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TOWN OF CALEDON
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March 12, 2026

A REPORT TO MOSAIK HOMES

A GEOTECHNICAL INVESTIGATION FOR PROPOSED TOWNHOUSE DEVELOPMENT

12944 ALBION VAUGHAN ROAD

TOWN OF BOLTON

REFERENCE NO. 1708-S156

NOVEMBER 2017

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1.0 **INTRODUCTION**

In accordance with written authorization dated August 29, 2017, from Mr. Goffredo Vitullo, President of Mosaic Homes, a geotechnical investigation was carried out at 12944 Albion Vaughan Road, in the Town of Bolton, for a proposed Townhouse Development.

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 the proposed project.

The findings and resulting geotechnical recommendations are presented in this Report.



2.0 **SITE AND PROJECT DESCRIPTION**

The site is situated on Halton-Peel till plain, where the drift dominates the soil stratigraphy. In places, lacustrine sand, silt, clay and drift which has been reworked by the water action of Peel Ponding (glacial lake) have modified the drift stratigraphy.

The subject property is irregular in shape and is situated at the northeast corner of Albion Vaughan Road and Queensgate Boulevard, in the Town of Bolton. The site is currently occupied by two buildings; the project area is generally grass-covered with some trees. The site ground surface is relatively flat and level, with some undulations.

The proposed project consists of the demolition of existing buildings and the construction of a new townhouse development, which will be provided with municipal services and paved roadways meeting urban standards.



3.0 **FIELD WORK**

The field work, consisting of 5 boreholes to a depth of 6.6 m, was performed on September 27, 2017, at the locations shown on the Borehole Location Plan, Drawing No. 1. A total of 4 monitoring wells were also installed at the location of Boreholes 1 (nested well), 2 and 5 for hydrogeological study.

The holes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed “List of Abbreviations and Terms”, were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or ‘N’ values) of the subsoil. The relative density of the granular strata and the consistency of the cohesive strata are 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.

The elevation at each of the borehole locations was determined from the spot elevations on the site plan provided by the client.



4.0 **SUBSURFACE CONDITIONS**

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 5, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2, and the engineering properties of the disclosed soils are discussed herein.

The investigation has disclosed that beneath a veneer of topsoil and a layer of earth fill, in places, the site is underlain by a stratum of silty clay.

4.1 **Topsoil** (All Boreholes)

The revealed topsoil veneer is 13 cm and 18 cm in thickness; thicker topsoil may occur in places. It is dark brown in colour, indicating that it contains appreciable amounts of roots and humus. These materials are unstable and compressible under loads; therefore, the topsoil is considered void of engineering value. Due to its humus content, it will generate an offensive odour and may produce volatile gases under anaerobic conditions. Therefore, the topsoil must not be buried below any structures or deeper than 1.2 m below the finished grade so it will not have an adverse impact on the environmental well-being of the developed areas.

Since the topsoil is considered void of engineering value, it can only be used for general landscaping and landscape contouring purposes.

4.2 **Earth Fill** (Boreholes 3, 4 and 5)

The earth fill extends to a depth of 0.7 m beneath the prevailing ground surface. The fill consists of silty sand, with occasional topsoil inclusions.



The obtained 'N' values for the fill range from 4 to 16, with a median of 6 blows per 30 cm of penetration, indicating that it was loosely placed with nominal compaction and has since partially self-consolidated.

The natural water content values range from 9% to 24%, with a median of 18%, confirming the moist to wet condition, as determined by the sample examinations.

A grain size analysis was performed on 1 representative sample of the earth fill and the result is plotted on Figure 6.

Due to its non-uniform and loose density, the earth fill is considered unsuitable for supporting structures. For structural use, the fill must be subexcavated sorted free of topsoil and any deleterious material and properly compacted.

One must be aware that the samples retrieved from boreholes 10 cm in diameter may not be truly representative of the geotechnical and environmental quality of the fill, and do not indicate whether the topsoil beneath the earth fill was completely stripped. This should be further assessed by laboratory testing and/or test pits.

4.3 **Silty Clay** (All Boreholes)

The silty clay was encountered beneath either a veneer of topsoil or a layer of earth fill and extends to the maximum investigated depth at all boreholes. It is laminated with sand and silt seams and layers, showing that it is a glaciolacustrine deposit.

The upper clay layer is weathered to depths of 0.7 m and 1.4 m below the prevailing ground surface.



The obtained 'N' values range from 8 to 44, with a median of 28 blows per 30 cm of penetration, indicating that the consistency of the clay is firm to hard, being generally very stiff. The firm clay occurred within the weathered zone.

The Atterberg Limits of 2 of the silty clay samples and the water content value of all the samples were determined. The results are plotted on the Borehole Log and summarized below:

Liquid Limit	42% and 45%
Plastic Limit	21% and 22%
Natural Water Content	13% to 25% (median 18%)

The above results show that the clay is a cohesive material with low to medium plasticity. The natural water content values generally lie below its plastic and liquid limits, confirming the generally very stiff consistency of the clay as determined from the 'N' values.

Grain size analyses were performed on 3 representative samples of the silty clay and the resulting gradations are plotted on Figure 7.

Based on the above findings, the following engineering properties are deduced:

- High frost susceptibility and high soil-adsfreezing potential.
- Low water erodibility.
- Low permeability, with an estimated coefficient of permeability of 10^{-7} cm/sec, an estimated percolation rate of over 80 min/cm, and runoff coefficients of:

**Slope**

0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive-frictional soil, its shear strength is derived from consistency and augmented by the internal friction of the silt. Its shear strength is moisture dependent.
- In excavation, the clay will be prone to sloughing if it is exposed for prolonged periods in steep cuts. This would generally be initiated by infiltrating precipitation or groundwater seeping out from the silt and fine sand layers.
- A very poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 3% or less.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 3500 ohm-cm.

4.4 **Compaction Characteristics of the Revealed Soils**

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied.

As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

**Table 1** - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	9 to 24 (median 18)	12	8 to 17
Silty Clay	13 to 25 (median 18)	16	12 to 21

Based on the above findings, the majority of the soil is generally suitable for 95% or + Standard Proctor compaction. However, some of the clay and earth fill is too wet and will require prior aeration in dry, warm weather or mixing with drier inorganic soils for proper compaction. The earth fill must be sorted free of topsoil inclusions and any deleterious materials prior to use as structural fill.

The silty clay should be compacted using a heavy-weight, kneading-type roller. The silty sand fill can be compacted by a smooth roller with or without vibration, depending on the water content of the soil being compacted. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

When compacting the clay on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soil and be transmitted laterally into the soil mantle. Therefore, the lifts of this soil must be limited to 20 cm or less (before compaction). It is difficult to monitor the lifts of backfill placed in deep trenches; therefore, it is preferable that the compaction of backfill at depths over 1.0 m below the pavement subgrade be carried out on the wet side of the optimum. This would allow a wider latitude of lift thickness. Wetting of the tills may be necessary to achieve this requirement.



If the compaction of the soil is carried out with the water content within the range for 95% Standard Proctor dry density but on the wet side of the optimum, the surface of the compacted soil mantle will roll under the dynamic compactive load. This is unsuitable for pavement construction since each component of the pavement structure is to be placed under dynamic conditions which will induce the rolling action of the subgrade surface and cause structural failure of the new pavement. The foundation or bedding of the sewer and slab-on-grade will be placed on a subgrade which will not be subjected to impact loads. Therefore, the structurally compacted soil mantle with the water content on the wet side or dry side of the optimum will provide an adequate subgrade for the construction.



5.0 **GROUNDWATER CONDITIONS**

No groundwater was detected and all boreholes remained dry upon completion of site investigation.

The groundwater yield from the silty clay, if any, due to its low permeability, is expected to be small and limited.



6.0 **DISCUSSION AND RECOMMENDATIONS**

The investigation has disclosed that beneath a veneer of topsoil and a layer of earth fill, in places, the site is underlain by a stratum of firm to hard, generally very stiff silty clay. The surficial soil layer is weathered to depths of 0.7 m and 1.4 m below the prevailing ground surface.

No groundwater was detected and all boreholes remained dry upon completion of site investigation.

The groundwater yield from the silty clay, if any, due to its low permeability, is expected to be small and limited.

The geotechnical findings which warrant special consideration are presented below:

1. The topsoil will generate volatile gases under anaerobic conditions and is unsuitable for engineering applications. For the environmental as well as the geotechnical well-being of the future development, the topsoil should not be buried deeper than 1.2 m below the proposed finished grade, or below any structure.
2. The earth fill in its present condition is not capable of supporting any structures susceptible to settlement. It must be upgraded to structural status by sorting it free of topsoil and any deleterious material and by proper compaction.
3. The sound natural soil is suitable for normal spread and strip footing construction. Due to the presence of topsoil, earth fill and weathered soil, the footing subgrade must be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that its condition is compatible with the design of the foundation.



4. For basement construction, perimeter subdrains and dampproofing of the foundation walls will be required. All the subdrains must be encased in a fabric filter to protect them against blockage by silting, and they must be connected to a positive outlet.
5. For slab-on-grade construction, any loose earth fill and weathered, soft or loose soils should be subexcavated, aerated and properly compacted for slab subgrade. Any new material for raising the grade should consist of organic-free soil compacted to at least 98% of its maximum Standard Proctor dry density. The slab should be constructed on a granular base, 20 cm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to its maximum Standard Proctor dry density.
6. A Class 'B bedding, consisting of compacted 20-mm Crusher-Run Limestone, is recommended for the construction of the underground services. The sewer joints should be leak-proof, or wrapped with an appropriate waterproof membrane, to prevent subgrade migration.
7. The silty clay on site is highly frost susceptible, with high soil-adfreezing potential. Where this soil is used to backfill against foundation walls, special measures must be incorporated into the building construction to prevent serious damage due to soil adfreezing.

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

Based on the borehole findings, it is recommended that normal spread and strip footings for the proposed townhouse buildings must be placed below the topsoil, earth fill and weathered soil onto the sound natural native soils. The recommended soil pressures and the corresponding suitable founding levels are given in Table 2.

Table 2 - Founding Levels

BH No.	Recommended Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Corresponding Founding Level	
	200 kPa (SLS) 320 kPa (ULS)	
	Depth (m)	El. (m)
1	1.0 or +	243.1 or -
2	1.0 or +	245.2 or -
3	1.0 or +	246.2 or -
4	1.0 or +	243.7 or -
5	1.6 or +	243.6 or -

The recommended soil pressures (SLS) for normal foundations incorporate a safety factor of 3. The total and differential settlements of the foundations are estimated to be 25 mm and 15 mm, respectively.

Due to the presence of topsoil, earth fill and weathered soil, the footing subgrade should be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that its condition is compatible with the foundation design requirements.



Foundations exposed to weathering or in unheated areas should be protected against frost action by a minimum of 1.2 m of earth cover, or must be properly insulated.

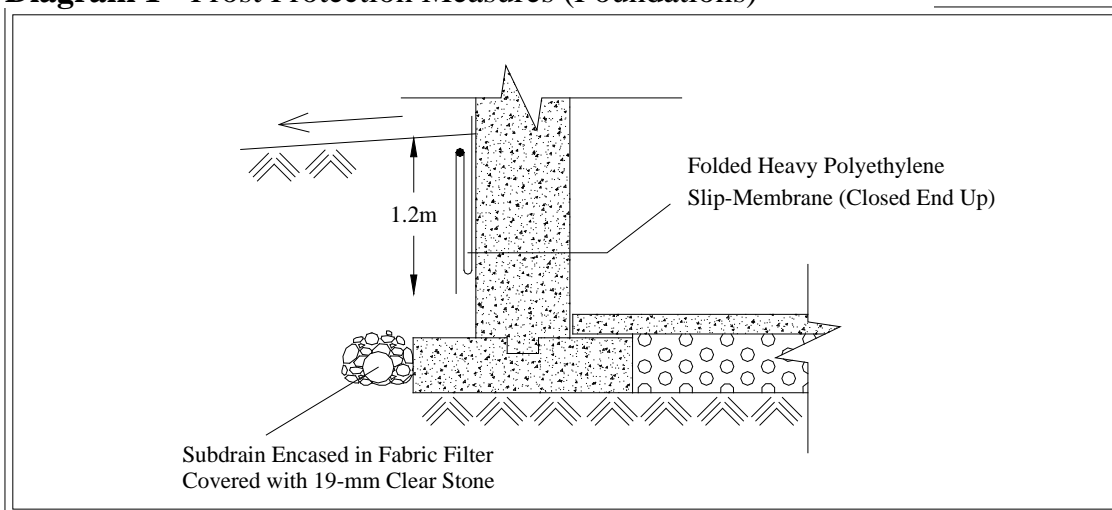
Where a basement is contemplated, perimeter subdrains and dampproofing of the foundation walls will be required. All the subdrains must be encased in a fabric filter to protect them against blockage by silting, and must be connected to a positive outlet. This can be assessed at the time of foundation construction.

The foundations must meet the requirements specified by the latest Ontario Building Code. The buildings must be designed to resist a minimum earthquake force using Site Classification 'D' (stiff soil).

The occurring silty clay is high in frost heave and soil-adfreezing potential. If this soil is to be used for the foundation backfill, the foundation walls should be shielded by a polyethylene slip-membrane for protection against soil adfreezing. The membrane will allow vertical movement of the heaving soil (due to frost) without imposing structural distress on the foundations.

The recommended measures are schematically illustrated in Diagram 1.

Diagram 1 - Frost Protection Measures (Foundations)





The implementation of the above recommendations should be determined by a building inspector or geotechnical technician or engineer at the time of construction.

6.2 **Engineered Fill**

Where earth fill is required to raise the site, it is generally more economical to place engineered fill for normal footings, sewer and road construction. The engineering requirements for a certifiable fill for road construction, municipal services, slab-on-grade, and footings designed with a Maximum Allowable Soil Pressure (SLS) of 150 kPa and a Factored Ultimate Soil Bearing Pressure (ULS) of 250 kPa for normal footings are presented below:

1. The topsoil must be removed. The earth fill and badly weathered soil must be subexcavated. The stripped surface must be inspected and surface compacted.
2. Inorganic soils must be used, and they must be uniformly compacted in lifts 20 cm thick to 98% or + of their maximum Standard Proctor dry density up to the proposed finished grade. The soil moisture must be properly controlled on the wet side of the optimum.
3. If imported fill is to be used, it should be inorganic soils, free of deleterious material with environmental issue (contamination). Any potential imported earth fill from off site must be reviewed for geotechnical and environmental quality by the appropriate personnel as authorized by the developer or agency, before it is hauled to the site.
4. If the house foundations are to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% of the maximum Standard Proctor compaction.



5. If the engineered fill is to be left over the winter months, adequate earth cover, or equivalent, must be provided for protection against frost action.
6. The engineered fill must extend over the entire graded area; the engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented by qualified surveyors. Foundations partially on engineered fill must be reinforced by two 15-mm steel reinforcing bars in the footings and upper section of the foundation walls, or be designed by a structural engineer, to properly distribute the stress induced by the abrupt differential settlement (about 15 mm) between the natural soil and engineered fill.
7. The engineered fill must not be placed during the period from late November to early April when freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
8. Where the fill is to be placed on a bank steeper than 1 vertical:3 horizontal, the face of the bank must be flattened to 3 + so that it is suitable for safe operation of the compactor and the required compaction can be obtained.
9. Where the ground is wet due to subsurface water seepage, an appropriate subdrain scheme must be implemented prior to the fill placement, particularly if it is to be carried out on sloping ground.
10. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.
11. The footing and underground services subgrade must be inspected by the geotechnical consulting firm that supervised the engineered fill placement. This is to ensure that the foundations are placed within the engineered fill envelope, and the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.



12. Any excavation carried out in certified engineered fill must be reported to the geotechnical consultant who supervised the fill placement in order to document the locations of excavation and/or to supervise reinstatement of the excavated areas to engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.
13. Despite stringent control in the placement of the engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the strip footings and the upper section of the foundation walls constructed on the engineered fill may require continuous reinforcement with steel bars, depending on the uniformity of the soils in the engineered fill and the thickness of the engineered fill underlying the foundations. Should the footings and/or walls require reinforcement, the required number and size of reinforcing bars must be assessed by considering the uniformity as well as the thickness of the engineered fill beneath the foundations. In sewer construction, the engineered fill is considered to have the same structural proficiency as a natural inorganic soil.

6.3 **Slab-On-Grade**

For slab-on-grade construction, the subgrade must consist of sound natural soils, or properly compacted inorganic soils to at least 98% of its maximum Standard Proctor dry density. The slab should be constructed on a granular base, 20 cm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to its maximum Standard Proctor dry density.

The sound natural soils are suitable for slab-on-grade construction. The weathered soils should be aerated and surface compacted for slab-on-grade construction.



A Modulus of Subgrade Reaction of 25 MPa/m is recommended for the design of the floor slab.

The ground around the buildings must be graded to direct water away from the structure to minimize the frost heave phenomenon generally associated with the disclosed soils.

6.4 **Underground Services**

The subgrade for the underground services should consist of natural soil or compacted organic-free earth fill. Where topsoil, earth fill and badly weathered soil are encountered, these materials must be subexcavated and replaced with properly compacted bedding material.

A Class 'B' bedding is recommended for construction of the underground services. The bedding material should consist of compacted 20-mm Crusher-Run Limestone, or its equivalent.

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

The pipe joints should be leak-proof or they should be provided with a waterproof membrane. This is to prevent the migration of fines due to leaks from faulty joints.

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



Since the silty clay has moderately high corrosivity to buried metal, the water main should be protected against corrosion. In determining the mode of protection, an electrical resistivity of 3500 ohm·cm should be used. This, however, should be confirmed by testing the soil along the water main alignment at the time of sewer construction.

6.5 **Trench Backfilling**

The on site inorganic soil is suitable for trench backfill. In the zone within 1.0 m below the pavement subgrade, the backfill should be compacted to at least 98% of its maximum Standard Proctor dry density with the moisture content 2% to 3% drier than the optimum. In the lower zone, a 95% or + Standard Proctor compaction is considered to be adequate; however, the material must be compacted on the wet side of the optimum. Backfill in the slab area must be compacted to 98% or + of its maximum Standard Proctor dry density.

In normal underground services construction practice, the problem areas of road settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns, and it is recommended that a sand backfill be used.

The narrow trenches should be cut at 1 vertical:2 or + horizontal so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement of proper compaction. 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.

One must be aware of the possible consequences during trench backfilling and exercise caution as described below:



- When construction is carried out in freezing winter weather, allowance should be made for these following conditions. Despite stringent backfill monitoring, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in situ soil have a water content on the dry side of the optimum, it would be impossible to wet the soil due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction. Furthermore, the freezing condition will prevent flooding of the backfill when it is required, such as in a narrow vertical trench section, or when the trench box is removed. The above will invariably cause backfill settlement that may become evident within 1 to several years, depending on the depth of the trench which has been backfilled.
- In areas where the underground services construction is carried out during winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement and the slab-on-grade construction.
- To backfill a deep trench, one must be aware that future settlement is to be expected, unless the side of the cut is flattened to at least 1 vertical: 1.5 + horizontal, and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 95% of the maximum Standard Proctor dry density, with the moisture content on the wet side of the optimum.
- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand. In a trench stabilized by a trench box, the void left after the removal of the box will be filled by the



backfill. It is necessary to backfill this sector with sand, and the compacted backfill must be flooded for 1 day, prior to the placement of the backfill above this sector, i.e., in the upper sloped trench section. This measure is necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section. In areas where groundwater movement is expected in the sand fill mantle, anti-seepage collars should be provided.

6.6 Pavement Design

Based on the borehole findings, the recommended pavement design for the local residential road is given in Table 3.

Table 3 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	50	HL-8
Granular Base	150	20-mm Crusher-Run Limestone or equivalent
Granular Sub-base Light-Duty	300	50-mm Crusher-Run Limestone or equivalent
Heavy-Duty	400	

In preparation of the subgrade, the subgrade surface should be proof-rolled and any soft subgrade, organics and deleterious materials within 1.0 m below the underside of the granular sub-base should be subexcavated and replaced by properly compacted organic-free earth fill or granular material.



All the granular bases should be compacted to their maximum Standard Proctor dry density.

In the zone within 1.0 m below the pavement subgrade, the backfill should be compacted to at least 98% of its maximum Standard Proctor dry density, with the water content 2% to 3% drier than the optimum. In the lower zone, a 95% or + Standard Proctor compaction is considered adequate.

Along the perimeter where surface runoff may drain onto the pavement, or water may seep into the granular base, a swale or an intercept subdrain system should be installed. Subdrains, consisting of filter-wrapped weepers, should also be installed below the granular sub-base and they should be connected to the catch basins and storm manholes in the paved areas and backfilled with free-draining granular material.

6.7 **Sidewalks, Interlocking Stone Pavement and Landscaping**

Interlocking stone pavement and the sidewalks in areas which are sensitive to frost-induced ground movement, such as entrances, must be constructed on a free-draining, non-frost-susceptible granular material such as Granular 'B'. It must extend to 1.2 m below the slab or pavement surface and be provided with positive drainage such as weeper subdrains connected to the storm system. Alternatively, the sidewalks and pavement should be insulated with 50-mm Styrofoam, or equivalent.

6.8 **Soil Parameters**

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

**Table 4 - Soil Parameters**

<u>Unit Weight and Bulk Factor</u>	Unit Weight (kN/m³)	<u>Estimated Bulk Factor</u>	
	Bulk	Loose	Compacted
Earth Fill and weathered Soil	21.0	1.20	1.00
Silty Clay	20.5	1.30	1.00

	<u>Lateral Earth Pressure Coefficients</u>		
	Active K_a	At Rest K_o	Passive K_p
Earth Fill and weathered Soil	0.45	0.55	2.22
Silty Clay	0.40	0.50	2.50

6.9 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91.

Excavations in excess of 1.2 m should be sloped at 1 vertical:1 horizontal for stability.

For excavation purposes, the types of soils are classified in Table 5.

Table 5 - Classification of Soils for Excavation

Material	Type
Very stiff to hard Silty Clay	2
Earth Fill and weathered Soil	3

The groundwater yield from silty clay, if any, due to its low permeability, will be small and limited and can be controlled by pumping from sumps.



Prospective contractors must be asked to assess the in situ subsurface conditions for soil cuts by digging test pits to at least 0.5 m below the intended bottom of excavation. These test pits should be allowed to remain open for a period of at least 4 hours to assess the trenching conditions.



7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Mosaik Homes, and for review by their designated agents, financial institutions, and government agencies. Use of the report is subject to the conditions and limitations of the contractual agreement. The material in the report reflects the judgment of Frank Lee, P.Eng., and Daniel Man, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, and/or any reliance on decisions to be made based on it are 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.

SOIL ENGINEERS LTD.

Frank Lee, P.Eng.



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

SOIL DESCRIPTION

Cohesionless Soils:

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

Cohesive Soils:

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 '—●—'

Undrained Shear Strength (ksf)

less than 0.25
0.25 to 0.50
0.50 to 1.0
1.0 to 2.0
2.0 to 4.0
over 4.0

'N' (blows/ft)

0 to 2
2 to 4
4 to 8
8 to 16
16 to 32
over 32

Consistency

very soft
soft
firm
stiff
very stiff
hard

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

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



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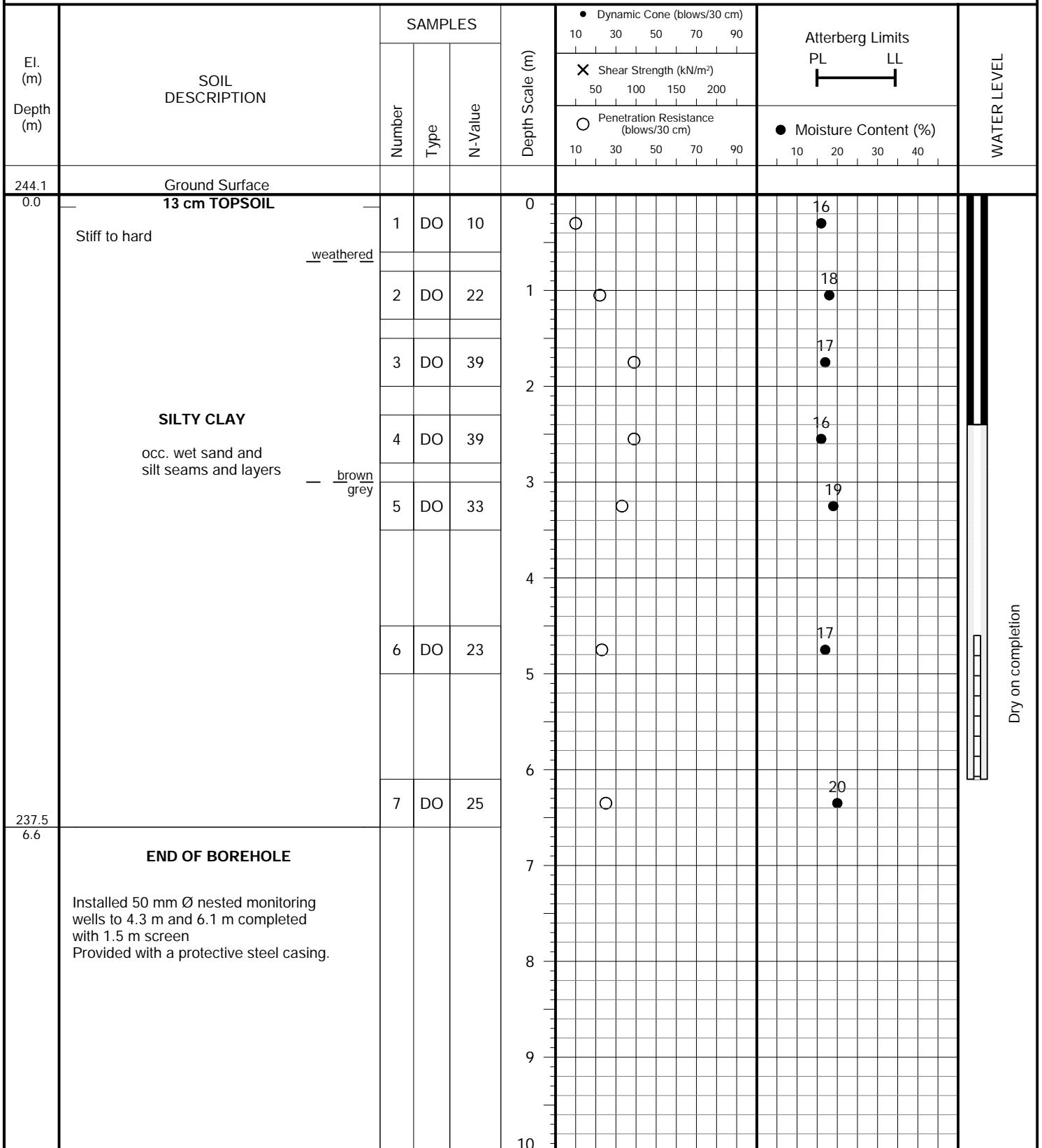
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

PROJECT DESCRIPTION: Proposed Townhouse Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: 12944 Albion Vaughan Road, Town of Bolton

DRILLING DATE: September 27, 2017

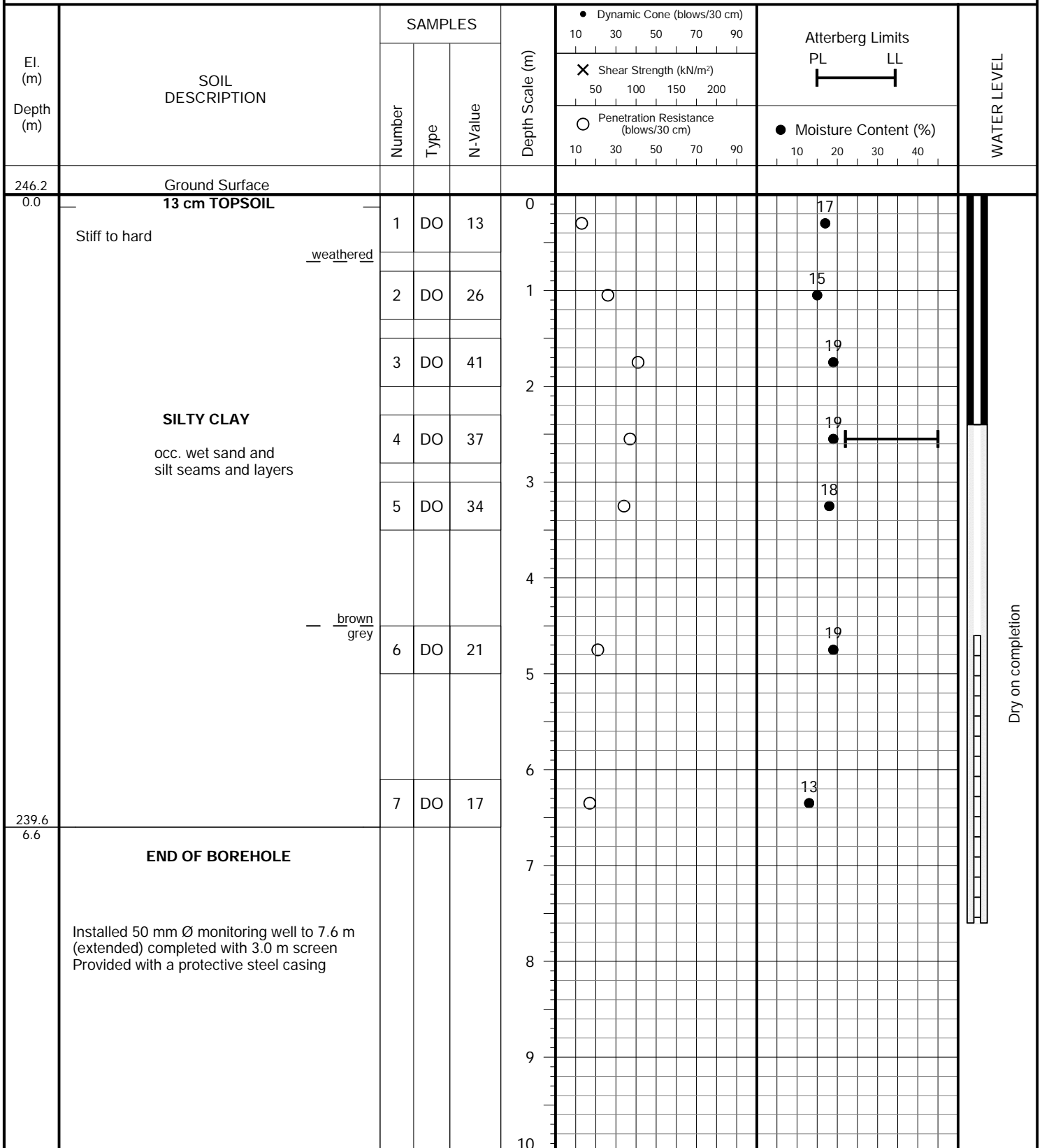


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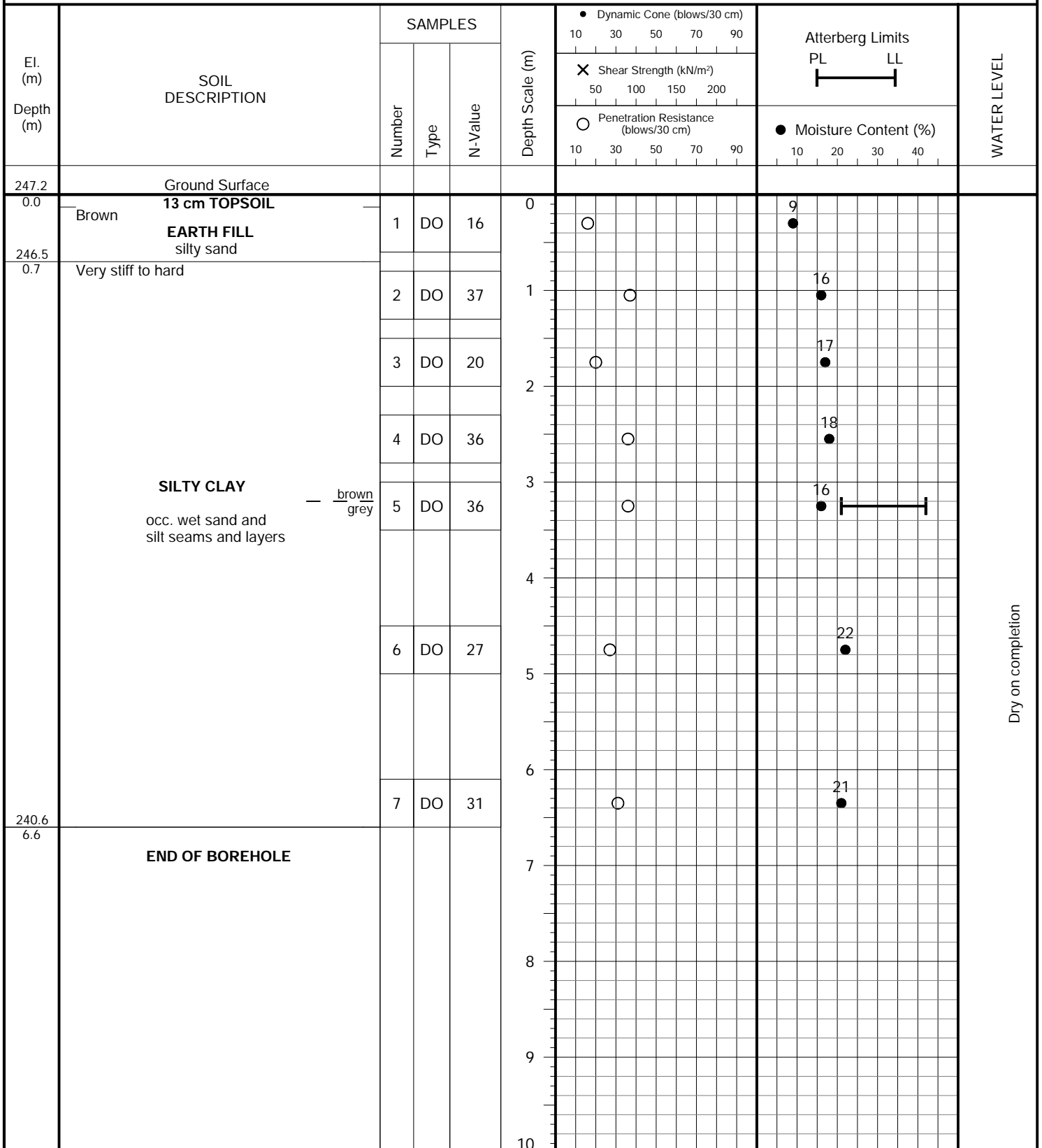


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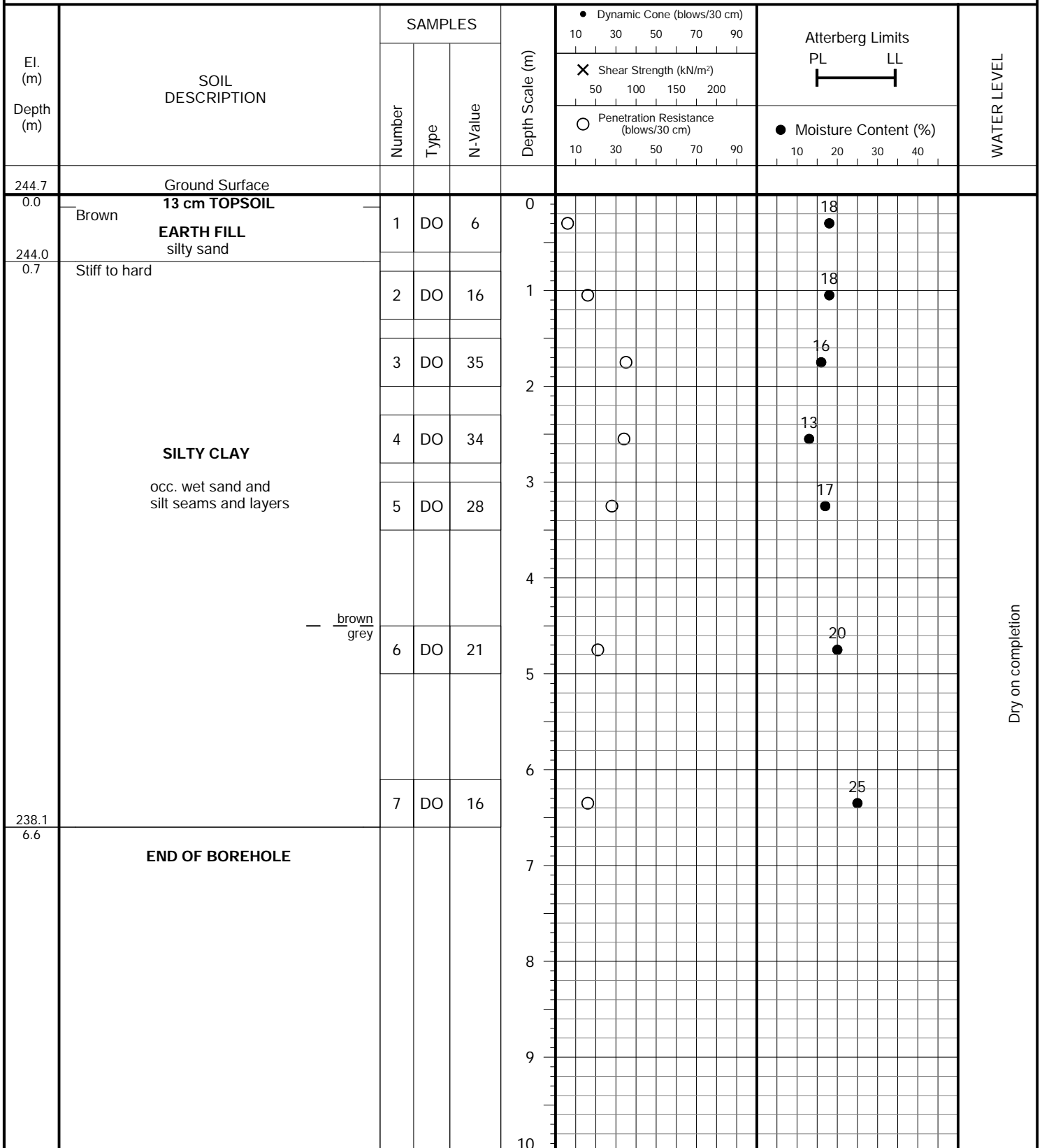


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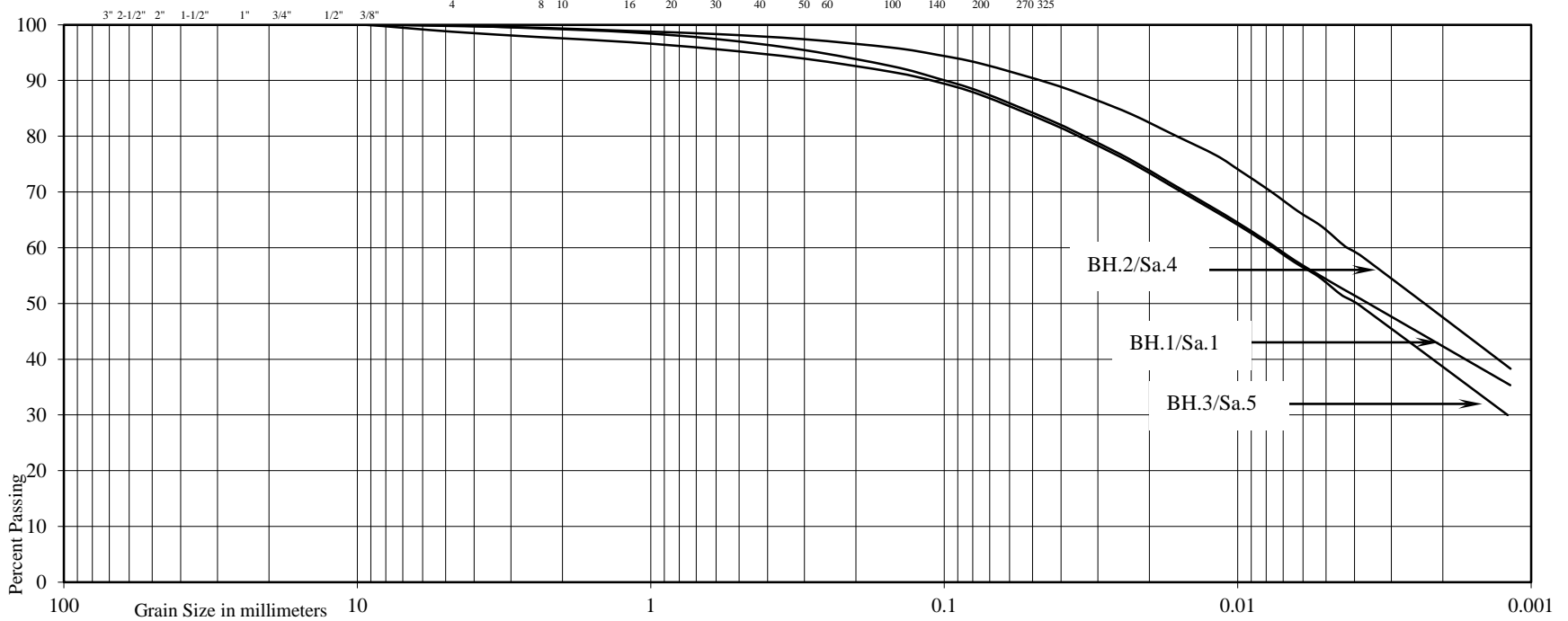


U.S. BUREAU OF SOILS CLASSIFICATION

GRAVEL				SAND				SILT	CLAY
COARSE		FINE	COARSE	MEDIUM	FINE	V. FINE			

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND				SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		



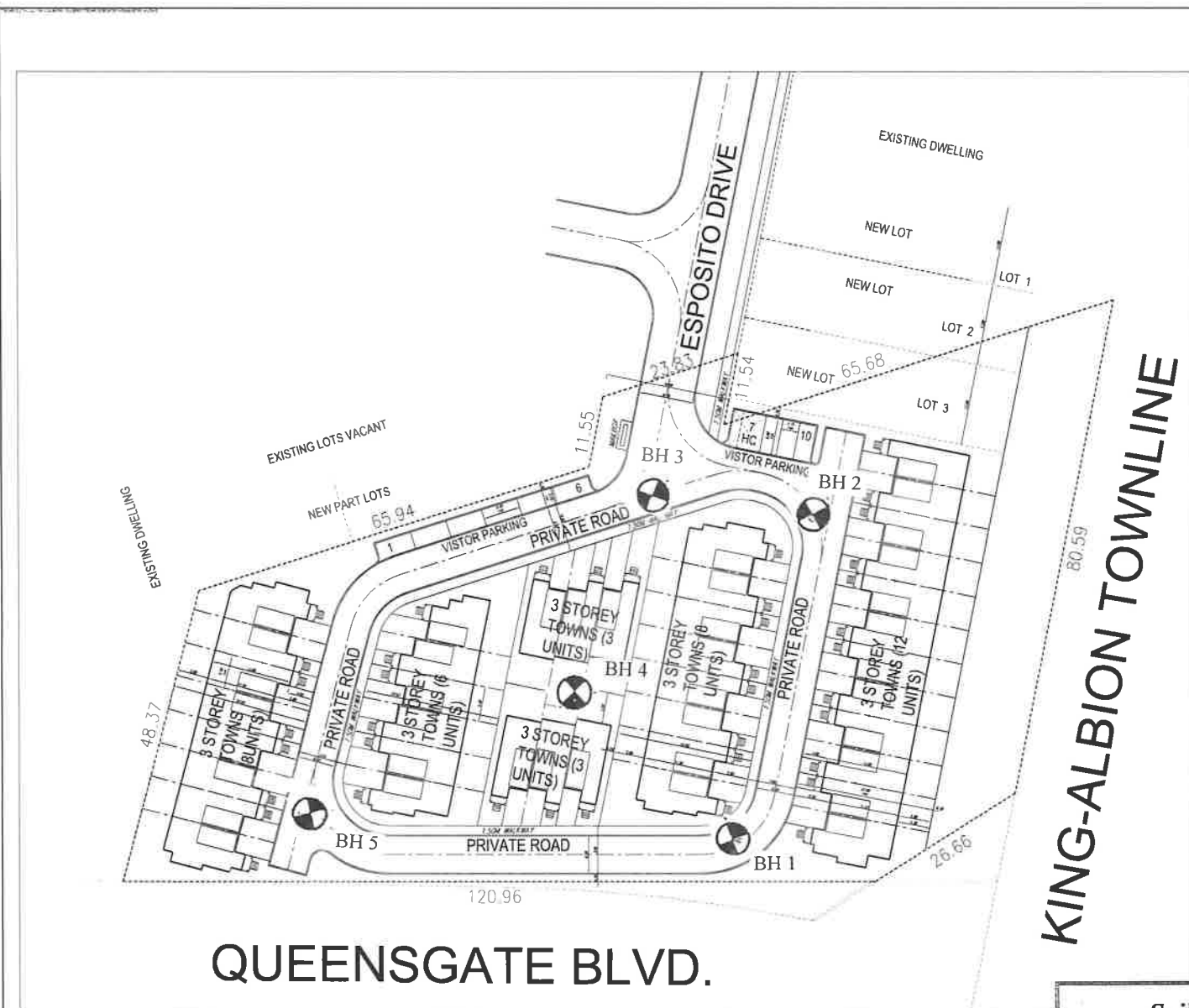
Project: Proposed Townhouse Development
 Location: 12944 Albion Vaughan Road, Town of Bolton

Borehole No:	1	2	3
Sample No:	1	4	5
Depth (m):	0.3	2.5	3.3
Elevation (m):	243.8	243.7	243.9

BH./Sa.	1/1	2/4	3/5
Liquid Limit (%) =	-	45	42
Plastic Limit (%) =	-	22	21
Plasticity Index (%) =	-	23	21
Moisture Content (%) =	16	19	16
Estimated Permeability (cm./sec.) =	10 ⁻⁷	10 ⁻⁷	10 ⁻⁷

Classification of Sample [& Group Symbol]: SILTY CLAY, some sand, traces of fine sand and gravel

Figure: 7

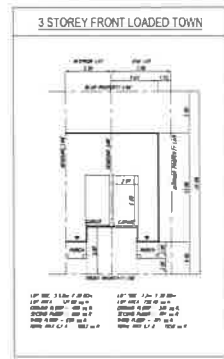


SITE STATISTICS

LOT AREA (DEFINED BOUNDARY)	=	0.95 HA
6.0m 3 STOREY STREET TOWNHOMES	=	40 UNITS
	DENSITY =	42.1 UNITS PER HA
13m 2 STOREY STREET DWELLING	=	8 (PART LOTS)

PARKING	PROVIDED (SP/UN)	RECD (SP/UN)
RESIDENTIAL PARKING:	40 (2)=80	40 (2)=80
VISITOR PARKING: CONDO	10	10
STANDARD		
BARRIER FREE	40(0.25)=10	40 (0.25)=10
TOTAL VISITOR		
TOTAL	90	90

BUILDING ENVELOPE STUDY:



QUEENSGATE BLVD.

KING-ALBION TOWNLINE

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 90 West Beaver Creek Road, Richmond Hill, Ontario L4B 1E 7 Tel: (416) 754-8515 Fax: (905) 881-8335

BOREHOLE LOCATION PLAN

DESIGNED	CHECKED	DWG NO. 1	REV
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SCALE 1:1000	REF. NO. 1708-S156	DATE November 2017
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SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.: 1708-S156
REPORT DATE: November 2017
PROJECT DESCRIPTION: Proposed Townhouse Development
PROJECT LOCATION: 12944 Albion Vaughan Road, Town of Bolton

LEGEND

TOPSOIL FILL SILTY CLAY

