t Soil Engineers Ltd.
GEOTECHNICAL • ENVIRONMENTAL • BUILDING SCIENCE
100 NUGGET AVENUE, TORONTO, ONTARIO M1S 3A7 • TEL: (416)754-8515 • FAX: (416)754-8516

BARRIE	MISSISSAUGA	BOWMANVILLE	NEWMARKET	GRAVENHURST	PETERBOROUGH	HAMILTON
Tel: (705) 721-7863	Tel: (905) 542-7605	Tel: (905) 623-8333	Tel: (905) 853-0647	Tel: (705) 684-4242	Tel: (705) 748-0576	Tel: (905) 777-7956
Fax: (705) 721-7864	Fax: (905) 542-2769	Fax: (905) 623-4630	Fax: (905) 853-5484	Fax: (705) 684-8522	Fax: (905) 623-4630	Fax: (905) 542-2769

A REPORT TO
TOWN OF NEWMARKET

A SOIL INVESTIGATION FOR PROPOSED BUILDING ADDITION

TIMOTHY STREET AND CIVIC DRIVE

TOWN OF NEWMARKET

REFERENCE NO. 1002-S010

MARCH 2010

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1.0 **INTRODUCTION**

In accordance with written authorization dated February 4, 2010, from Mr. Jim G. Koutroubis, Associate, of The Town of Newmarket, a soil investigation was carried out at Timothy Street and Civic Drive, Town of Newmarket, for a proposed Building Addition.

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 Town of Newmarket is situated on Schomberg Lake (glacial) plain where drift has been partly eroded and filled, in places, with lacustrine clay, silt and sand.

The site is presently occupied by an existing 1-storey brick building and an arena with associated lawn, concrete and interlocking brick sidewalk, an asphalt-paved driveway and parking lots. The site is bounded by Timothy Street to the north and Doug Duncan Drive to the west. The ground surface of the investigated area is generally flat.

The proposed project consists of a 1-storey building addition with no basement to the east of the existing building and Zamboni parking area south of the arena. The finished floor elevation of the existing building is at 239.0 m.

3.0 FIELD WORK

The field work, consisting of 5 boreholes to depths ranging from 3.7 to 6.2 m, was performed on February 17, 2010, at the locations shown on the Borehole Location Plan, Drawing No. 1. A test pit that was previously planned was cancelled by the client.

The holes were advanced at intervals to the sampling depths by a truck-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 recorded by a Geotechnical Technician.

The elevation at each of the borehole locations was determined with reference to the site bench mark shown on Drawing No. 1. It has a geodetic elevation of 239.0 m at the finished floor.

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.

This investigation has disclosed that beneath pavement structures or a layer of topsoil fill, and a layer of earth fill and topsoils in some locations, the site generally underlain by strata of silty clay and silty sand tills.

4.1 **Pavement Structure** (Boreholes 2, 3, 4 and 5)

The pavement structures disclosed by the boreholes are presented in Table 1.

Table 1 - Pavement Structure

	Thickness (mm)		
BH No.	**Asphaltic Concrete Pavement**	**Granular Fill**	**Interlocking Stone Pavement**
2	51	200	-
3	-	-	150
4	100	200	-
5	76	150	-

Sample examination indicates that the granular fill consists of crushed stone with well-graded sand, and the granular fill is generally in a damp to moist condition.

Grain size analyses were performed on 2 representative samples of granular fill; the results are plotted on Figure 6.

The gradations show that the granular fill generally failed to meet the gradations required for OPS Specifications for Granular 'B' with excessive fines of 12% to 17% by weight. Should the granular fill be reused for pavement construction, frequent laboratory testing will be required. The fill is an excellent material for floor slab-
on-grade construction, however.

Further bulk samples must be retrieved for gradation analyses in order to determine the quality of the existing granular fill for the reuse as base or sub-base material.

4.2 **Topsoil Fill** (Boreholes 1, 4 and 5) and **Topsoil** (Borehole 3)

A topsoil fill veneer, 20 cm thick, was found overlying the silty clay and sand fills in Borehole 1, and occasional topsoil or topsoil fill layers were found at depths of 2.3 m and 3.0 m from the prevailing ground surface in Boreholes 3, 4 and 5. The topsoil fill and topsoil are dark brown in colour, indicating that they contain an appreciable amount of roots and humus. These materials are unstable and compressible under loads; therefore, the topsoil and topsoil fill are considered to be void of engineering value. Due to their humus content, the topsoil fill and topsoil may produce volatile gases and will generate an offensive odour under anaerobic conditions.

4.3 **Earth Fill** (All Boreholes)

The earth fill extends to depths ranging from 3.0 to 4.6 m below the prevailing ground surface and is amorphous. It consists of silty sand and silty clay, with variable amounts of topsoil inclusions, gravel and occasional wood fragments.

The obtained ‘N’ values range from 16 to 100+, with a median of 34 blows per 30 cm of penetration, showing that the fill may have been compacted or has well self-consolidated.

Grain size analyses were performed on 2 representative samples of the fill; the results are plotted on Figure 7. The gradations confirm that part of the fill consists of silty clay with some sand and silty sand. Grain size distribution of the latter shows that the fill is similar to the native silty clay and sandy silt tills, indicating the fill is derived from those soils.

The natural water content of the earth fill ranges from 8% to 33%, with a median of 16%, showing that the fill is in a moist to wet condition, being generally moist. The high moisture content is likely due to the presence of topsoil inclusions in the fill.

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.

4.4 **Silty Clay Till** (Boreholes 1, 2, 3 and 4)

The silty clay till was encountered in 4 of 5 boreholes, showing it is the placement native soil stratum that occurs at the project area. It often extends to at least to the maximum investigated depths. The till is heterogeneous in structure, indicating that it is a glacial deposit.

Hard resistance and refusal to augering was encountered, indicating the presence of cobbles and boulders in the till mantle. Sample examination shows it is laminated with occasional sand seams.

The obtained 'N' values range from 23 to 100+, with a median of 88. This indicates that the consistency of the till is very stiff to hard, being generally hard.

The Atterberg Limits of 1 representative sample and the natural water content of the samples were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	22%
Plastic Limit	15%
Natural Water Content	8% to 19% (median 11%)

The results indicate that the clay deposit is a cohesive material with low plasticity and that it is in a damp to moist condition. The natural water content is generally below its plastic limit, confirming the generally hard consistency as inferred from the 'N' values.

Grain size analyses were performed on 2 representative samples of the silty clay till; the results are plotted on Figure 8.

Based on the laboratory and field findings, the engineering properties related to the project are given below:

- Moderate frost susceptibility and soil-adfreezing potential.
- Low water erodibility.
- Low permeability, with an estimated coefficient of permeability of 10^{-6} cm/sec, and runoff coefficients of:

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

- A cohesive soil, its shear strength is derived from consistency. It contains some fine sand; therefore, its shear strength is augmented by internal friction. In excavations, the clay till will be stable with relatively steep slopes; however, prolonged exposure will allow the wet sand and silt layers to become saturated, which may lead to slow localized sheet sloughing.
- A poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) valueof about 3%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4500 ohm·cm.

4.5 **Sandy Silt Till** (Boreholes 3 and 5)

The silty sand till generally extends to at least the maximum investigated depth. The till consists of a random mixture of particle sizes ranging from clay to gravel, with silt being the dominant fraction. It is heterogeneous in structure showing the deposit is a glacial till.

The obtained 'N' values are 26 and 100+. This indicates that the density of the till is compact to very dense.

Intermittent hard resistance to augering during Standard Penetration Testing indicates the presence of cobbles and boulders.

Sample examination shows the very dense sandy silt till is often cemented.

The natural water content values of the sandy silt till are 8%, 9% and 11%. This shows that the sandy silt till is in a moist condition.

A grain size analysis was performed on 1 representative sample of the sandy silt till; the result is plotted on Figure 9.

Based on the laboratory and field findings, the engineering properties related to the project are given below:

- Moderate frost susceptibility and soil-adfreezing potential.
- Low water erodibility.
- Low permeability, with an estimated coefficient of permeability of 10^{-5} cm/sec, and runoff coefficients of:

Slope	
0% - 2%	0.11
2% - 6%	0.16
6% +	0.23

- A frictional soil, its shear strength is primarily derived from internal friction and is augmented by cementation. Therefore, its strength is soil density dependent.
- It will be stable in relatively steep cuts; however, under prolonged exposure, localized sheet collapse will occur.
- A fair pavement-supportive material, with an estimated CBR of about 8%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of about 4500 ohm·cm.

4.6 Soil Compatibility with Concrete

In order to assess the potential for concrete attack by the occurring soils, 5 samples were selected for testing to determine their sulphate concentration and pH values. An approximate sulphate concentration is determined by placing a set amount of each sample in a chemical solution and comparing the colour of the solution to a reference chart. The results are summarized in Table 2.

Table 2 - Sulphate Concentration and pH Value

BH No.	Sample No.	Soil Description	pH Value	Sulpahte Concentration (ppm)	Chlorides Concentration (ppm)
1	7	Silty Clay Till	7.4	20	50
3	6	Sandy Silt Till	7.5	20	50
4	5	Silty Clay Till	7.5	20	50

The above results reveal that the tested samples have a pH value of 7.4 and 7.5 and a sulphate concentration of 20 ppm, disclosing that the actual sulphate concentration of the soils will be less than 1,000 ppm. Thus, it is inferred that the soils have a negligible potential to attack a normal type of concrete. Two other samples have been sent to our lab and the results will be in shortly.

4.7 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

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Silty Clay Till	8 to 19 (median 11)	14	10 to 19
Sandy Silt Till	8, 9 and 11	13	8 to 18
Earth Fill	8 to 33 (median 16)	10 to 15	6 to 20

Based on the above findings, the silty clay till and silty sand till are generally suitable for a 95% or + Standard Proctor compaction. However, the overall water content of the tills is generally on the dry side of the optimum; therefore, wetting of these soils will be required, particularly in dry, warm weather, for structural compaction. The fills must be subexcavated and sorted free of topsoil inclusions and other detrimental materials prior to structural compaction.

The fill and tills should be compacted using a heavy-weight, kneading-type roller. 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 hard silty clay till and cemented, very dense sandy silt till on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soils and be transmitted laterally into the soil mantle. Therefore, the lifts of these soils must be limited to 20 cm or less before compaction. It is difficult to monitor the lifts of backfill placed in deep trenches; it is preferable that the compaction of backfill at depths over 1.0 m below the subgrade be carried out on the wet side of the optimum. This would allow a wider latitude of lift thickness. Wetting of the tills will be necessary to achieve this requirement.

The presence of boulders will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of boulders over 15 cm in size is mixed with the material, it must either be sorted or must not be used for construction of structural backfill.

5.0 GROUNDWATER CONDITIONS

Groundwater was encountered in all of the boreholes, except Borehole 5 which remained dry upon completion. The boreholes were checked for the presence of groundwater and the occurrence of cave-in; the groundwater and cave-in levels measured on completion are plotted on the Borehole Logs and listed in Table 4.

Table 4 - Groundwater Levels

BH No.	Borehole Depth (m)	Soil Changes from Brown to Grey	Seepage Encountered During Augering		Measured Groundwater/Cave-in* Level On Completion	
		Depth (m)	Depth (m)	Amount	Depth (m)	El. (m)
1	6.2	6.2+	-	-	5.5	233.3
2	6.2	6.2+	-	-	4.9	233.1
3	5.5	5.5+	-	-	5.2	233.1
4	5.2	3.0	-	-	4.9	233.9
5	3.7	3.7+	-	-	Dry	-

The colour changes from brown to grey only in Borehole 4 at a depth of 3.0 m below the prevailing ground surface, indicating that the revealed soils have generally oxidized. The groundwater detected at the time of investigation will fluctuate with the seasons. During wet seasons, infiltrating precipitation is likely to become trapped in the voids in the fill and in the sand and silt seams laminated in the till, causing perched groundwater to occur in places at shallower depths.

The yield of groundwater from the silty clay till, due to its low permeability, is expected to be small and limited. The yield of groundwater from the earth fill and sandy silt till, due to their moderately low permeability, will be moderate.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that the ground surface consists of either pavement structures or a layer of topsoil fill, overlying a layer of earth fill to depths ranging from 3.0 to 4.6 m. In most places, a layer of topsoil or topsoil fill lies below the earth fill. The site is underlain by native strata of very stiff to hard, generally hard silty clay till and compact to very dense sandy silt till. The tills extend to at least the maximum investigated depths ranging from 3.7 to 6.2 m.

Groundwater was encountered in all of the boreholes at depths ranging from 4.9 to 5.5 m, except Borehole 5 which was dry on completion. At the time of investigation, it is expected that the groundwater level will fluctuate with the seasons. During wet seasons, groundwater will likely occur at a shallower depth. The yield of groundwater, if any, from the silty clay till will be limited; from the earth fill and sandy silt till, it is expected to be moderate.

The geotechnical findings which warrant special consideration are presented below:

1. The existing fill contains topsoil inclusions and occasional wood debris; from the obtained 'N' values, the fill seems to have been compacted or well self-consolidated. .
2. For slab-on-grade construction, the fills must be further assessed by test pits and/or during foundation excavation. For structural backfill, the fill must be subexcavated, sorted free of topsoil inclusions and deleterious materials, aerated and properly compacted.
3. The sound natural soil is suitable for normal spread and strip footing construction. The footing subgrade must be inspected to ensure that its condition is compatible with the design of the foundations.

4. The tills contain occasional boulders and cobbles. Excavation into the very stiff to hard or compact to very dense tills containing boulders will require extra effort and the use of a heavy-duty backhoe.

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**

It is understood that the building addition will be located in the vicinity of Boreholes 3 to 5 and the Zamboni parking area will be located in the vicinity of Borehole 2.

Based on the findings, it is recommended that the normal spread and strip or trench footings for the building foundations can be placed into the compacted well self-consolidated earth fill. A Maximum Allowable Soil Pressure (SLS) of 100 kPa with a Factored Ultimate Soil Bearing Pressure (ULS) of 150 kPa can be used for the design of foundations. This must be exercised with cautions, that during construction, the founding subgrade must be inspected on a full-time basis by a geotechnical consultant, and the foundation must be reinforced to spread the stress induced by the differential settlement of 25 mm. Otherwise, the foundation must be extended into the underlying native soils. Maximum Allowable Soil Pressures (SLS) of 300 kPa, 600 kPa and 900 kPa with Factored Ultimate Soil Bearing Pressures (ULS) of 500 kPa, 1000 kPa and 1600 kPa can be used for the design of the foundation.

The recommended suitable founding levels and soil pressures are given in Table 5.

Table 5 - Founding Levels

	Recommended Maximum Allowable Soil Pressure (SLS), Factored Ultimate Soil Bearing Pressure (ULS) and Suitable Founding Level					
	300 kPa (SLS) 500 kPa (ULS)		600 kPa (SLS) 1000 kPa (ULS)		900 kPa (SLS) 1600 kPa (ULS)	
BH No.	**Depth (m)**	**El. (m)**	**Depth (m)**	**El. (m)**	**Depth (m)**	**El. (m)**
1	-	-	4.0 or +	234.8 or -	-	-
2	-	-	-	-	4.8 or +	233.2 or -
3	2.6 or +	236.3 or -	-	-	4.5 or +	234.4 or -
4	2.7 or +	236.1 or +	-	-	4.5 or +	234.3 or -
5	-	-	-	-	3.4 or +	235.5 or -

The above indicates that a stepped footing scheme may be required for normal footing construction. In areas where the foundations are to be extended, it may be more cost-effective to subexcavate to a size of 20% to 30% larger than the designed footing width, and fill with structural concrete up to the proposed footing elevation immediately after the suitable founding soil is exposed. In order to allow the incidental loose material to remain on the subgrade approved prior to construction, the concrete must be readily available. The entire operation of footing excavation, subgrade inspection and concreting must be carried out on a continuous basis.

Alternatively, the buildings loads can be borne by caissons. A 40% increase in the Maximum Allowable Soil Pressure (SLS) and Factored Ultimate Soil Bearing Pressure (ULS) can be used for caissons, which must be extended at least 1.0 m below the depths recommended for 900 kPa (SLS) and 1600 kPa (ULS), given in Table 5.

For caisson construction, the ratio of the embedded soil depth to the diameter of the caisson should be at least 2:1. The centre-to-centre spacing between the caissons must be at least twice the diameter of the largest adjacent caisson base.

To facilitate the ease of subgrade inspection and cleaning, the caisson should be at least 80 cm in diameter and must be lined for safety and to prevent seepage from entering the excavation to prevent cave-in.

Foundations exposed to weathering, and in unheated areas, should have at least 1.2 m of earth cover for protection against frost action.

The foundations should meet the requirements specified by the Ontario Building Code, and the building addition should be designed to resist a minimum earthquake force using Site Classification 'C' (dense soil).

At the interface of the existing building and the addition, provided the footing subgrade is appropriate, the underside of the new footing must be flush with the underside of the existing footing and a slip joint must be provided between the footings. This is to allow slight settlement of the new foundation without causing structural distress to the existing building. If the appropriate new footing subgrade is lower than the underside of the existing footing at the interface, the existing footing should be underpinned and the structural engineer for the project must be consulted.

6.3 **Slab-On-Grade**

It is understood that part of the building addition will be borne by the existing foundations. The subgrade of the existing foundations and the dimensions of the foundations must be investigated to ensure they have the structural capability to bear the new loads. The existing fill is suitable to support slab-on-grade construction.

The surface of the subgrade must be inspected and proof-rolled. Any soft or loose areas detected must be subexcavated and replaced with inorganic fill, compacted to at least 98% of its maximum Standard Proctor dry density prior to placement of the granular base.

New fill used to raise the grade must consist of inorganic soil compacted at least 98% of its maximum Standard Proctor dry density. If the subgrade has been loosened due to construction traffic, it must be proof-rolled before placement of the granular base.

As noted, the existing fill contains topsoil inclusions and likely other deleterious material. In order to guard against a foul smell emanating from the fill mantle, the new building addition should be well-ventilated and a gas barrier should provided below the slab.

The slab should be constructed on a granular base 20 cm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to 100% of its maximum Standard Proctor dry density.

A Modulus of Subgrade Reaction of 25 MPa/m can be used for the design of the floor slab.

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

At the entrance doors where the ambient temperature is often low during the winter months, the slab and the interior of the foundation wall should be insulated with 50-mm Styrofoam, or equivalent, extending 5.0 m internally. This measure is to prevent cold drafts in the winter from inducing frost action in the subgrade which may damage the floor slab.

Where slab-on-grade is exposed to the open air, or areas where it is not heated, it must be insulated with 50-mm Styrofoam. If the slab-on-grade is to be borne onto dry to damp non-frost-susceptible material, the material must extend at least 1.2 m below the underside of the slab.

6.4 Underground Services

The subgrade for the underground services should consist of sound natural soil or properly compacted inorganic soil.

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

6.5 Backfilling in Trenches and Excavated Areas

The on-site inorganic soils are 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. As noted, the overall water content of the tills is generally on the dry side of the optimum; therefore, wetting of these soils will be necessary to achieve this requirement. Below the slab-on-grade, the backfill must be compacted to at least 98% of its maximum Standard Proctor dry density.

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. 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 Design

The subgrade will generally consist of silty clay till material. Based on the borehole findings, the recommended pavement design is given in Table 6.

Table 6 - 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 Crushed Concrete
Granular Sub-base Light Duty (Parking) Heavy Duty (Fire Route)	 200 350	50-mm Crusher-Run Limestone or Crushed Concrete

In preparation of the subgrade, the surface should be proof-rolled, and any soft subgrade should be subexcavated, aerated and properly recompacted.

All the granular bases should be compacted to 100% or + of their maximum Standard Proctor dry density.

The zone of the subgrade within 1.0 m below the underside of the granular sub-base should be compacted to at least 98% of its maximum Standard Proctor dry density in the top 1.0 m, with the water content 2% to 3% drier than the optimum. This is necessary to provide a stable subgrade for pavement construction.

The subgrade should be proof-rolled and any soft spots should be rectified prior to placement of the granular base.

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 0.3 m 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 manholes or catch basins. Alternatively, the sidewalks and the interlocking stone pavement should be properly insulated with 50-mm Styrofoam, or equivalent.

6.8 Soil Parameters

The recommended soil parameters for the project design are given in Table 7.

Table 7 - Soil Parameters

Unit Weight and Bulk Factor			
	Unit Weight (kN/m^3)	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
Earth Fill	20.5	1.30	1.00
Tills	21.5	1.33	1.03
Lateral Earth Pressure Coefficients			
	Active K_a	**At Rest K_o**	**Passive K_p**
Earth Fill	0.40	0.45	2.50
Tills	0.35	0.45	2.86
Electrical Resistivity			
	About 4000 ohm·cm (to be confirmed with in situ field tests)		

6.9 Excavation

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

Excavations should be sloped at 1 vertical:1 horizontal for stability.

For excavation purposes, the types of soils are classified in Table 8.

Table 8 - Classification of Soils for Excavation

Material	Type
Tills	2
Fill	3

Groundwater, if encountered during excavation, can be controlled by pumping from sumps.

Prospective contractors must assess the in situ conditions for excavation by performing test cuts 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

It should be noted that no tests have been carried out to determine whether environmental contaminants are present in the soils. Therefore, this report deals only with a study of the geotechnical aspects of the proposed project.

This report was prepared by Soil Engineers Ltd. for the account of Town of Newmarket and for review by its designated consultants. The material in it reflects the judgement of Mohammed Eqdaih, B.A.Sc., and Victor S. Chan, 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, 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.

Mohammed Eqdaih, B.A.Sc.

Victor S. Chan, P.Eng.
ME/VSC:dd

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:

1. SAMPLES TYPES

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

2. PENETRATION RESISTANCE/'N'

Dynamic Cone Penetration Resistence:

A continuous profile showing the number of blows for each foot of penetration of 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 'O'

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

3. SOIL DESCRIPTION

a) 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

b) 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

c) 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 meters
1 lb. = 0.453 kg
1 inch = 25.4 mm
1 ksf = 47.88 kN/m^2

Soil Engineers Ltd.
GEOTECHNICAL • ENVIRONMENTAL • BUILDING SCIENCE
100 NUGGET AVENUE, TORONTO, ONTARIO M1S 3A7 • TEL: (416)754-8515 • FAX: (416)754-8516

JOB NO: 1002-S010

LOG OF BOREHOLE NO: 1

FIGURE NO: 1

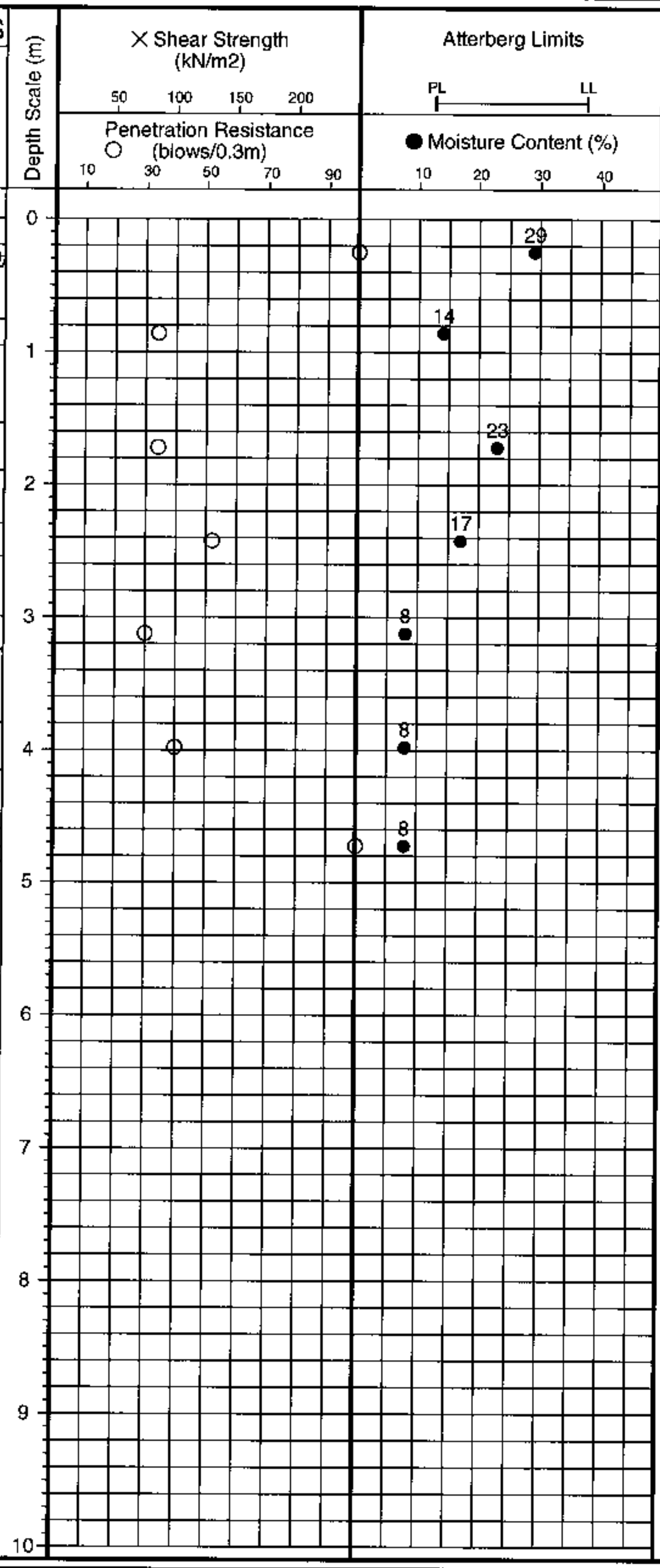
JOB DESCRIPTION: Proposed Building Addition

JOB LOCATION: Timothy Street and Civic Drive, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: February 17, 2010

Depth / Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0 / 238.8	Ground Surface **20 cm TOPSOIL, Fill**	1	DO	100+
	Greyish-brown **EARTH, Fill** silty clay, some sand a trace of gravel occ. topsoil layers and roots	2	DO	34
		3	DO	34
		4	DO	52
		5	DO	30
3.8 / 235.0	Brown/grey, hard **SILTY CLAY, Till** sandy, a trace of gravel occ. cobbles, boulders and sand seams	6	DO	40
		7	DO	100+
6.2 / 232.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 233.3 m on completion

Soil Engineers Ltd.

JOB NO: 1002-S010

LOG OF BOREHOLE NO: 2

FIGURE NO: 2

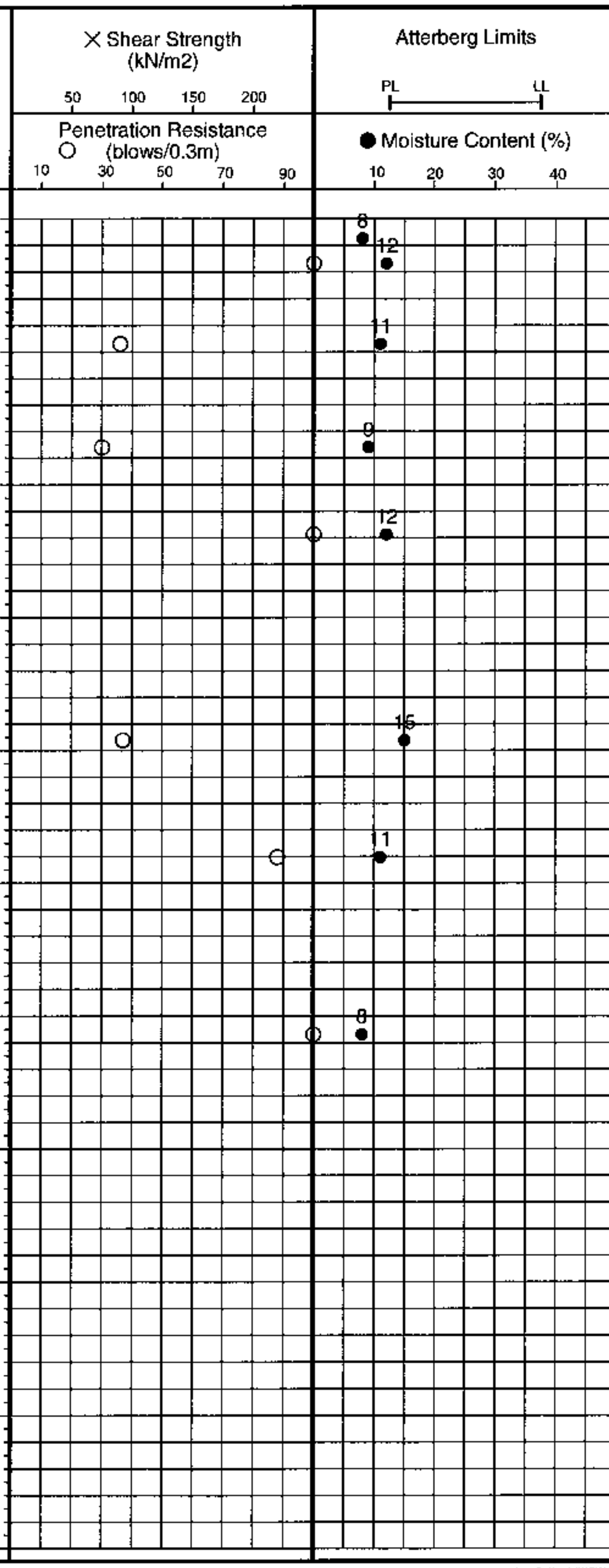
JOB DESCRIPTION: Proposed Building Addition

JOB LOCATION: Timothy Street and Civic Drive, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: February 17, 2010

Depth / Elev. (m)	SOIL DESCRIPTION	Samples: Number	Type	N-Value	Depth Scale (m)
0.0	Pavement Surface				0
238.0	51 mm **ASPHALTIC CONCRETE**	1	AS	-	
	200 mm **GRANULAR, Fill**	2	DO	100+	
	EARTH, Fill silty sand, silty clay (brown / grey) some gravel occ. wood debris, boulders and cobbles	3	DO	36	1
		4	DO	30	2
		5	DO	100+	3
		6	DO	37	4
4.6 / 233.4	Greyish-brown, hard **SILTY CLAY, Till** sandy, a trace of gravel occ. cobbles, boulders and sand seams	7	DO	88	5
6.2 / 231.8	**END OF BOREHOLE**	8	DO	100+	6



WATER LEVEL

W.L. @ El. 233.1 m on completion

Soil Engineers Ltd.

JOB NO: 1002-S010

LOG OF BOREHOLE NO: 3

FIGURE NO: 3

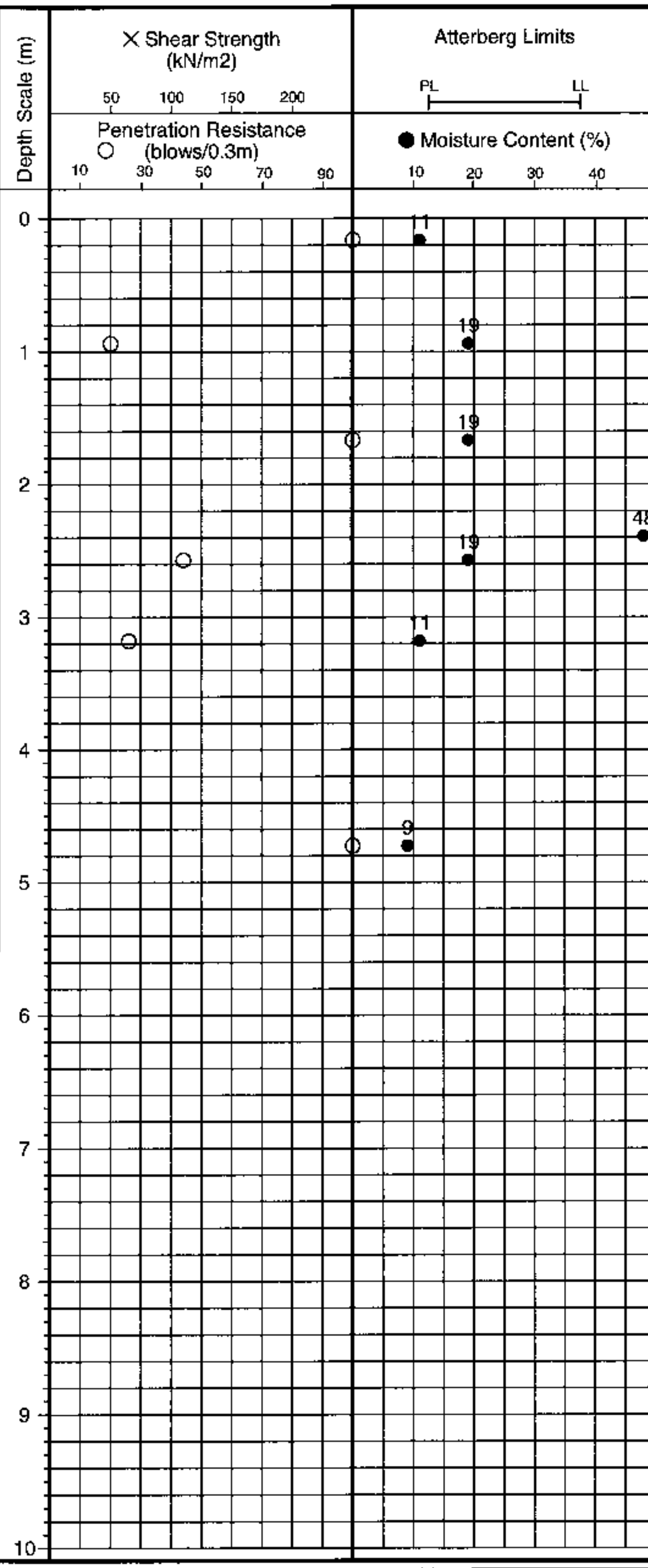
JOB DESCRIPTION: Proposed Building Addition

JOB LOCATION: Timothy Street and Civic Drive, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: February 17, 2010

Depth / Elev. (m)	SOIL DESCRIPTION	Sample Number	Type	N-Value
0.0 / 238.9	Pavement Surface			
	150 mm INTERLOCKING STONE PAVEMENT	1	DO	100+
	Brown/grey **EARTH, Fill** sand, silty clay, sandy silt, a trace of gravel, occ. topsoil layers	2	DO	20
		3	DO	100+
2.3 / 236.6	**18 cm TOPSOIL**	4A	DO	-
	Grey **SILTY CLAY, Till** sandy, a trace of gravel	4B	DO	44
3.0 / 235.9	Brown, compact to very dense **SANDY SILT, Till** traces of clay and gravel, occ. cobbles, boulders and sand seams	5	DO	26
		6	DO	100+
5.5 / 233.4	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 233.7 m on completion

JOB NO: 1002-S010

LOG OF BOREHOLE NO: 4

FIGURE NO: 4

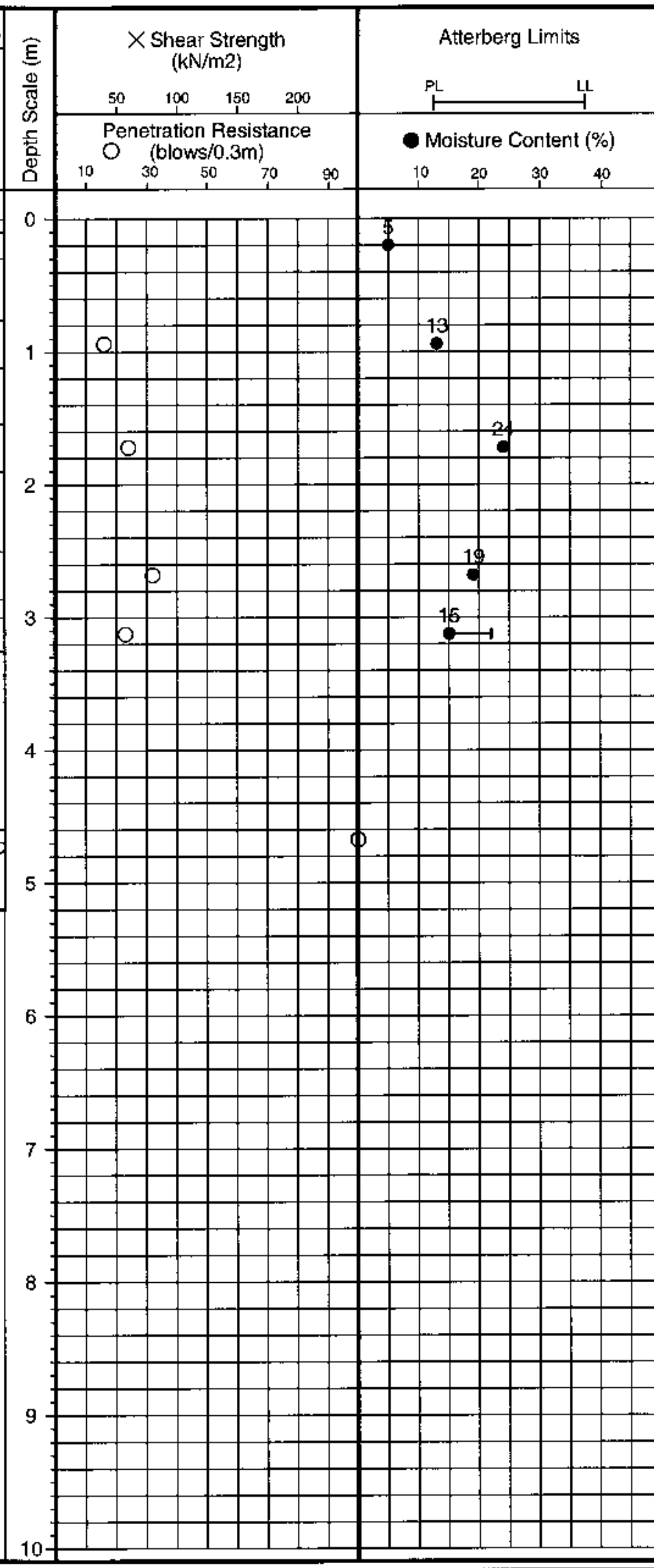
JOB DESCRIPTION: Proposed Building Addition

JOB LOCATION: Timothy Street and Civic Drive, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: February 17, 2010

Depth / Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0 / 238.8	Pavement Surface **100 mm ASPHALTIC CONCRETE** **200 mm GRANULAR, Fill**	1	AS	-
	Brown/grey **EARTH, Fill** silty clay a trace of gravel occ. topsoil and roots	2	DO	16
		3	DO	24
2.3 / 236.5	**18 cm TOPSOIL**			
	very stiff to hard **SILTY CLAY, Till** (brown / grey) occ. cobbles, boulders and sand seams a trace of gravel	4	DO	32
		5	DO	23
		6	DO	100+
5.2 / 233.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 233.9 m on completion

Soil Engineers Ltd.

JOB NO: 1002-S010

LOG OF BOREHOLE NO: 5

FIGURE NO: 5

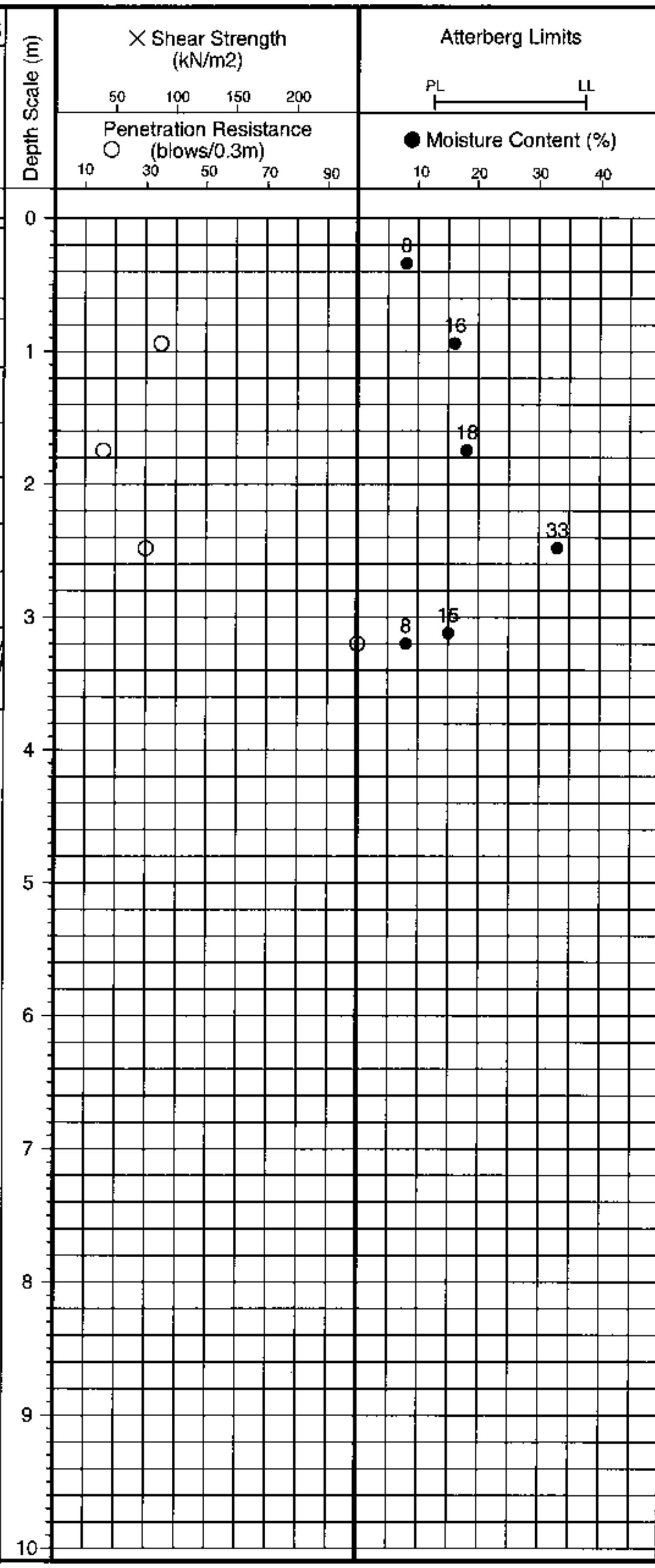
JOB DESCRIPTION: Proposed Building Addition

JOB LOCATION: Timothy Street and Civic Drive, Town of Newmarket

METHOD OF BORING: Flight-Auger

DATE: February 17, 2010

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Pavement Surface			
238.9	**76 mm ASPHALTIC CONCRETE**			
	150 mm GRANULAR, Fill	1	AS	-
	Brown/grey **EARTH, Fill** fine sand, silty clay, silty clay a trace of gravel occ. topsoil and roots	2	DO	35
		3	DO	16
		4	DO	30
3.0 / 235.9	**8 cm TOPSOIL**	5A	DO	-
	Brown **SANDY SILT, Till** sand, a trace of gravel occ. cobbles and boulders	5B	DO	100+
3.7 / 235.2	**END OF BOREHOLE**			



WATER LEVEL: Dry on completion

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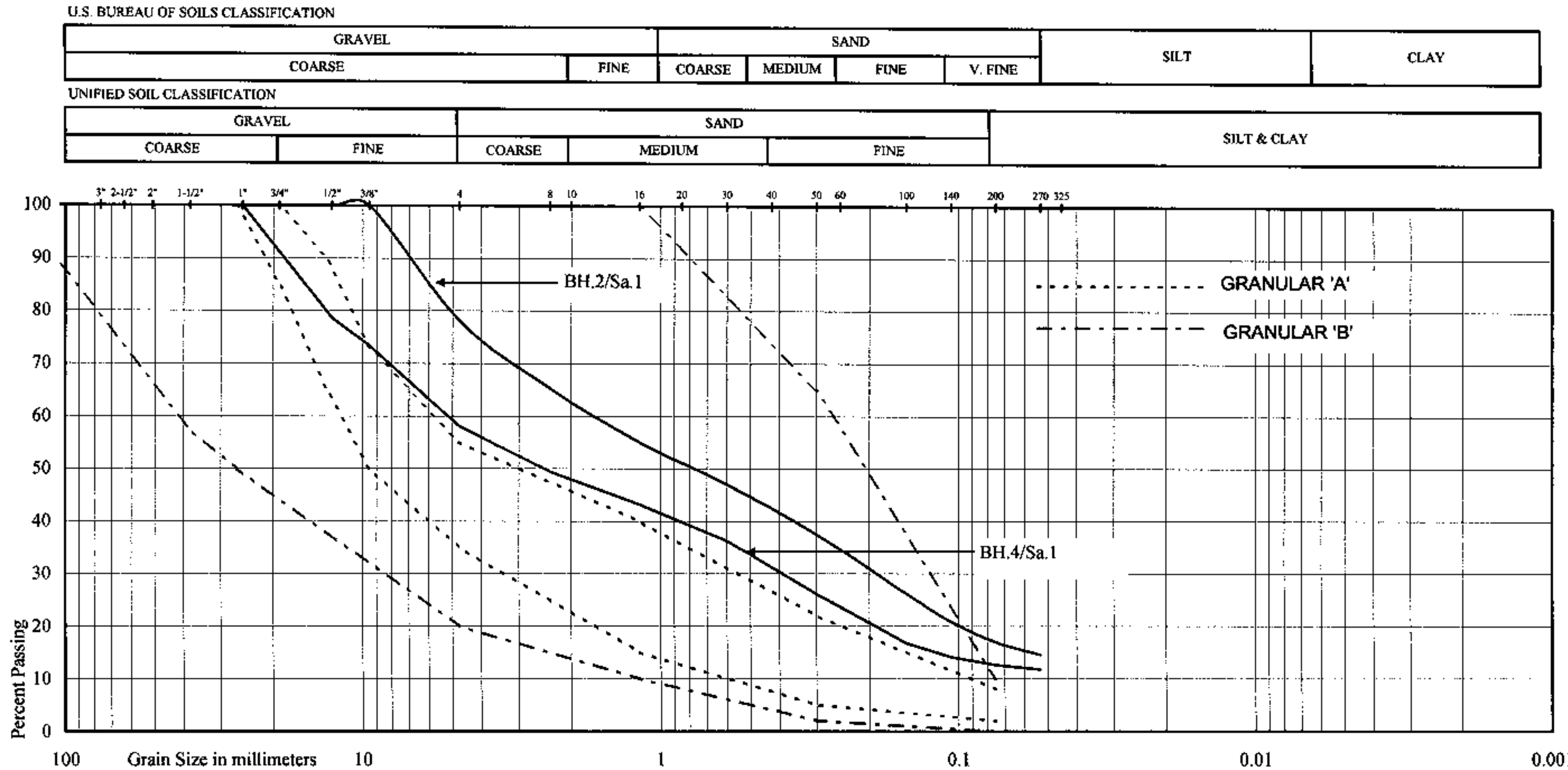
GRAIN SIZE DISTRIBUTION

Reference No: 1002-S010



Project:	Proposed Building Addition	
Location:	Timothy Street and Civic Drive, Town of Newmarket	
Borehole No:	2	4
Sample No:	1	1
Depth (m):	0.2	0.2
Elevation (m):	237.8	238.6

BH./Sa.	2/1	4/1
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	8	5
Estimated Permeability (cm./sec.) =	10^{-4}	10^{-4}

Classification of Sample [& Group Symbol]: GRANULAR, Fill

Figure: 6

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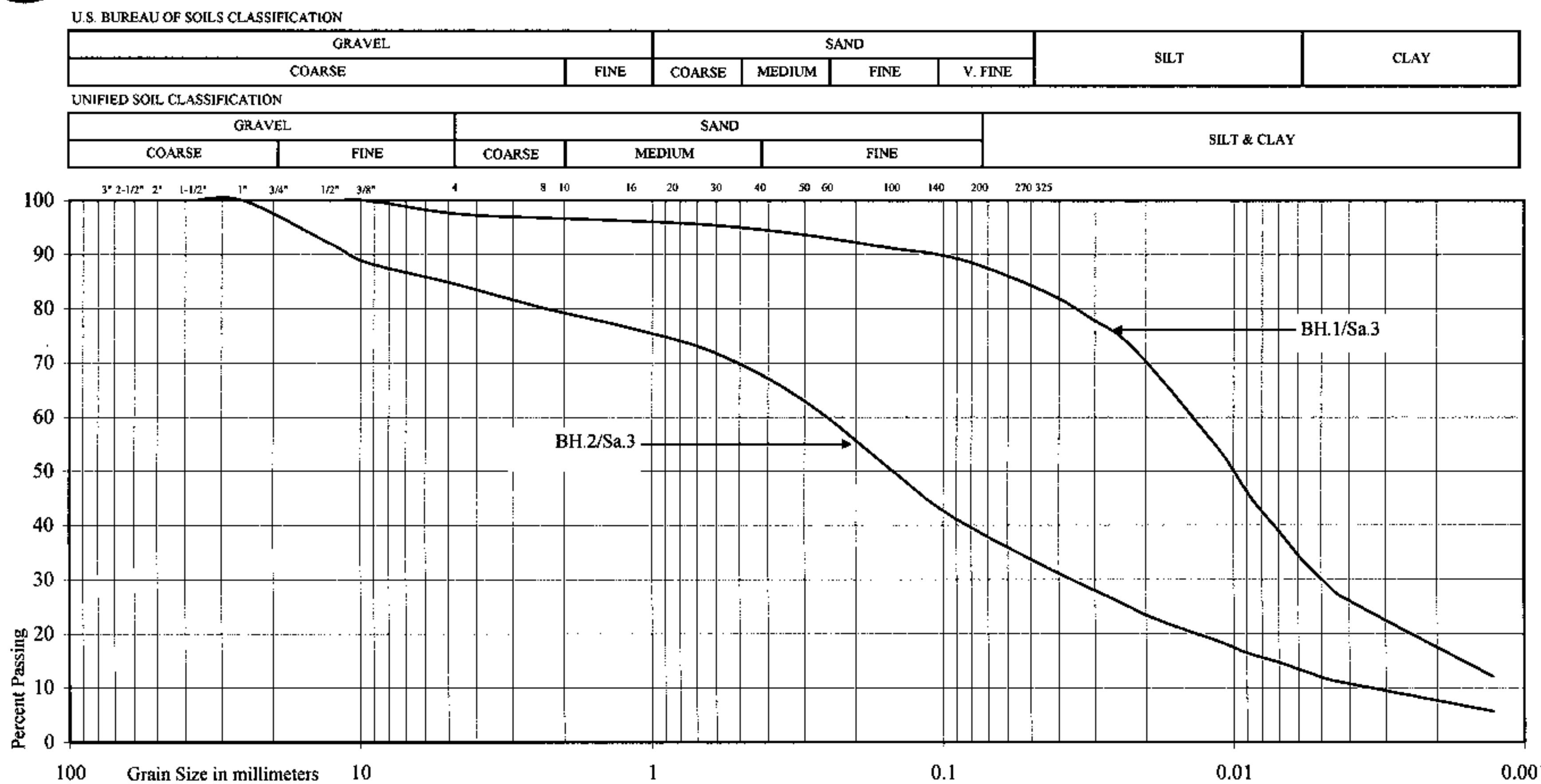
GRAIN SIZE DISTRIBUTION

Reference No: 1002-S010



BH./Sa.	1/3	2/3
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	23	11
Estimated Permeability (cm./sec.) =	10^{-6}	10^{-5}

Project: Proposed Building Addition

Location: Timothy Street and Civic Drive, Town of Newmarket

Borehole No:	1	2
Sample No:	3	3
Depth (m):	1.7	1.0
Elevation (m):	237.1	237.0

Classification of Sample [& Group Symbol]: EARTH, Fill

BH.1/Sa.3 - silty clay, some sand, a tr. of gravel

BH.2/Sa.3 - silty sand, some gravel and clay

Figure: 7

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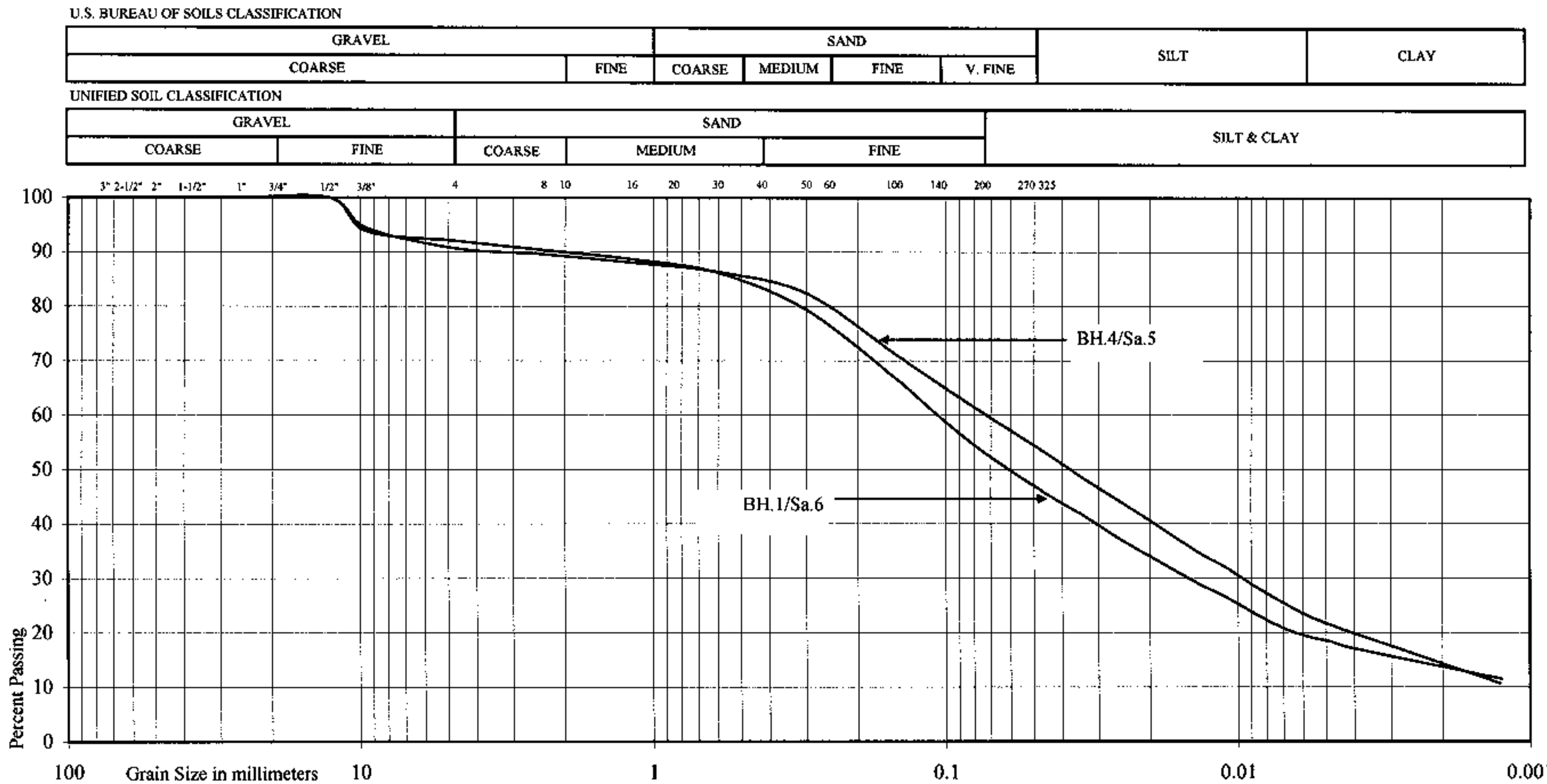
GRAIN SIZE DISTRIBUTION

Reference No: 1002-S010



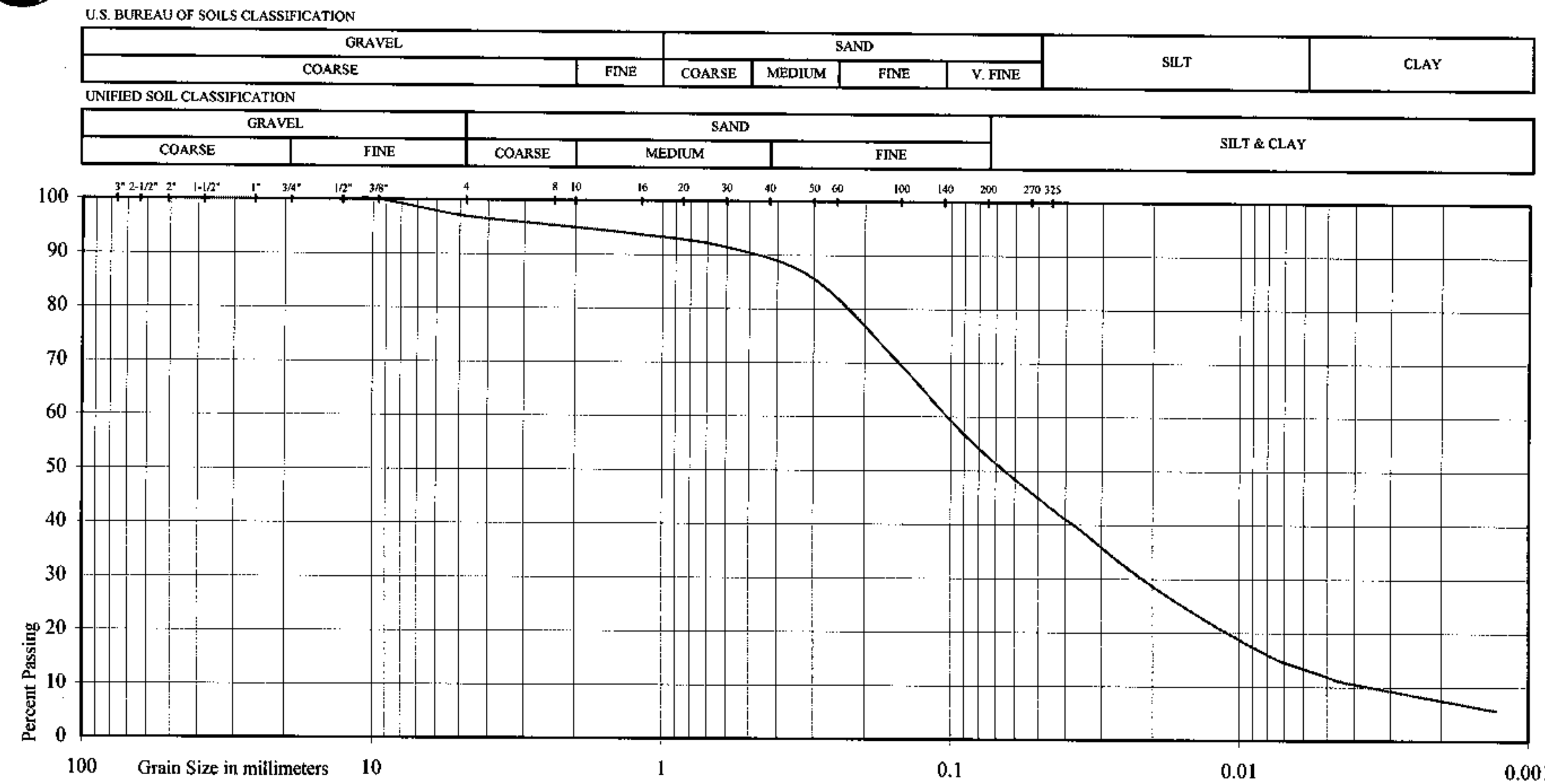
BH./Sa.	1/6	4/5
Liquid Limit (%) =	-	22
Plastic Limit (%) =	-	15
Plasticity Index (%) =	-	7
Moisture Content (%) =	8	15
Estimated Permeability (cm./sec.) =	10^{-6}	10^{-6}

Project:	Proposed Building Addition	
Location:	Timothy Street and Civic Drive, Town of Newmarket	
Borehole No:	1	4
Sample No:	6	5
Depth (m):	4.0	3.2
Elevation (m):	235.0	235.6

Classification of Sample [& Group Symbol]: SILTY CLAY, Till
BH.1/Sa.6 - traces of gravel and clay with some clay
BH.4/Sa.5 - sandy, a tr. of gravel

Figure: 8

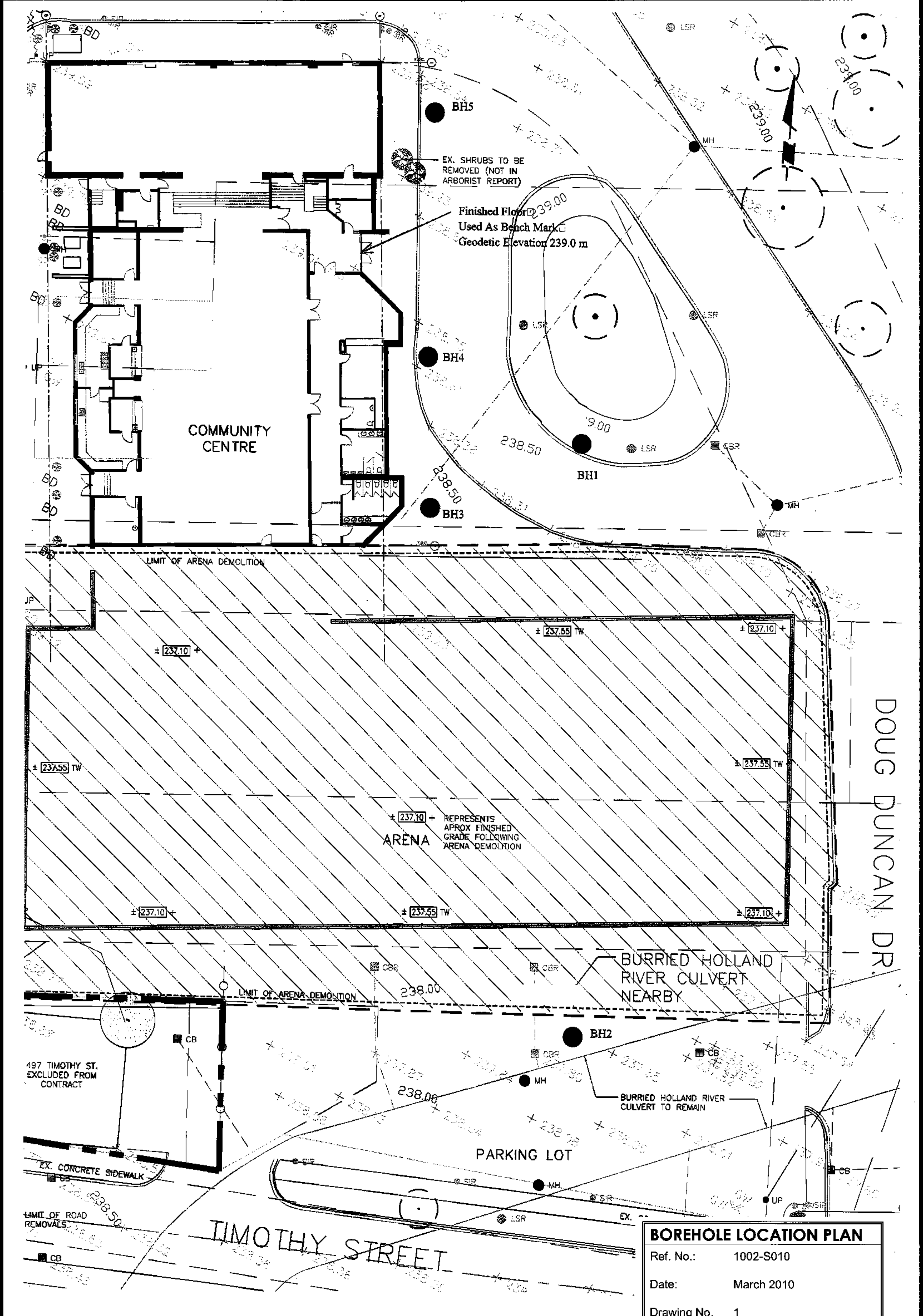
Soil Engineers Ltd. **GRAIN SIZE DISTRIBUTION** Reference No: 1002-S010



Project:	Proposed Building Addition	Liquid Limit (%) =	-
Location:	Timothy Street and Civic Drive, Town of Newmarket	Plastic Limit (%) =	-
Borehole No:	3	Plasticity Index (%) =	-
Sample No:	5	Moisture Content (%) =	11
Depth (m):	3.2	Estimated Permeability	
Elevation (m):	235.7	(cm./sec.) =	10^{-5}

Classification of Sample [& Group Symbol]: SANDY SILT, Till
traces of gravel and clay

Figure: 9



BOREHOLE LOCATION PLAN

Ref. No.:	1002-S010
Date:	March 2010
Drawing No.	1
Scale –	1:300

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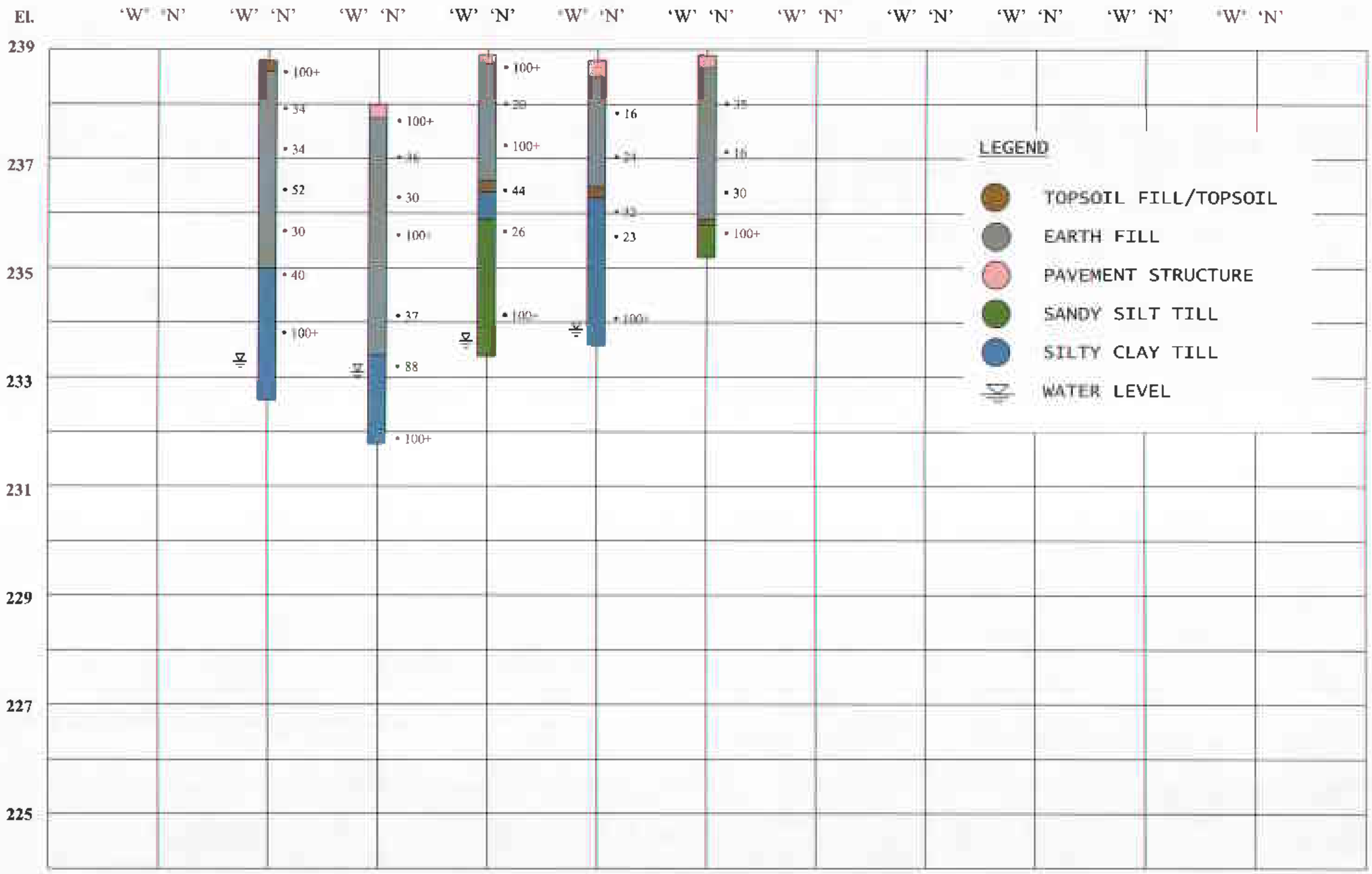
JRA

Project:
COMMUNITY URBAN SPACE PROJECT

Drawing:
BOREHOLE LOCATIONS FOR STRUCTURAL TESTING OF SUBGRADE

BH. No.	1	2	3	4	5					
Topsoil Fill/Topsoil (cm)	20	-	18	18	8					
Elevation (m)	238.8	238.0	238.9	238.8	238.9					



SUBSURFACE PROFILE

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Scale: Horiz. N.T.S.
Vert. 1:100

Ref. No. 1002-S010
Drawing No. 2