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A REPORT TO
SPHERE DEVELOPMENTS (KINGSTON) LP

A GEOTECHNICAL INVESTIGATION
FOR
PROPOSED MIXED-USE DEVELOPMENT

875 KINGSTON ROAD

CITY OF PICKERING

REFERENCE NO. 2204-S019

JULY 2022

DISTRIBUTION

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1.0 INTRODUCTION

In accordance with written authorization dated March 18, 2022, from Mr. Rohan Gawri of Sphere Developments (Kingston) LP, a geotechnical investigation was conducted at 875 Kingston Road, in the City of Pickering.

The purpose of the investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of a mixed-use development.

2.0 SITE AND PROJECT DESCRIPTION

The City of Pickering is situated on Iroquois (glacial lake) plain where, in places, the glacial till stratigraphy has been partly eroded by the water action of the glacial lake and filled with lacustrine sand, silt, clay and reworked till.

The subject site, encompassing a total area of 7,471.20 square metres, is located between Kingston Road and Highway 401, approximately 650 m east of Whites Road North in the City of Pickering. It is currently vacant with weed and tree growth. The existing site gradient generally descends towards the west and south.

Based on the site plan drawings prepared by Icon Architects Inc. dated July 25, 2022, it is understood that the property will be developed for a 17-storey mixed-use building with two levels of underground parking.

3.0 FIELD WORK

The field work, consisting of seven (7) sampled boreholes, was performed between May 3 and May 6, 2022, at the locations shown on the Location Plan, Drawing No. 1. These boreholes were terminated at the refusal depth of augering, at 7.7 to 15.6 m from the prevailing ground surface.

The boreholes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration Test, using the procedures described on the enclosed “List of Abbreviations and Terms,” was performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or ‘N’ values) of the subsoil. The consistency of the cohesive strata is inferred from the ‘N’ values. Split-spoon samples were recovered for soil classification and laboratory testing. The field work was supervised and the findings were recorded by a Geotechnical Technician.

Upon the completion of borehole drilling and sampling, five (5) monitoring wells were installed in the selected boreholes to facilitate groundwater monitoring and hydrogeological assessment. Details of the monitoring wells are included in the corresponding Borehole Logs.

The ground elevation of each borehole location was determined using hand-held Global Navigation Satellite System (GNSS) survey equipment.

4.0 SUBSURFACE CONDITIONS

The boreholes were drilled on the weed covered area. The investigation has revealed that beneath a topsoil and a layer of earth fill in one of the boreholes, the area is underlain by silty clay and silty clay till deposit, overlying probable bedrock or boulder at a depth of 7.7 m to 15.6 m.

Detailed descriptions of the encountered subsurface conditions are presented on the enclosed Borehole Logs comprising Figures 1 to 7, inclusive. The revealed stratigraphy is plotted on the Subruface Profile, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

4.1 **Topsoil** (All Boreholes)

The ground surface is covered by topsoil veneer, approximately 20 cm to 60 cm in thickness. Thicker topsoil may occur in low lying areas beyond the borehole locations.

4.2 **Earth Fill** (Borehole 1)

A layer of earth fill, extending to a depth of 1.5 m, was contacted beneath the topsoil layer in Borehole 1. It consisted of silty clay, with topsoil inclusions.

4.3 **Silty Clay Till/Silty Clay** (All Boreholes)

Beneath the topsoil and a layer of earth fill in Borehole 1, silty clay and silty clay till deposits were contacted, extending to auger refusal depths of the boreholes.

Grain size analyses were performed on four (4) representative samples of silty clay till and four (4) samples of silty clay; the results are plotted on Figures 8 and 9, respectively. Atterberg Limits were also performed on four (4) selected samples and the results are plotted in the respective borehole log. The resulting Liquid Limit and Plastic Limit are summarized below:

Liquid Limit:	37% to 43%
Plastic Limit:	19% and 22%

Based on the results, this indicates both clay and clay till are medium in plasticity.

The natural water content of the clay and clay till samples were determined; the results range from 7% to 27%, with a median of 12%, indicating that the clay and clay till are in moist conditions.

The obtained 'N' values of the clay and clay till range from 8 to more than 100, with a median of 58 blows per 30 cm of penetration, indicating that the clay and clay till are stiff to hard, being generally hard in consistency.

The engineering properties of the clay and clay till are given below:

- High frost susceptibility and low water erodibility.
- Low permeability, with an estimated coefficient of permeability of 10^{-7} cm/sec and a percolation time of 80 min/cm.
- Both clay and clay till will be relatively stable in steep excavation; however, the sides of the excavation may slough due to prolonged exposure.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 3000 ohm·cm.

4.4 **Interpretation of Auger Refusal** (All Boreholes)

Shale fragments and refusal to augering was encountered in the boreholes, at a depth of 7.7 m to 15.6 m (or El. 81.0 to 85.4 m). This may infer that shale bedrock occurs at this level. However, this is not proven by rock coring, which is beyond the scope of this investigation.

5.0 GROUNDWATER CONDITION

Records of groundwater were not feasible in the boreholes upon completion of drilling since potable water was used. However, groundwater was recorded in the monitoring wells on May 12 and June 14, 2022. These records are summarized in Table 1.

Table 1 - Groundwater Level in Monitoring Wells

Monitoring Well No.	Ground Elevation (m)	Well Depth (m)	Measured Groundwater Level			
			May 12, 2022		June 14, 2022	
			Depth (m)	El. (m)	Depth (m)	El. (m)
1	95.2	13.8	3.3	91.9	3.0	92.2
2	97.6	15.6	11.9	85.7	10.8	86.8
4	96.9	14.7	12.2	84.7	10.6	86.3
5	93.7	12.3	1.5	92.2	1.5	92.2
7	93.1	7.7	1.4	91.7	1.4	91.7

Groundwater was recorded in the monitoring wells at a depth of 1.4 m to 12.2 m, or between El. 84.7 m to 92.2 m. Based on the natural water content, soil stratigraphy, and water levels, perched water exist in the sand and silt layers within the silty clay and silty clay till deposits and is subject to seasonal fluctuation. Continuous groundwater, however, is not anticipated within the depth of investigation. Detail groundwater condition of the site will be discussed in the hydrogeological report, under separate cover.

6.0 DISCUSSION AND RECOMMENDATIONS

The boreholes were drilled on the weed covered area. The investigation has revealed that beneath a topsoil and a layer of earth fill in Borehole 1, the area is underlain by a stiff to hard silty clay and silty clay till deposits, overlying probable bedrock or boulder at a depth of 7.7 m to 15.6 m.

Groundwater was recorded in the monitoring wells at a depth of 1.4 m to 12.2 m, or between El. 84.7 m to 92.2 m. Based on the natural water content, soil stratigraphy, and water levels, perched water exist in the sand and silt layers within the silty clay and silty clay till deposits and is subject to seasonal fluctuation. Continuous groundwater, however, is not anticipated within the depth of investigation.

Based on the site plan, the property will be developed for a 17-storey mixed-use building with two levels of underground parking. The geotechnical findings which warrant special consideration are presented below:

1. With two levels of underground parking, the lowest floor elevation of the proposed building ranged between El. 87 m and 88 m, which consist of native clay and clay till deposits, suitable to support the proposed buildings on conventional spread and strip footings.
2. Perimeter drainage and dampproofing of the foundation walls will be required for the underground structure.
3. Where slope excavation is not feasible, a brace shoring will be required.

The recommendations appropriate for the project described in Section 2.0 are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should this become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

6.1 **Foundations**

The proposed building will be provided with two levels of underground parking. With the lowest floor elevation between El. 87 m and 88 m, the founding level is anticipated to extend into the native silty clay and clay till deposits, suitable to support the proposed buildings on conventional spread and strip footings. The recommended bearing pressures for the design of conventional footings are provided:

- Maximum Bearing Pressure at Serviceability Limit State = 600 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State = 900 kPa

The total and differential settlements of foundation, designing for the recommended bearing pressures at SLS, are estimated to be 25 mm and 20 mm, respectively.

The foundation subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the revealed conditions are compatible with the foundation design requirements.

Footings exposed to weathering, or in unheated areas, should have at least 1.2 m of earth cover for protection against frost action. For an unheated underground parking garage with limited open access, a minimum earth cover of 0.9 m for interior footings and 0.6 m for perimeter footings is necessary for frost protection. Footings adjacent to the fresh air ducts, the entrance of the garage and other areas which may be exposed to the extreme temperature from the exterior should be provided with a minimum frost cover of 1.2 m or properly insulated.

The foundations should meet the requirements specified in the latest Ontario Building Code. The structure should be designed to resist an earthquake force using Site Classification 'C' (very stiff soil).

6.2 **Underground Structure**

The perimeter walls of the conventional underground structure should be designed to sustain a lateral earth pressure calculated using the soil parameters given in Section 6.7. Any applicable surcharge loads adjacent to the underground structure must also be considered in the design of the foundation walls.

The perimeter walls of conventional underground structures should be dampproofed and provided with a perimeter subdrain system as shown in Drawing No. 3. Backfill of open excavation should consist of free-draining granular material unless prefabricated drainage board is installed over the entire wall below grade, such as besides shoring walls as shown in Drawing No. 4. The subdrains should be shielded by a fabric filter and covered with stone filter to prevent blockage by silting and discharge to a positive outlet.

The subgrade for slab-on-grade should consist of well compacted earth fill or native subsoil. The concrete slab should be constructed on a granular bedding, consisting of 19-mm Crusher-Run Limestone (CRL), or equivalent, 20 cm in thickness, compacted to its maximum Standard Proctor dry density (SPDD).

The elevator pit, which normally extends a few metres below the floor level, should be designed as a submerged 'tank' structure with waterproofed pit walls and pit floor.

6.3 **Underground Services**

The subgrade for underground services should consist of sound native soils or properly compacted earth fill, free of organics. In areas where the subgrade consists of loose or wet soil, it should be subexcavated and replaced with bedding material, compacted to at least 98% SPDD.

A Class ‘B’ bedding, consisting of compacted 19-mm CRL or equivalent, is recommended for construction of the underground services. The pipe joints connecting into the catch basins and manholes should be leak-proof, or wrapped with a waterproof membrane to prevent subgrade migration through leakage at joints resulting from inadvertent faulty installation.

Openings to subdrains and catch basins should be shielded with a fabric filter to prevent silting.

In order to prevent pipe floatation when the sewer trench is deluged with water, a soil cover with a thickness two times the diameter of the pipe should be in place at all times after completion of the pipe installation.

All metal fittings for the underground services should be protected against soil corrosion. For estimation of anode weight requirements, the estimated electrical resistivity of the disclosed soil can be used. This, however, should be confirmed by testing the soil along the service pipe alignment at the time of site service construction. The proposed anode weight must meet the minimum requirement as specified by the City standard.

6.4 **Backfilling in Trenches and Excavated Areas**

The on-site inorganic soils are generally suitable for use as trench backfill. They should be free of deleterious materials or oversized (over 15 cm) boulders. The backfill should be compacted to 95% SPDD. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

Below concrete slab-on-grade, sidewalk, or within 1.0 m below the pavement subgrade, the backfill should be compacted to 98% SPDD with the water content at 2% to 3% drier than the optimum. This is to provide the required stiffness for pavement and slab-on-grade construction.

In normal construction practice, the problem areas of ground settlement largely occur adjacent to manholes, catch basins, services crossing, foundation walls and columns. In areas which are inaccessible to a heavy compactor, granular backfill should be used for compaction with light equipment.

6.5 **Pavement Design**

The recommended pavement design for on-grade access driveway is presented in Table 2.

Table 2 - Pavement Design for On-Grade Access Driveway

Course	**Thickness (mm)**	**OPS Specifications**
Asphalt Surface	40	HL-3
Asphalt Binder	50	HL-8
Granular Base	150	Granular 'A'
Granular Sub-base	300	Granular 'B'

Where the pavement is to be built on structural slabs such as the underground parking structure, sufficient granular base and adequate drainage must be provided to prevent frost heaving in the pavement. In addition, an impervious membrane must be placed above the structural slab of the underground structure to prevent water leakage as well as to protect the reinforcing steel bars in the structure against brine corrosion. The recommended pavement to be placed above the underground structure is presented in Table 3.

Table 3 - Pavement Design on Structural Slab

Course	**Thickness (mm)**	**OPS Specifications**
Asphalt Surface	40	HL-3
Asphalt Binder	50	HL-8
Granular Base	200	20-mm CRL or equivalent
Granular Sub-base	100	Free-Draining Sand Fill

Prior to placement of the granular bases, the soil subgrade should be proof-rolled and any soft spots should be rectified. In order to provide a stable subgrade for pavement construction, it is imperative that the subgrade within the 1.0 m zone below the underside of the granular base be compacted to at least 98% SPDD, with the moisture content at 2% to 3% drier than the optimum. This is to provide adequate stability for the pavement construction. The granular base and sub-base should be compacted to 100% SPDD.

The pavement subgrade will suffer a strength regression if water is allowed to saturate the mantle. Along the perimeter where runoff may drain onto the pavement, swale or an intercept subdrain system should be installed to prevent infiltrating precipitation from seeping into the granular bases (since this may inflict frost damage on the flexible pavement). At the lower spots around catch basins, subdrains consisting of filter-wrapped weepers should also be installed and they should be connected into the catch basins. The subdrains should be backfilled with free-draining granular material.

6.6 Sidewalks, Interlocking Stone Pavement and Landscaping

Interlocking stone pavement, sidewalks and landscaping structures in open areas should be designed to tolerate the frost-induced ground movement.

In areas where ground movement is not tolerable, such as in front of building entrances, the sidewalk and barrier-free ramp must be constructed on free-draining, non-frost-susceptible granular material such as Granular 'B'. This material must extend to at least 0.3 m to 1.2 m below the sidewalk, slab or pavement surface, depending on its tolerance on ground movement, and be provided with positive drainage, such as weeper subdrains connected to manholes or catch basins. Alternatively, the area can be properly insulated with 50-mm Styrofoam, or equivalent.

The final grading around structures must be such that it directs the runoff away from the structures.

6.7 Soil Parameters

The recommended soil parameters for the project design are given in Table 4.

Table 4 - Soil Parameters

Unit Weight and Bulk Factor	**Bulk Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
		Loose	**Loose**
Existing Earth Fill/Silty Clay	21.0	1.30	1.00
Silty Clay Till	22.5	1.33	1.05
Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_o**	**Passive K_p**
Compacted Earth Fill	0.35	0.55	2.75
Silty Clay, Silty Clay Till	0.30	0.45	3.25

Table 4 (Continued) - Soil Parameters

Coefficients of Friction	
Between Concrete and Granular Base	0.50
Between Concrete and Natural Soils	0.35

6.8 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of material are classified in Table 5.

Table 5 - Classification of Material for Excavation

Material	Type
Silty Clay/Silty Clay Till	2
Earth Fill	3

Where safe sloped excavation is not feasible, a braced shoring will be required. The overburden and surcharge from any adjacent structures should be considered in the design of shoring. The recommendations for shoring design are attached in the Appendix.

Continuous groundwater is not anticipated within the depth of investigation. However, perched water may be encountered in the excavation. The groundwater yield, if any, will be slow in rate and limited in quantity and can be removed by pumping from conventional sumps.

Excavation into the tills containing boulders may require extra effort and the use of a heavy-duty excavator.

6.9 Monitoring of Performance

It is recommended that close monitoring of vertical and lateral movement of the shoring wall should be carried out and frequent site inspections be conducted to ensure that the excavation does not adversely affect the structural stability of the adjacent buildings and the existing underground utilities. Extra bracing or support may be required if any movement is found excessive. The contractor should maintain the shoring to ensure any movement is within the design limit.

Vibration control and pre-construction survey is strongly recommended for the adjacent properties and structures prior to any excavation activities at the site. Our office can provide further advice or undertaking the vibration control and pre-construction survey as necessary.

7.0 LIMITATION OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Sphere Developments (Kingston) LP, and for review by its designated consultants and government agencies. The material in the report reflects the judgement of Cedric Ramos, B.A.Sc. and Kin Fung Li, P.Eng., in light of the information available to it at the time of preparation.

Use of this report is subject to the conditions and limitations of the contractual agreement. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

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LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0	Field vane test in borehole; the number denotes the sensitivity to remoulding
△	Laboratory vane test
□	Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

JOB NO.: 2204-S019

LOG OF BOREHOLE: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Mixed-Use Development

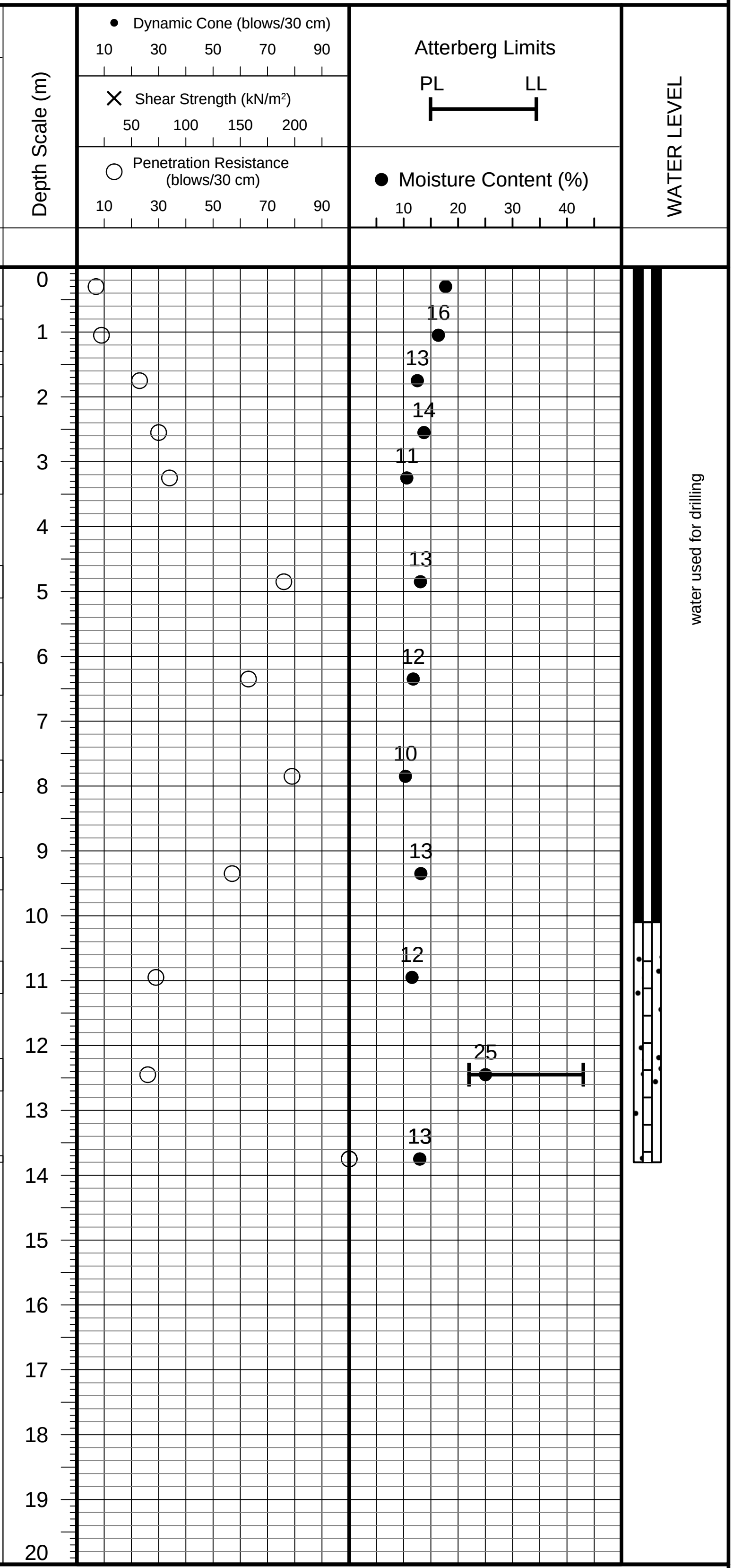
METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 3, 2022

El. (m) Depth (m)	SOIL DESCRIPTION
95.2	Ground Surface
0.0	**20 cm Topsoil** **EARTH FILL** Brown to dark brown silty clay occ. topsoil inclusions
93.7 1.5	Very stiff to hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers brown grey
83.5 11.7	Grey, very stiff **SILTY CLAY** a trace to some sand medium plasticity occ. shale fragments
81.4 13.8	**END OF BOREHOLE** **due to auger refusal on probable bedrock** Installed 50 mm Ø monitoring well to 13.8 m completed with 3.1 m screen Sand backfill from 10.1 to 13.8 m Bentonite seal from 0.0 m to 10.1 m Provided with a monument steel casing

SAMPLES Number	Type	N-Value
1	DO	7
2	DO	9
3	DO	23
4	DO	30
5	DO	34
6	DO	76
7	DO	63
8	DO	79
9	DO	57
10	DO	29
11	DO	26
12	DO	50/13



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JOB NO.: 2204-S019

LOG OF BOREHOLE: 2

FIGURE NO.: 2

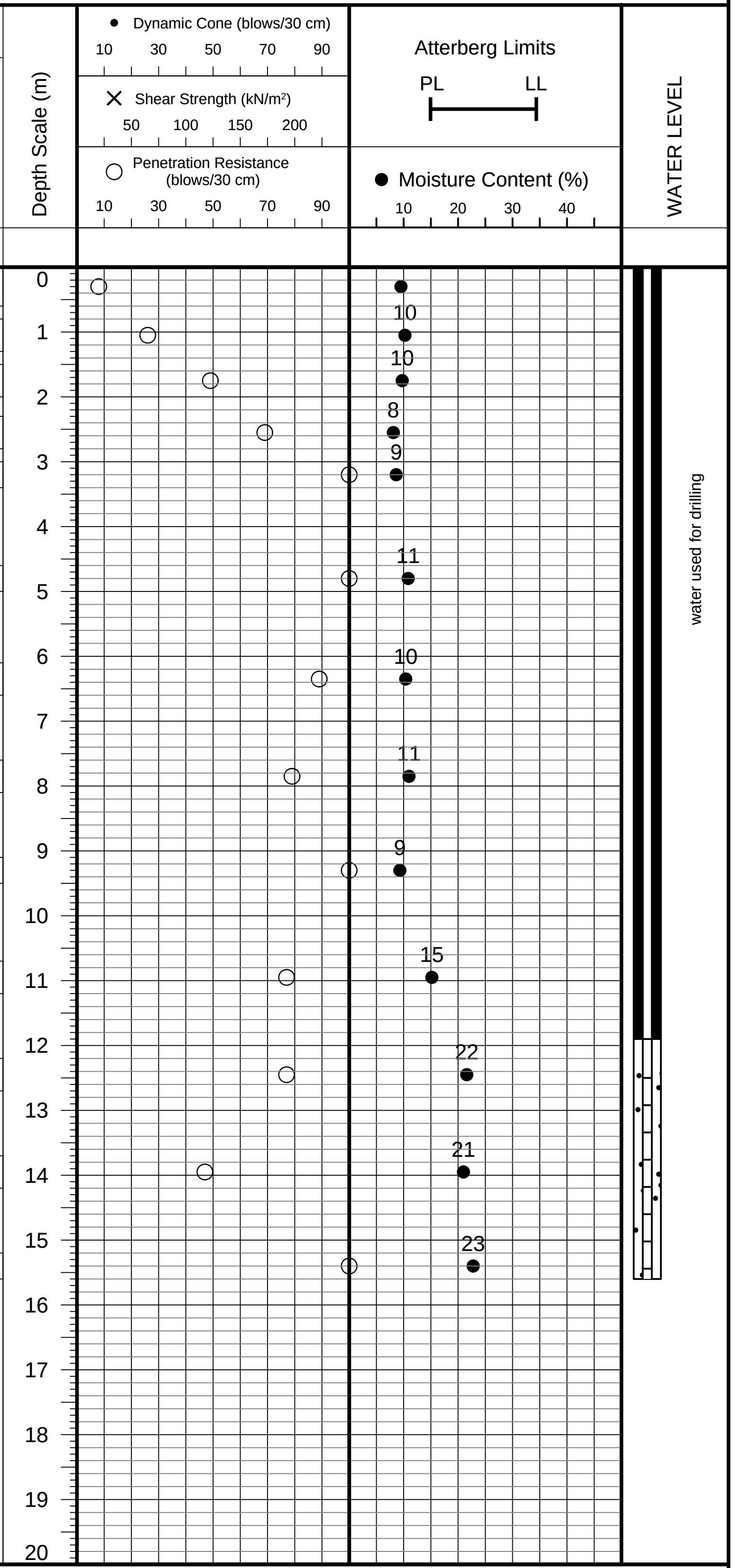
PROJECT DESCRIPTION: Proposed Mixed-Use Development

PROJECT LOCATION: 875 Kingston Road, City of Pickering

METHOD OF BORING: Flight Auger (Tricone)

DRILLING DATE: May 3, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
97.6	Ground Surface			
0.0	**20 cm Topsoil**			
	Stiff to hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers weathered	1	DO	8
		2	DO	26
		3	DO	49
		4	DO	69
		5	DO	50/23
	brown grey			
		6	DO	50/28
		7	DO	89
		8	DO	79
		9	DO	50/28
		10	DO	77
85.9 11.7	Grey, hard **SILTY CLAY** a trace to some sand medium plasticity	11	DO	77
		12	DO	47
	occ. shale fragments	13	DO	50/23
82.0 15.6	**END OF BOREHOLE due to auger refusal on probable bedrock** Installed 50 mm Ø monitoring well to 15.6 m completed with 3.1 m screen Sand backfill from 11.9 to 15.6 m Bentonite seal from 0.0 m to 11.9 m Provided with a monument steel casing			



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JOB NO.: 2204-S019

LOG OF BOREHOLE: 3

FIGURE NO.: 3

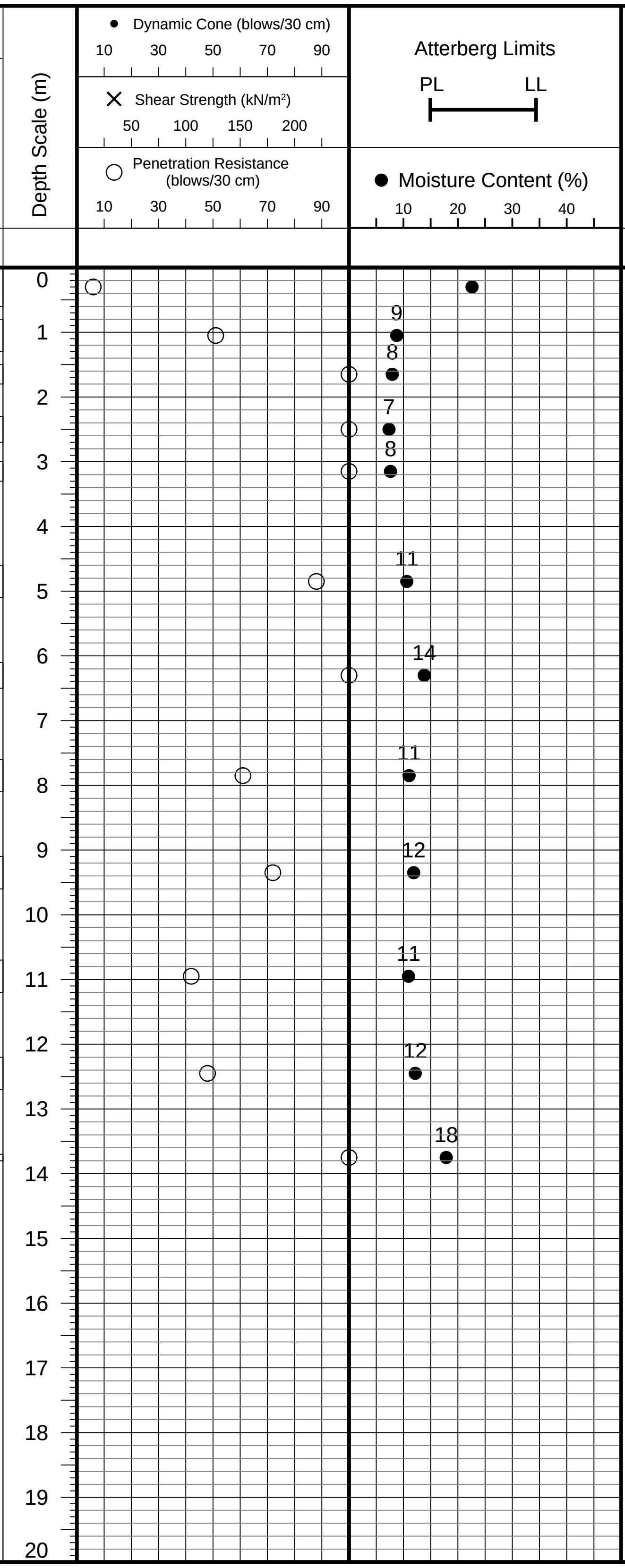
PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 4, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
94.8 0.0	Ground Surface			
	60 cm Topsoil	1	DO	6
	Hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers weathered	2	DO	51
		3	DO	50/13
		4	DO	50/23
		5	DO	50/13
	brown grey			
		6	DO	88
		7	DO	50/28
		8	DO	61
		9	DO	72
		10	DO	42
		11	DO	48
81.6 13.2	Grey, hard **SILTY CLAY** a trace to some sand medium plasticity occ. shale fragments	12	DO	50/5
81.0 13.8	**END OF BOREHOLE** **due to auger refusal on probable bedrock**			



WATER LEVEL

water used for drilling

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JOB NO.: 2204-S019

LOG OF BOREHOLE: 4

FIGURE NO.: 4

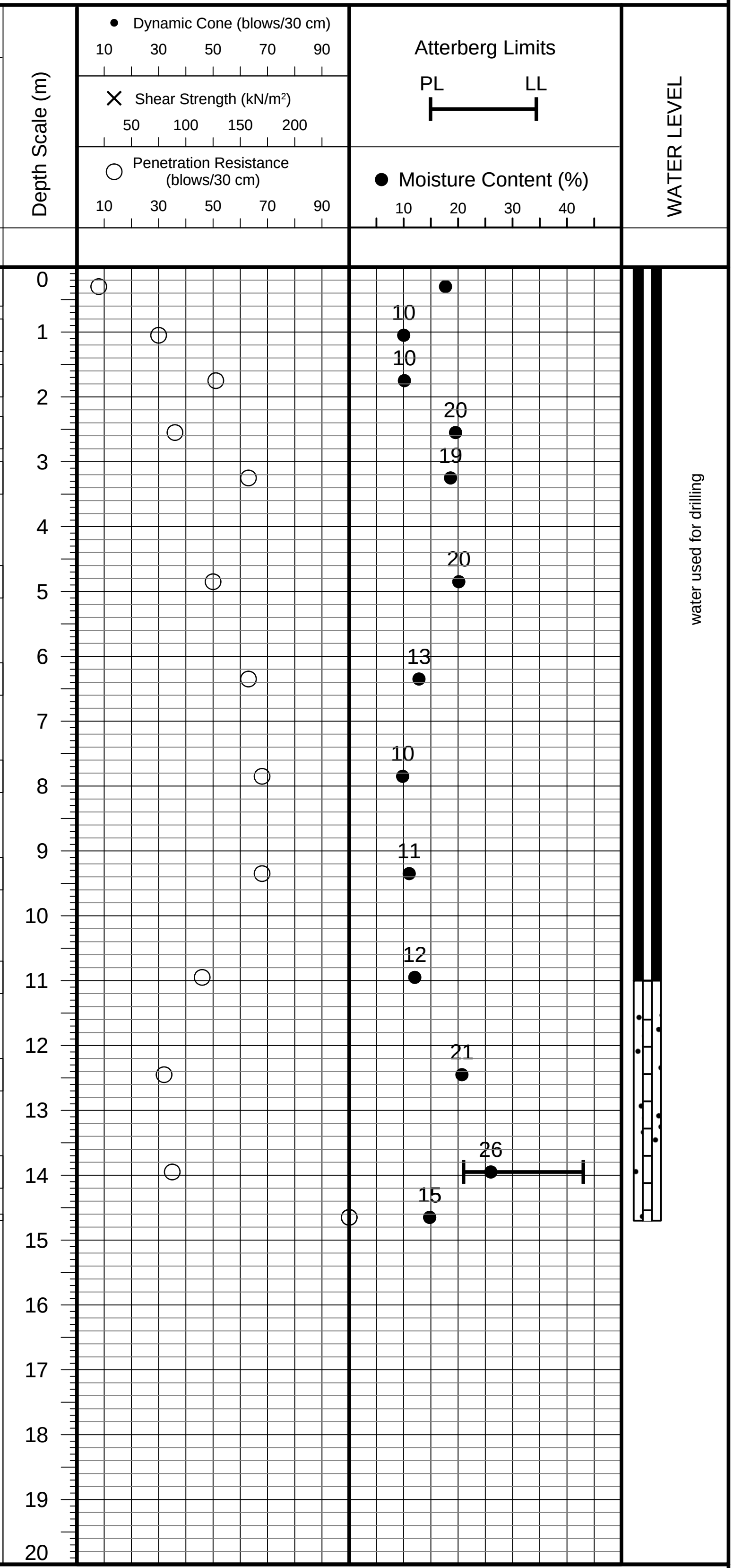
PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 5, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
96.9	Ground Surface			
0.0	**36 cm Topsoil**	1	DO	8
	Brown, very stiff to hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers weathered	2	DO	30
		3	DO	51
94.7 2.2	Hard **SILTY CLAY** a trace to some sand medium plasticity brown grey	4	DO	36
		5	DO	63
		6	DO	50
91.3 5.6	Grey, hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers	7	DO	63
		8	DO	68
		9	DO	68
		10	DO	46
85.2 11.7	Grey, hard **SILTY CLAY** a trace to some sand medium plasticity occ. shale fragments	11	DO	32
		12	DO	35
		13	DO	50/8
82.2 14.7	**END OF BOREHOLE** **due to auger refusal on probable bedrock** Installed 50 mm Ø monitoring well to 14.7 m completed with 3.1 m screen Sand backfill from 11.0 to 14.7 m Bentonite seal from 0.0 m to 11.0 m Provided with a monument steel casing			



Soil Engineers Ltd.

JOB NO.: 2204-S019

LOG OF BOREHOLE: 5

FIGURE NO.: 5

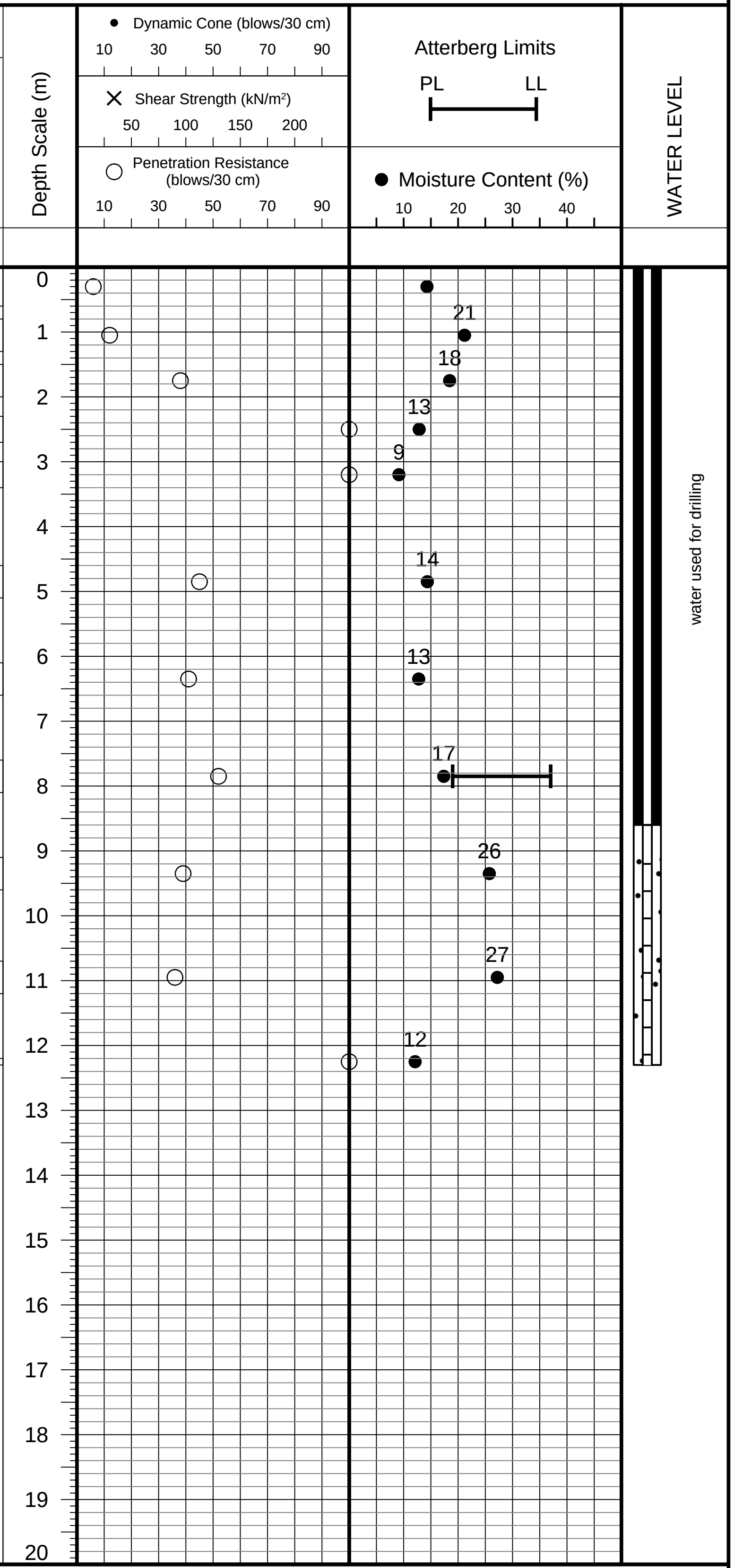
PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger
(Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 4, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
93.7	Ground Surface				
0.0	**60 cm Topsoil**	1	DO	6	0
	Stiff to hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers — — — weathered	2	DO	12	1
		3	DO	38	2
		4	DO	50/23	
		5	DO	50/25	3
	— — — brown grey				4
		6	DO	45	5
		7	DO	41	6
		8	DO	52	7 8
85.1 8.6	Grey, hard **SILTY CLAY** a trace to some sand medium plasticity	9	DO	39	9
		10	DO	36	10 11
	occ. shale fragments	11	DO	50/8	12
81.4 12.3	**END OF BOREHOLE** **due to auger refusal on probable bedrock** Installed 50 mm Ø monitoring well to 12.3 m completed with 3.1 m screen Sand backfill from 8.6 to 12.3 m Bentonite seal from 0.0 m to 8.6 m Provided with a monument steel casing				13 – 20



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JOB NO.: 2204-S019

LOG OF BOREHOLE: 6

FIGURE NO.: 6

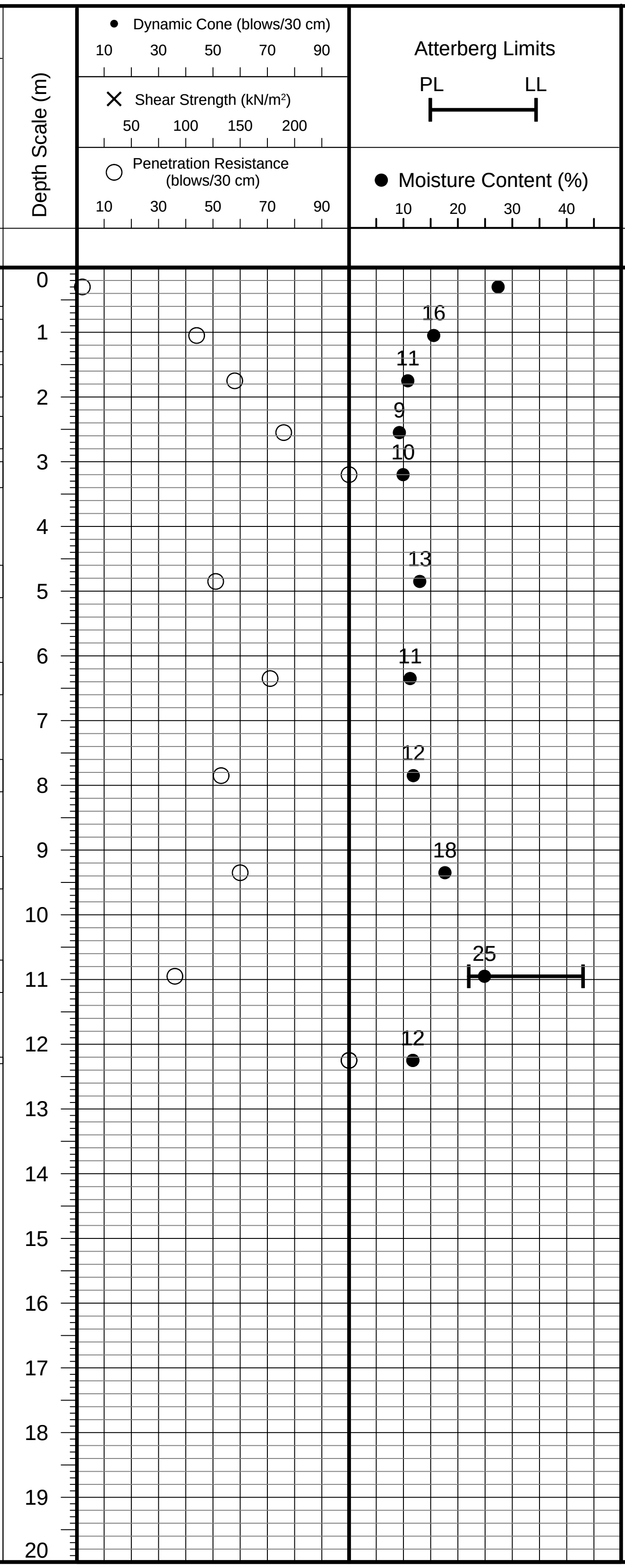
PROJECT DESCRIPTION: Proposed Mixed-Use Development

METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 6, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
94.0	Ground Surface			
0.0	**45 cm Topsoil**	1	DO	2
	Hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers weathered	2	DO	44
		3	DO	58
		4	DO	76
		5	DO	50/28
	brown grey			
		6	DO	51
		7	DO	71
		8	DO	53
		9	DO	60
83.9 10.1	Grey, hard **SILTY CLAY** a trace to some sand medium plasticity	10	DO	36
	occ. shale fragments	11	DO	50/8
81.7 12.3	**END OF BOREHOLE** **due to auger refusal on probable bedrock**			



WATER LEVEL

water used for drilling

Soil Engineers Ltd.

JOB NO.: 2204-S019

LOG OF BOREHOLE: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Mixed-Use Development

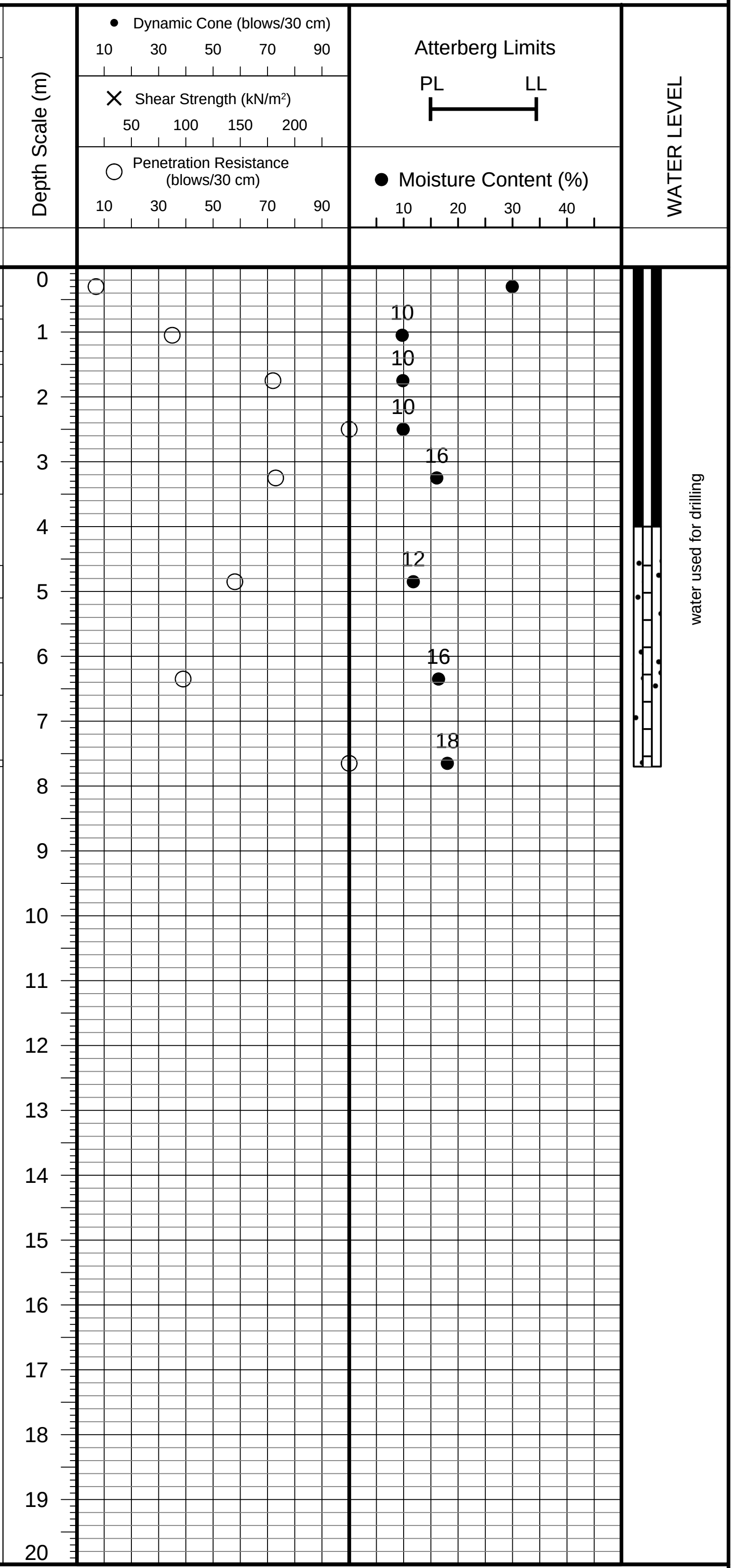
METHOD OF BORING: Flight Auger (Tricone)

PROJECT LOCATION: 875 Kingston Road, City of Pickering

DRILLING DATE: May 5, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
93.1	Ground Surface			
0.0	**60 cm Topsoil**	1	DO	7
	weathered Hard **SILTY CLAY TILL** some sand to sandy a trace of gravel occ. cobbles and boulders occ. sand and silt seams and layers	2	DO	35
		3	DO	72
		4	DO	50/28
		5	DO	73
	brown grey	6	DO	58
87.5 5.6	Grey, hard **SILTY CLAY** a trace to some sand medium plasticity	7	DO	39
85.4 7.7	occ. rock fragments	8	DO	50/5

END OF BOREHOLE
due to auger refusal on probable boulder
Installed 50 mm Ø monitoring well to 7.7 m
completed with 3.1 m screen
Sand backfill from 4.0 to 7.7 m
Bentonite seal from 0.0 m to 4.0 m
Provided with a monument steel casing



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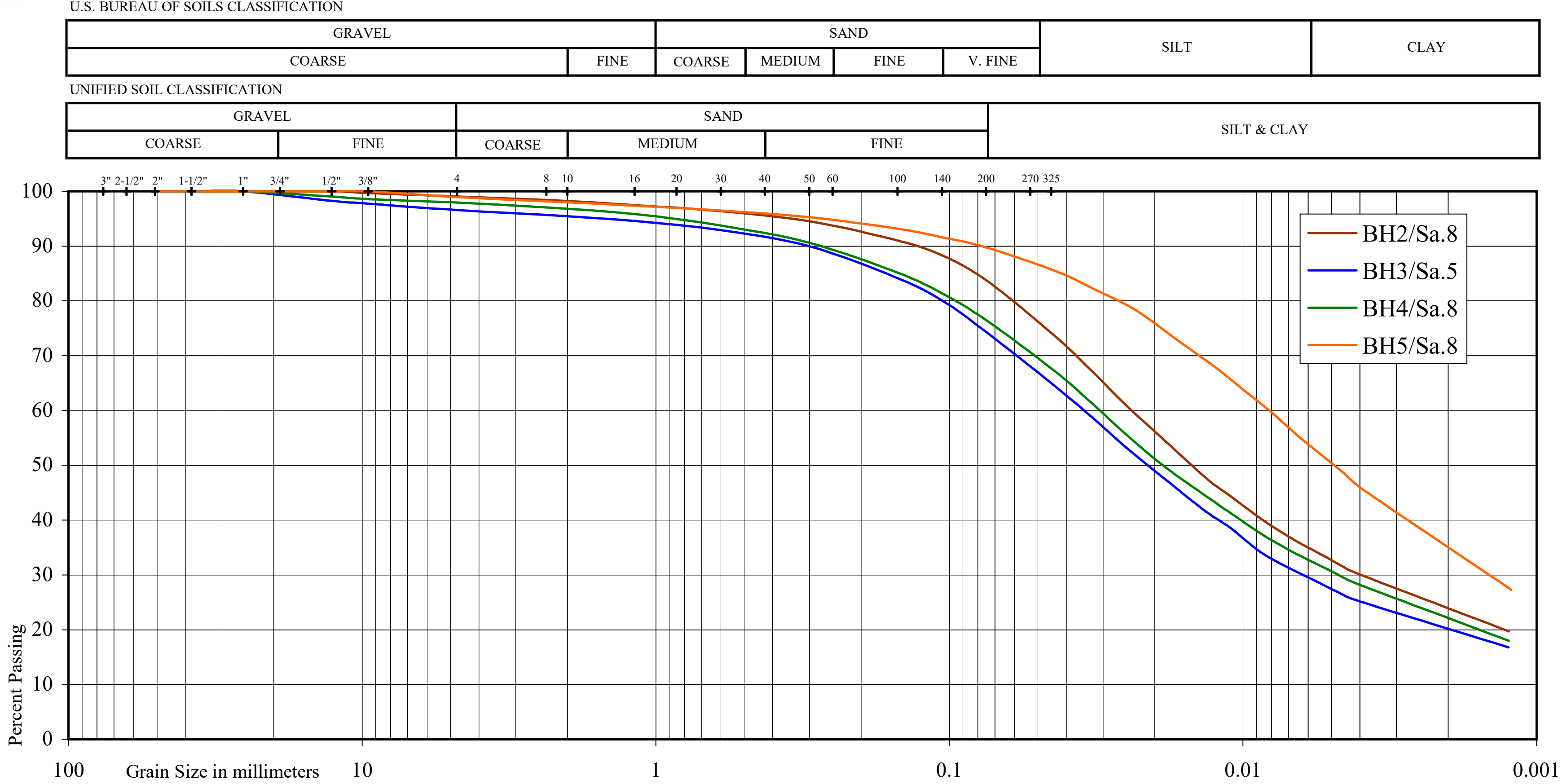
GRAIN SIZE DISTRIBUTION

Reference No: 2204-S019



Project: Proposed Mixed-Use Development

Location: 875 Kingston Road, City of Pickering

Borehole No:	2	3	4	5
Sample No:	8	5	8	8
Depth (m):	7.6	3.0	7.6	7.6
Elevation (m):	90.0	91.8	89.3	86.1

BH/Sa.:	2/8	3/5	4/8	5/8
Liquid Limit (%) =	-	-	-	37
Plastic Limit (%) =	-	-	-	19
Plasticity Index (%) =	-	-	-	18
Moisture Content (%) =	11	8	10	17
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY TILL

some sand to sandy, a trace of gravel

Figure 8

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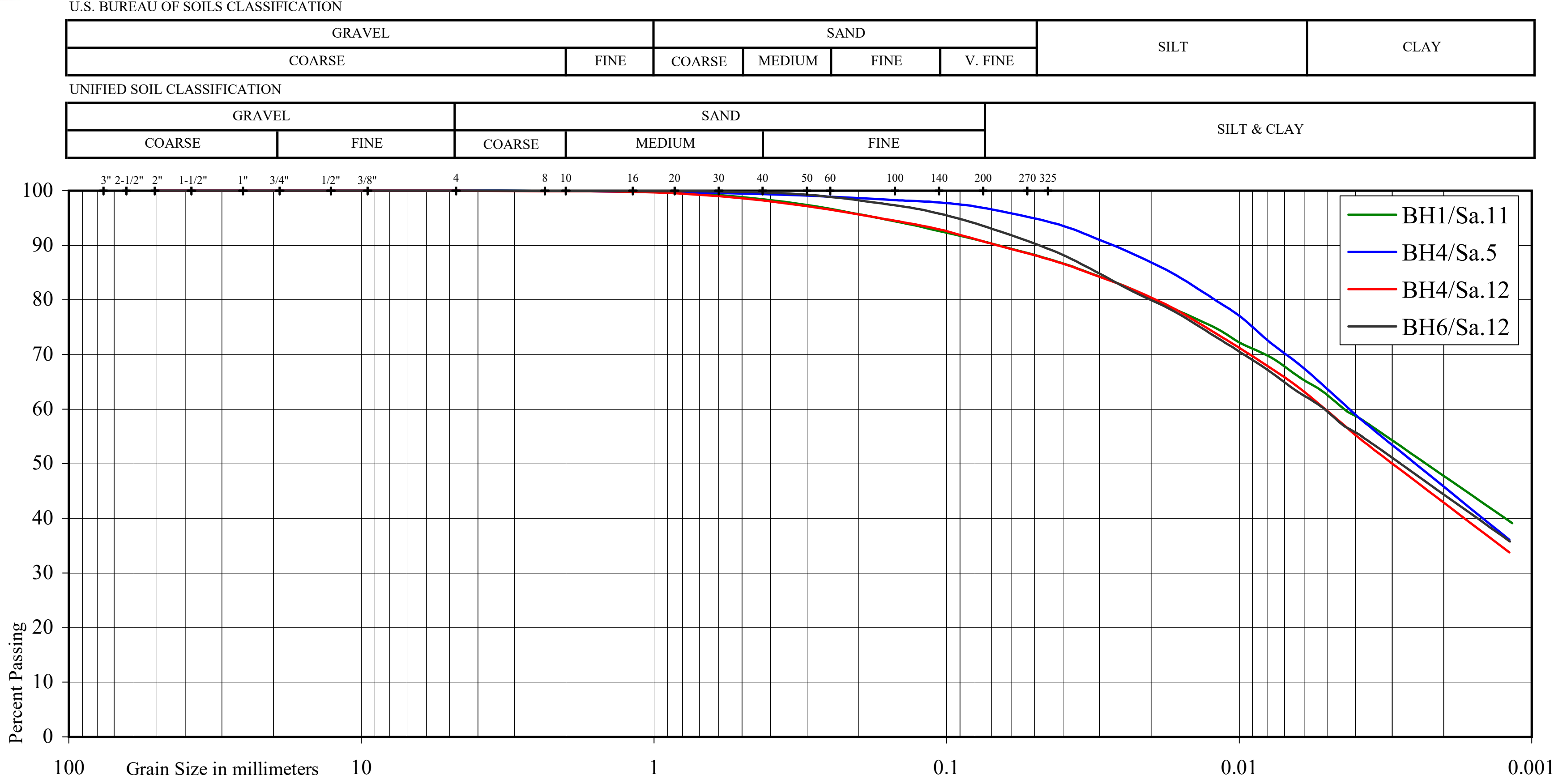
GRAIN SIZE DISTRIBUTION

Reference No: 2204-S019



Project: Proposed Mixed-Use Development

Location: 875 Kingston Road, City of Pickering

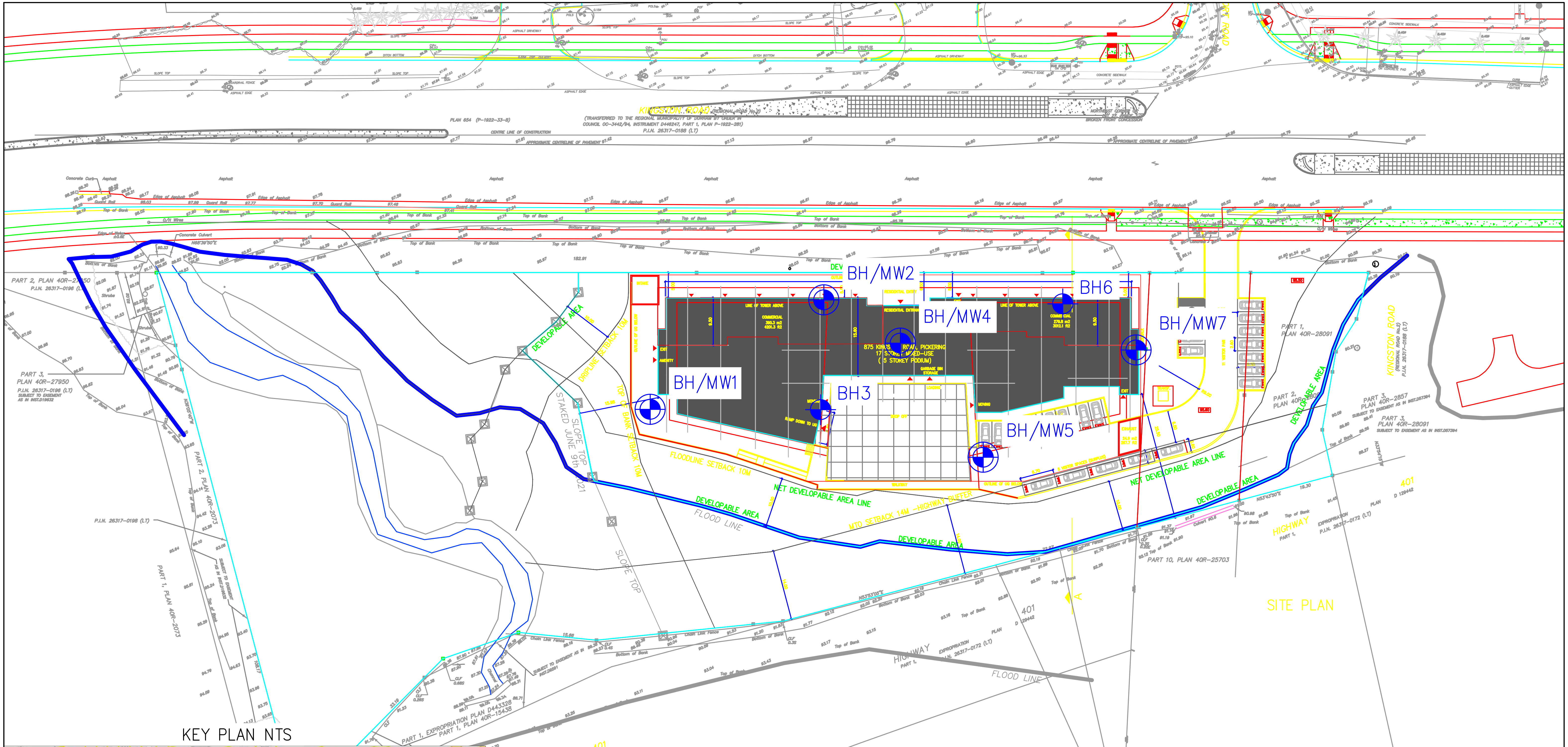
Borehole No:	1	4	4	6
Sample No:	11	5	12	10
Depth (m):	12.2	3.0	13.7	10.7
Elevation (m):	83	93.9	83.2	83.3

BH/Sa.:	1/11	4/5	4/12	6/10
Liquid Limit (%) =	43	-	43	42
Plastic Limit (%) =	22	-	22	22
Plasticity Index (%) =	21	-	21	20
Moisture Content (%) =	25	19	26	25
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}	10^{-7}

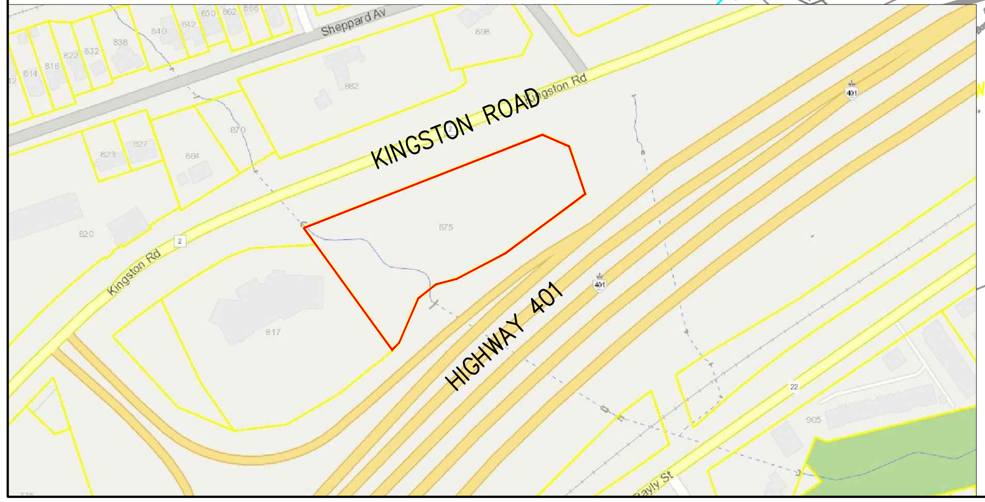
Classification of Sample [& Group Symbol]: SILTY CLAY

a trace to some sand

Figure 9



KEY PLAN NTS



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Borehole and Monitoring Well Location Plan

SITE: 875 Kingston Road, City of Pickering

DESIGNED BY: CR	CHECKED BY: KFL	DWG NO.: 1
SCALE: 1:750	REF. NO.: 2204-S019	DATE: July 2022	REV

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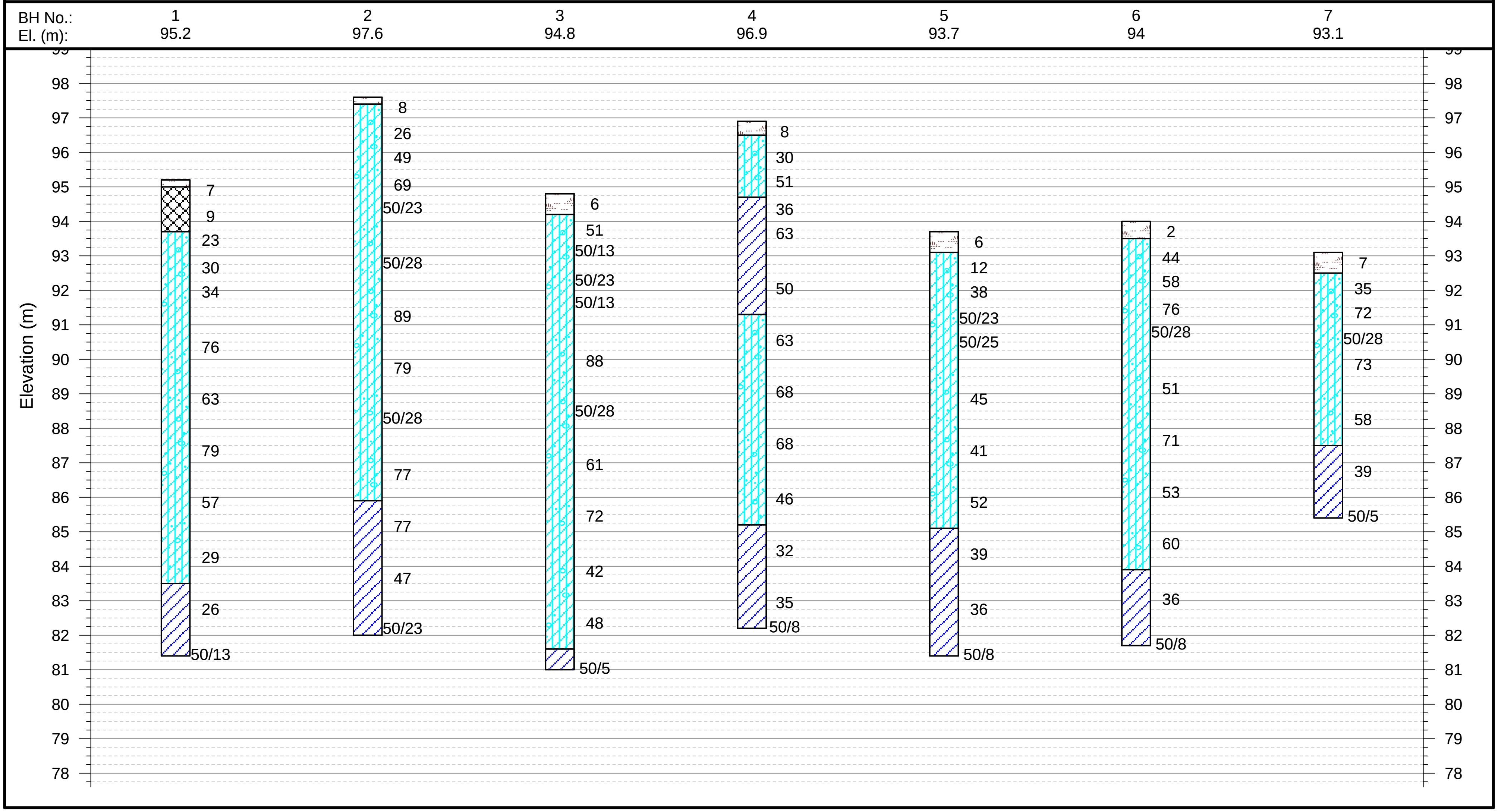
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

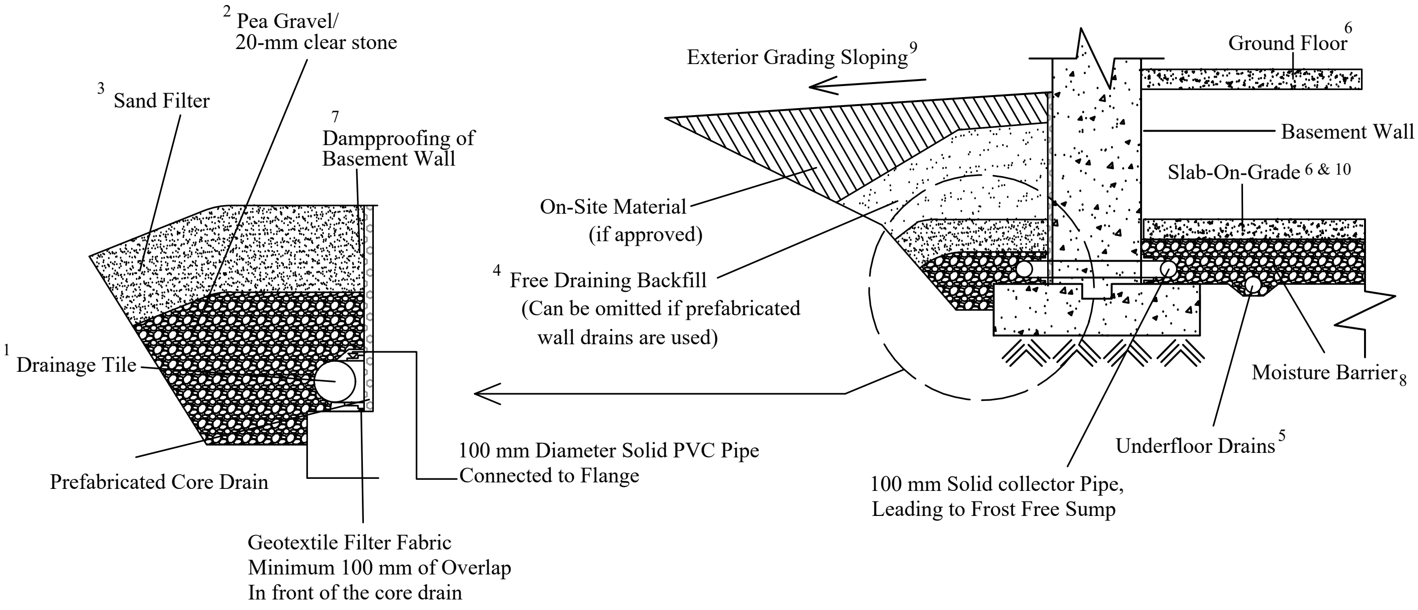
JOB NO.: 2204-S019
REPORT DATE: July 2022
PROJECT DESCRIPTION: Proposed Mixed-Use Development

PROJECT LOCATION: 875 Kingston Road, City of Pickering

LEGEND

▩ FILL ▨ SILTY CLAY ▥ SILTY CLAY TILL ▤ TOPSOIL





NOTES:

1. **Drainage tile**: consists of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet. Invert to be at minimum of 150 mm (6") below underside of basement floor slab.

2. **Pea gravel**: at 150 mm (6") on the top and sides of drain. If drain is not placed on concrete footing, provide 100 mm (4") of pea gravel below drain. The pea gravel may be replaced by 20 mm clear stone provided that the drain is covered by a porous geotextile membrane of Terrafix 270R or equivalent.

3. **Filter material**: consists of C.S.A. fine concrete aggregate. A minimum of 300 mm (12") on the top and sides of gravel. This may be replaced by an approved porous geotextile membrane of Terrafix 270R or equivalent.

4. **Free-draining backfill**: OPSS Granular 'B' or equivalent, compacted to 95% to 98% (maximum) Standard Proctor dry density. Do not compact closer than 1.8 m (6') from wall with heavy equipment. This may be replaced by on-site material if prefabricated wall drains (Miradrain) extending from the finished grade to the bottom of the basement wall are used.

5. **Underfloor drains*** should be placed in parallel rows at 6 to 8 m (20'-25') centre, on 100 mm (4") of pea gravel with 150 mm (6") of pea gravel on top and sides. The invert should be at least 300 mm (12") below the underside of the floor slab. The drains should be connected to positive sumps or outlets. Do not connect the underfloor drains to the perimeter drains.

6. **Do not backfill** until the wall is supported by the basement floor slab and ground floor framing, or adquate bracing.

7. **Dampproofing** of the basement wall is required before backfilling

8. **Moisture barrier**: 20-mm clear stone or compacted OPSS Granular 'A', or equivalent. The thickness of this layer should be 150 mm (6") minimum.

9. **Exterior Grade**: slope away from basement wall on all the sides of the building. Surface can be sodded immediately after construction.

10. **Slab-On-Grade** should not be structurally connected to walls or foundations.\

* Underfloor drains can be deleted where not required.

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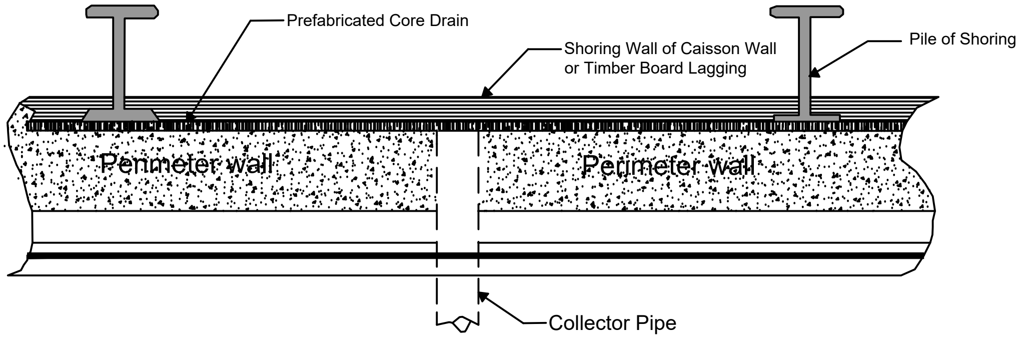
Details of Permanent Perimeter Drainage System

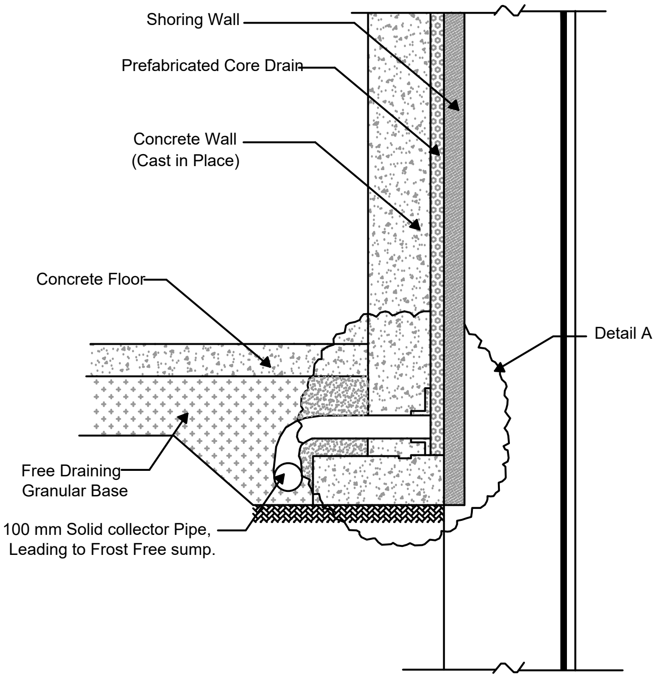
SITE 875 Kingston Road, City of Pickering

DESIGNED BY K.F.L. **CHECKED BY** B.S. **DWG NO.** 3

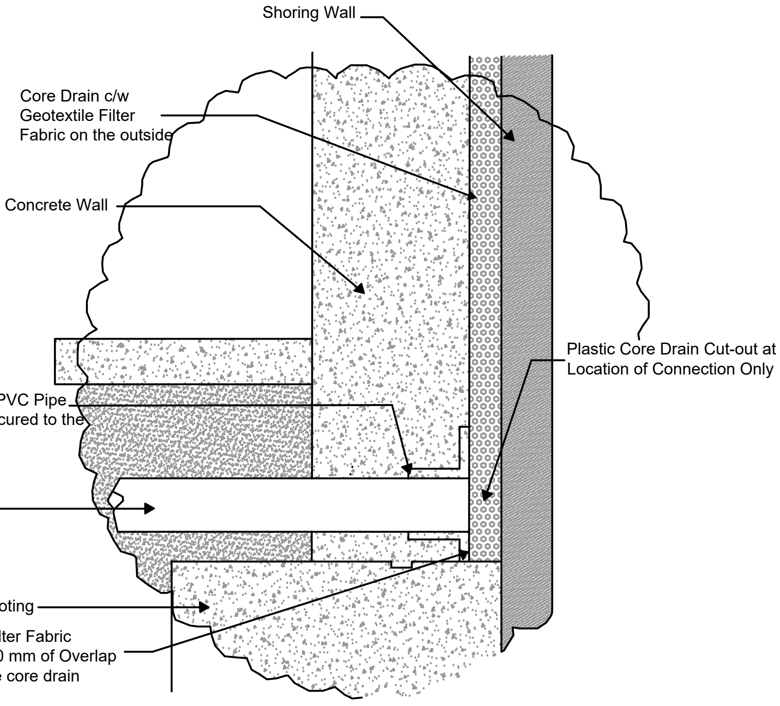
SCALE N.T.S. **REF. NO.** 2204-S019 **DATE** July 2022 **REV** -



PLAN



TYPICAL SECTION



DETAIL A

NOTES:

1. A continuous blanket of prefabricated drainage system, Miradrain 6000 or equivalent, should extend continuously from the top of footings to the ground surface.

2. All joints of the Miradrain should be taped. All openings above the concrete footing must be covered with filter fabric to prevent intrusion of fresh concrete into the core of the drain.

3. Backfill behind the lagging board must be free draining. Filter fabric or straw should be used to prevent loss of fines behind the lagging.

4. The perimeter drainage and any subfloor drainage systems must be kept separate.

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Permanent Perimeter Drainage System

SITE: 875 Kingston Road, City of Pickering

DESIGNED BY: K.F.L.	**CHECKED BY:** B.S.	**DWG NO.:** 4

SCALE: N.T.S.	**REF. NO.:** 2204-S019	**DATE:** July 2022	**REV** -

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FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

APPENDIX

SHORING DESIGN

REFERENCE NO. 2204-S019

SHORING SYSTEM

Shoring will be required in an excavation to limit the horizontal and vertical movements of adjacent properties.

A shoring system consisting of soldier piles and lagging boards can be used in an excavation where slight movement in the adjacent properties is tolerable. In an area with close proximity of adjacent structure and the excavation will be extending below the foundation level where any movement in the adjacent properties is a concern, or in an excavation embedding into saturated sand or silt deposit, an interlocking caisson wall is more appropriate.

The design and construction of the shoring system should be carried out by a specialist designer and contractor experienced in this type of construction. All specifications for the design of the shoring system should be in accordance with the latest edition of the Canadian Foundation Engineering Manual (CFEM).

LATERAL EARTH PRESSURE

For single and multiple level supporting systems, the lateral earth pressure distributions on the shoring walls are shown on Drawing A1. The design soil parameters are provided in the geotechnical report.

The lateral earth pressure expressions do not include hydrostatic pressure buildup behind the shoring. If the wall is designed to be watertight or undrained, such as a caisson wall, the anticipated hydrostatic pressure must be included behind the structure.

PILE PENETRATION

The depth of pile support should be calculated from the following expressions:

$$R = 9\ c_u\ D\ (L - 1.5\ D)$$

where

where	R = Ultimate Load to be restrained	(kN)
	D = Diameter of concrete filled hole	(m)
	L = Embedment depth of the pile	(m)
	c_u = Undrained shear strength of subsoil	(kPa)

The shoring system should be designed for a factor of safety of F = 2.

For anchor supported shoring system, the global factor of safety against sliding and overturning of the anchored block of soil must also be considered.

The steel soldier piles in the shoring system must be installed in pre-augured holes. The lower portion will have to be filled with 20 MPa (3000 psi) concrete to the excavation level. The upper portion of the pile within the excavation depth should be filled with lean mix concrete or non-shrinkable cementitious filler (U-fill).

LAGGING

The following thicknesses of lagging boards have been recommended in CFEM:

Thickness of Lagging	Maximum Spacing of Soldier Piles
50 mm (2 in)	1.5 m (5 ft)
75 mm (3 in)	2.5 m (8 ft)
100 mm (4 in)	3.0 m (10 ft)

Local experience has indicated that the lagging board thickness of 75 mm has been adequate for soldier pile spacing of 3 m for soil conditions similar to those encountered at the subject site. However, it is important to consider all local conditions, such as the duration of excavation, the weather likely to be encountered through the construction period, seasonal variations in the ground water and ice lensing causing frost heave and softening of soils in determining the lagging thickness. During winter months, the shoring should be covered with thermal blankets to prevent frost penetration behind the shoring system which may result in unacceptable movements.

During construction of shoring, all the spaces behind the lagging board must be filled with free-draining granular fill. If wet conditions are encountered, the space between the boards should be packed with a geotextile filter fabric or straw to prevent the loss of fine particles.

TIEBACK ANCHORS

The minimum spacing and the depths of the soil anchors should be as recommended in the CFEM.

All drilled holes for tieback anchors should be temporarily cased or lined to minimize the risk of caving. Systems involving high grout pressures should be avoided if working near other basements or buried services.

The tieback anchor lengths can be estimated using an adhesion values of 40 kPa. Full scale load tests should be carried out on the tieback anchors in each type of soils and at each level of anchor support at the site to confirm the design parameters and the adhesion values. The test anchors should be loaded in a pattern as described in CFEM, to 200% of the design load or until there is a significant increase in the pullout rate. In the latter case, the design load must be limited to 50% of the maximum load at which the pullout increases. Based on the results of the pullout test, it may be necessary to modify the anchor design of the production anchors.

Each tieback anchor must be proof-loaded to 133% of the design load, and the anchor must be capable of sustaining this load for a minimum of 10 minutes without creep. The load may then be relaxed to 100% of the design and locked in. The higher the lock-in loads, the less will be the outward movement on the shoring wall after excavation.

RAKERS

An alternative to tieback anchor support of the shoring is to use raker footings. Rakers inclining at an angle of 45º, founded in the native soil deposit below the bottom of excavation should be designed for the allowable bearing pressure of 300 kPa (6.0 k.s.f.).

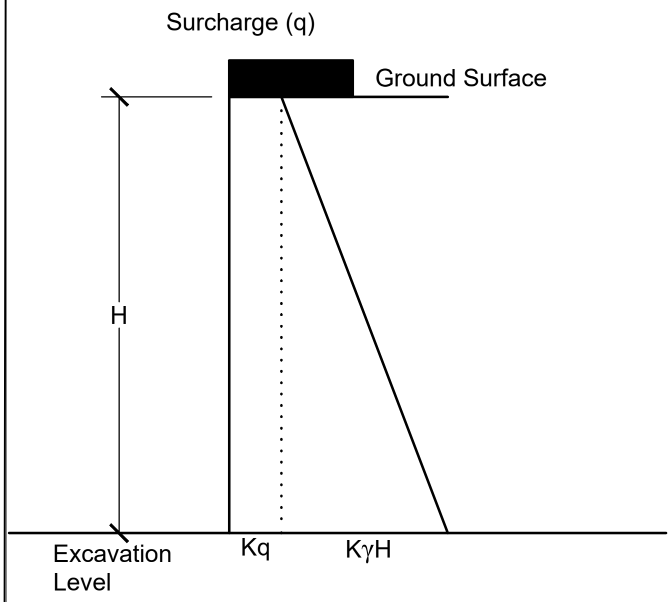
The raker footings should be located outside the zone of influence of the buried portion of the soldier piles at a distance of not less than 1.5 of the length of embedment of the soldier pile.

To prevent undermining of the raker footing, no excavation should be made within two times the width of raker footing on the opposite side of the raker.

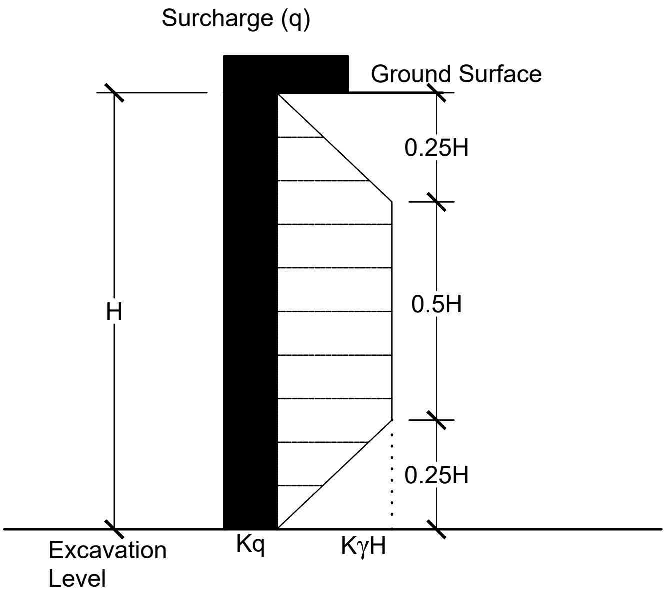
MONITORING OF PERFORMANCE

Close monitoring of the vertical and lateral movement of the shoring system, by inclinometers or by survey on targets, should be carried out at the site. Extra bracing or support may be required if any movement is found excessive. The contractor should maintain the shoring to ensure any movement is within the design limit.

TEMPORARY SHORING
Lateral Earth Pressures



Single Support System



Multiple Support System

Lateral Pressure $P = K (\gamma H + q)$

Where

H = Height of Shoring	m
γ = Unit Weight of Retained Soil	21 kN/m^3
q = Surcharge	kPa
K = Earth Pressure Coefficient	

- If moderate ground and shoring movements are permissible then:
  $K = K_a$ = Active Earth Pressure Coefficient

- if there are building foundations within a distance of 0.5 H behind the shoring then:
  $K = K_o$ = Earth Pressure at rest

- If there are building foundations within a distance of between 0.5 H and H behind the shoring then:
  $K = 0.5 (K_a + K_o)$

Note:

1. The lateral pressure expression assumes effective drainage from behind the temporary shoring.
2. The earth pressure coefficients are specified in the geotechnical report.

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Temporary Shoring

SITE: 875 Kingston Road, City of Pickering

DESIGNED BY: K.F.L. | **CHECKED BY:** B.S. | **DWG NO.:** A1

SCALE: N.T.S. | **REF. NO.:** 2204-S019 | **DATE:** July 2022 | **REV** -