18.3	18.00	19.00			
Weight of Water (g) W_w	$W_w = W_2 - W_3$	1.30	1.30	1.30			
Weight of Dry Soil (g) W_s	$W_s = W_3 - W_1$	5.90	5.50	7.00			
Plastic Limit (%)	$w = (W_w / W_s) * 100$	22.03	23.64	18.57			
Average Plastic Limit (%) w_p		21.41					

Result Summary	
Liquid Limit (%)	40
Plastic Limit (%)	21
Plasticity Index (%)	19
Sample status	Plastic

AECOM CANADA LTD.		AECOM					
DETERMINATION OF LIQUID LIMIT							
Client	AECOM	Project Number	60634662	Date	April 3, 2022		
Project Name	Sheffield Rd			Tested By			
Location	Ottawa			Reviewed By	Ramana M		
Borehole Number	S2/MW	Sample Id	TW1/SS1	Depth (feet)	Lab Number	202204006S	
Description	Formula	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Container Number		284	278	40	251		
Weight of Empty Container (g) W_1		12.41	12.40	12.00	12.40		
Weight of Container + Wet Soil (g) W_2		22.80	23.10	23.90	23.80		
Weight of Container + Dry Soil(g) W_3		20.60	20.70	20.90	20.66		
Weight of Water (g) W_w	$W_w = W_2 - W_3$	2.20	2.40	3.00	3.14		
Weight of Dry Soil (g) W_s	$W_s = W_3 - W_1$	8.19	8.30	8.90	8.26		
Water Content (%)	$w = (W_w / W_s) * 100$	26.86	28.92	33.71	38.01		
Number of Blows		35	25	17	13		
Liquid Limit (%) From Graph		29.9					



AECOM CANADA LTD. AECOM							
DETERMINATION OF PLASTIC LIMIT							
Client	AECOM	Project Number	60634662	Date	April 3, 2022		
Project Name	Sheffield Rd			Tested By	0		
Location	Ottawa			Reviewed By	Ramana M		
Borehole Number	SZ/MW	Sample Id	TW1/SS1	Depth (feet)	0	Lab Number	202204006S
Description	Formula	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Container Number		214	18	293			
Weight of Empty Container (g) W_1		12.4	11.90	12.40			
Weight of Container + Wet Soil (g) W_2		20.4	18.90	20.00			
Weight of Container + Dry Soil(g) W_3		19.12	17.78	18.79			
Weight of Water (g) W_w	$W_w = W_2 - W_3$	1.28	1.12	1.21			
Weight of Dry Soil (g) W_s	$W_s = W_3 - W_1$	6.72	5.88	6.39			
Plastic Limit (%)	$w = (W_w / W_s) * 100$	19.05	19.05	18.94			
Average Plastic Limit (%) w_p		19.01					

Result Summary	
Liquid Limit (%)	30
Plastic Limit (%)	19
Plasticity Index (%)	11
Sample status	Plastic

Client	AECOM	Borehole No	S1/MW	Lab No	2022040015
Project Number	60634622	Sample ID	SS2	Date	April 1, 2022
Project Name	Sheffield Rd			Depth (Feet)	2.5-5
Location	Ottawa			Tested by	SAM
Soil Classification	Silty Sand, some gravel (SM)			Reviewed by	Ramona M

Total Sample Mass (A) g	134.8	% Coarse Aggregate (D)	17.7	% Fine Aggregate (E)	82.3
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COARSE AGGREGATE					
Sieve (mm)	Individual Mass Retained (g)	Cumulative Mass Retained (g) [X]	Coarse Aggregate Portion Only		% Passing (Total Sample)
			% Retained	% Passing	
106				100.0	100.0
75.0				100.0	100.0
63.0				100.0	100.0
53.0				100.0	100.0
37.5				100.0	100.0
26.5				100.0	100.0
22.4				100.0	100.0
19.0				100.0	100.0
16.0				100.0	100.0
13.2	3.8	3.8	15.7	84.3	97.2
9.5	8.7	12.4	52.0	48.0	90.8
6.7	7.1	19.5	81.6	18.4	85.5
4.75	4.4	23.9	100.0		82.3
Pan	109.9	Pan + [B]	Mass Passing 4.75 mm (g) [C = A-B]		110.9

FINE AGGREGATE			
Sample Mass before washing (g) [F]	109.9	Mass passing 75 µm sieve by washing (g)	32.77
Sample Mass after washing (g)	77.13	Mass passing 75 µm sieve by sieving (g)	0.65

Sieve (mm)	Cumulative Mass Retained (g) [Y]	Fine Aggregate Portion Only		% Passing (Total Sample)
		% Retained	% Passing	
4.75			100.0	82.27
2.36	13.7	12.5	87.5	72.01
1.18	33.33	30.3	69.7	57.32
0.600	50.56	46.0	54.0	44.42
0.425	57.17	52.0	48.0	39.47
0.300	63.19	57.5	42.5	34.97
0.150	71.02	64.6	35.4	29.11
0.075	76.48	69.6	30.4	25.02
Pan	0.65	Total Mass passing 75 µm sieve (g)	33.42	

Calculations:

D = (B/A) * 100
E = (C/A) * 100

Coarse Aggregate Portion:
% Retained = (X/B) * 100
% Passing = ((B-X)/B) * 100

Fine Aggregate Portion:
% Retained = (Y/F) * 100
% Passing = ((F-Y)/F) * 100

Total Mass Calculations

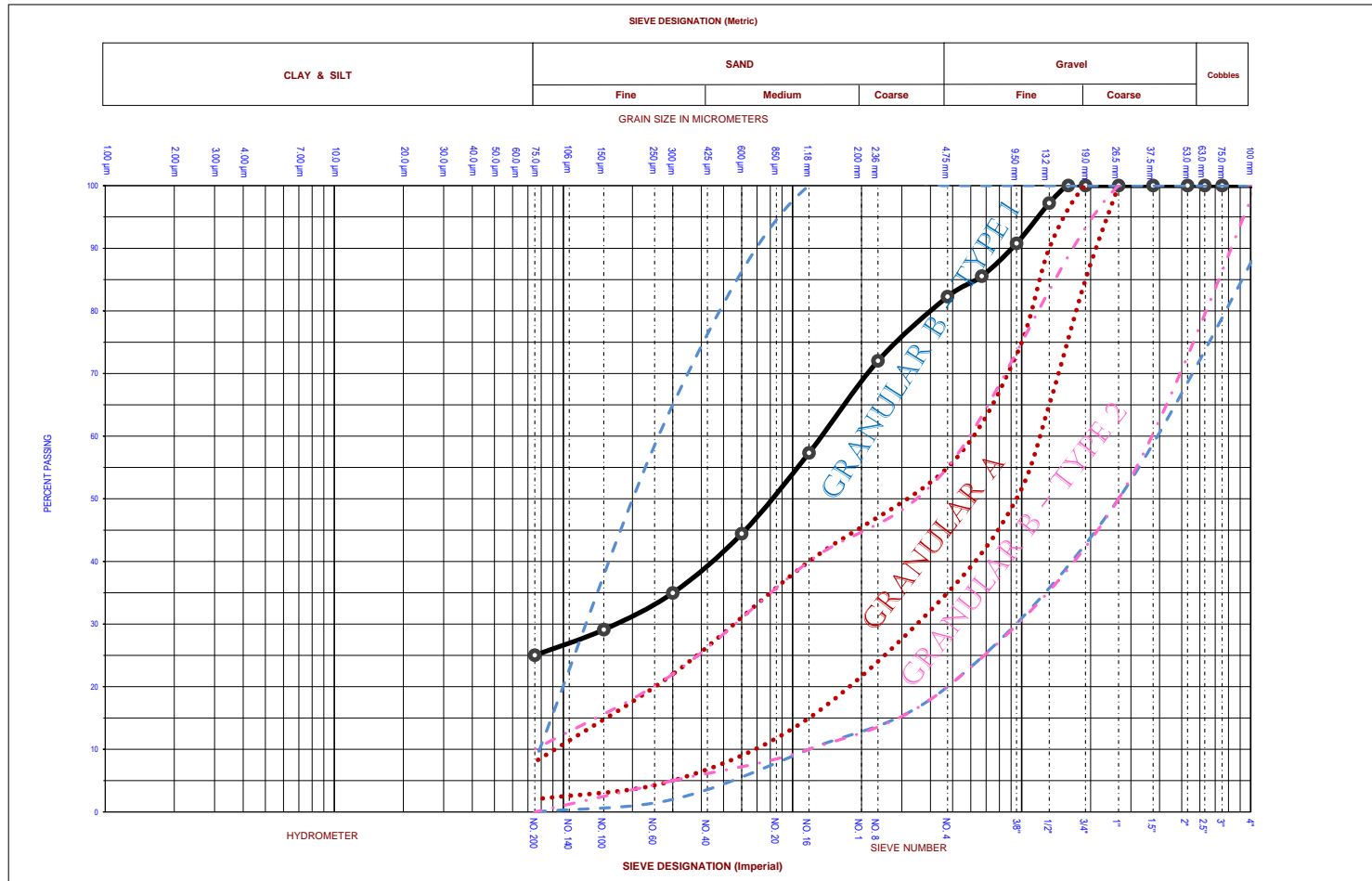
% Retained on Coarse Aggregate Sieves = (X/A) * 100

% Retained on Fine Aggregate Sieves = (Y/F) * E + % Ret. 4.75

% Passing Coarse Aggregate Sieves = ((A - X)/A) * 100

% Passing on Fine Aggregate Sieves = ((F - Y)/F) * E

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)

AECOM CANADA LTD. 83 Galaxy Blvd, Unit 6 Toronto, Ontario	Client		AECOM		Date		April 1, 2022		Project Number		60634622				
	Borehole No / Sample Id		S1/MW SS2		Depth (feet)		2.5-5		Lab No		202204001S				
	Project Name		Sheffield Rd						Project Location		Ottawa				
	Soil Classification		Silty Sand, some gravel (SM)						Figure No:						
Gravel(%)	18	Sand(%)	57	Fines(%)	25	D ₆₀ (mm)	1.395	D ₃₀ (mm)	0.173	D ₁₀ (mm)	N/A	C _u	N/A	C _c	N/A

AECOM CANADA LTD.



Client	AECOM	Borehole No	S2/MW	Lab No	2022040045
Project Number	60634622	Sample ID	SS2	Date	April 1, 2022
Project Name	Sheffield Rd			Depth (Feet)	2.5-5
Location	Ottawa			Tested by	SAM
Soil Classification	Silty Sand, trace gravel (SM)			Reviewed by	

Total Sample Mass (A) g	475.5	% Coarse Aggregate (D)	10.9	% Fine Aggregate (E)	89.1
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COARSE AGGREGATE					
Sieve (mm)	Individual Mass Retained (g)	Cumulative Mass Retained (g) [X]	Coarse Aggregate Portion Only		% Passing (Total Sample)
			% Retained	% Passing	
106				100.0	100.0
75.0				100.0	100.0
63.0				100.0	100.0
53.0				100.0	100.0
37.5				100.0	100.0
26.5				100.0	100.0
22.4				100.0	100.0
19.0				100.0	100.0
16.0	5.9	5.9	11.3	88.7	98.8
13.2	9.1	14.9	28.8	71.2	96.9
9.5	12.4	27.4	52.9	47.1	94.2
6.7	10.0	37.4	72.1	27.9	92.1
4.75	14.4	51.8	100.0		89.1
Pan	423.1	Pan + [B]	Mass Passing 4.75 mm (g) [C = A-B]		423.72

FINE AGGREGATE			
Sample Mass before washing (g) [F]	210.5	Mass passing 75 µm sieve by washing (g)	53
Sample Mass after washing (g)	157.5	Mass passing 75 µm sieve by sieving (g)	8.8

Sieve (mm)	Cumulative Mass Retained (g) [Y]	Fine Aggregate Portion Only		% Passing (Total Sample)
		% Retained	% Passing	
4.75			100.0	89.11
2.36	8.09	3.8	96.2	85.69
1.18	16.08	7.6	92.4	82.30
0.600	23.7	11.3	88.7	79.08
0.425	30.03	14.3	85.7	76.40
0.300	42.42	20.2	79.8	71.15
0.150	105.36	50.1	49.9	44.51
0.075	148.7	70.6	29.4	26.16
Pan	8.8	Total Mass passing 75 µm sieve (g)	61.8	

Calculations:

D = (B/A) * 100
E = (C/A) * 100

Coarse Aggregate Portion:
% Retained = (X/B) * 100
% Passing = ((B-X)/B) * 100

Fine Aggregate Portion:
% Retained = (Y/F) * 100
% Passing = ((F-Y)/F) * 100

Total Mass Calculations

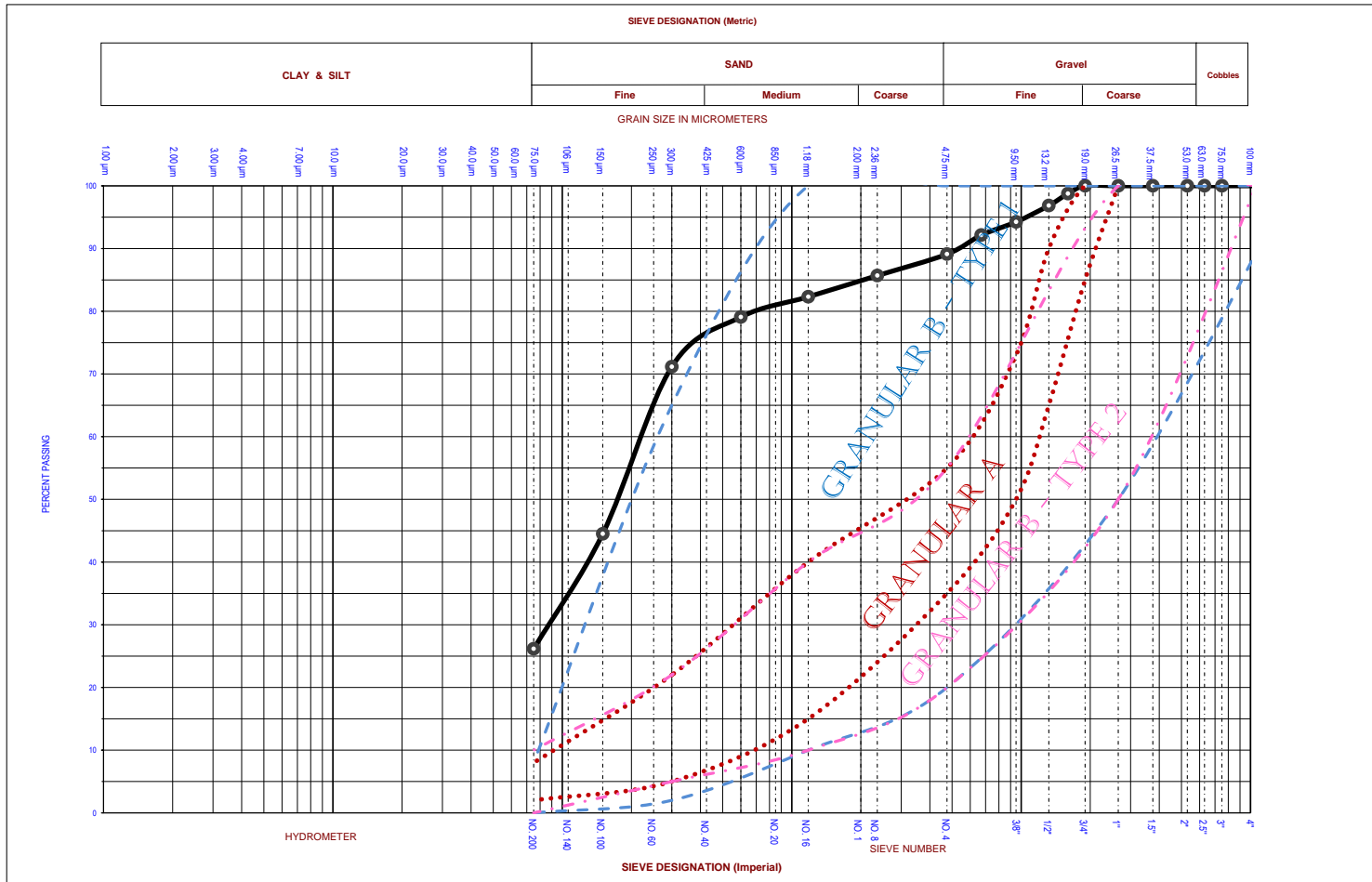
% Retained on Coarse Aggregate Sieves = (X/A) * 100

% Retained on Fine Aggregate Sieves = (Y/F) * E + % Ret. 4.75

% Passing Coarse Aggregate Sieves = ((A - X)/A) * 100

% Passing on Fine Aggregate Sieves = ((F - Y)/F) * E

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)

AECOM CANADA LTD. 83 Galaxy Blvd, Unit 6 Toronto, Ontario	Client		AECOM		Date		April 1, 2022		Project Number		60634622				
	Borehole No / Sample Id		S2/MW SS2		Depth (feet)		2.5-5		Lab No		202204004S				
	Project Name		Sheffield Rd						Project Location		Ottawa				
	Soil Classification		Silty Sand, trace gravel (SM)						Figure No:						
Gravel(%)	11	Sand(%)	63	Fines(%)	26	D ₆₀ (mm)	0.237	D ₃₀ (mm)	0.091	D ₁₀ (mm)	N/A	C _u	N/A	C _c	N/A

Hydrometer Analysis

Lab No	202204002S
Project Name	DYT3
Project Number	60634622
Location	OTTAWA

Borehole No	S1/MW	Tested by	IP/SAM/DHARMIK
Sample Id	SS4	Reviewed by	Ramana M
Depth (feet)		Date	
Soil Classification	Lean Clay, trace sand (CL)		

Soil Hydrometer Used	
151 H SN#	993585
	115105

Soil Information	
Liquid Limit (LL)	
Plasticity Index (PI)	
Specific Gravity of Soil (Gs)	2.70
Specific Gravity of Water (Gw)	1
Sg Correction Factor (α)	0.989
Total Mass of sample	197.8 g
Soil Particles Greater Than This Are Excluded From Graph	9.50 mm

Hydrometer Details	
Volume of Bulb (V _b)	61.1 cm ³
Length of Bulb (L _b)	14.44 cm
Length from '1.0' reading to top of Bulb (L _s)	10.17 cm
Scale Dimension (hs)	0.27 cm/Div
Cross-sectional Area of Cylinder (A)	28.3535 cm ²
Meniscus Correction (Hm)	0.0005 Divisions

Calculation of Dry Soil Mass	
Oven Dried Mass (W _o)	30.48 g
Air Dried Mass (W _a)	30.55 g
Hygroscopic Corr Factor (F)	0.998
Air Dried Mass in Analysis (M _a)	50 g
Oven Dried Mass in Analysis (M _o)	49.9 g
% Passing 2.0 mm Sieve (P ₁₀)	99.8
Sample Represented (W)	50.0 g

Sieve Analysis of Retained on 2.0 mm Sieve (M2)			
Sieve Size (mm)	Cummulative Mass Retained (g)	Mass Passing (g)	% Passing
75.0			
63.0			
53.0			
37.5			
26.5			
19.0			
13.2			
9.5			
4.75	0.0	197.8	100.0
2.0	0.4	197.4	99.8

Sieve Analysis of Hydrometer Material (M7)			
Sieve Size (mm)	Cummulative Mass Retained (g)	Mass Passing (g)	% Passing
2.00	0.0	49.9	99.8
0.850	0.1	49.8	99.7
0.425	0.2	49.7	99.4
0.25	0.4	49.5	99.1
0.106	0.7	49.2	98.4
0.075	0.8	49.0	98.1
Pass 0.075	0.0		

Percent In Suspension (P) as per Section 14.3 of ASTM D 422

$$P = [(100000/W) * (Gs/(Gs - Gw))] * (R - Gw) \text{ in percent (for Soil Hydrometer 151 H)}$$

Where R = Corrected Hydrometer Reading = Hs - Hc

Hs = Actual Hydrometer Reading
Hc = Composite Correction to be determined as per Section 7 of ASTM D 422

Diameter of Soil Particles (D) as per Section 15 of ASTM D 422

$$D = \text{SQRT of } \{[(30 \cdot \eta) / (980 \cdot (Gs - Gw))] \cdot (L/T)\} \text{ in mm}$$

Where η = Viscosity of suspending Medium (Water) in poises
L = Effective Depth = L1 + 0.5 * [L₂ - V_b / A] in cm
L1 = distance from the top of the bulb to Recorded Hydrometer Reading in cm
T = Time in minutes

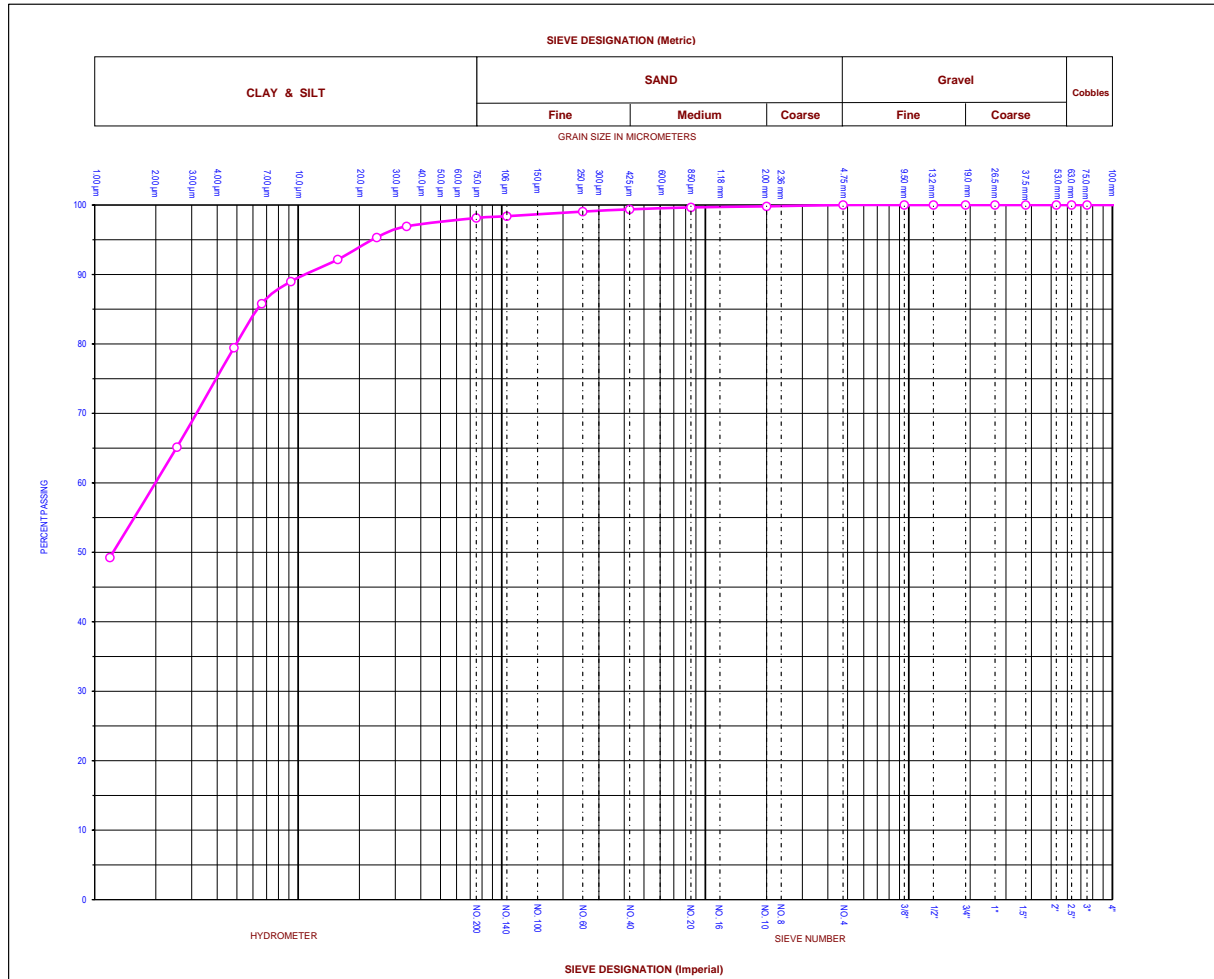
Date	Time	Elapsed Time (minutes)	Hs in Divisions	Hc in Divisions	Temp Tc in C	R=Hs-Hc	P in %	L in cm	η in Poise	K	D in mm
1-Jan-00	10:34:00 AM	1.0	1.0335	0.0030	26.1	1.0305	96.9	7.36	8.75559	0.0125568	0.0341
	10:35:00 AM	2.0	1.0330	0.0030	26.1	1.0300	95.3	7.49	8.75559	0.0125568	0.0243
	10:38:00 AM	5.0	1.0320	0.0030	26.1	1.0290	92.2	7.76	8.75559	0.0125568	0.0156
	10:48:00 AM	15.0	1.0310	0.0030	26.0	1.0280	89.0	8.03	8.77493	0.01257066	0.0092
	11:03:00 AM	30.0	1.0300	0.0030	25.9	1.0270	85.8	8.30	8.79435	0.01258456	0.0066
	11:33:00 AM	60.0	1.0280	0.0030	25.8	1.0250	79.4	8.84	8.81384	0.0125985	0.0048
2-Jan-00	2:43:00 PM	250.0	1.0235	0.0030	25.4	1.0205	65.1	10.06	8.89259	0.01265465	0.0025
	10:33:00 AM	1440.0	1.0185	0.0030	20.8	1.0155	49.3	11.41	9.89606	0.01334957	0.0012

L1 cm	Viscosity		K (η/(Gs-1))
	C		
1.21	-0.522902		5.1503494
1.35	-0.522902		5.1503494
1.62	-0.522902		5.1503494
1.89	-0.520695		5.1617255
2.16	-0.518485		5.1731466
2.70	-0.516271		5.1846127
3.91	-0.507377		5.2309329
5.27	-0.400459		5.821213

Mass Retained on Sieve # 10	40.5
Mass Passed Sieve # 10	157.3
Jar Number	

Hygroscopic Data	Can Id	53
	Empty Can Weight (g)	13.43
	Can+ Air Dried Soil (g)	43.98
	Can + Oven Dried Soil (g)	43.91

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)

AECOM CANADA LTD. 83 Galaxy Blvd, Unit 6 Toronto, Ontario	Client		AECOM		Date		January 0, 1900		Project Number		60634622		Gravel (%)		0								
	Sample ID		S1/MW SS4		Depth (feet)		0		Project Name		DYT3		Sand (%)		2								
	Lab Sample No:		202204002S						Project Location		OTTAWA		Silt (%)		39								
	Soil Classification		Lean Clay, trace sand (CL)												Clay (%)		59						
	Figure No.				D10		N/A		D30		N/A		D60		0.002		Cu		N/A		Cc		N/A

Hydrometer Analysis

Lab No	202204003S
Project Name	DYT3
Project Number	60634622
Location	OTTAWA

Borehole No	S1/MW	Tested by	IP/SAM/DHARMIK
Sample Id	SS7	Reviewed by	Ramana M
Depth (feet)		Date	12-Apr-22
Soil Classification	Silty Sand, some clay, trace gravel (SM)		

Soil Hydrometer Used	
151 H SN#	993585
	115105

Soil Information	
Liquid Limit (LL)	
Plasticity Index (PI)	
Specific Gravity of Soil (Gs)	2.70
Specific Gravity of Water (Gw)	1
Sg Correction Factor (α)	0.989
Total Mass of sample	511.9 g
Soil Particles Greater Than This Are Excluded From Graph	9.50 mm

Hydrometer Details	
Volume of Bulb (V _b)	63.1 cm ³
Length of Bulb (L _b)	14.15 cm
Length from '1.0' reading to top of Bulb (L _s)	10.5 cm
Scale Dimension (hs)	0.27 cm/Div
Cross-sectional Area of Cylinder (A)	28.1351 cm ²
Meniscus Correction (Hm)	0.0005 Divisions

Calculation of Dry Soil Mass	
Oven Dried Mass (W _o)	28.88 g
Air Dried Mass (W _a)	29.07 g
Hygroscopic Corr Factor (F)	0.993
Air Dried Mass in Analysis (M _a)	50 g
Oven Dried Mass in Analysis (M _o)	49.7 g
% Passing 2.0 mm Sieve (P ₁₀)	84.6
Sample Represented (W)	58.7 g

Sieve Analysis of Retained on 2.0 mm Sieve (M2)			
Sieve Size (mm)	Cummulative Mass Retained (g)	Mass Passing (g)	% Passing
75.0			
63.0			
53.0			
37.5			
26.5			
19.0			
13.2			
9.5			
4.75	36.8	475.2	92.8
2.0	79.0	432.9	84.6

Sieve Analysis of Hydrometer Material (M7)			
Sieve Size (mm)	Cummulative Mass Retained (g)	Mass Passing (g)	% Passing
2.00	0.0	49.7	84.6
0.850	5.3	44.4	75.5
0.425	9.7	40.0	68.1
0.25	13.4	36.3	61.8
0.106	19.6	30.1	51.3
0.075	22.0	27.7	47.1
Pass 0.075	1.2		

Percent In Suspension (P) as per Section 14.3 of ASTM D 422

$$P = [(100000/W) * (Gs/(Gs - Gw))] * (R - Gw) \text{ in percent (for Soil Hydrometer 151 H)}$$

Where R = Corrected Hydrometer Reading = Hs - Hc

Hs = Actual Hydrometer Reading
Hc = Composite Correction to be determined as per Section 7 of ASTM D 422

Diameter of Soil Particles (D) as per Section 15 of ASTM D 422

$$D = \text{SQRT of } \{[(30 \cdot \eta) / (980 \cdot (Gs - Gw))] \cdot (L/T)\} \text{ in mm}$$

Where η = Viscosity of suspending Medium (Water) in poises
L = Effective Depth = L1 + 0.5 * [L2 - V_b / A] in cm
L1 = distance from the top of the bulb to Recorded Hydrometer Reading in cm
T = Time in minutes

Date	Time	Elapsed Time (minutes)	Hs in Divisions	Hc in Divisions	Temp Tc in C	R=Hs-Hc	P in %	L in cm	η in Poise	K	D in mm
13-Apr-22	10:44:00 AM	1.0	1.0175	0.0030	25.7	1.0145	39.2	11.49	8.83341	0.01261248	0.0427
	10:45:00 AM	2.0	1.0160	0.0030	25.7	1.0130	35.1	11.89	8.83341	0.01261248	0.0308
	10:48:00 AM	5.0	1.0145	0.0030	25.7	1.0115	31.1	12.30	8.83341	0.01261248	0.0198
	10:58:00 AM	15.0	1.0130	0.0030	25.6	1.0100	27.0	12.70	8.85306	0.0126265	0.0116
	11:13:00 AM	30.0	1.0120	0.0030	25.7	1.0090	24.3	12.97	8.83341	0.01261248	0.0083
	11:43:00 AM	60.0	1.0110	0.0030	25.6	1.0080	21.6	13.24	8.85306	0.0126265	0.0059
	2:53:00 PM	250.0	1.0085	0.0030	25.8	1.0055	14.9	13.92	8.81384	0.0125985	0.0030
14-Apr-22	10:43:00 AM	1440.0	1.0080	0.0030	20.7	1.0050	13.5	14.05	9.92007	0.01336576	0.0013

L1 cm	Viscosity		K (η/(Gs-1))
	C		
5.53	-0.514053		5.1961241
5.94	-0.514053		5.1961241
6.35	-0.514053		5.1961241
6.75	-0.511832		5.2076811
7.02	-0.514053		5.1961241
7.29	-0.511832		5.2076811
7.97	-0.516271		5.1846127
8.10	-0.398036		5.8353345

Mass Retained on Sieve # 10	185.3
Mass Passed Sieve # 10	326.6
Jar Number	

Hygrosopic Data	Can Id	55
	Empty Can Weight (g)	13.33
	Can+ Air Dried Soil (g)	42.40
	Can + Oven Dried Soil (g)	42.21

Hydrometer Analysis

Lab No	202204005S
Project Name	DYT3
Project Number	60634622
Location	OTTAWA

Borehole No	S2MW	Tested by	IP/SAM/DHARMIK
Sample Id	SS5	Reviewed by	Ramana M
Depth (feet)	10-12	Date	01-Apr-22
Soil Classification	Lean Clay, trace sand, trace gravel (CL)		

Soil Hydrometer Used	
151 H SN#	993585
	115105

Soil Information	
Liquid Limit (LL)	
Plasticity Index (PI)	
Specific Gravity of Soil (Gs)	2.70
Specific Gravity of Water (Gw)	1
Sg Correction Factor (α)	0.989
Total Mass of sample	297.4 g
Soil Particles Greater Than This Are Excluded From Graph	9.50 mm

Hydrometer Details	
Volume of Bulb (V _b)	61.1 cm ³
Length of Bulb (L _b)	14.44 cm
Length from '1.0' reading to top of Bulb (L _s)	10.17 cm
Scale Dimension (hs)	0.27 cm/Div
Cross-sectional Area of Cylinder (A)	28.3535 cm ²
Meniscus Correction (Hm)	0.0005 Divisions

Calculation of Dry Soil Mass	
Oven Dried Mass (W _o)	22.18 g
Air Dried Mass (W _a)	22.5 g
Hygroscopic Corr Factor (F)	0.986
Air Dried Mass in Analysis (M _a)	50 g
Oven Dried Mass in Analysis (M _o)	49.3 g
% Passing 2.0 mm Sieve (P ₁₀)	98.4
Sample Represented (W)	50.1 g

Sieve Analysis of Retained on 2.0 mm Sieve (M2)			
Sieve Size (mm)	Cummulative Mass Retained (g)	Mass Passing (g)	% Passing
75.0			
63.0			
53.0			
37.5			
26.5			
19.0			
13.2			
9.5			
4.75	2.1	295.4	99.3
2.0	4.8	292.6	98.4

Sieve Analysis of Hydrometer Material (M7)			
Sieve Size (mm)	Cummulative Mass Retained (g)	Mass Passing (g)	% Passing
2.00	0.0	49.3	98.4
0.850	0.4	48.9	97.6
0.425	0.7	48.6	97.0
0.25	1.2	48.1	96.1
0.106	2.4	46.9	93.6
0.075	4.2	45.1	90.0
Pass 0.075	1.4		

Percent In Suspension (P) as per Section 14.3 of ASTM D 422

$$P = [(100000/W) * (Gs/(Gs - Gw))] * (R - Gw) \text{ in percent (for Soil Hydrometer 151 H)}$$

Where R = Corrected Hydrometer Reading = Hs - Hc

Hs = Actual Hydrometer Reading
Hc = Composite Correction to be determined as per Section 7 of ASTM D 422

Diameter of Soil Particles (D) as per Section 15 of ASTM D 422

$$D = \text{SQRT of } \{[(30 * \eta) / (980 * (Gs - Gw))] * (L/T)\} \text{ in mm}$$

Where η = Viscosity of suspending Medium (Water) in poises
L = Effective Depth = L1 + 0.5 * [L₂ - V_b / A] in cm
L1 = distance from the top of the bulb to Recorded Hydrometer Reading in cm
T = Time in minutes

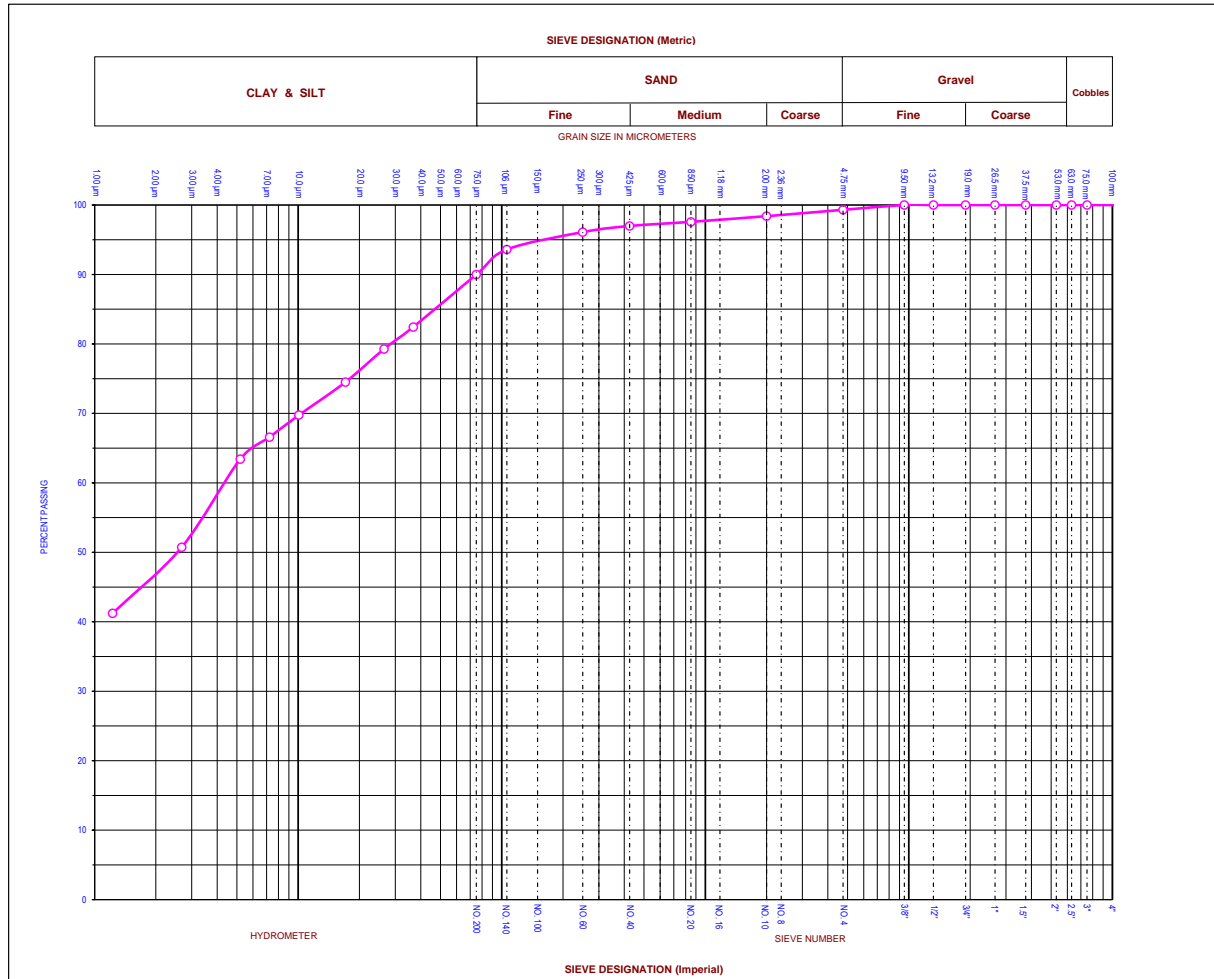
Date	Time	Elapsed Time (minutes)	Hs in Divisions	Hc in Divisions	Temp Tc in C	R=Hs-Hc	P in %	L in cm	η in Poise	K	D in mm
2-Apr-22	10:55:00 AM	1.0	1.0290	0.0030	26.1	1.0260	82.4	8.57	8.75559	0.0125568	0.0368
	10:56:00 AM	2.0	1.0280	0.0030	26.1	1.0250	79.3	8.84	8.75559	0.0125568	0.0264
	10:59:00 AM	5.0	1.0265	0.0030	26.1	1.0235	74.5	9.25	8.75559	0.0125568	0.0171
	11:09:00 AM	15.0	1.0250	0.0030	26.0	1.0220	69.8	9.65	8.77493	0.01257066	0.0101
	11:24:00 AM	30.0	1.0240	0.0030	25.9	1.0210	66.6	9.92	8.79435	0.01258456	0.0072
	11:54:00 AM	60.0	1.0230	0.0030	25.8	1.0200	63.4	10.19	8.81384	0.0125985	0.0052
3-Apr-22	3:04:00 PM	250.0	1.0190	0.0030	25.7	1.0160	50.7	11.27	8.83341	0.01261248	0.0027
	10:54:00 AM	1440.0	1.0160	0.0030	20.6	1.0130	41.2	12.08	9.94418	0.01338199	0.0012

L1 cm	Viscosity		K (η/(Gs-1))
	C		
2.43	-0.522902		5.1503494
2.70	-0.522902		5.1503494
3.11	-0.522902		5.1503494
3.51	-0.520695		5.1617255
3.78	-0.518485		5.1731466
4.05	-0.516271		5.1846127
5.13	-0.514053		5.1961241
5.94	-0.395608		5.8495155

Mass Retained on Sieve # 10	76.3
Mass Passed Sieve # 10	221.1
Jar Number	

Hygroscopic Data	Can Id	146
	Empty Can Weight (g)	13.80
	Can+ Air Dried Soil (g)	36.30
	Can + Oven Dried Soil (g)	35.98

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION CURVE (SIEVE AND HYDROMETER ANALYSIS)

AECOM CANADA LTD. 83 Galaxy Blvd, Unit 6 Toronto, Ontario	Client	AECOM	Date	April 1, 2022	Project Number	60634622	Gravel (%)	1				
	Sample ID	S2MW S55	Depth (feet)	10-12	Project Name	DY3	Sand (%)	9				
	Lab Sample No:	2022040055			Project Location	OTTAWA	Silt (%)	44				
	Soil Classification	Lean Clay, trace sand, trace gravel (CL)					Clay (%)	46				
	Figure No.		D10	N/A	D30	N/A	D60	0.005	Cu	N/A	Cc	N/A

Hydrometer Analysis

Lab No	202204006S
Project Name	DYT3
Project Number	60634622
Location	OTTAWA

Borehole No	S2MW	Tested by	IP/SAM/DHARMIK
Sample Id	TW1 SS1	Reviewed by	Ramana M
Depth (feet)		Date	01-Apr-22
Soil Classification	Lean Clay, trace sand (CL)		

Soil Hydrometer Used	
151 H SN#	993585
	115105

Soil Information

Liquid Limit (LL)	
Plasticity Index (PI)	
Specific Gravity of Soil (Gs)	2.70
Specific Gravity of Water (Gw)	1
Sg Correction Factor (α)	0.989
Total Mass of sample	297.2 g
Soil Particles Greater Than This Are Excluded From Graph	9.50 mm

Hydrometer Details

Volume of Bulb (V _b)	61.1	cm ³
Length of Bulb (L _b)	14.44	cm
Length from '1.0' reading to top of Bulb (L _s)	10.17	cm
Scale Dimension (hs)	0.27	cm/Div
Cross-sectional Area of Cylinder (A)	28.3535	cm ²
Meniscus Correction (Hm)	0.0005	Divisions

Calculation of Dry Soil Mass

Oven Dried Mass (W _o)	18.58	g
Air Dried Mass (W _a)	18.7	g
Hygroscopic Corr Factor (F)	0.994	
Air Dried Mass in Analysis (M _a)	50	g
Oven Dried Mass in Analysis (M _o)	49.7	g
% Passing 2.0 mm Sieve (P ₁₀)	100.0	
Sample Represented (W)	49.7	g

Sieve Analysis of Retained on 2.0 mm Sieve (M2)

Sieve Size (mm)	Cummulative Mass Retained (g)	Mass Passing (g)	% Passing
75.0			
63.0			
53.0			
37.5			
26.5			
19.0			
13.2			
9.5			
4.75	0.0	297.2	100.0
2.0	0.0	297.2	100.0

Sieve Analysis of Hydrometer Material (M7)

Sieve Size (mm)	Cummulative Mass Retained (g)	Mass Passing (g)	% Passing
2.00	0.0	49.7	100.0
0.850	0.1	49.6	99.9
0.425	0.1	49.6	99.8
0.25	0.1	49.5	99.7
0.106	0.2	49.5	99.6
0.075	0.3	49.4	99.5
Pass 0.075	0.0		

Percent In Suspension (P) as per Section 14.3 of ASTM D 422

$$P = [(100000/W) * (Gs/(Gs - Gw))] * (R - Gw) \text{ in percent (for Soil Hydrometer 151 H)}$$

Where R = Corrected Hydrometer Reading = Hs - Hc

Hs = Actual Hydrometer Reading
Hc = Composite Correction to be determined as per Section 7 of ASTM D 422

Diameter of Soil Particles (D) as per Section 15 of ASTM D 422

$$D = \text{SQRT of } \{[(30 \cdot \eta) / (980 \cdot (Gs - Gw))] \cdot (L/T)\} \text{ in mm}$$

Where η = Viscosity of suspending Medium (Water) in poises
L = Effective Depth = L1 + 0.5 * [L₂ - V_b / A] in cm
L1 = distance from the top of the bulb to Recorded Hydrometer Reading in cm
T = Time in minutes

Date	Time	Elapsed Time (minutes)	Hs in Divisions	Hc in Divisions	Temp Tc in C	R=Hs-Hc	P in %	L in cm	η in Poise	K	D in mm
2-Apr-22	11:30:00 AM	1.0	1.0330	0.0030	21.9	1.0300	95.9	7.49	9.63853	0.01317473	0.0361
	11:31:00 AM	2.0	1.0325	0.0030	21.9	1.0295	94.3	7.63	9.63853	0.01317473	0.0257
	11:34:00 AM	5.0	1.0320	0.0030	21.9	1.0290	92.7	7.76	9.63853	0.01317473	0.0164
	11:44:00 AM	15.0	1.0305	0.0030	21.9	1.0275	87.9	8.17	9.63853	0.01317473	0.0097
	11:59:00 AM	30.0	1.0290	0.0030	21.8	1.0260	83.1	8.57	9.66145	0.01319039	0.0071
	12:29:00 PM	60.0	1.0250	0.0030	21.8	1.0220	70.3	9.65	9.66145	0.01319039	0.0053
	3:39:00 PM	250.0	1.0190	0.0030	21.7	1.0160	51.2	11.27	9.68448	0.01320609	0.0028
3-Apr-22	11:29:00 AM	1440.0	1.0140	0.0030	20.1	1.0110	35.2	12.62	10.06625	0.01346388	0.0013

L1 cm	Viscosity		K (η/(Gs-1))
	C		
1.35	-0.426827		5.6697227
1.49	-0.426827		5.6697227
1.62	-0.426827		5.6697227
2.03	-0.426827		5.6697227
2.43	-0.424451		5.6832087
3.51	-0.424451		5.6832087
5.13	-0.422071		5.696751
6.48	-0.383407		5.9213247

Mass Retained on Sieve # 10	0
Mass Passed Sieve # 10	297.2
Jar Number	

Hygroscopic Data	Can Id	100
	Empty Can Weight (g)	13.60
	Can+ Air Dried Soil (g)	32.30
	Can + Oven Dried Soil (g)	32.18

DETERMINATION OF UNIT WEIGHT - ASTM D7263										
Project Number	60634622		Date Tested	29-Mar-22			Tested by			
Project Name	DYT3		Location	2625 Sheffield Rd, Ottawa, ON			Checked by	Ramana M		
Water Content										
Test Info	Lab Number	202204007S								
	Borehole Name	S1-MW								
	Sample ID	TW1								
	Depth	78'(Bottom 20cm)								
	Trial	A	B	A	B	A	B	A	B	
	Tare ID	190	192							
Mass in Grams	Tare Wt	13.50	13.60							
	Tare + Wet Soil	51.40	45.60							
	Tare + Dry Soil	43.90	39.19							
	Water	M _w	7.50	6.41						
	Dry Soil	M _d	30.40	25.59						
	Water Content %	w	24.67	25.05						
Average %		24.86								
Weight- Volume Relations										
Temp of water (C)		20	20							
Density of Water		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Mass in Grams	Wet Soil	M _t	147.32	169.82						
	Soil + Wax in Air		162.27	179.80						
	Wax		14.95	9.98						
	Wet Soil + Wax in water		73.79	85.63						
	Dry Soil ^A	M _d	118.17	135.80						
Specific Gravity of Soil (assumed)	G _s	2.72	2.72							
Volume in CC	Wet Soil + Wax ^B		88.48	94.17						
	Wax		16.46	10.99						
	Wet Soil	V	72.02	83.18						
	Dry Soil = M _d / G _s	V _s	43.52	50.02						
KN/cum	Wet Unit Weight = (M _t /V)x9.81		20.07	20.03						
	Average Wet Unit Weight	γ _m	20.05							
	Dry Unit Weight = (M _d /V)x9.81		16.10	16.02						
	Average Dry Unit Weight	γ _d	16.06							
Void Ratio = (V-V _s)/V _s	e	0.65	0.66							
Porosity % = [(V-V _s)/V]x100	n	39.56	39.87							
Degree of Saturation = [V _w /(V-V _s)] x100	S	100.00	100.00							

DETERMINATION OF SPECIFIC GRAVITY OF SOIL SOLIDS

Client	AECOM	Project Number	60634622		Date	4-Apr-22		
Project Name	DYT3				Done By	Ian P		
Location	Ottawa				Reviewed By	Ramana M		
Borehole Number	S2/MW TW1	Sample Id	SS7	Depth (feet)		Lab#	202204006S	
Description	Formula	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	
Weight of Empty Density Bottle (g) W_1		89.32	87.44	89.18				
Weight of Density Bottle + Dry Soil (g) W_2		109.43	109.54	109.92				
Weight of Dry Soil W_s (g)	$W_0 = W_2 - W_1$	20.11	22.1	20.74				
Weight of Density Bottle + Water (g) W_4		338.35	337.11	338.42				
Weight of Density Bottle + Soil + Water (g) W_3		351.24	351.28	351.72				
Weight of Water Displaced (g) W_4	$W_5 = \{(W_0 + W_4) - W_3\}$	7.22	7.93	7.44				
Specific Gravity of Soil Solids	$G_s = (W_0) / (W_5)$	2.785	2.787	2.788				
Average Specific Gravity at room temperature (G_T)		2.787						

Description	Formula	Data
Room Temperature $T^{\circ}C$		21.5
Standard Temperature for Reporting Specific Gravity		20
Relative Density of Water at Room Temperature γ_T		0.997913
Relative Density of Water at Standard Temperature γ_{20}		0.998234
Corrected Specific Gravity (G_{20})	$G_{20} = G_T * (\gamma_T / \gamma_{20})$	2.786

k 0.999677931

One-Dimension Consolidation Test as per ASTM D2435-11

Lab Number	2022040065		Date of Testing	30-Mar-22	
Project Num	60634622	Client	AECOM	Tested by	Ian / Dharmik/ Sam
Project Name	DYT3 Ottawa		Reviewed by	Ramana M	
Project Location	2625 Sheffield Road, Ottawa, Ontario				
Sample Id	BHS2/MW TW 1 (SS7)		Depth (feet)	20-22	



Grain Size Analysis Results					
Gravel %	Sand %	Silt %	Clay %	Soil Type	
0	1	56	43	Lean Clay	
Atterberg's Limits			Other Results		
LL %	PL %	PI %	SG	*** γ kN/m ³	*** γ_d kN/m ³
30	19	11	2.787	1.947	1.486

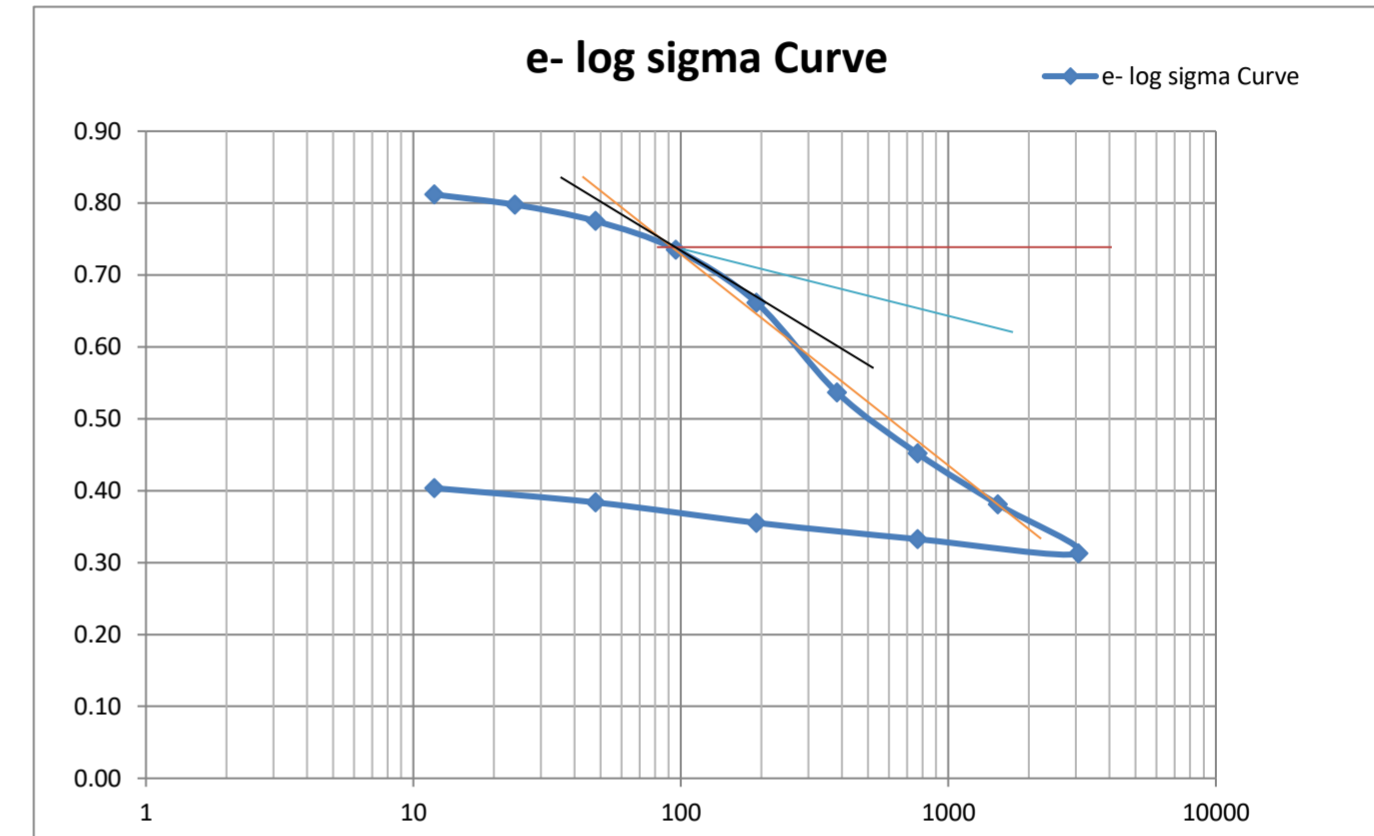
Note: ** Assumed Values *** Before Testing

CONSOLIDATION TEST SUMMARY

Initial Height of Specimen H_0 (mm)		1.91		Height of Solids H_s (cm)		0.896	
Load Increment	Axial Stress σ_a (lb/ft ²)	Axial Stress σ_a (kPa)	Corrected Deformation ΔH (cm)	Specimen Height H (cm)	Axial Strain ϵ_a (%)	Void Ratio e	
1	Seating Load		0.0000	1.9100	0	1.13	
2	125	11.97	0.2870	1.6230	15.0272251	0.81	
3	250	23.94	0.2997	1.6103	15.6921466	0.80	
4	500	47.88	0.3200	1.5900	16.7560209	0.78	
5	1000	95.76	0.3556	1.5544	18.617801	0.74	
6	2000	191.52	0.4216	1.4884	22.0753927	0.66	
7	4000	383.04	0.5334	1.3766	27.9267016	0.54	
8	8000	766.08	0.6096	1.3004	31.9162304	0.45	
9	16000	1532.16	0.6731	1.2369	35.2408377	0.38	
10	32000	3064.32	0.7341	1.1759	38.4324607	0.31	
11	8000	766.08	-0.7163	1.1937	-37.5015707	0.33	
12	2000	191.52	-0.6960	1.2140	-36.4376963	0.36	
13	500	47.88	-0.6706	1.2394	-35.1078534	0.38	
14	125	11.97	-0.6528	1.2572	-34.1769634	0.40	

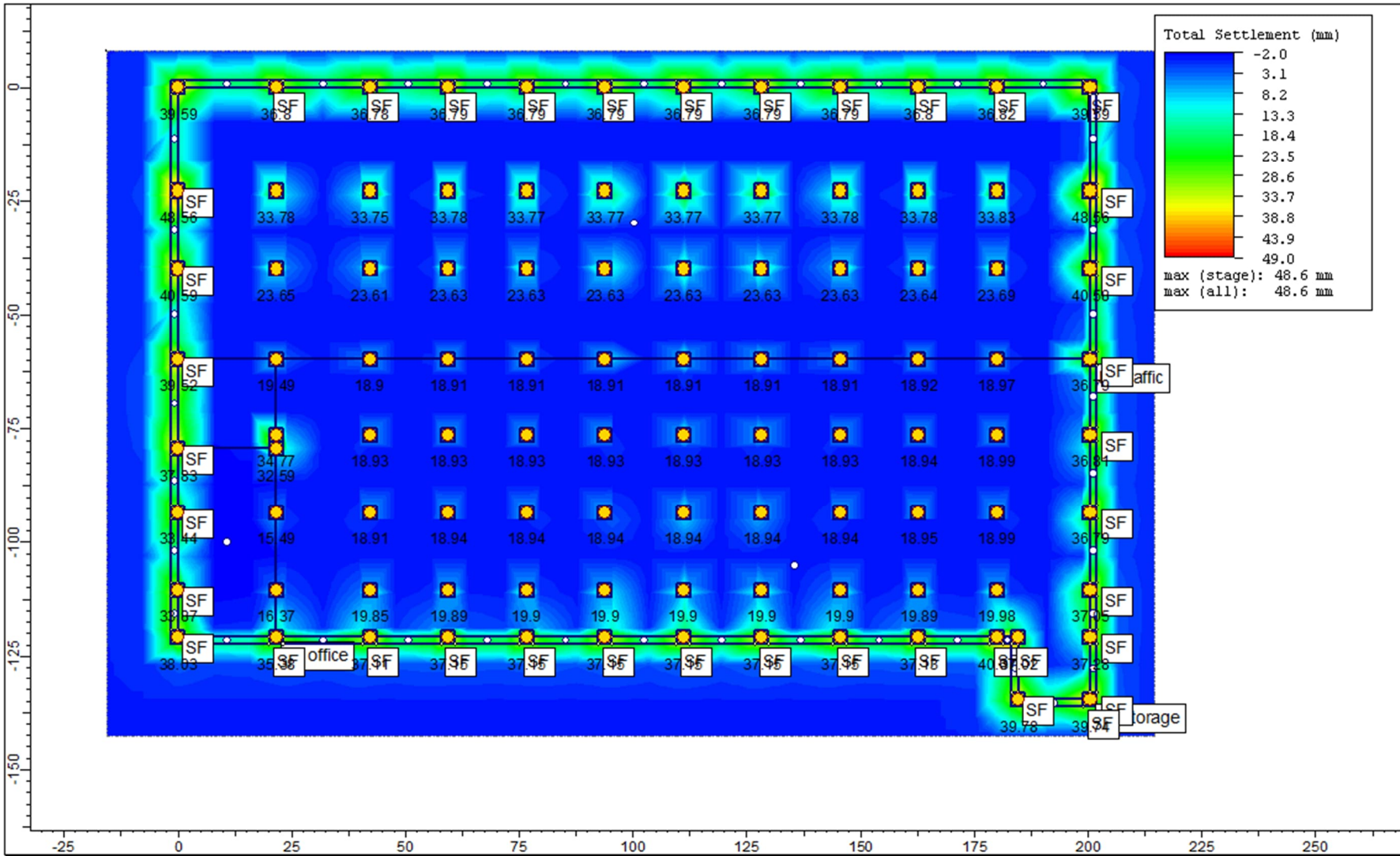
Determination of Pre-Consolidation Pressure from e-log σ Curve


Void Ratio e	Axial Stress σ_a (kPa)	Log of Axial Stress σ_a (kPa)
1.13	0	#NUM!
0.81	11.97	1.078094
0.80	23.94	1.379124
0.78	47.88	1.680154
0.74	95.76	1.981184
0.66	191.52	2.282214
0.54	383.04	2.583244
0.45	766.08	2.884274
0.38	1532.16	3.185304
0.31	3064.32	3.486334
0.33	766.08	2.884274
0.36	191.52	2.282214
0.38	47.88	1.680154
0.40	11.97	1.078094



Coefficient of Compressibility C_c	Preconsolidation Pressure p_0 kPa
0.3109	100

Appendix C Settlement Analysis



	Project		AMZL-DYT3 Settlement Analysis	
	Analysis Description		Total Settlement at 15 Years	
	Drawn By	Jack Yu Guo	Company	AECOM Canada Ltd.
	Date	2022-04-12, 12:13:31 PM	File Name	Settlement_detailed.s3z