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**A REPORT TO
2055672 ONTARIO INC.**

**A GEOTECHNICAL INVESTIGATION FOR
PROPOSED BUILDING ADDITION**

**MIDLAND TOYOTA
806 KING STREET**

TOWN OF MIDLAND

REFERENCE NO. 2408-S160

OCTOBER 2024

DISTRIBUTION

2 Copies - 2055672 Ontario Inc.
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1.0 **INTRODUCTION**

In accordance with an email authorization on August 26, 2024 from Mr. Michael Yallowega of Yallowega Architecture Inc., on behalf of 2055672 Ontario Inc., a geotechnical investigation was carried out at Midland Toyota located at 806 King Street in the Town of Midland.

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for the proposed building addition for the car dealership. The geotechnical findings and recommendations for the proposed building additions are presented in this report.

2.0 **SITE AND PROJECT DESCRIPTION**

The Town of Midland is located on the Penetang Peninsula within the physiographic region known as Simcoe Upland which is comprised of a series of broad rolling till plains. The tills are generally sandy in composition and have been partly eroded by glacial Lake Algonquin and in places filled with glaciofluvial and lacustrine sand, silt and clay.

The investigation was carried out within the pavement area of the car dealership, at the service entrance and the south and west side of the building. The area is paved and is being used as parking.

It is understood that building additions will be constructed; however, detail design for the proposed additions are not available at the time of the report preparation.

3.0 **FIELD WORK**

The field work, consisting of 4 sampled boreholes extending to depths of 5.2 m, 6.3 m and 6.6 m, was carried out on September 18, 2024 at the locations shown on the Borehole Location Plan, Drawing No. 1. The borehole location were specified by Yallowega Architecture Inc.

The boreholes were advanced at intervals to the sampling depths by a truck-mounted equipment with solid stem augers and split spoon 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. The relative density of the non-cohesive 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 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 4, inclusive. The revealed stratigraphy is plotted in the Subsurface Profile on Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

The investigation has disclosed that beneath the pavement structure and in place, a layer of earth fill, the site is generally underlain by a deposit of silty sand till.

4.1 **Pavement Structure**

The pavement thickness at each borehole location is summarized in Table 1.

Table 1 - Revealed Pavement Structure

Borehole No.	Pavement Thickness (mm)			Subgrade Condition
	Asphaltic Concrete	Granular Fill	Total	
1	75	380	455	Silty Sand Fill
2	50	380	430	Silty Sand Till
3	50	410	460	Silty Sand Till
4	50	910	960	Silty Sand Till

The water content of the granular fill samples was determined and the results are plotted on the Borehole Logs; the values range from 2% to 6%, with a median of 4% indicating the granular fill is in a dry to moist, generally damp condition.

4.2 **Earth Fill**

A layer of earth fill, extending to a depth of 2.1 m below the prevailing ground surface, was encountered at Borehole 1. The fill consists of silty sand.



The obtained water content values are 9% and 11%, indicating it is in a moist condition. The obtained 'N' values are 10 and 17 blows per 30 cm of penetration, indicating that the fill was likely placed with some compaction effort.

One must be aware that the samples retrieved from the borehole may not be truly representative of the geotechnical quality of the fill.

4.3 **Silty Sand Till**

The silty sand till was encountered in all boreholes. It consists of a random mixture of particle sizes ranging from clay to gravel, with the sand and silt being the predominant fraction. A tactile examination of the soil samples indicated that the till is cemented, indicating a variable amount of clay. Grain size analysis was performed on a representative sample of the silty sand till, the result is plotted on Figure 5.

The relative density of the deposit is compact to very dense, as inferred from the 'N' values ranging from 11 to over 100 blows per 30 cm of penetration. Sample examination indicates that the surficial till, in place, is weathered to a depth of 0.9 to 1.2 m below the prevailing ground surface. Frequent hard resistance to augering was encountered, indicating the presence of cobbles and boulders within the till.

The natural water content of the soil samples ranges between 6% and 36%, with a median of 8%, showing damp to wet, generally moist conditions. The wet condition was restricted to the weathered zone at Borehole 2.

The engineering properties of the till deposit are listed below:

- High frost susceptibility and low water erodibility, with the sand layer being erodible.
- The till will be stable in relatively steep cuts; however, under prolonged exposure, localized sheet sliding may occur in the sand layers.

4.4 **Soil Compatibility with Concrete**

In order to assess the potential of concrete attack by the occurring soils, a representative soil sample was selected for testing to determine its pH value, sulphate and chloride content.

The results are summarized in Table 2.

**Table 2 - pH Values, Sulphate and Chloride Concentration**

Borehole No.	Sample No.	Soil Description	pH Value	Sulphate Concentration (ppm)	Chloride Concentration (ppm)
1	4	Silty Sand Till	8.2	50	500

The results reveal that the tested sample have a pH value of 8.2, sulphate content of 50 ppm and chloride content of 500 ppm, disclosing that the actual sulphate and chloride concentration of the soils will be less than 1,000 ppm. Thus, it is inferred that the soils have a negligible potential to attack on concrete.

4.5 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 3.

Table 3 - 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	13	11	6 to 16
Silty Sand Till	6 to 36 (median 8)	10	6 to 15

* The above values are provided as a guideline. Standard Proctor Tests must be performed on bulk samples collected from site during construction prior to backfill and compaction.

5.0 GROUNDWATER CONDITION

All boreholes remained dry on completion of the boreholes. During wet seasons, perched groundwater may occur at shallower depths within the earth fill, or in the sand or silt. The groundwater level will be subjected to seasonal fluctuation.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath the pavement structure and a layer of earth fill in places, the site is underlain by a deposit of silty sand till.



All boreholes remained dry upon completion of the boreholes. The groundwater level will fluctuate with seasons.

The project will consist of the construction of building additions around the existing building. The geotechnical findings which warrant special consideration are presented below:

1. The existing earth fill is not suitable for supporting any structures. For structural use, it must be subexcavated, sorted free of any deleterious material, and properly compacted. If it is impractical to sort the fill, it must be wasted.
2. The sound natural soils below the earth fill and weathered till are suitable for normal spread and strip footing construction. 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.
3. For slab-on-grade construction, the slab should be placed on sound natural soils or properly compacted earth fill. Prior to the slab construction, the subgrade must be proof-rolled and inspected. Any weathered or soft areas detected must be subexcavated and replaced with inorganic material compacted to 98% or + Standard Proctor dry density.
4. Excavation into the till containing boulders will require extra effort and may require the use of a heavy-duty backhoe. Boulders larger than 15 cm in size are not suitable for structural backfill and/or in the construction of engineered fill.

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**

The existing pavement structure should be removed. The existing earth fill and weathered soils should be subexcavated, sorted, inspected and recompact in layers. If it is impractical to sort the soil, it must be wasted and replaced with properly completed inorganic earth fill.



6.2 **Foundations**

Based on the borehole findings, it is recommended that the normal spread and strip footings for the proposed project must be placed below the earth fill and weathered soils onto the sound natural native soils. The recommended soil pressures and suitable founding levels are presented in Table 4.

Table 4 - Founding Levels

Borehole No.	Recommended Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Corresponding Founding Level	
	250 kPa (SLS)/400 kPa (ULS)	
	Depth (m)	Elevation (m)
1	2.4 or +	211.3 or -
2	1.6 or +	213.6 or -
3	1.0 or +	215.5 or -
4	1.0 or +	215.8 or -

Where engineered fill is constructed, footings founded on the engineered fill can be designed using a Maximum Allowable Soil Pressure (SLS) of 150 kPa and Factored Ultimate Soil Bearing Pressure (ULS) of 225 kPa.

The total and differential settlements of structures designed using the bearing pressure at SLS are estimated to be within 25 mm and 20 mm, respectively.

The foundations exposed to weathering and in unheated areas should have at least 1.5 m of earth cover for protection against frost action, or must be properly insulated.

To ensure that the condition of the subgrade is compatible with the foundation design requirements, the footing subgrade of the normal foundations must be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer.

The footings should meet the requirements specified in the latest Ontario Building Code, and the building must be designed to resist a minimum earthquake force using Site Classification 'C' (very dense soil).



The type of foundations for the new addition and the existing building should be similar and compatible. If the new footing subgrade lies lower than adjacent existing footings, the existing footings must be underpinned. In this case, the structural engineer and geotechnical engineer for the project must be consulted.

A slip-joint should be provided at the interface of the new structure and the existing building. This is to allow for abrupt differential settlement at the interface without imposing structural distress on the existing foundations.

Where the building is to be constructed without a basement, permanent perimeter and under-floor drainage will not be required.

6.3 **Slab-On-Grade Construction**

For slab-on-grade construction, the earth fill and badly weathered soil must be subexcavated, sorted free of topsoil and any deleterious materials, and properly recompacted to at least 98% SPDD.

The slab should be constructed on a granular base, 20 cm thick, consisting of 19-mm Crusher-Run Limestone (CRL), or equivalent, compacted to its maximum SPDD.

A Modulus of Subgrade Reaction of 25 MPa/m is recommended for use in the design of the floor slab on compacted granular fill.

The ground around the building must be graded to direct water away from the structure.

6.4 **Underground Services**

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

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.



In order to prevent pipe floatation when the sewer trench is deluged with water derived from precipitation, 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.

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

6.5 **Backfilling in Trenches and Excavated Areas**

The backfill in the trenches and excavated areas should consist of organic-free soil, such as the revealed silty sand till and inorganic earth fill, compacted to at least 95% SPDD. In slab-on-grade areas and in the zone within 1.0 m below the pavement subgrade, the material should be compacted to 98% SPDD, with the water content 2% to 3% drier than the optimum.

As shown in Table 1, selected on site inorganic till is generally suitable for use as trench backfill. Any dry soils encountered will require wetting prior to its use as structural backfill. The till should be sorted free of oversized boulders (over 15 cm in size) before use as backfill. The weathered till and earth fill must be screened, sorted free of topsoil and organics before reusing for structural 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 should be cut at 2 Horizontal (H):1 Vertical (V) or flatter 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.

6.6 **Pavement Restoration**

Upon completion of the building additions, underground services and trench backfilling, the pavement will be restored. The recommended pavement design is presented in Table 5.

**Table 5 - Pavement Design**

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL3
Asphalt Binder	50	HL8
Granular Base	150	Granular 'A'
Granular Sub-base		Granular 'B', Type I
Parking	300	
Fire Route	450	

Prior to the placement of the granular bases, the subgrade should be proof-rolled; any soft subgrade should be subexcavated and replaced with properly compacted organic-free material.

The subgrade within 1.0 m below the underside of the granular sub-base should be compacted to at least 98% SPDD, with water content 2% to 3% drier than its optimum.

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

At the transition between the existing pavement structure and the new pavement, the surface and binder courses must overlap the existing pavement to avoid water penetration at the pavement joint. Tack coat should be applied at the transition below the 300 mm longitudinal step joint to ensure proper transition when the new asphalt is placed.

6.6 Soil Parameters

The recommended soil parameters for the project design are given in Table 6.

Table 6 - Soil Parameters

<u>Unit Weight and Bulk Factor</u>			
	Unit Weight (kN/m³)	Estimated Bulk Factor	
	Bulk	Loose	Compacted
Earth Fill and Weathered Till	21.0	1.20	1.00
Silty Sand Till	22.5	1.33	1.03



Table 6 - Soil Parameters (Cont'd)

<u>Lateral Earth Pressure Coefficients</u>			
	Active K_a	At Rest K_o	Passive K_p
Earth Fill and weathered Soil	0.40	0.50	2.50
Silty Sand Till	0.32	0.48	3.12
<u>Effective Shear Strength Parameters</u>		Cohesion c' (kPa)	Angle of Internal Friction, φ'
Silty Sand Till		2	33°
Compacted Earth Fill		0	30°
<u>Coefficient of Permeability (K) and Percolation Time (T)</u>			
	K (cm/sec)	T (min/cm)	
Silty Sand Till	10 ⁻⁵	20	
<u>Estimated Electrical Resistivity</u>			
Silty Sand Till	5000 ohm·cm		
<u>Coefficients of Friction</u>			
Between Concrete and Granular Base			0.50
Between Concrete and Sound Native Soils			0.35

6.7 Excavation

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

For excavation purposes, the types of soils are classified in Table 7.

Table 7 - Classification of Soils for Excavation

Material	Type
Silty Sand Till	2
Earth Fill and weathered Silty Sand Till	3

Excavation into the till containing boulders will require extra effort and the use of a heavy-duty, properly equipped backhoe.



If encountered, the groundwater yield from the silty sand till, due to its relatively low permeability, will be small to some 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 1.0 m below the anticipated depth of excavation. These test pits should be allowed to remain open for a few hours to assess the trenching conditions.

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of 2055672 Ontario Inc. and 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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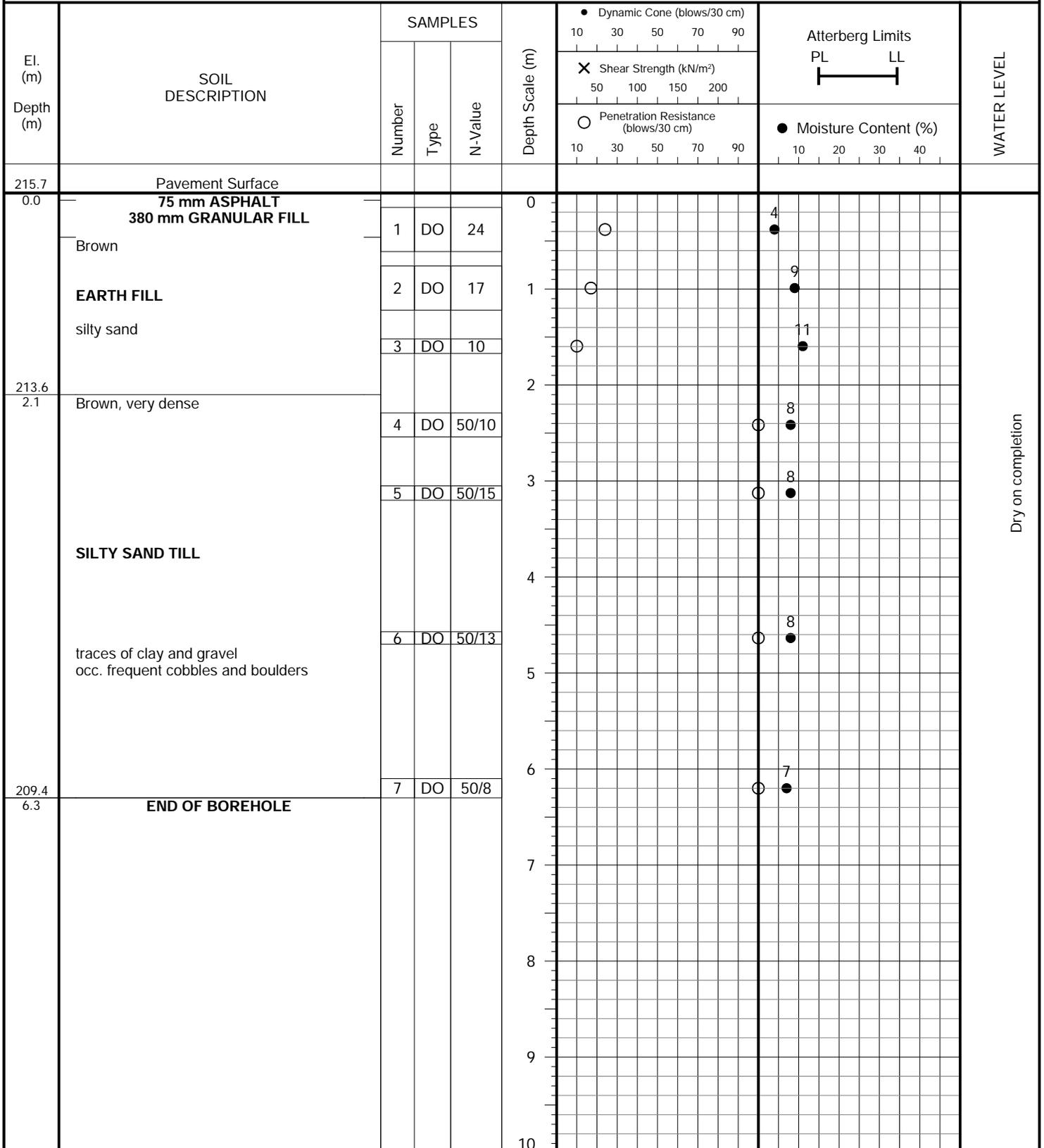
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

PROJECT DESCRIPTION: Proposed Building Addition

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: 806 King Street, Town of Midland

DRILLING DATE: September 18, 2024



Dry on completion

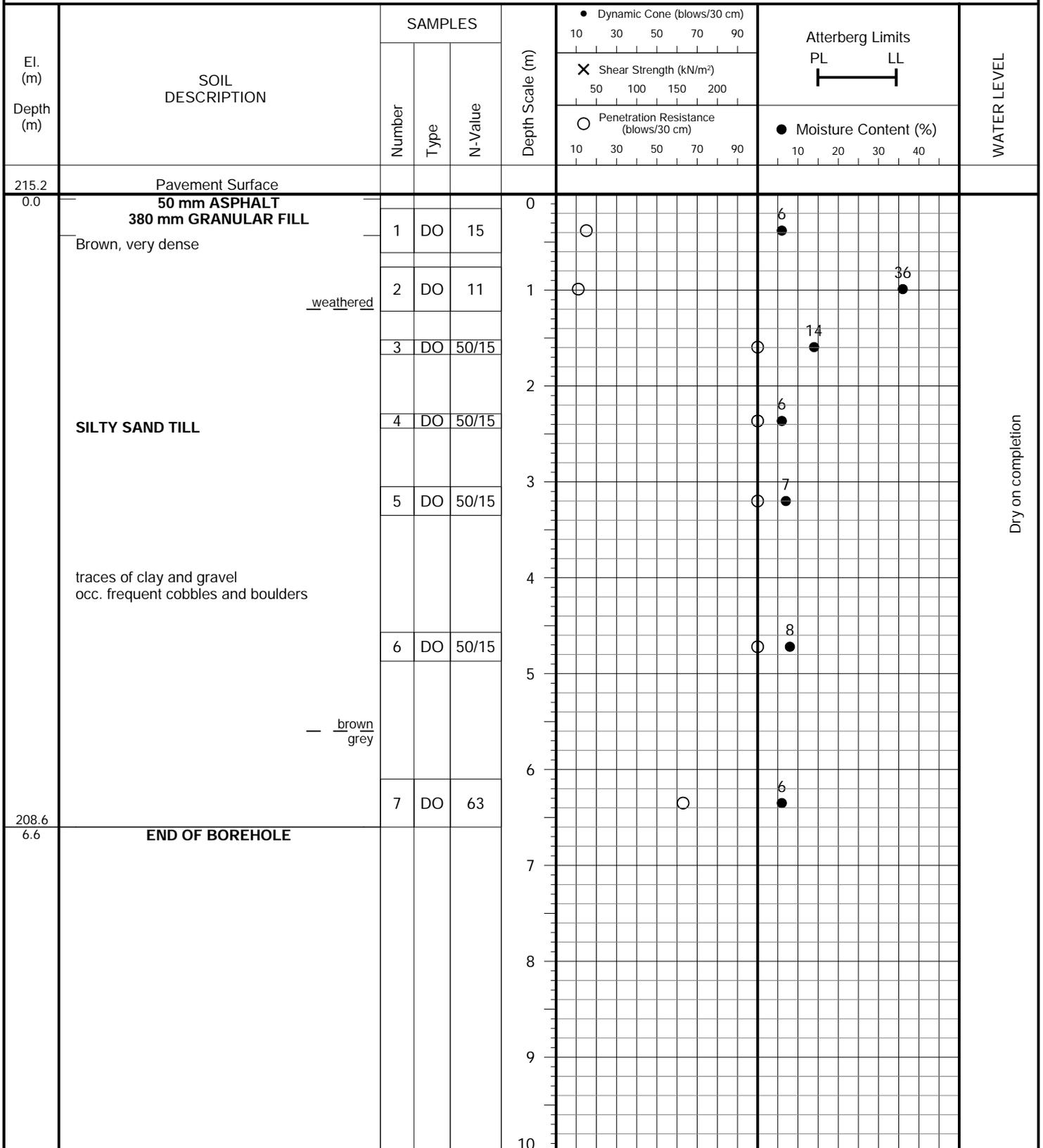


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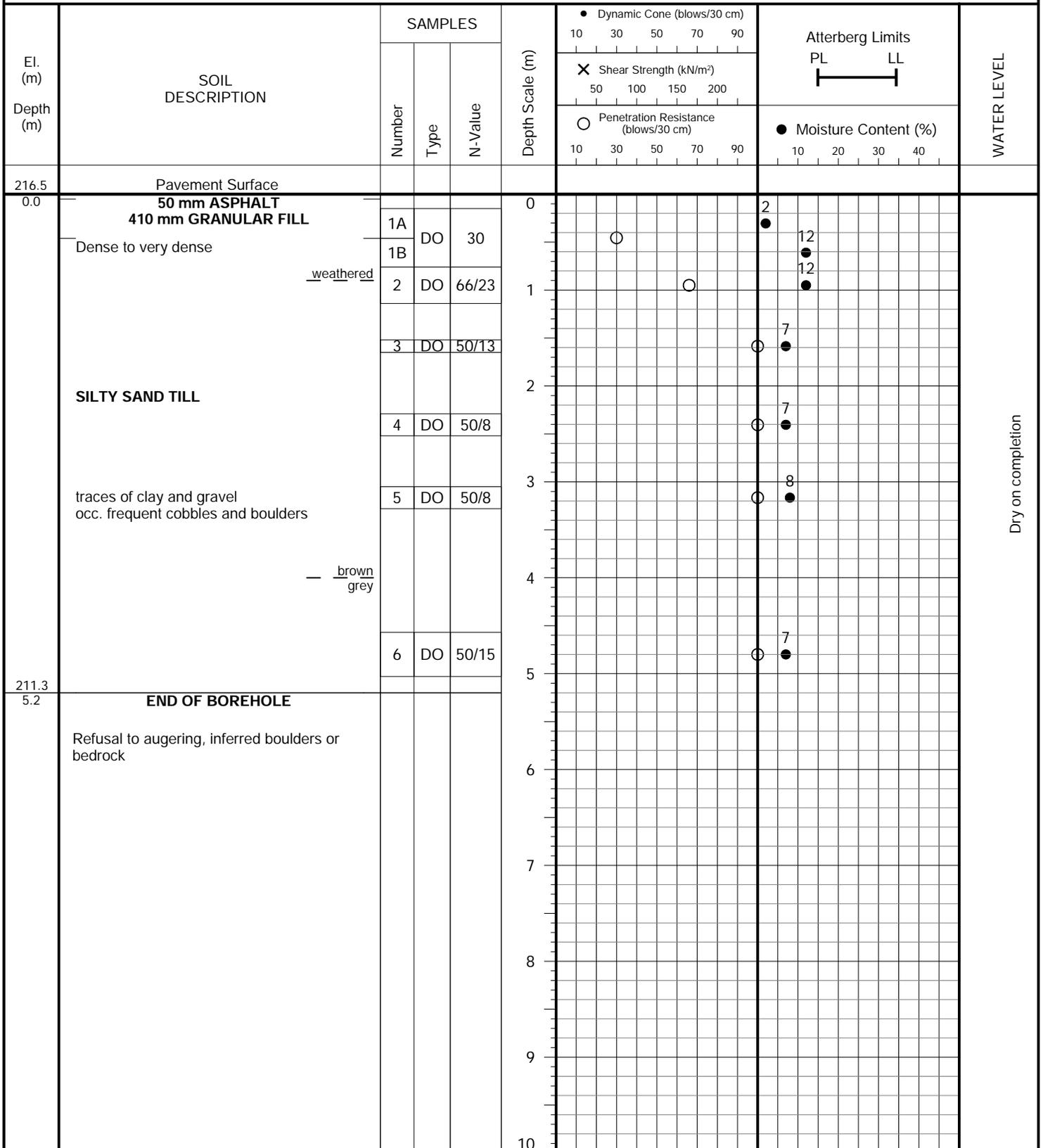


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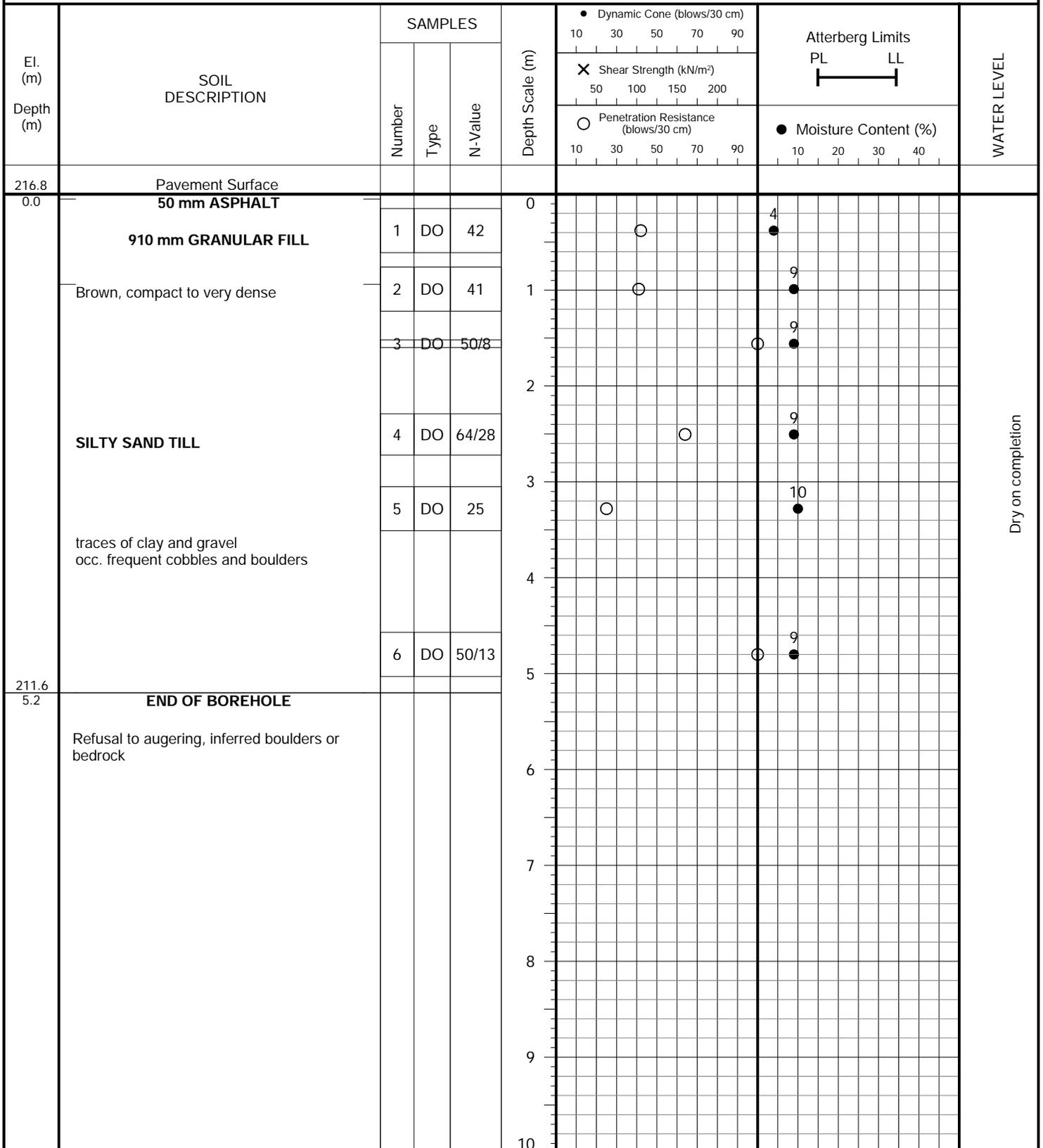


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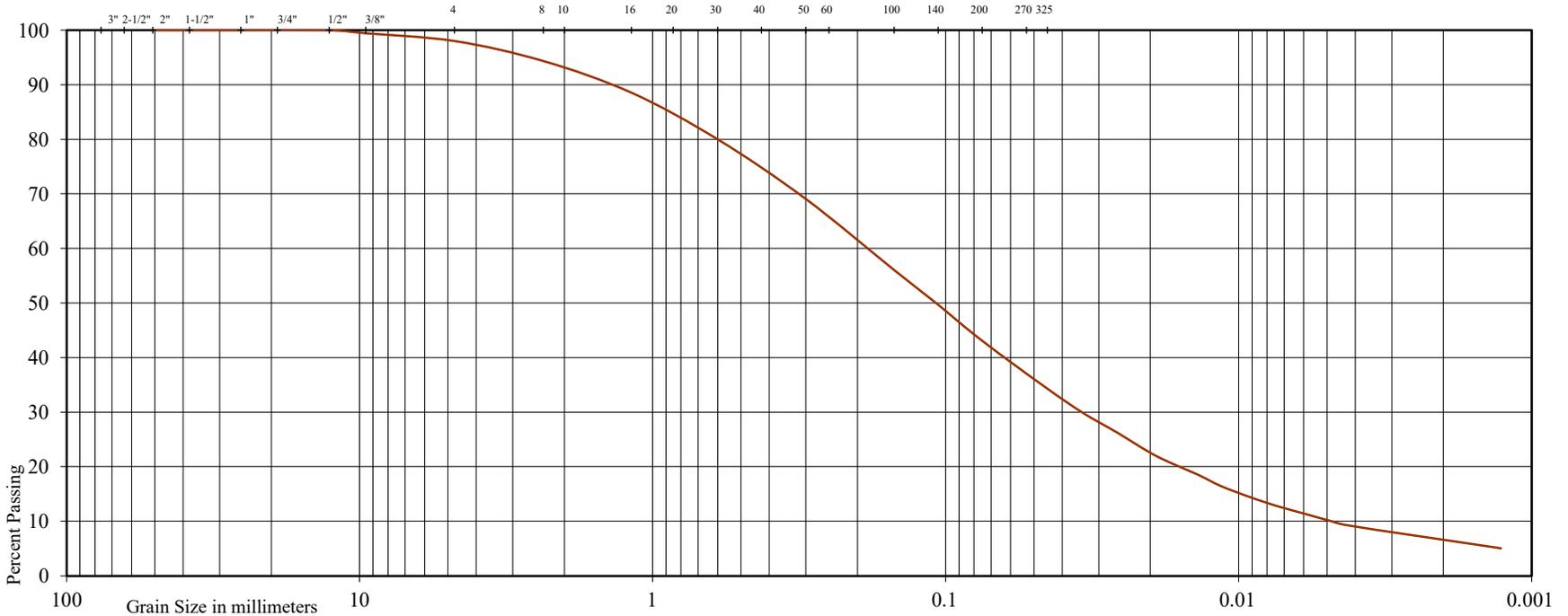


U.S. BUREAU OF SOILS CLASSIFICATION

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

UNIFIED SOIL CLASSIFICATION

GRAVEL		SAND			SILT & CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	





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SUBSURFACE PROFILE

DRAWING NO. 2

SCALE: AS SHOWN

JOB NO.: 2407-S160
REPORT DATE: September 2024
PROJECT DESCRIPTION: Proposed Building Addition

PROJECT LOCATION: 806 King Street, Town of Midland

LEGEND

- ASPHALT
- GRANULAR
- FILL
- SILTY SAND TILL

BH No.:	1	2	3	4
El. (m):	215.7	215.2	216.5	216.8

