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**A REPORT TO
LIVESPACE INTERIORS CANADA LTD. AND EAST & WEST INC.**

**A GEOTECHNICAL INVESTIGATION FOR
PROPOSED COMMERCIAL/INDUSTRIAL DEVELOPMENT**

**4243 SIXTH LINE
TOWN OF OAKVILLE**

REFERENCE NO. 2306-S222

SEPTEMBER 2023

DISTRIBUTION

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1.0 **INTRODUCTION**

In accordance with a written authorization from Ms. Preeti Dhall of Livespace Interiors Canada Ltd. and East & West Inc., dated June 26, 2023, and our revised proposal dated July 12, 2023, a geotechnical investigation was carried out at 4243 Sixth Line in the Town of Oakville.

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for the proposed commercial/industrial development. The geotechnical findings and recommendations for the proposed development are presented in this report.

Soil Engineers Ltd. confirms that the geotechnical report has been completed in compliance with Ontario Building Code 2012 Subsection 4.2.4.

2.0 **SITE AND PROJECT DESCRIPTION**

The site is situated on Halton till plain overlying a shale bedrock of Queenston Formation which occurs at a shallow to moderate depth.

The subject property, approximately 3.8 hectares in area, has a municipal address of 4243 Sixth Line, located in the northeast quadrant of William Halton Parkway East and Sixth Line in the Town of Oakville. At the time of investigation, the site is occupied by a vacant two-storey dwelling and a Bell Canada cellular tower. The balance of the site is generally vacant, with a pond at the northwest corner of the property and soil stockpiles along the northern limit of the property. The existing site gradient is relatively flat, generally level with Sixth Line.

A review of the site plan provided by Candevcon Inc. indicates that the property will be developed into two commercial/industrial buildings. It will be provided with municipal services and access roadway to Sixth Line.

3.0 **FIELD WORK**

The field work, consisted of ten (10) boreholes extending to depths of 4.7 m, 5.0 m and 6.6 m below grade, was carried out on August 10 and 11, 2023, at the locations specified by Candevcon Inc. and adjusted by Soil Engineers Ltd. The borehole locations are shown on the Borehole Location Plan, Drawing No. 1.



The boreholes were advanced at intervals to the sampling depths by a track-mounted machine equipped with solid stem augers and split spoons 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 results are recorded as the Standard Penetration Resistance (or ‘N’ values) of the subsoil. Split-spoon samples were recovered for soil classification and laboratory testing.

Upon completion of borehole drilling, monitoring wells were installed in Boreholes 1, 7 and 9 to facilitate future groundwater level measurements and hydrogeological assessment. Details of the monitoring wells are presented in the borehole logs.

The field work was supervised and the findings were recorded by a Geotechnical Technician. The ground elevation at each of the borehole location was obtained using the Global Navigation Satellite System (GNSS).

4.0 **SUBSURFACE CONDITIONS**

Detailed descriptions of the subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 10, inclusive. The revealed stratigraphy is plotted in the Subsurface Profiles, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

The investigation has disclosed that beneath a topsoil veneer and a layer of earth fill generally in the north half portion of the site, the property is generally underlain by a stratum of silty clay till.

4.1 **Topsoil**

The revealed topsoil ranges from 20 to 36 cm in thickness. Thicker topsoil layers can be anticipated in places, especially in low-lying areas.

4.2 **Earth Fill**

A layer of earth fill, extending to depths ranging from 1.4 to 3.0 m, was encountered in Boreholes 1 to 5, inclusive, generally in the north half of the property. It consists of silty clay, with a variable amount of topsoil inclusions and layers, and rootlets.

The natural water content of the samples was determined and the results are plotted on the Borehole Logs; the values range from 14% to 32%, with a median of 19%, indicating that the



fill is in a moist to very moist condition. The high water content value indicates the presence of topsoil inclusions.

The obtained 'N' values range from 5 to 32, with a median of 9 blows per 30 cm of penetration, indicating that the fill was likely placed with non-uniformly compaction.

Due to its unknown history, the earth fill is not suitable to support any structures sensitive to settlement. It must be subexcavated, sorted free of deleterious material and organics and properly recompacted in layers.

4.3 **Silty Clay Till**

The silty clay till was encountered in all boreholes, with a weathered zone extending to a depth of up to 1.0 m below the prevailing ground surface. It consists of a random mixture of particle sizes ranging from clay to gravel, with the silt and clay being the dominant fraction. Intermittent high resistance to augering was encountered, indicating the presence of cobbles, boulders and shale fragments. Grain size analyses were performed on 2 representative samples; the results are plotted on Figure 11.

The obtained 'N' values range from 4 to over 100 blows per 30 cm of penetration, with a median of 31 blows per 30 cm of penetration, indicating the clay till is firm to hard, being generally very stiff in consistency. The firm clay till was contacted in the weathered zone near the ground surface.

Atterberg Limits on 2 samples were completed; having liquid limits of 23% and 25%, and plastic limit of 16%, indicating the clay till is low in plasticity.

The natural water content of the soil samples ranges between 10% and 27%, with a median of 12%, showing a generally moist condition.

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

- High frost susceptibility and low water erodibility.
- The clay till will be stable in relatively steep slopes; however, prolonged exposure will allow the sand seams to slough, which may lead to local sliding.



5.0 **GROUNDWATER CONDITION**

All boreholes remained dry upon completion of the field work.

During wet seasons, shallower groundwater may be encountered and will be subjected to seasonal fluctuations.

6.0 **DISCUSSION AND RECOMMENDATIONS**

The investigation has disclosed that beneath a topsoil veneer and a layer of earth fill within the north half of the property, the site is underlain by a stratum of silty clay till, firm to hard in consistency.

All boreholes remained dry upon completion of the field work.

The proposed development will consist of two commercial/industrial buildings, with municipal services and access road. The geotechnical findings warranting special consideration for the proposed project are presented below:

1. The topsoil must be removed for site development. It can only be re-used for landscaping in designated areas only.
2. The existing earth fill is not suitable to support structures sensitive to settlement. It must be subexcavated and replaced with properly compacted engineered fill unless other soil improvement technique is being considered for the proposed development.
3. Existing structures on site should be demolished. After demolition and removal of structures, the debris must be disposed of off-site. The cavities and trenches should be backfilled with selected on-site material, free of organics, compacted to 98% Standard Proctor Dry Density (SPDD).
4. The pond should be properly decommissioned prior to re-development. Any wet material in the pond must be removed and the subgrade should be inspected prior to backfilling with engineered fill for future development.
5. The site can be re-graded with an engineered fill for development. The weathered soils must be sub-excavated, sorted free of topsoil and organics before reuse for engineered fill or structural backfill.
6. The engineered fill and sound native soils are suitable for supporting the proposed structures, underground services and road pavement.



The recommendations appropriate for the design of the development are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should subsurface variances become apparent during construction, a geotechnical engineer must be consulted.

6.1 **Site Preparation**

After demolition of the existing dwelling and structures, the debris and underground utilities must be removed and disposed of off-site. The cavities should be backfilled according to engineered fill standards. Existing water wells, monitoring wells and septic system, if any, should be removed and properly decommissioned.

Any decommissioned ponds previously backfilled should be identified and assessed. The remaining pond on site should be properly decommissioned prior to development. Any wet material in the pond must be removed and the subgrade should be inspected prior to backfilling to engineered fill standards.

Prior to site grading, the vegetation and topsoil must be removed. The topsoil can be stockpiled on site for reuse in landscaped areas.

The engineering requirements for a certifiable fill for building foundations, municipal services, slab-on-grade, and pavement construction are presented below:

1. The topsoil must be removed; the disturbed soils, earth fill and weathered soils must be subexcavated and further assessed of their suitability for engineered fill.
2. The native soil subgrade must be inspected and proof-rolled prior to any fill placement.
3. Inorganic soils must be used for the fill, and they must be uniformly compacted in lifts 20 cm thick to 98% or + of the maximum Standard Proctor dry density up to the proposed pre-grade or finished grade. The soil moisture must be properly controlled near the optimum. If the 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.
4. If the engineered fill is compacted with the moisture content on the wet side of the optimum, the underground services and pavement construction should not begin until the pore pressure within the fill mantle has completely dissipated. This must be further assessed at the time of the engineered fill construction.
5. If imported fill is to be used, it should be inorganic soils, free of any 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.



6. The engineered fill must not be placed during the period where freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
7. The fill operation must be supervised on a full time basis and monitored by a technician under the direction of a geotechnical engineer.
8. The engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented.
9. Foundations founded on engineered fill must be reinforced and should be designed by a structural engineer to properly distribute the stress induced by the abrupt differential settlement (about 20 mm) in engineered fill.
10. Any excavation carried out in the 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.
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 and service pipes 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.

6.2 **Foundation**

The proposed structures can be supported on conventional spread and strip footings, founded on the undisturbed native soil or engineered fill. The recommended soil bearing pressures for the design of conventional footings are provided below:

- Maximum Bearing Pressure at Serviceability Limit State (SLS) = 150 kPa
- Factored Bearing Pressure at Ultimate Limit State (ULS) = 240 kPa

The total and differential settlements of structures designing for the bearing pressure at SLS are estimated within 25 mm and 20 mm, respectively.

During construction, the foundation subgrade should be inspected by the geotechnical engineer or a senior geotechnical technician to ensure that the revealed conditions are compatible with the foundation design requirements.



The perimeter footings exposed to the weather should have at least 1.2 m of earth cover for protection against frost action, unless they are properly insulated. In order to alleviate the risk of frost damage, the foundation walls must be constructed of concrete and either backfilled with non-frost susceptible granular material, or shielded with a polyethylene slip-membrane. The membrane will allow vertical movement of the heaving soil (due to frost) without imposing structural distress on the foundation.

Where water seepage is encountered during footing excavations, or where the subgrade of the foundations is found to be wet, the subgrade should be protected by a concrete mud-slab immediately after exposure. This will prevent construction disturbance and costly rectification.

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

6.3 **Slab-On-Grade Construction**

The subgrade for slab-on-grade construction must consist of sound native soils, or engineered fill.

In preparation of the subgrade, the subgrade should be inspected and assessed by proof-rolling. Any weathered and/or loose soil should be subexcavated, sorted free of any deleterious material, aerated and uniformly compacted to at least 98% SPDD.

The concrete slab must be constructed on a 20 cm thick granular bedding, consisting of 19-mm Crusher-Run Limestone (CRL), compacted to 100% SPDD. A Modulus of Subgrade Reaction (k_s) of 25 MPa/m can be used for slab design.

The floor slab at the entrances into the buildings should be insulated with 50-mm Styrofoam, or equivalent, extending 1.2 m internally. This measure is to prevent cold drafts in the winter from inducing frost action in the subgrade and causing damage to the floor slab.

The grading around the building structure must be such that it directs runoff away from the structure.



6.4 **Underground Services**

The underground services should be founded on sound native soil or properly compacted inorganic earth fill. Where weathered soil is encountered, it should be subexcavated and replaced with the bedding material, compacted to at least 98% SPDD.

A Class 'B' bedding is recommended for the underground services construction. It should consist of compacted 19-mm Crusher-Run Limestone, or equivalent, as approved by a geotechnical engineer.

The pipe joints into the manholes and catch basins must be leak-proof to prevent the migration of fines through the joints. Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

A soil cover having a thickness at least equal to the diameter of the pipe should be in place at all times after pipe installation, to prevent pipe floatation when the trench is deluged with water derived from precipitation.

The on-site soils are considered corrosive to ductile iron pipes and metal fittings; therefore, the underground services should be protected against soil corrosion. For estimation for the anode weight requirements, the electrical resistivities of the disclosed soils can be used. The proposed anode weight must meet the minimum requirements as specified by the Town of Oakville and Peel Region Standard.

6.5 **Backfilling in Trenches and Excavated Areas**

The backfill in service trenches should be compacted to at least 98% SPDD, particularly below concrete floor subgrade and in the zone within 1.0 m below the pavement. The material should be compacted with the water content at 2% to 3% drier than the optimum.

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 of On-Site Material**

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	14 to 32 (median 19)	16	12 to 20
Silty Clay Till	10 to 27 (median 12)	16	12 to 20

The above values show the in-situ native till is mostly suitable for 95% or + Standard Proctor compaction.

The weathered till and existing fill must be sorted free of topsoil inclusions and deleterious materials, if any, prior to its use as structural backfill.

When compacting the till 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 must be limited to 20 cm or less (before compaction). Boulders over 15 cm in size must be sorted and removed from the backfill.

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

The narrow trenches for services crossings should be cut at 1 vertical:2 horizontal so that the backfill in the trenches can be effectively compacted. Otherwise, soil arching in the trenches will prevent achievement of the proper compaction. In confined areas where the desired slope cannot be achieved or the operation of a proper kneading-type roller cannot be facilitated, imported sand fill, which can be appropriately compacted by using a smaller vibratory compactor, must be used.

6.6 **Pavement Design**

The pavement design for the proposed development is presented in Table 2.

**Table 2 - Pavement Design**

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL3
Asphalt Binder	50	HL8
Granular Base	150	Granular 'A' or equivalent
Granular Sub-base Light-Duty Heavy-Duty/Fire Route	300 450	Granular 'B' or equivalent

In preparation of pavement subgrade, all topsoil and compressible material should be removed. The final subgrade must be proof-rolled using a heavy roller or loaded dump truck. Any soft spot identified must be rectified by subexcavation and replacing with selected dry inorganic material. The subgrade within 1.0 m below the underside of the granular sub-base must be compacted to at least 98% SPDD, with the water content at 2% to 3% drier than its optimum.

All the granular bases should be compacted in 150 to 200 mm lifts to 100% SPDD.

For the parking area, swales or an intercept subdrain system should be installed along the perimeter where surface runoff may drain onto the pavement. In paved areas, catch basins with stub drains in all four directions should be provided. The stub drains and subdrains should drain into the catch basin through filter-sleeved weepers. The invert of the subdrains should be at least 0.4 m beneath the underside of the granular sub-base and should be backfilled with free-draining granular material.

6.7 Soil Parameters

The recommended soil parameters for the project design are given in Table 3.

Table 3 - Soil Parameters

<u>Unit Weight and Bulk Factor</u>	Bulk Unit Weight γ (kN/m ³)	Estimated Bulk Factor	
		Loose	Compacted
Silty Clay Till	22.0	1.30	1.05
Earth Fill	21.5	1.25	1.00



Table 3 - Soil Parameters (Cont'd)

<u>Lateral Earth Pressure Coefficients</u>	Active K_a	At Rest K_o	Passive K_p
Silty Clay Till	0.33	0.50	3.00
<u>Effective Shear Strength Parameters</u>	Cohesion c' (kPa)	Angle of Internal Friction, φ'	
Silty Clay Till	5	30°	
<u>Coefficient of Permeability (K) and Percolation Time (T)</u>			
	K (cm/sec)	T (min/cm)	
Silty Clay Till	10 ⁻⁶ to 10 ⁻⁷	More than 50	
<u>Estimated Electrical Resistivity</u>			
Silty Clay Till	3500 ohm·cm		
<u>Coefficients of Friction</u>			
Between Concrete and Granular Base			0.50
Between Concrete and Sound Native Soils			0.35
<u>Maximum Allowable Soil Pressure (SLS) For Thrust Block Design</u>			
Engineered Fill and Sound Native Soils			75 kPa

6.8 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 4.

Table 4 - Classification of Soils for Excavation

Material	Type
Silty Clay Till	2
Weathered Till and Earth Fill	3

In the silty clay till deposit, any perched groundwater yield can be collected and removed by conventional pumping from sumps.

Excavation into the sound till with boulders and shale fragments will require extra effort and the use of properly equipped heavy-duty excavator.



7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Livespace Interiors Canada Ltd. and East & West Inc., for review by the designated consultants, financial institutions, government agencies and contractors. The material in the report reflects the judgment of Kelvin Hung, P.Eng., and Bernard Lee, P.Eng., in light of the information available to it at the time of preparation.

Use of the report is subject to the conditions and limitations of the contractual agreement. Any use which a Third Party makes of this report, and/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.

SOIL ENGINEERS LTD.

Kelvin Hung, P.Eng.

Bernard Lee, P.Eng.
KH/BL



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

Standard Penetration Resistance or 'N' Value:

The number of blows of a 63.5 kg hammer falling from a height of 76 cm required to advance a 51 mm outer diameter drive open sampler 30 cm into undisturbed soil, after an initial penetration of 15 cm.

Plotted as '○'

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows per each 30 cm of penetration of a 51 mm diameter, 90° point cone driven by a 63.5 kg hammer falling from a height of 76 cm.

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:

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

Cohesive Soils:

<u>Undrained Shear Strength (kPa)</u>	<u>'N' (blows/30 cm)</u>	<u>Consistency</u>
<12	<2	very soft
12 to <25	2 to <4	soft
25 to <50	4 to <8	firm
50 to <100	8 to <15	stiff
100 to 200	15 to 30	very stiff
>200	>30	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

METRIC CONVERSION FACTORS

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



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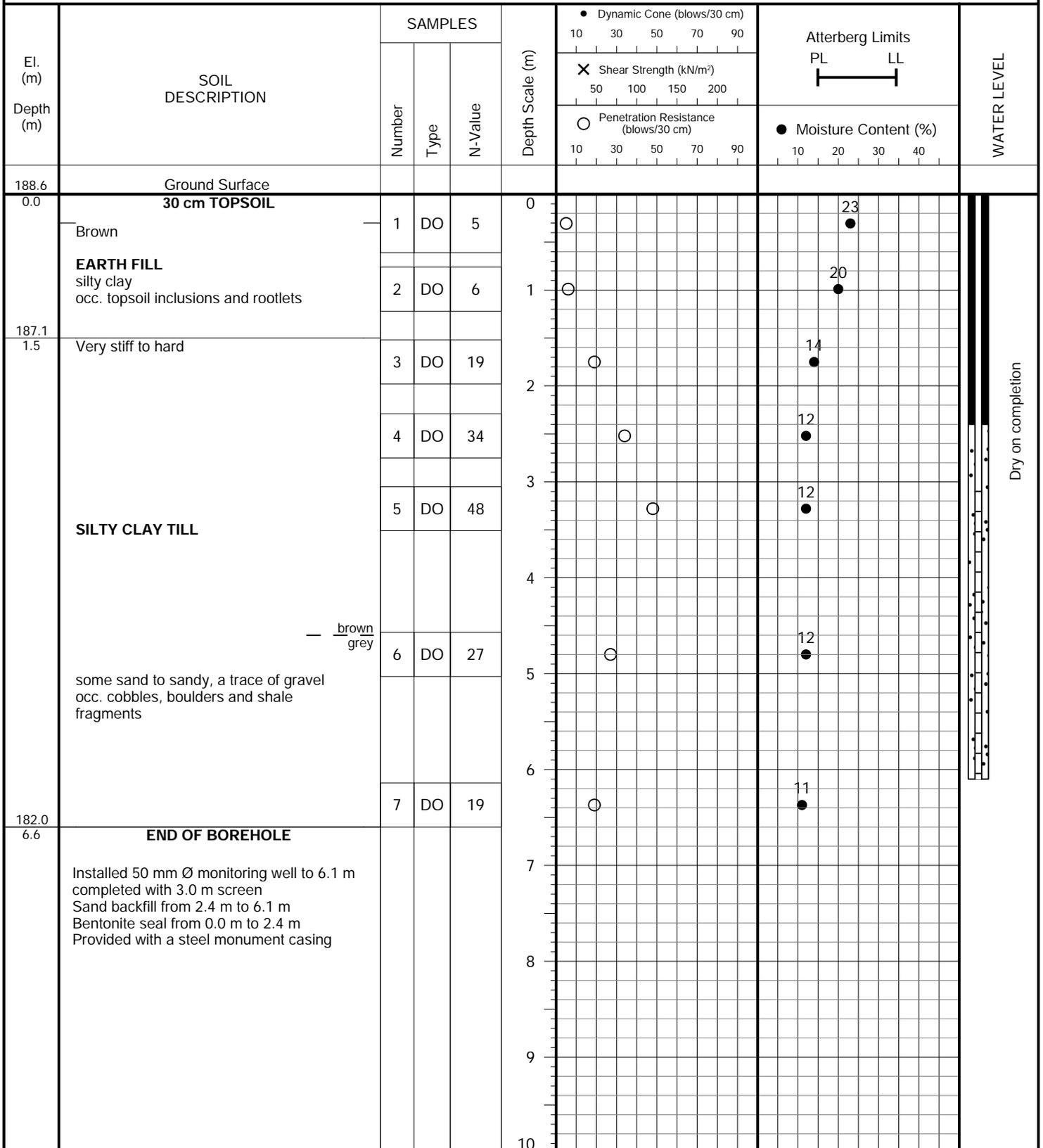
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PROJECT DESCRIPTION: Proposed Commercial/Industrial Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 4243 Sixth Line, Town of Oakville

DRILLING DATE: August 11, 2023

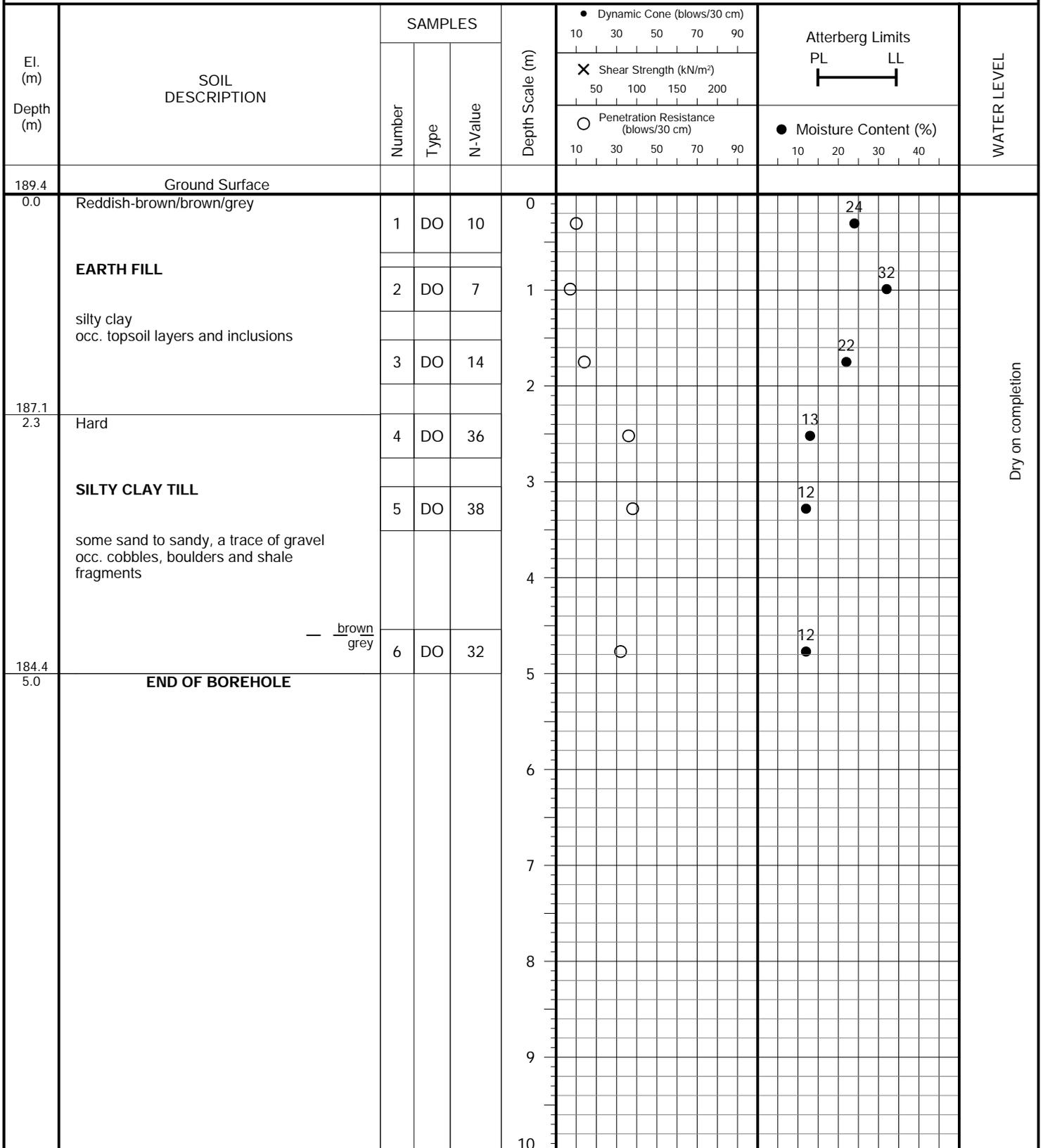


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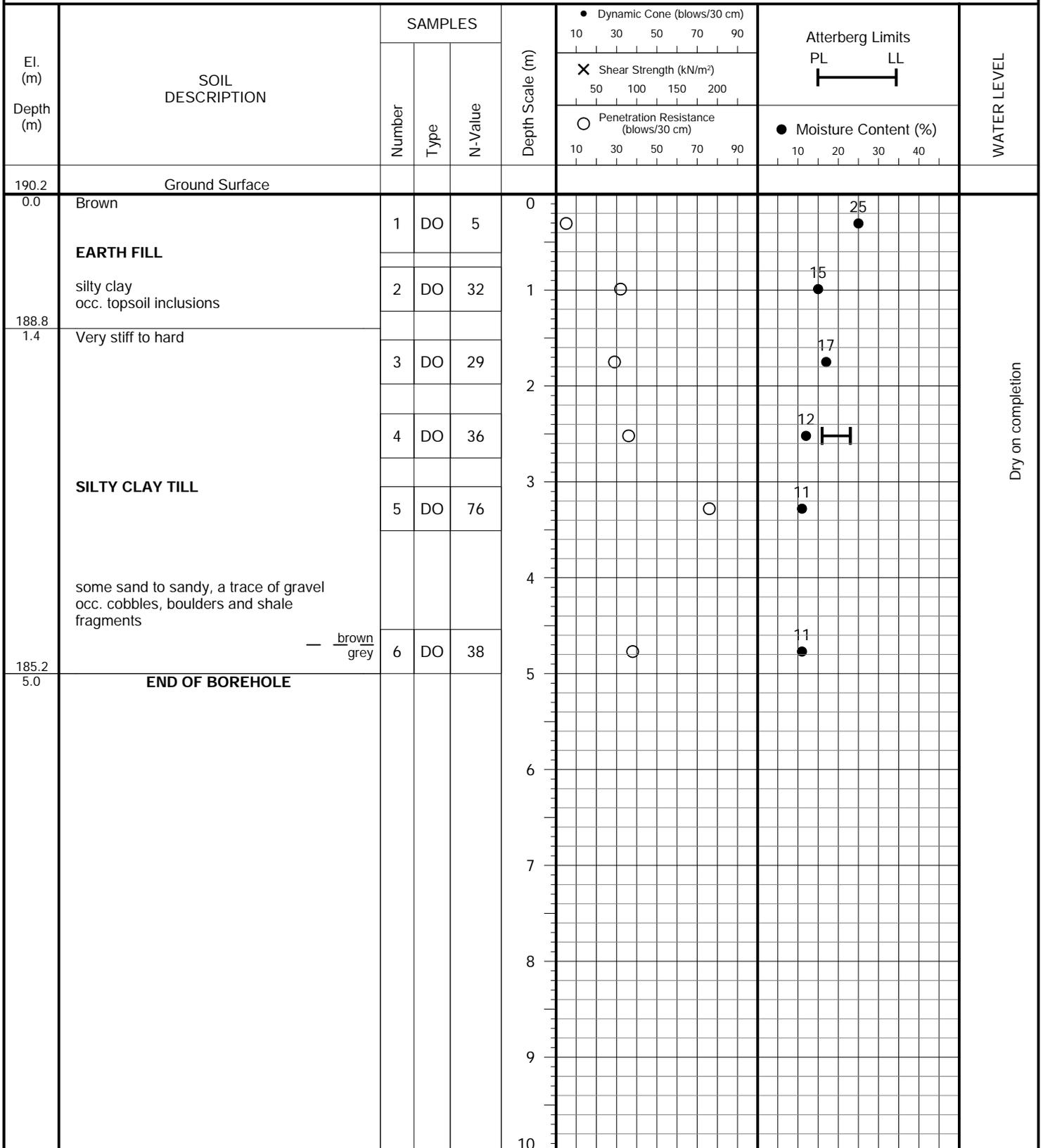


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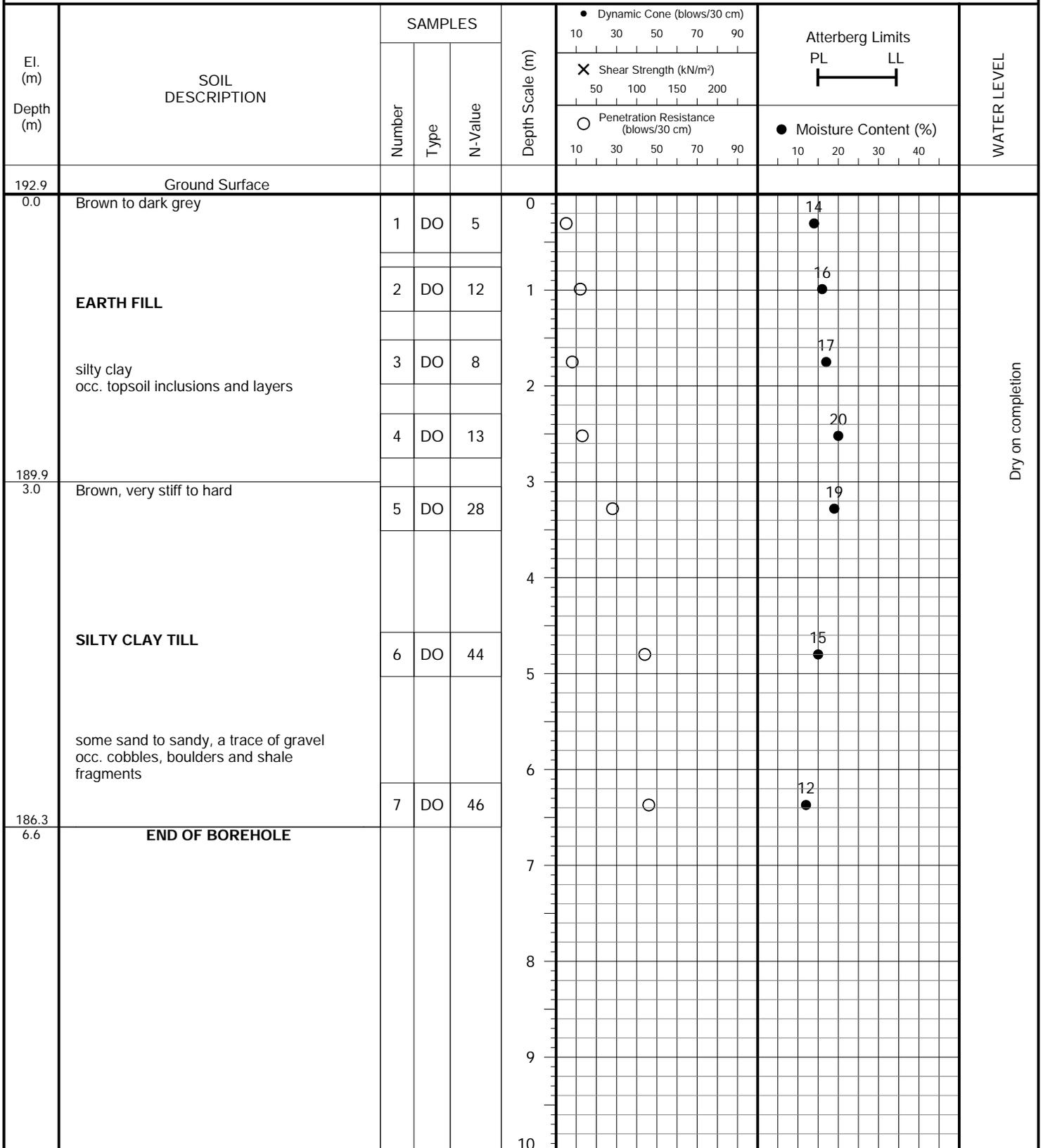


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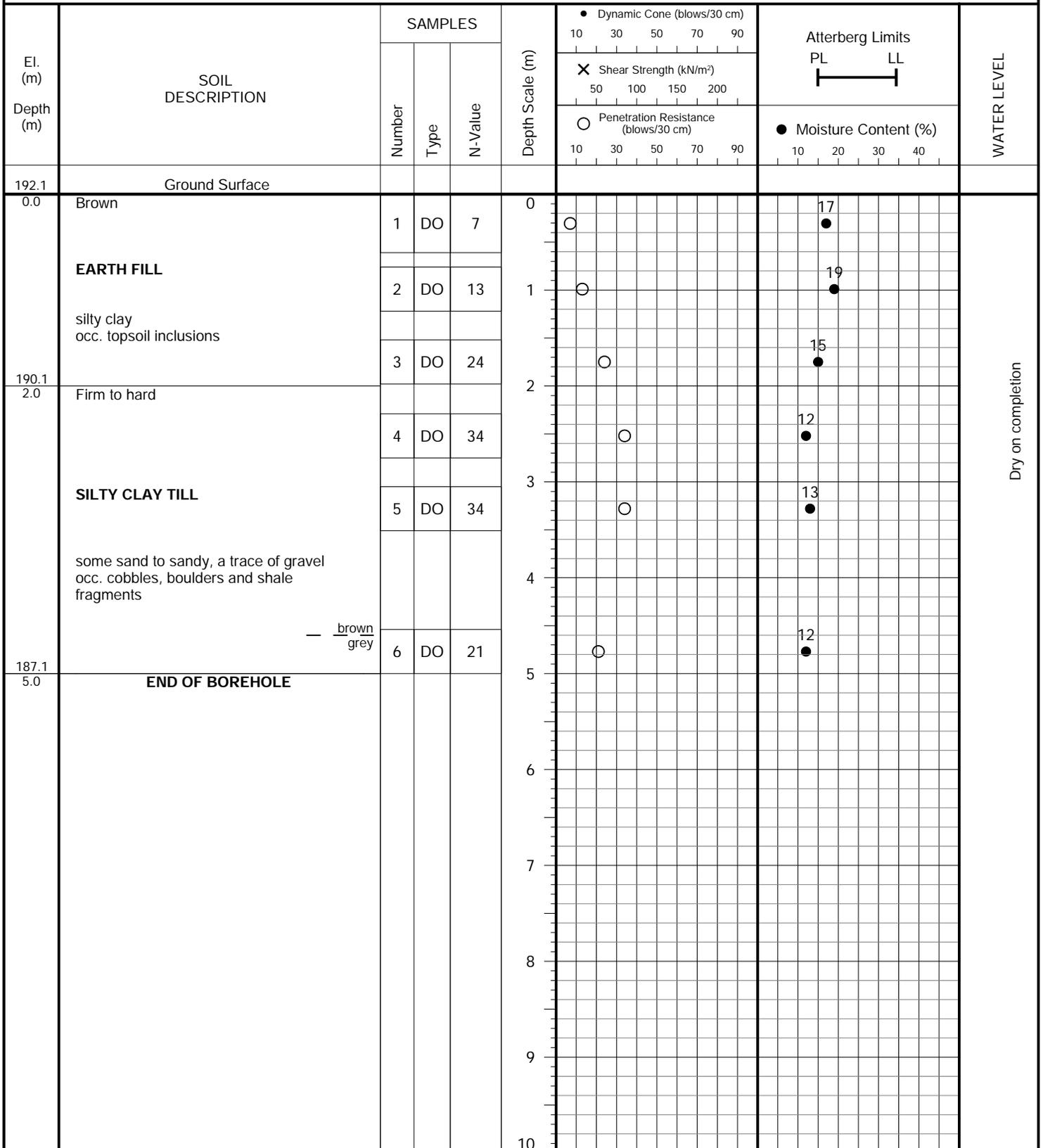


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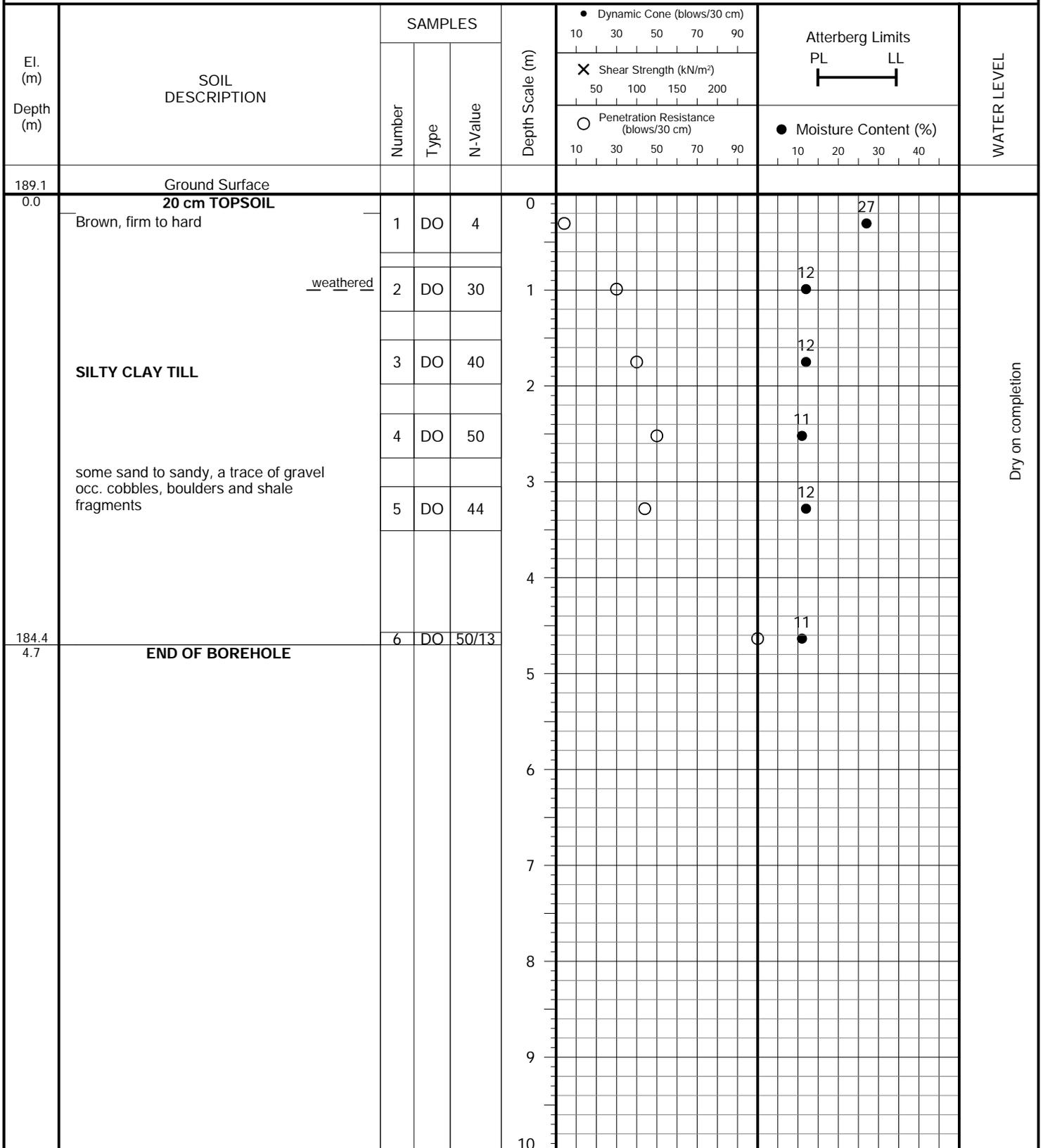


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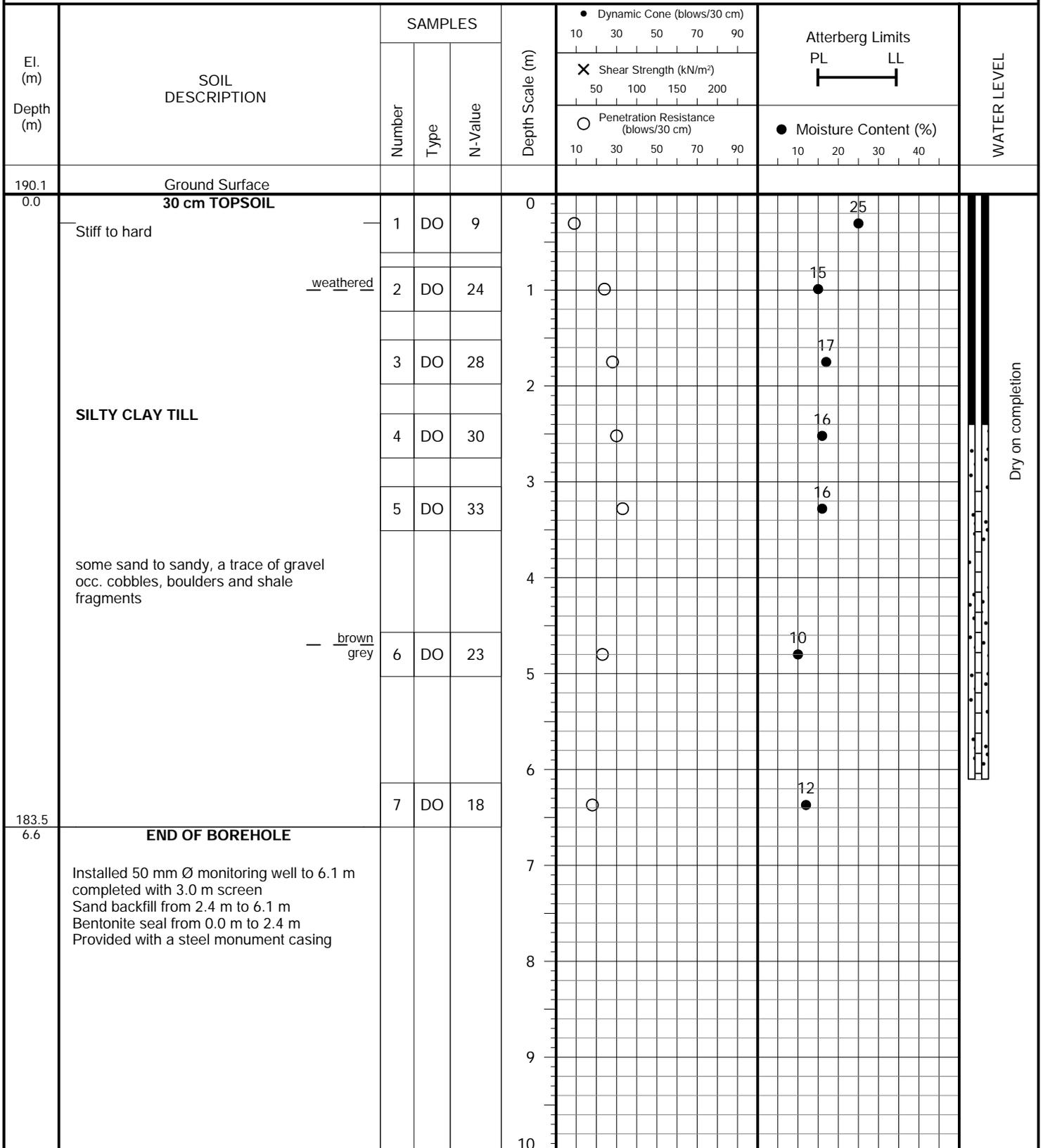


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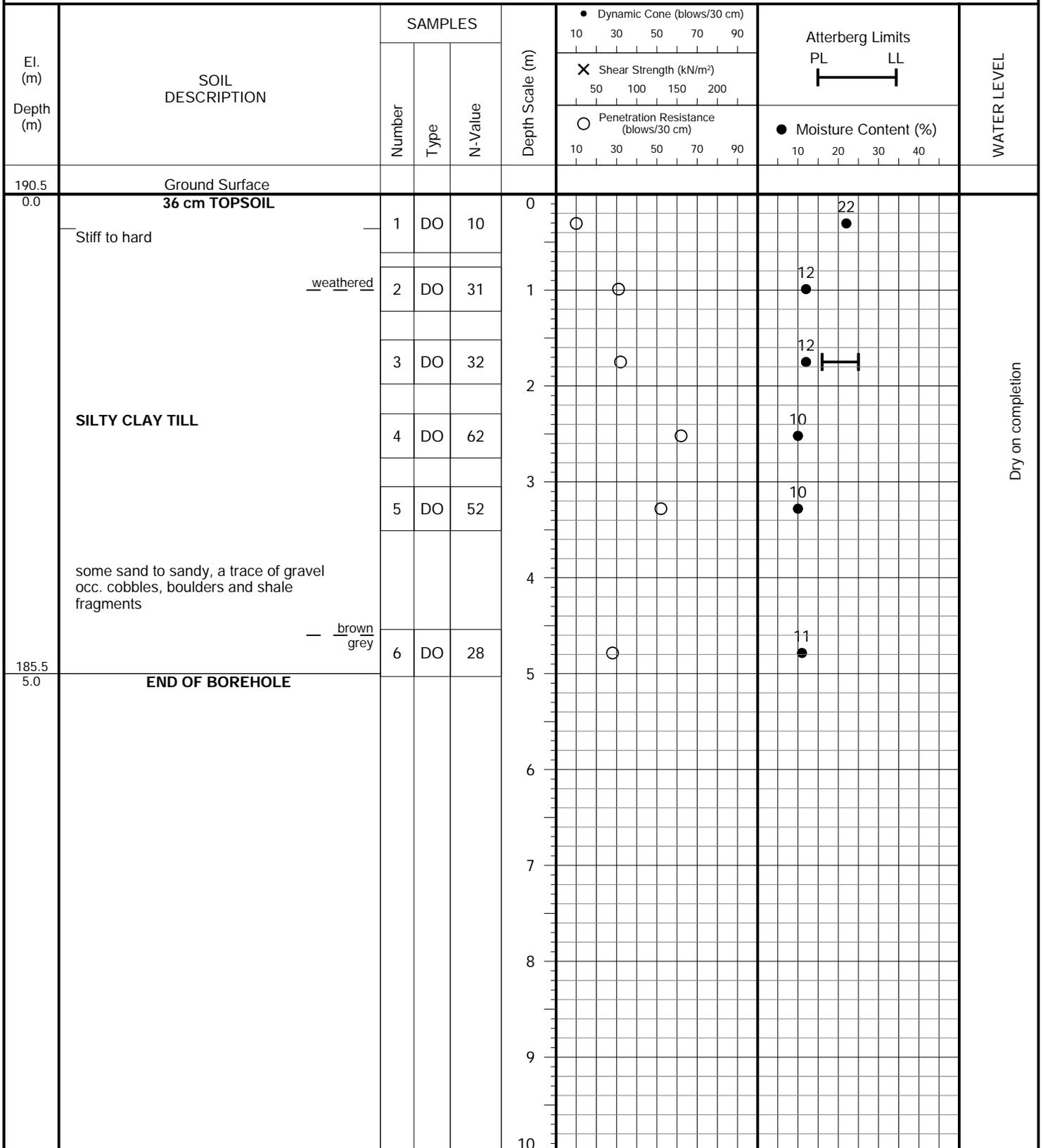


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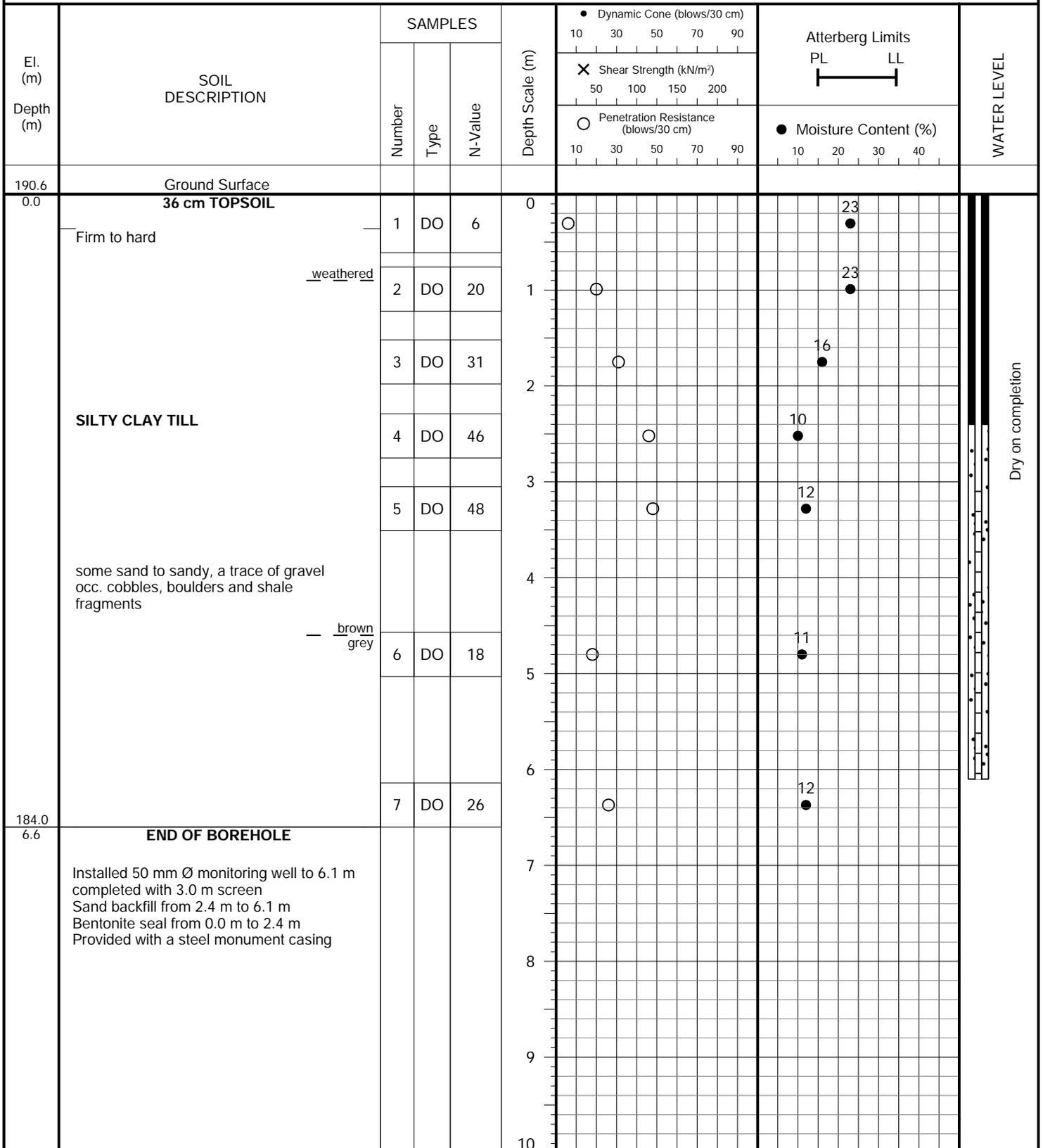


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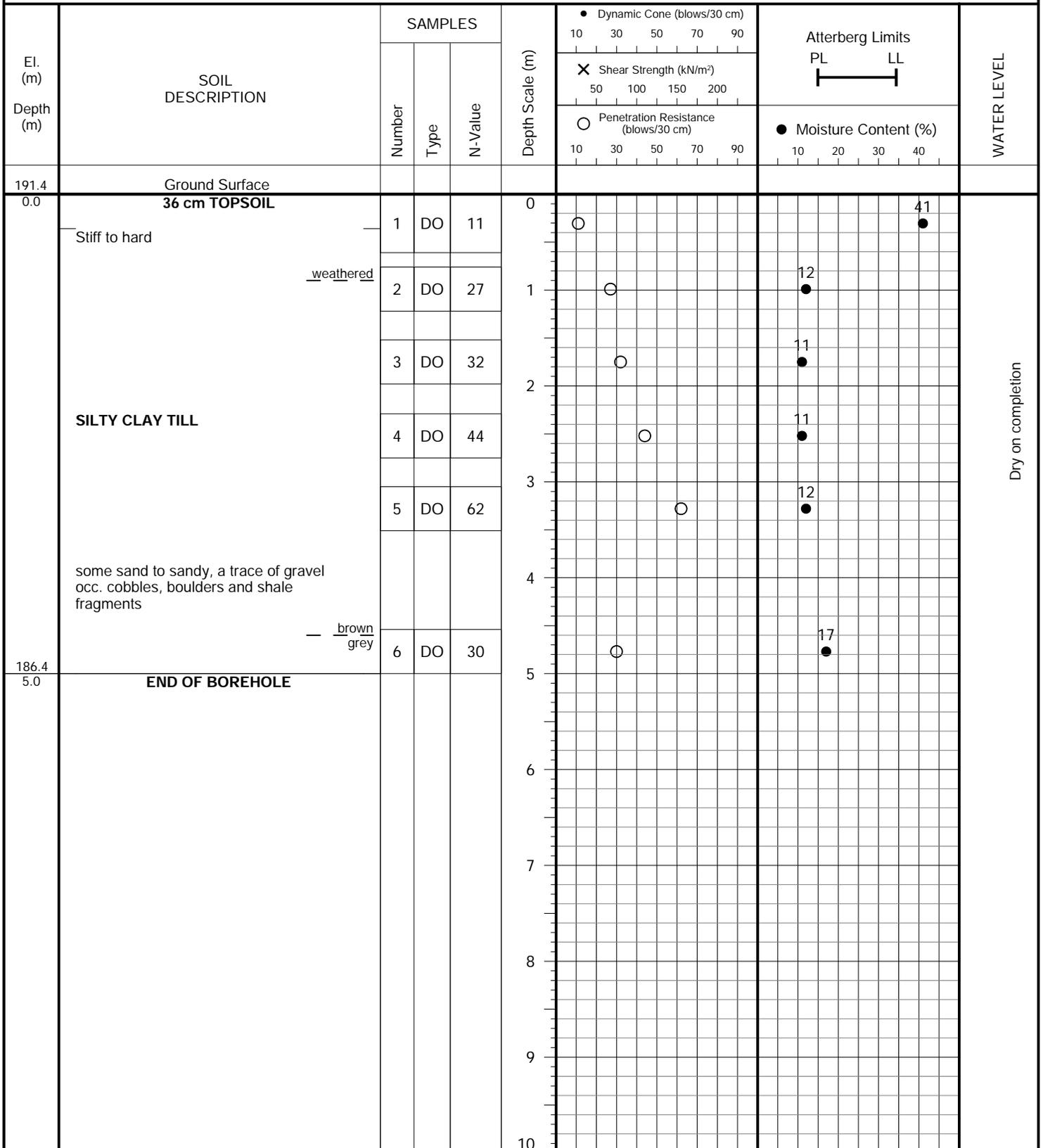


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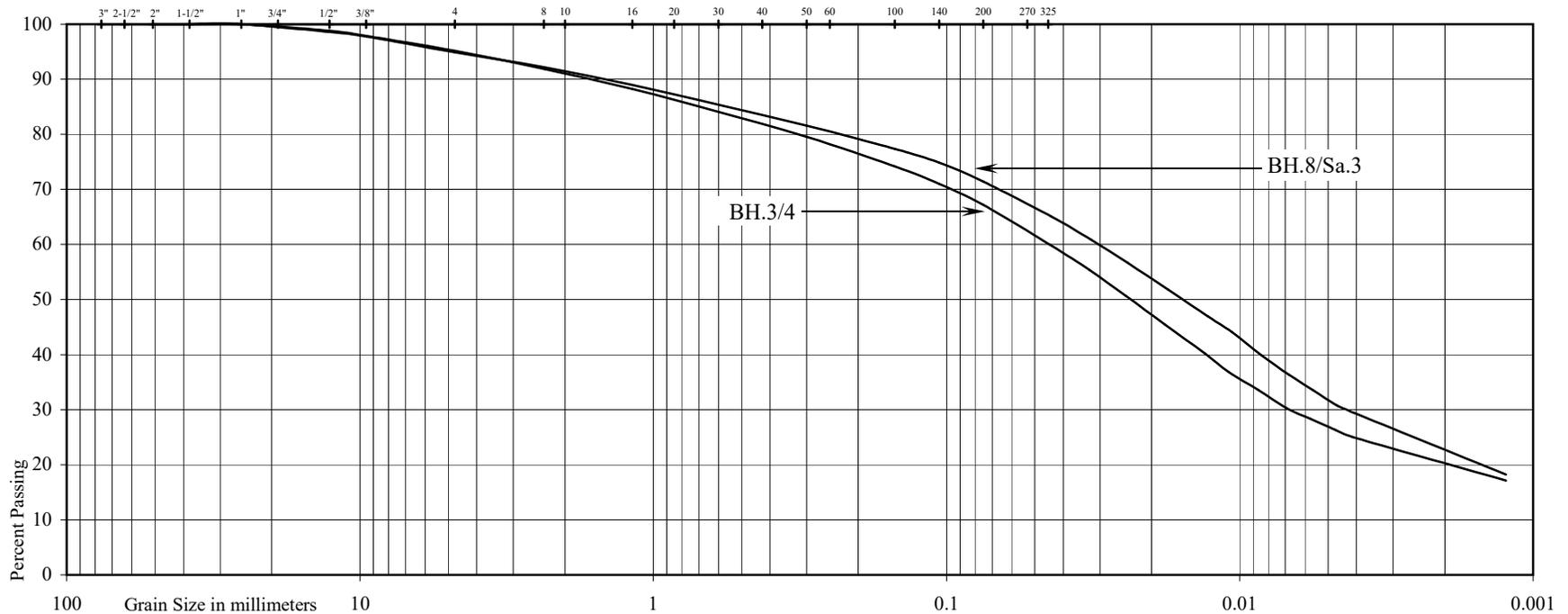


U.S. BUREAU OF SOILS CLASSIFICATION

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

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



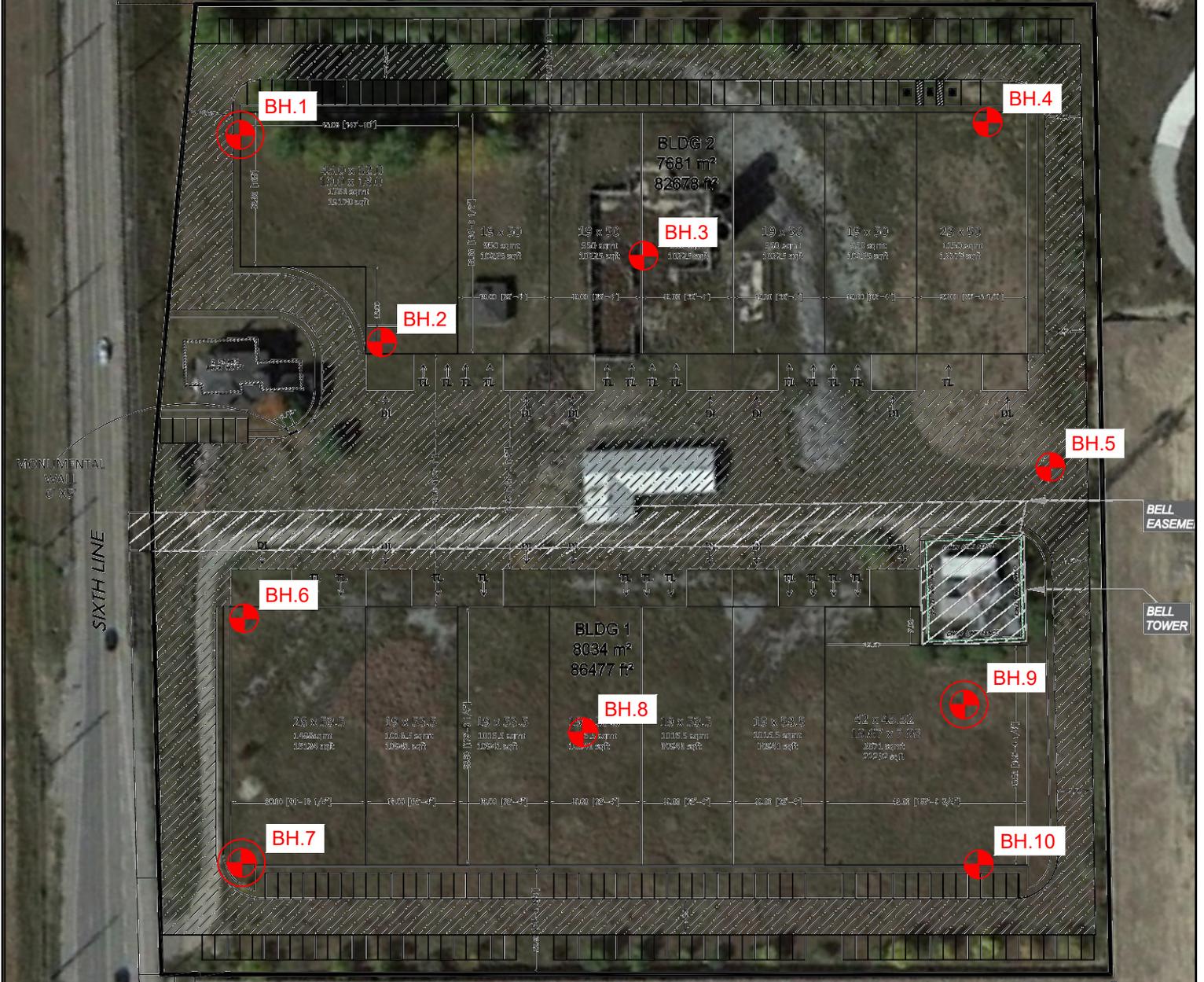
Project: Proposed Commercial/Industrial Development
 Location: 4243 Sixth Line, Town of Oakville

Borehole No: 3 8
 Sample No: 4 3
 Depth (m): 2.5 1.8
 Elevation (m): 187.7 188.7

BH./Sa.	3/4	8/3
Liquid Limit (%) =	23	25
Plastic Limit (%) =	16	16
Plasticity Index (%) =	7	9
Moisture Content (%) =	12	12
Estimated Permeability		
(cm./sec.) =	10 ⁻⁷	10 ⁻⁷

Classification of Sample [& Group Symbol]:	SILTY CLAY TILL sandy, a trace of gravel
--	---

Figure: 11



- LEGEND**
- Borehole
 - Borehole with Monitoring Well

Soil Engineers Ltd.
 CONSULTING ENGINEERS
 GEOTECHNICAL | ENVIRONMENTAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
 90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 TEL: (416) 754-8515 FAX: (905) 881-8335

BOREHOLE AND MONITORING WELL LOCATION PLAN

SITE: 4243 Sixth Line, Town of Oakville

DESIGNED BY: -	CHECKED BY: -	DWG NO.: 1
SCALE: 1:1250	REF. NO.: 2306-S222	DATE: September 2023
		REV 2



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SUBSURFACE PROFILE

DRAWING NO. 2

SCALE: AS SHOWN

JOB NO.: 2306-S222
REPORT DATE: September 2023
PROJECT DESCRIPTION: Proposed Commercial/Industrial Development
PROJECT LOCATION: 4243 Sixth Line, Town of Oakville

LEGEND

TOPSOIL FILL SILTY CLAY TILL

