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A REPORT TO
THE KAITLIN GROUP LTD.

A SLOPE STABILITY AND SOIL INVESTIGATION FOR PROPOSED EXTERIOR SERVICING

46 STEVENS ROAD
TOWN OF BOWMANVILLE

Reference No. 0711-S052

JUNE 2008

DISTRIBUTION

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1.0 INTRODUCTION

In accordance with written authorization dated November 12, 2007, from Mr. Kelvin Whalen of The Kaitlin Group Ltd., a soil investigation for proposed Exterior Servicing and a slope stability study were carried out at 42 Stevens Road, Town of Bowmanville.

The purpose of the slope stability study was to determine the long term geotechnical stable slope for the proposed residential development. The purpose of the soil 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

Bowmanville is situated on Iroquois Lake plain where drift has been partly eroded by the water action of the glacial lake and, in places, filled with lacustrine clay, silt and sand.

The subject site is irregular in shape and encompasses an approximate area of 8.68 ha (21.47 ac). At present, a single residence with a garage and a tennis court are located on the site.

The subject site abuts the Bowmanville Creek along the north and east property limits. The investigated areas include two sections of the slope located at the north and east sectors of the proposed site along Bowmanville Creek. The investigated slope is 12.0± m in height with an overall slope gradient of 1 vertical: 0.8 to 3.0 horizontal. Bowmanville Creek ranges from 10.0± to 15.0± m in width and is situated at distance of 27.0+ m away from the toe of the slope.

The proposed exterior servicing traverses the central sector of the property and across Bowmanville Creek.

3.0 FIELD WORK

The field work, consisting of 10 boreholes to depths ranging from 2.3 to 11.1 m, was performed on December 7 and 10, 2007 and June 3, 2008, at the locations shown on the Borehole Location Plan and Subsurface Profile, Drawing No. 1.

Boreholes 2, 3 and 5 were advanced to the sampling depths using the weight of a 31.75 kg (70 lb) hammer. The remainder of the boreholes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration 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 interpolated from the contours on a topographic plan provided by D.G. Biddle & Associates Ltd.

4.0 SUBSURFACE CONDITIONS

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

The boreholes along the top of bank revealed that beneath a topsoil veneer or a layer of earth fill, the subsoils consist of strata of silty clay, silty clay till, silty sand till and sandy silt. The boreholes along the toe of bank indicates that beneath a topsoil veneer, the subsoils consist strata of silty fine sand and gravelly sand.

4.1 Topsoil (All Boreholes, except Borehole 1)

The revealed topsoil veneer ranges from 18 to 36 cm in thickness. The topsoil is dark brown in colour, indicating the presence of appreciable amounts of roots and humus. These materials are unstable and compressible under loads; therefore, the topsoil is considered to be void of engineering value, but can be used for general landscaping purposes. A fertility analysis should be carried out to assess the suitability of the topsoil as a planting soil or sodding medium.

Due to its humus content, the topsoil may produce volatile gases and will generate an offensive odour under anaerobic conditions. Therefore, it must not be buried deeper than 1.2 m below the external finished grade, or within the building/house envelopes. This is to avoid an adverse impact on the environmental well-being of the proposed project.

4.2 **Earth Fill** (Borehole 1)

The earth fill, 4.2 m thick, generally consists of silty clay material with occasional topsoil inclusions.

The original topsoil was not detected beneath the earth fill, but may have been obscured by the augering.

The natural water content of the samples was determined to range from 9% to 28%, with a median of 17%, indicating that the fill is moist to wet, being generally very moist.

The obtained 'N' values range from 4 to 18, with a median of 7 blows per 30 cm of penetration, indicating that the earth fill was placed without uniform compaction and has partially self-consolidated. The fill is generally in a loose condition.

A grain size analysis was performed on 1 representative sample of the sitly clay fill, and the result is plotted on Figure 11.

Due to the non-uniform, loose density of the fill, and its unknown history, it is unsuitable for supporting structures in its present state and must be subexcavated, sorted free of topsoil inclusions or deleterious materials, and properly compacted for structural usage.

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

4.3 Silty Clay (Boreholes 1, 4, 6, 8, 9 and 10)

The silty clay deposit was generally encountered in the lower zone of the soil stratigraphy. It contains a trace of sand, and occasional silt seams and layers.

Sample examinations indicate that the surficial layer of the clay, extending to a depth of 1.5± m, has been loosened by the weathering process.

The obtained 'N' values range from 4 to 45, with a median of 16, indicating that the consistency of the clay is firm to hard, being generally very stiff. The firm clay occurs in the weathered zone of the stratum

The Atterberg Limits of 2 representative samples and the natural water content values of all the samples were determined; the results are plotted on the Borehole Logs and summarized below:

Liquid Limit	31% and 36%
Plastic Limit	17% and 19%
Natural Water Content	10% to 35% (median 19%)

The results indicate that the clay deposit is a cohesive material with medium plasticity. The natural water content generally lies close to its plastic limit, confirming the consistency determined by the 'N' values. The low 'N' values and high moisture content occurs in the weathered zone of the clay stratum.

Grain size analyses were performed on 2 representative samples of the clay, and the results are plotted on Figure 12.

According to the above findings, the soil engineering properties pertaining to the project are given below:

- High frost susceptibility, with low soil-adfreezing potential.
- Low water erodibility.
- Practically impervious, with an estimated coefficient of permeability of 10^{-7} cm/sec, and runoff coefficients of:

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

- Its shear strength is derived from consistency and is augmented by internal friction. The strength is, therefore, inversely dependent on the soil moisture and, to a lesser degree, directly dependent on the soil density.
- In excavations, the clay will be stable with relatively steep slopes; however, prolonged exposure will allow infiltrating precipitation to saturate the soil fissures and the sand and silt layers in the mantle. This may lead to slow localized sheet sloughing.
- A very poor material to support flexible pavement, with an estimated California Bearing Ratio (CBR) value of 3% or less.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4000 ohm/cm.

4.4 <u>Silty Clay Till</u> (Boreholes 4, 6, 7, 8, 9 and 10)

The clay till consists of a random mixture of soils; the particle sizes range from clay to gravel, with the clay fraction exerting the dominant influence on its soil properties. Occasional silt and sand seams and layers were encountered in the till mantle.

Intermittent hard resistance to augering was encountered, indicating the presence of cobbles and boulders in the stratum.

The silty clay till has been weathered in the zone within a depth of 1.5± m below the prevailing ground surface.

The obtained 'N' values range from 7 to 63, with a median of 23, indicating that the consistency of the till is firm to hard, being generally very stiff. The firm clay till occurs in the weathered zone.

The Atterberg Limits of 2 representative samples and the natural water content values of all the samples were determined; the results are plotted on the Borehole Logs and summarized below:

Liquid Limit	23% and 25%
Plastic Limit	15% and 16%
Natural Water Content	7% to 36% (median 11%)

The results indicate that the clay deposit is a cohesive material with low plasticity. The natural water content generally lies below its plastic limit, confirming the consistency determined by the 'N' values.

Grain size analyses were performed on 2 representative samples of the clay till, and the results are plotted on Figure 13.

According to the above findings, the soil engineering properties pertaining to the project are given below:

- Moderate frost susceptibility and water erodibility.
- Low permeability, with an estimated coefficient of permeability of 10^{-7} 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 primarily derived from consistency which is inversely related to its water content. It contains sand; therefore, its shear strength is augmented by internal friction.
- It will generally be stable in a relatively steep cut; however, prolonged exposure will allow the weathered layers and the wet sand seams to become saturated which may lead to localized sloughing.
- A poor pavement-supportive material, with an estimated CBR value of 3%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4,000 ohm/cm.

4.5 <u>Silty Fine Sand</u> (Boreholes 2, 3 and 5) and <u>Sandy Silt</u> (Borehole 4)

The sandy silt deposit was only encountered in one borehole, showing its presence is localized. The silty fine sand deposit was generally encountered in the boreholes at the toe of slope, and it contains silt seams and layers.

Sample examination indicates that the surficial layer of the sandy silt and silty fine sand has been loosened by the weathering process.

The natural water content was determined range from 8% to 28%, with a median of 20%, indicating that the deposits are moist to wet, generally wet. The values are plotted on the Borehole Logs.

The obtained 'N' values range from 1 to 5, with a median of 4, indicating that the relative density is very loose to loose, being generally loose.

Grain size analyses were performed on 2 representative samples of each of the sandy silt and silty fine sand. The results are plotted on Figures 14 and 15.

According to the above findings, the following engineering properties are deduced:

- High frost susceptibility and soil-adfreezing potential.
- High water erodibility; susceptible to migration through small openings under seepage pressure.
- Pervious, with an estimated coefficient of permeability of 10^{-6} cm/sec for the silt and of 10^{-4} cm/sec for the sand, and runoff coefficients of:

Slope	**Sand**	**Silt**
0% - 2%	0.07	0.15
2% - 6%	0.12	0.20
6% +	0.18	0.28

- Frictional soils, their shear strength is derived from internal friction and is soil density dependent.
- In cuts, the deposits will be stable in a moist condition, but the wet deposits will run with water seepage and boil under a piezometric head of about 0.4 m.
- Fair pavement-supportive materials, with an estimated CBR value of 10%.
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5500 to 6000 ohm/cm.

4.6 <u>Silty Sand Till</u> (Boreholes 4, 6, 7, 9 and 10)

The silty sand till was found predominating the lower zone of the stratigraphy. It consists of a random mixture of soil particle sizes ranging from clay to gravel, with silt being the predominant fractions. Occasional silt and clay seams and layers were found in the till mantle.

Intermittent hard resistance to augering was encountered, indicating the presence of cobbles and boulders in the stratum.

The obtained 'N' values range from 28 to 100+, with a median of 100+, indicating that the relative density of the till is compact to very dense, being generally very dense.

The natural water content was determined and the values are plotted on the Borehole Logs. The values range from 5% to 8%, with a median of 6%, showing that it is damp to moist, being generally moist.

Grain size analyses were performed on 2 representative samples of the sand till, and the results are plotted on Figure 16.

According to the above findings, the engineering properties are listed below:

- High frost susceptibility and moderate water erodibility.
- Relatively low permeability, with an estimated coefficient of permeability of 10^{-4} to 10^{-6} cm/sec, and runoff coefficients of:

Slope	
0% - 2%	0.07 to 0.15
2% - 6%	0.12 to 0.20
6% +	0.18 to 0.28

- A frictional soil, its shear strength is primarily derived from internal friction and is augmented by cementation. Therefore, its strength is primarily soil-density dependent.
- It will be stable in steep cuts; however, under prolonged exposure, local sheet collapse will likely occur.
- A fair pavement-supportive material, with an estimated CBR value of 10%
- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm/cm.

4.7 Gravelly Sand (Boreholes 2, 3 and 5)

The sand deposit was only found in the boreholes at the toe of slope. It contains some silt with occasional silt seams and fine to medium sand layers.

The natural water content values are 8%, 10% and 11%, indicating it is generally moist. However, due to its high permeability, some water would likely have drained during the sampling process. Sample examinations indicate that it is generally in a wet to saturated condition and is considered water-bearing.

The obtained 'N' values are 22, 27 and 30, showing the relative density of the sand is generally compact.

A grain size analysis was performed on 1 representative sample of the gravelly sand, and the results are plotted on Figure 17.

According to the above findings, the following engineering properties are deduced:

- Low to high frost susceptibility depending on the silt content.
- High water erodibility.
- Pervious, with an estimated coefficient of permeability of 10^{-3} cm/sec, and runoff coefficients of:

Slope	
0% - 2%	0.04
2% - 6%	0.09
6% +	0.13

- A frictional soil, its shear strength is derived from internal friction, thus being density dependent.
- In relatively steep cuts, the sand will be stable in a damp to moist condition, but will slough if it is wet and run with water seepage.
- When excavated, the wet soil will run with seepage and the bottom will boil under a piezometric head of 0.4 m.
- A good pavement-supportive material, with an estimated CBR value of 21%.
- Moderately low corrosivity to buried material, with an estimated electrical resistivity of 5500 to 6000 ohm/cm.

4.8 Compaction Characteristics of the Revealed Soils

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

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

Table 1 - Estimated Water Content for Compaction

		Water Content (%) for Standard Proctor Compaction	
Soil Type	Determined Natural Water Content (%)	100% (optimum)	Range for 95% or +
Silty Clay	10 to 35 (median 19)	19 to 21	15 to 26
Silty Clay Till	7 to 36 (median 11)	15 to 16	11 to 21
Sandy Silt and Silty Fine Sand	8 to 28 (median 20)	11 to 12	6 to 16
Silty Sand Till	5 to 8 (median 6)	10	6 to 15
Gravelly Sand	8, 10 and 11	8	4 to 13

The above indicates that the sandy silt and silty fine sand are too wet and should be properly stockpiled to drain the excess water prior to structural compaction. The remaining soils are either on the dry or wet side optimum and should be properly mixed prior to structural compaction.

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

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

One should be aware that, with considerable effort, a 90%± Standard Proctor compaction of the wet sandy silt and silty fine sand is achievable. Further densification is prevented by the pore pressure induced by the compactive effort; however, large random voids will be expelled, and with time, the pore pressure will dissipate and the percentage of compaction will increase. There are many cases on record where, after a few months of rest, the density of the compacted mantle has increased to over 95% of its maximum Standard Proctor dry density.

The presence of boulders in the tills 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 detected in Boreholes 1 and 2 at depths of 3.4 m and 2.7 m, respectively. The remainder of the boreholes were dry upon completion of the field work, but minor seepage was encountered at various depths and locations.

The brown, oxidized soils extend to depths ranging from 2.7 to 7.0 m below the prevailing ground surface. A study of the water content profile indicates that the sand deposits at the toe of bank are generally in a wet to saturated condition. The findings indicate that the groundwater lies below depths of 2.5± m to 7.0± m from the prevailing ground surface. The groundwater regime will be subject to seasonal fluctuation, and will also be influenced by the fluctuation of the water level in the creek.

The yield from the tills and clay, due to their relatively low to low permeability, is expected to be small and limited. The yield from the saturated silt and sand deposits is expected to be appreciable, and persistent.

6.0 DISCUSSION AND RECOMMENDATIONS

The boreholes drilled along the top of the bank have revealed that beneath a topsoil veneer or a layer of earth fill, the subsoils consist of strata of firm to hard, generally very stiff silty clay; firm to hard, generally very stiff silty clay till; compact to very dense, generally very dense silty sand till and loose sandy silt. The boreholes drilled at the toe of bank have revealed that beneath a topsoil veneer, the subsoils consist of strata of very loose to loose silty fine sand and compact gravelly sand.

The groundwater lies at a depth of 2.5± m at the toe of the bank, and below depths of 2.5± m to 7.0± m at the remainder of the site. The groundwater regime will be subject to seasonal fluctation, and will be influenced by the fluctuation of the water level in the creek.

The yield from the tills and clay, due to their relatively low to low permeability, is expected to be small and limited. The yield from the saturated silt and sand deposits is expected to be appreciable and persistent.

The geotechnical findings which warrant special consideration are presented below:

1. The topsoil must be stripped for the project construction. The revealed topsoil ranges from 18 to 36 cm in thickness. The topsoil will generate volatile gases under anaerobic conditions and is unsuitable for engineering application. Therefore, the topsoil should be placed in the landscaped areas and should not be buried within the building envelope, or deeper than 1.2 m below the exterior finished grade of the subdivision.

2. The existing earth fill, in its present state, is unsuitable for supporting structures; for structural usage, the fill must be subexcavated, sorted free of topsoil inclusions and properly compacted.
3. Due to the occurrence of earth fill, and weathered soils, 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 the subgrade conditions are compatible with the foundation design requirements..
4. The sides of the excavations in the wet sand and silts will run and the bottom will boil under a piezometric head of about 0.3 m. Excavation below groundwater must be stabilized by vigorous pumping from closely spaced sump-wells or, if necessary, by a well-point dewatering system. The appropriate method of dewatering should be determined by a test pit programme carried out by the contractor prior to tendering and construction of the project when the intended bottom of excavation is determined.
5. In the wet sand, the sewer joints should be leak-proof, or wrapped with an appropriate waterproof membrane. A Class 'B' bedding is recommended for the design of the underground services construction. The bedding material should consist of 20-mm Crusher-Run Limestone, or a Class 'A' bedding should be considered.

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 Slope Stability

The slope stability assessment was carried out for the slope along the north and east property limits. The assessment consists of a site inspection and a stability analyses at six representative sections. The overall height of the bank at these section ranges from 12.0 to 13.0 m, with an overall gradient of 1 vertical:0.9 to 3.2 horizontal. The locations of the analyzed sections, Cross-Sections A-A to F-F, are shown on the Borehole Location Plan and Subsurface Profile, Drawing No. 1.

A visual inspection of the pattern of the tree growth and the slope surface indicated that the face of the bank is generally wooded and weed-covered and the bank slope is in a stable condition.

The surface profile at each section was interpreted from the contours on a topographic plan provide by D.G. Biddle & Associates Ltd. The subsurface profile as revealed by the borehole findings is shown on Drawing Nos. 2 to 7.

The slope stability was analyzed using force-moment-equilibrium criteria of the Bishop Method and the soil strength parameters given in Table 2.

Table 2 - Soil Strength Parameters

	γ (kN/m^3)	c (kPa)	ϕ (degrees)
Sandy Silt	20.5	0	31
Clay	20.5	5	26
Silty Clay Till	22.0	5	30
Silty Sand Till	22.5	2	31

The results of the stability analysis are given on Drawing Nos. 3 to 6, inclusive, and are summarized in Table 3.

Table 3 - Results of Slope Stability Analysis

Cross - Section	Factor of Safety	Overall Gradient
A-A	1.603	1V:2.00H
B-B	2.238	1V:3.20H
C-C	1.343	1V:1.50H
D-D	1.080	1V:1.08H
E-E	1.035	1V:1.04H
F-F	0.997	1V:0.90H

The factor of safety at Cross-Sections A-A and B-B satisfies the Ontario Ministry of Natural Resources (OMNR) guidelines for residential land use; the factor of safety at the remainder of the cross sections does not. The results indicate that a slope of 1 vertical:2.0 horizontal is considered to be geotechnically stable.

In summary, the slope at the east sector of the property is considered geotechnically stable in its present state. Where the slope along the north property limit has a gradient flatter than 1 vertical:2.0 horizontal, it is considered geotechnically stable; where the slope gradient is steeper than 1 vertical:2.0 horizontal, a stability setback is required. The long term geotechnically stable slope line is plotted on Drawing No. 1.

In order to prevent the occurrence of localized surface slides and to enhance the stability of the bank, the following geotechnical constraints should be stipulated:

1. Any leafy topsoil cover on the bank face should not be disturbed since this provides insulation and screens against frost wedging and rainwash erosion.

2. Where structure runoff is likely to discharge onto the bank face, the runoff must be intercepted by subdrains.
3. Groundwater must not be allowed to exit from the bank face. Should this occur, it must be controlled by intercept subdrains.
4. In order to minimize human degradation, a development setback will be required. The limit for the setback is to be set by the regional conservation authority.

The recommendations should be reviewed and are subject to the approval of the local Region Conservation Authority.

6.2 Underground Services

At the time of report preparation, the proposed exterior servicing has not yet been designed. Based on the borehole findings, the proposed exterior servicing on the east bank of Bowmanville Creek will be constructed in the non-uniformly compacted or self-consolidated silty clay fill which contains occasional topsoil inclusions.

Open Cut in Silty Clay Fill

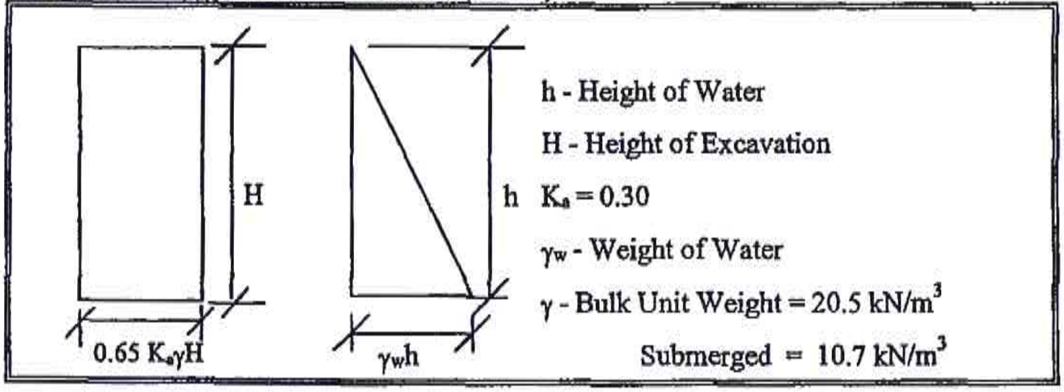
The sides of open cuts in the fill must be sloped at 1 vertical:1 horizontal for stability. If the fill is found to be in a wet condition, the sides of the fill must be flattened to 1.5 or + horizontal. Where the subgrade consists of loose fill with appreciable topsoil inclusions and/or debris, the fill must be subexcavated and replaced with compacted granular bedding material. The bedding should consist of compacted Granular 'A' or Crusher-Run Limestone.

Creek Crossing

A boring and pipe jacking operation would be carried out in the compact to dense gravelly sand which contains cobbles and boulders. This may render the boring and jacking operation difficult. Assuming the difficulties can be overcome, the soil friction on this pipe jacking through the sand and till can be calculated by the overburden load multiplied by a factor of 0.3.

The jacking pit will be built in the wet sands. The pit must be shored. The recommended lateral earth pressure distribution for the design of the shoring structure is shown in the Diagram 1.

Diagram 1 - Lateral Earth Pressure (Sands)



h - Height of Water
H - Height of Excavation
$K_a = 0.30$
γ_w - Weight of Water
γ - Bulk Unit Weight = 20.5 kN/m^3
Submerged = 10.7 kN/m^3

Groundwater seepage into the pit is expected to be controllable by vigorous pumping from sumps. Should boulders in the till obstruct the pipe jacking operation, extra effort will be required to remove the boulders, or the watermain alignment will need to be changed. Alternatively, the installation of the watermain can be carried out by open cut.

If an open cut of the creek bed is required, a diversion channel must be dug. The sides of the open cut must be protected.

6.3 Backfilling In Trenches and Excavated Areas

Where the tolerance of ground settlement is limited, the backfill in the trenches and excavated areas should be compacted to at least 95% of its maximum Standard Proctor dry density. In the zone within 1.0 m below the road subgrade, the material should be compacted with the water content 2% to 3% drier than the optimum and the compaction should be increased to 98% of the respective maximum Standard Proctor dry density. This is to provide the required stiffness for pavement construction.

The in situ inorganic soils are generally suitable for 95% or + Standard Proctor compaction; however, most of the silt till is on the dry side of the optimum and will require proper mixing with wetter soils, or the additionof water, particularly during the dry, warm weather.

The narrow trenches for services crossings should be cut at 1 vertical:
2 or + horizontal so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement of proper compaction. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

6.4 Soil Parameters

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

Table 4 - Soil Parameters

Unit Weight and Bulk Factor

	Unit Weight (kN/m^3)	Estimated Bulk Factor	
	Bulk	**Loose**	**Compacted**
Clay	21.0	1.33	1.05
Clay Till	22.5	1.33	1.05
Sand Till	21.5	1.30	1.05
Earth Fill, Silt and Sands	20.5	1.20	1.00

Lateral Earth Pressure Coefficients

	Active K_a	At Rest K_o	Passive K_p
Clay and Clay Till	0.35	0.45	2.86
Silt, Sands and Sand Tills	0.30	0.40	3.33

Coefficients of Permeability (cm/sec)

Clay and Clay Till	10^{-7}
Sand Till	10^{-4} to 10^{-6}
Sandy Silt	10^{-6}
Silty Fine Sand	10^{-4}
Gravelly Sand	10^{-3}

6.5 Excavation

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

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

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

Table 5 - Classification of Soils for Excavation

Material	Type
Sound Clay and Tills	2
Earth Fill, Weathered Soils, Sands above groundwater level	3
Sands below groundwater level	4

As discussed, the yield from the tills and clay, due to their relatively low to low permeability, is expected to be small and limited. The yield from the saturated silt and sand deposits is expected to be moderate to appreciable, and will be persistent; in this case, a well-point dewatering system may be required. This can be vertified by test pumping prior to the project construction.

Excavation into the sound soil containing cobbles and boulders will require extra effort and the use of a heavy-duty backhoe.

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

7.0 LIMITATIONS OF REPORT

It should be noted that a Phase I Environmental Site Assessment has been completed. The assessment and recommendations will be given under separate cover, Report Reference No. 0711-S052E, dated December 11, 2007. 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 The Kaitlin Group Ltd. and for review by its designated consultants and government agencies. The material in it reflects the judgement of Corey S.C. Fan, B.A.Sc. and, Daniel Man, P.Eng., *in light of the information available to it at the time of* preparation. Any use which a Third Party makes of this report, 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.

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LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

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

1. SAMPLE 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 Resistance:

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

Standard Penetration Resistance or 'N' value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.
Plotted as '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 metres
1 lb. = 0.453 kg
1 inch = 25.4 mm
1 ksf = 47.88 kN/m^2

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

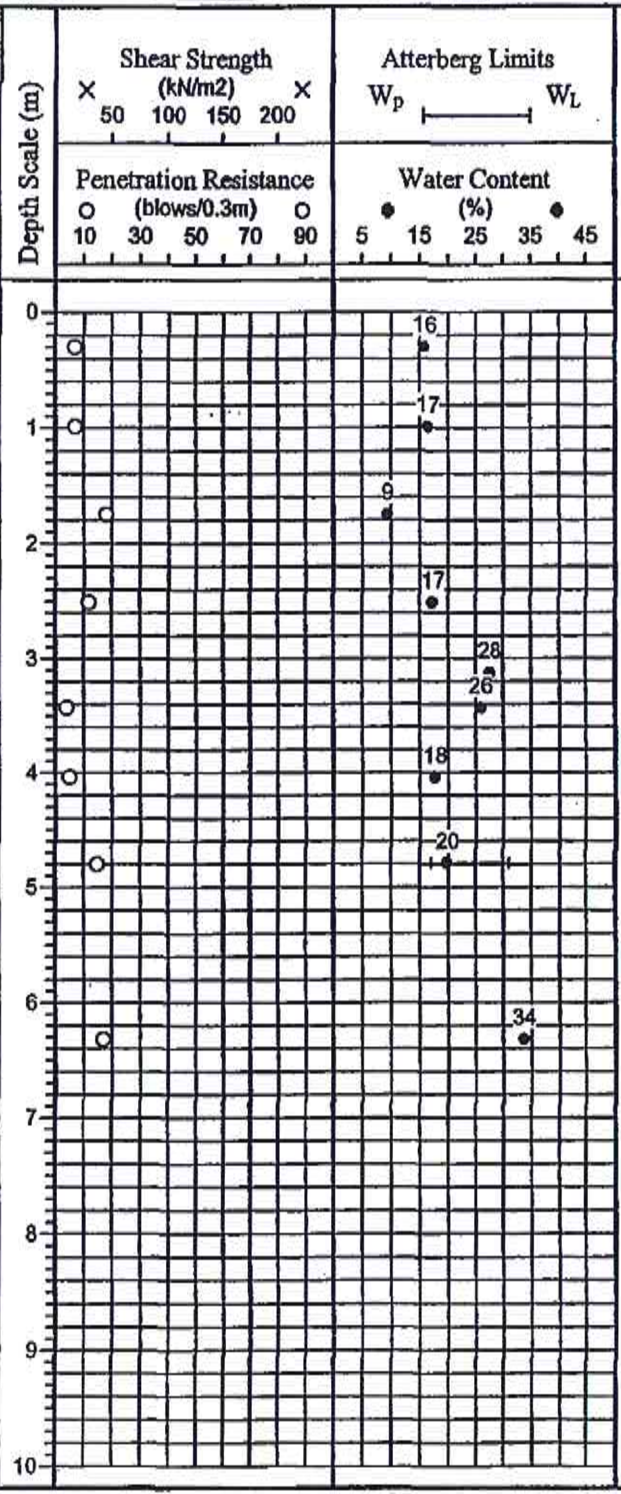
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 10, 2007

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
110.5	Ground Surface			
0.0	Brown	1	DO	7
		2	DO	7
	SILTY CLAY, Fill	3	DO	18
	occ. topsoil inclusions	4	DO	12
		5A	DO	-
		5B	DO	4
106.3		6	DO	5
4.2	Brown, stiff to very stiff			
	SILTY CLAY	7	DO	15
	some sand occ. silt and sand seams and layers	8	DO	17
103.9				
6.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 107.1 m on completion

Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

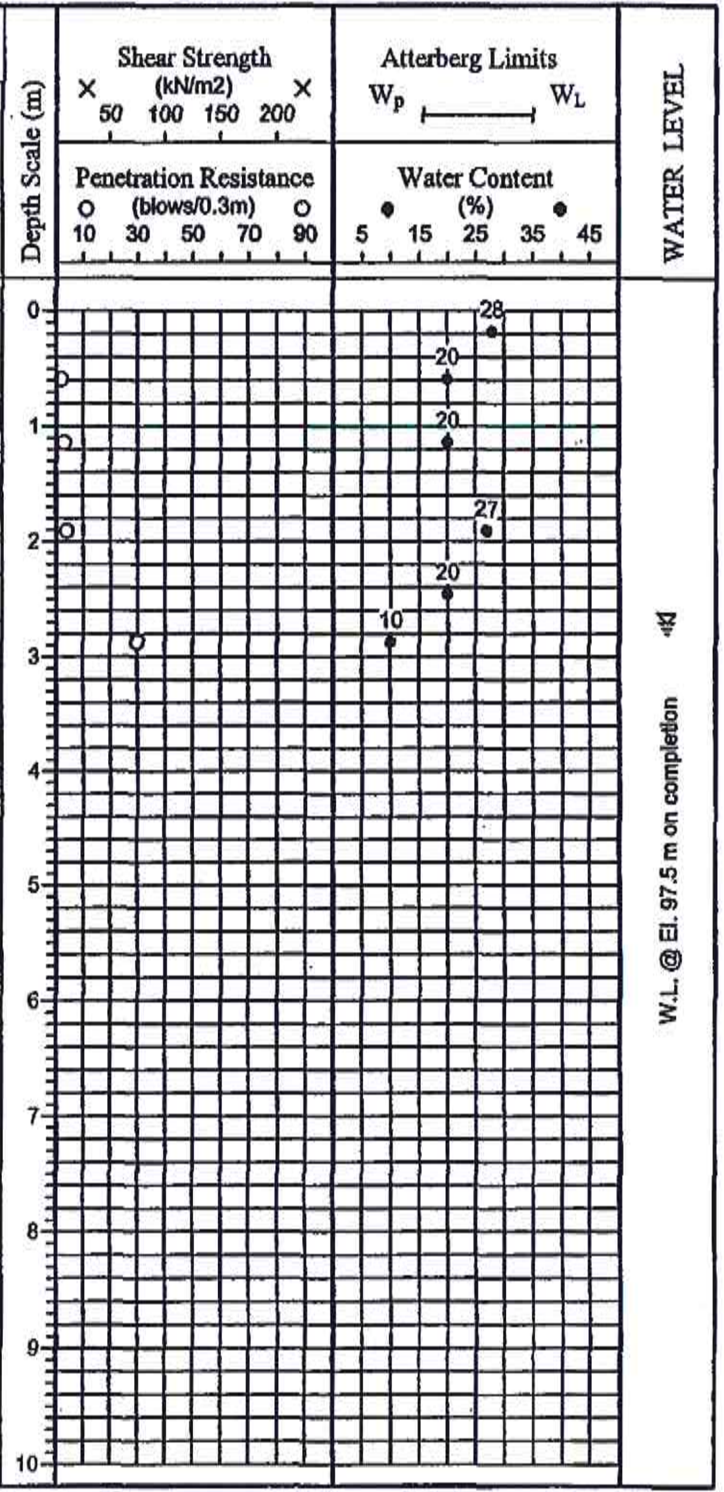
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: June 3, 2008

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
97.5 0.0	Ground Surface			
	25cm TOPSOIL	1A	DO	-
	Brown, very loose, weathered	1B	DO	2
	SILTY FINE SAND	2	DO	3
	with silt seams and layers	3	DO	4
		4A	DO	-
94.8 2.7	Grey, compact GRAVELLY SAND	4B	DO	30
94.4 3.1	END OF BOREHOLE			



Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

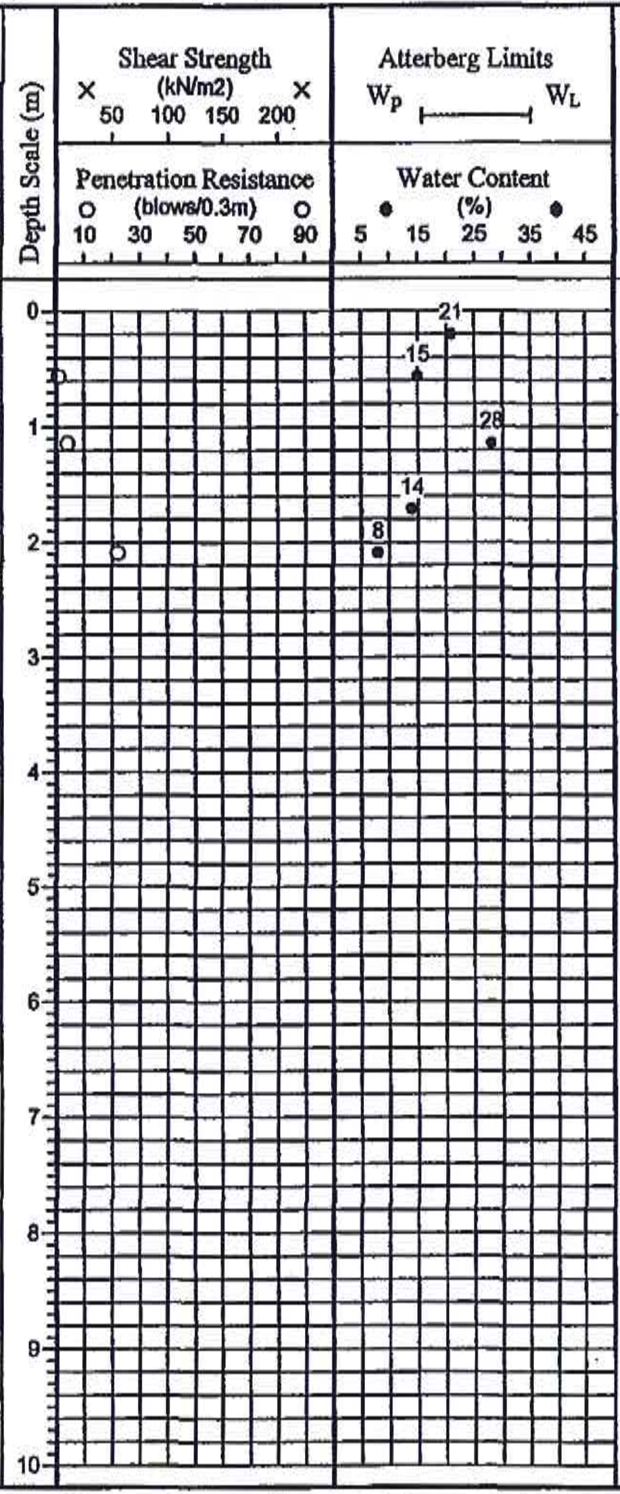
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: June 3, 2008

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
98.5	Ground Surface				
0.0	**20cm TOPSOIL**	1A	DO	-	Dry on completion
	Brown, very loose, weathered	1B	DO	1	
	SILTY FINE SAND	2	DO	4	
	with silt seams and layers	3A	DO	-	
96.6 1.9	Brown, compact **GRAVELLY SAND**	3B	DO	22	
96.2 2.3	**END OF BOREHOLE**				



Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

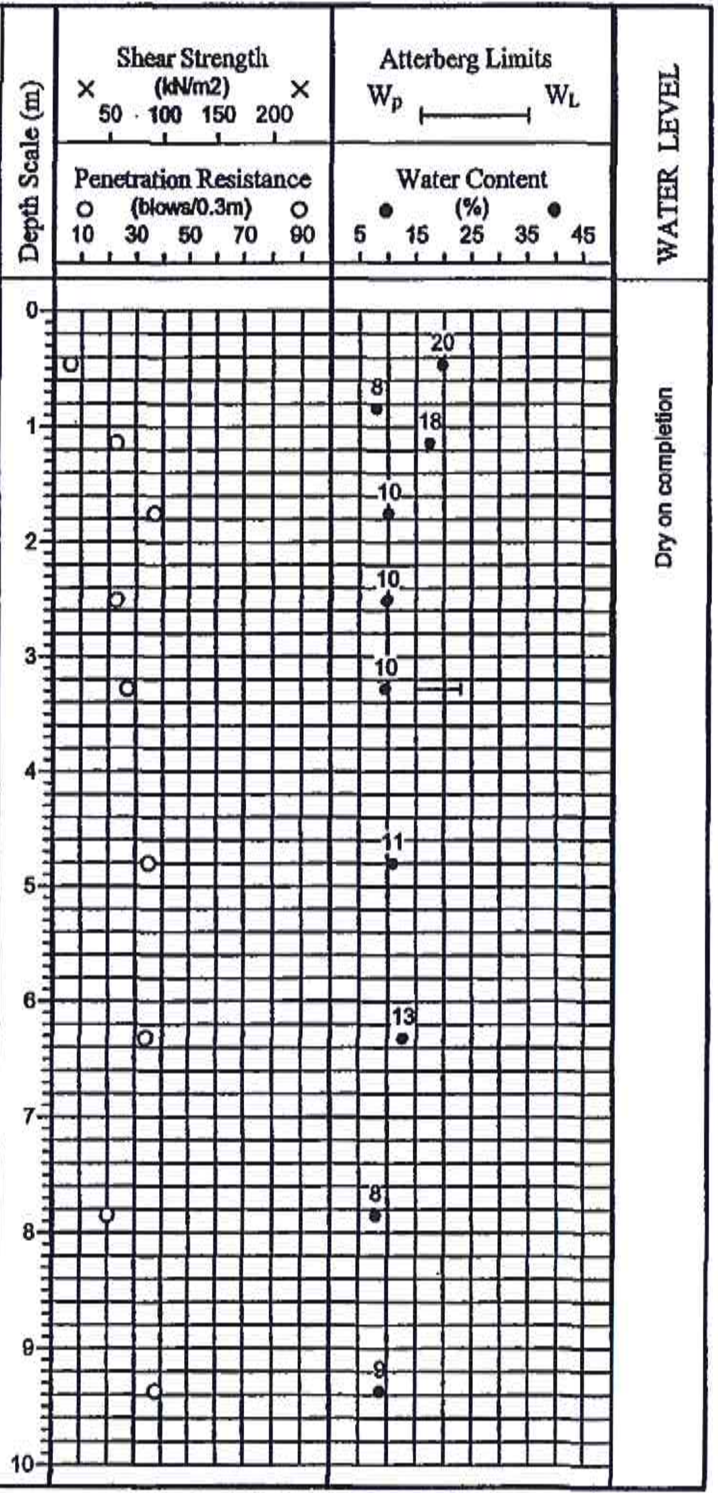
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
112.0 0.0	Ground Surface 18cm TOPSOIL Brown, loose, weathered SANDY SILT	1	DO	6
111.0 1.0		2A	DO	-
	Brown, very stiff to hard SILTY CLAY some sand occ. silt and sand seams and layers	2B	DO	23
		3	DO	37
109.7 2.3	Very stiff to hard	4	DO	23
		5	DO	27
	SILTY CLAY, Till	6	DO	35
		7	DO	34
	brown ---- grey			
	some sand a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	8	DO	20
		9	DO	38
102.0 10.0	Cont'd on Fig.4A			



Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4 A

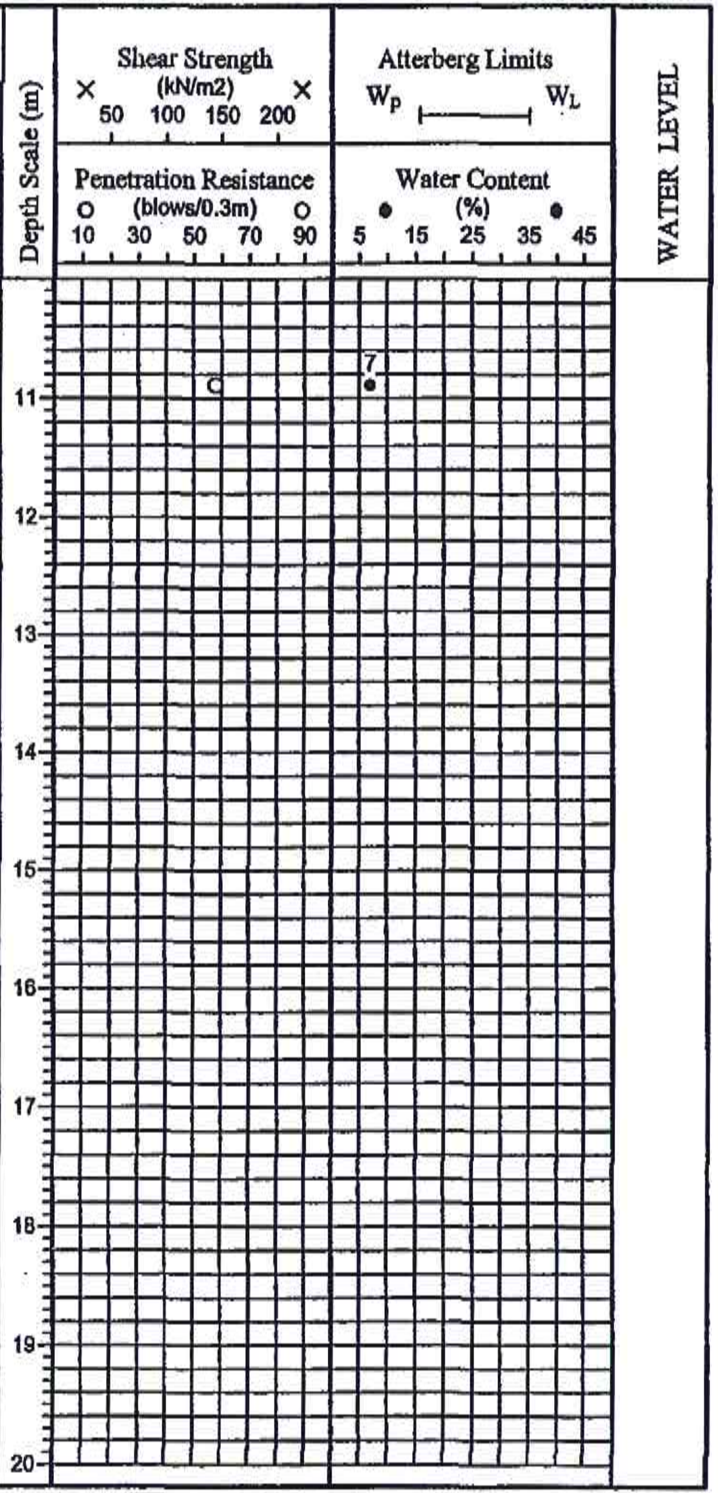
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m) 102.0	SOIL DESCRIPTION Cont'd	SAMPLES Number	Type	N-Value
10.0	Grey, very dense **SILTY SAND, Till** traces of gravel and clay occ. silt and clay seams and layers, cobbles and boulders	10	DO	58
100.9 11.1	**END OF BOREHOLE**			



JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

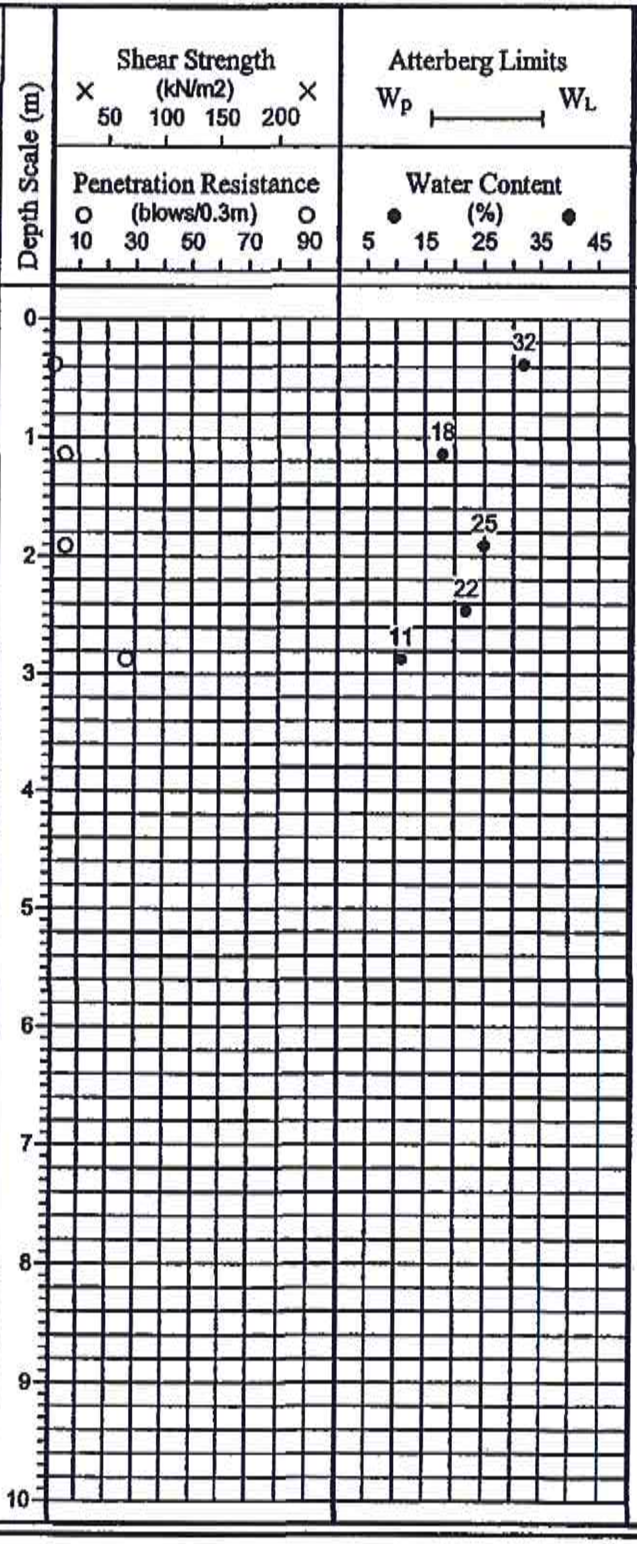
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: June 3, 2008

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
97.5 0.0	Ground Surface				
	20cm TOPSOIL Brown, very loose to loose, weathered	1	DO	1	Dry on completion
	SILTY FINE SAND	2	DO	5	
		3	DO	5	
	with silt seams and layers	4A	DO	-	
94.8 2.7	Brown, compact GRAVELLY SAND	4B	DO	27	
94.4 3.1	END OF BOREHOLE				



JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

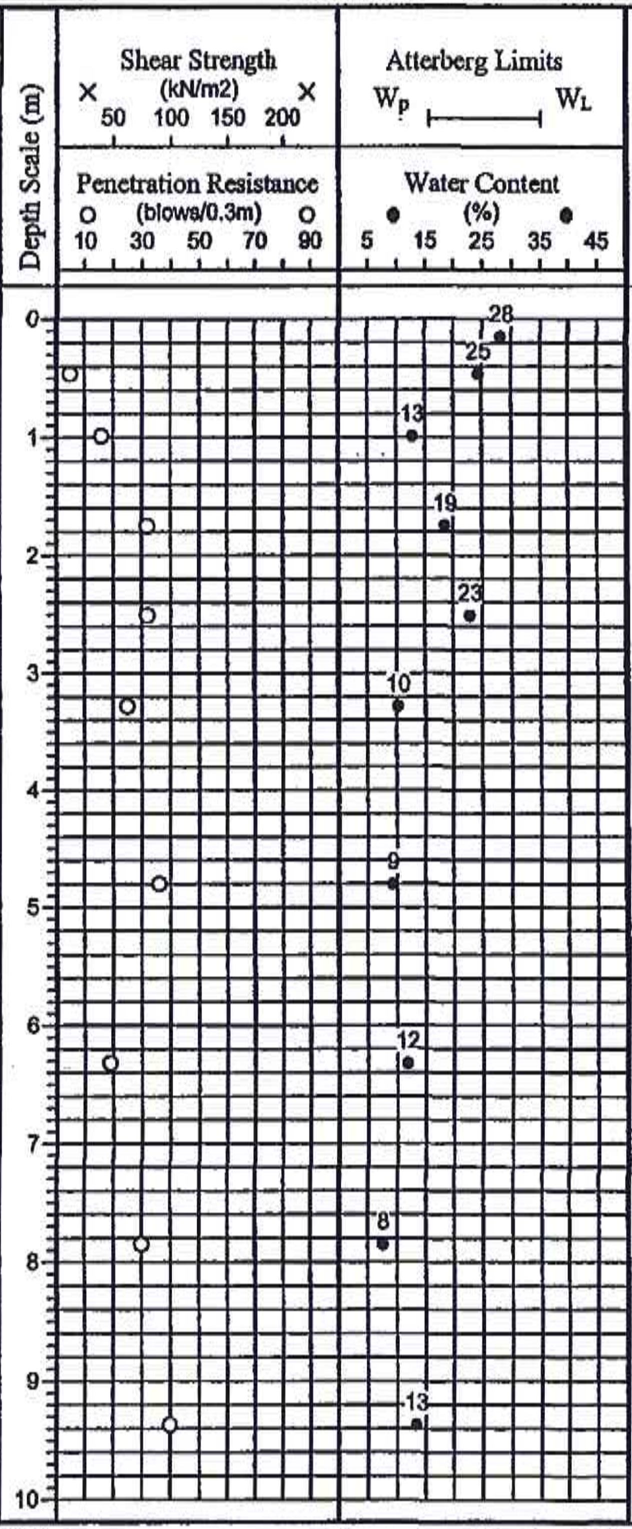
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
111.2 0.0	*Ground Surface*				Dry on completion
	25cm TOPSOIL	1A	DO	-	
	Brown, firm to hard weathered	1B	DO	5	
	SILTY CLAY	2	DO	16	
		3	DO	32	
	some sand occ. silt and sand seams and layers	4	DO	32	
108.2 3.0	Very stiff to hard	5	DO	25	
	SILTY CLAY, Till brown grey	6	DO	36	
		7	DO	19	
	SILTY SAND TILL LAYER	8	DO	30	
	some sand a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	9	DO	40	
101.2 10.0	Cont'd on Fig.6A				



Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6 A

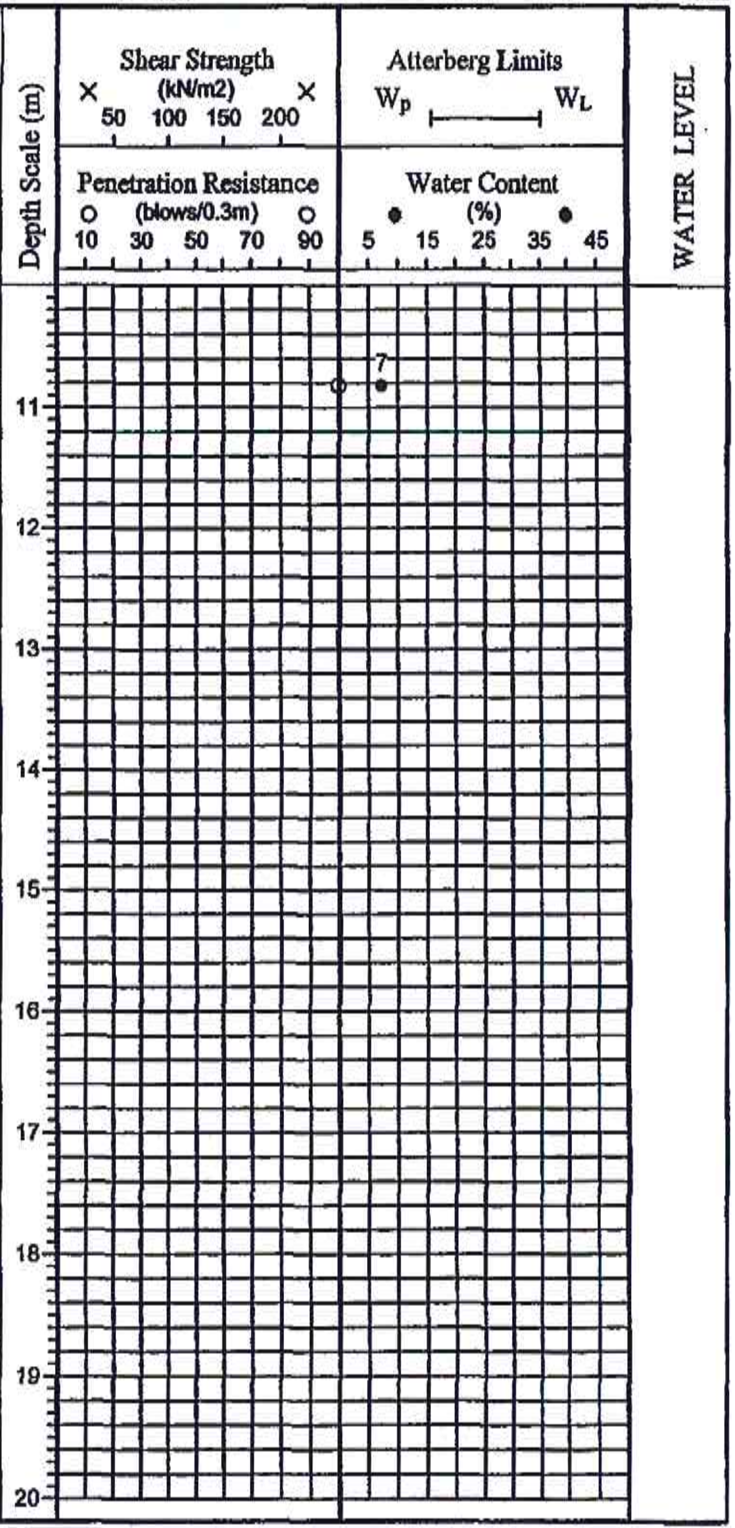
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m)	SOIL DESCRIPTION Cont'd	SAMPLES Number	Type	N-Value
101.2 10.0	Grey, very dense **SILTY SAND, Till** traces of gravel and clay occ. silt and clay seams and layers, cobbles and boulders	10	DO	100+
100.2 11.0	**END OF BOREHOLE**			



JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

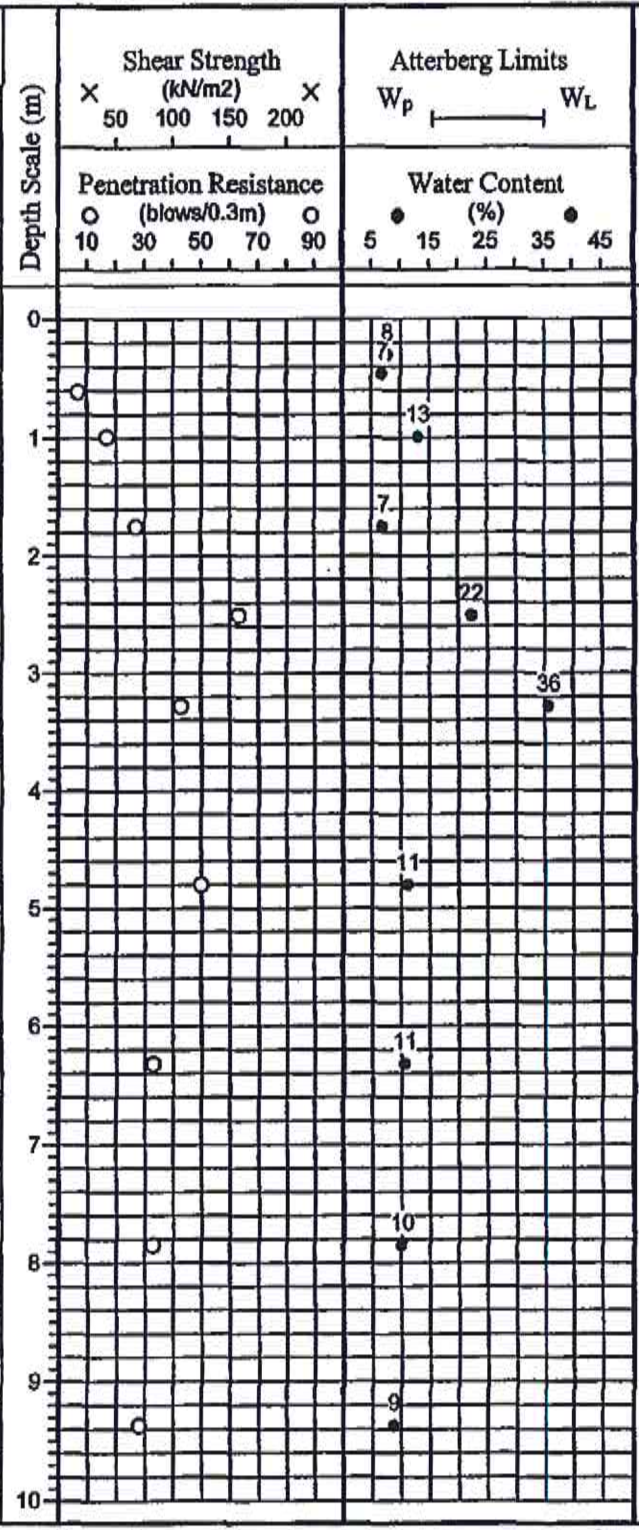
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
111.2 0.0	Ground Surface 23cm TOPSOIL			
	Very stiff to hard WEATHERED SILTY CLAY LAYER	1A	DO	-
		1B	DO	7
		2	DO	17
		3	DO	27
		4	DO	63
	SILTY CLAY, Till	5	DO	43
	brown grey			
		6	DO	50
	some sand a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	7	DO	33
		8	DO	33
102.7 8.5	Grey, compact **SILTY SAND, Till** traces of gravel and clay occ. silt and clay seams and layers, cobbles and boulders	9	DO	28
101.2 10.0	Cont'd on Fig.7A			



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7 A

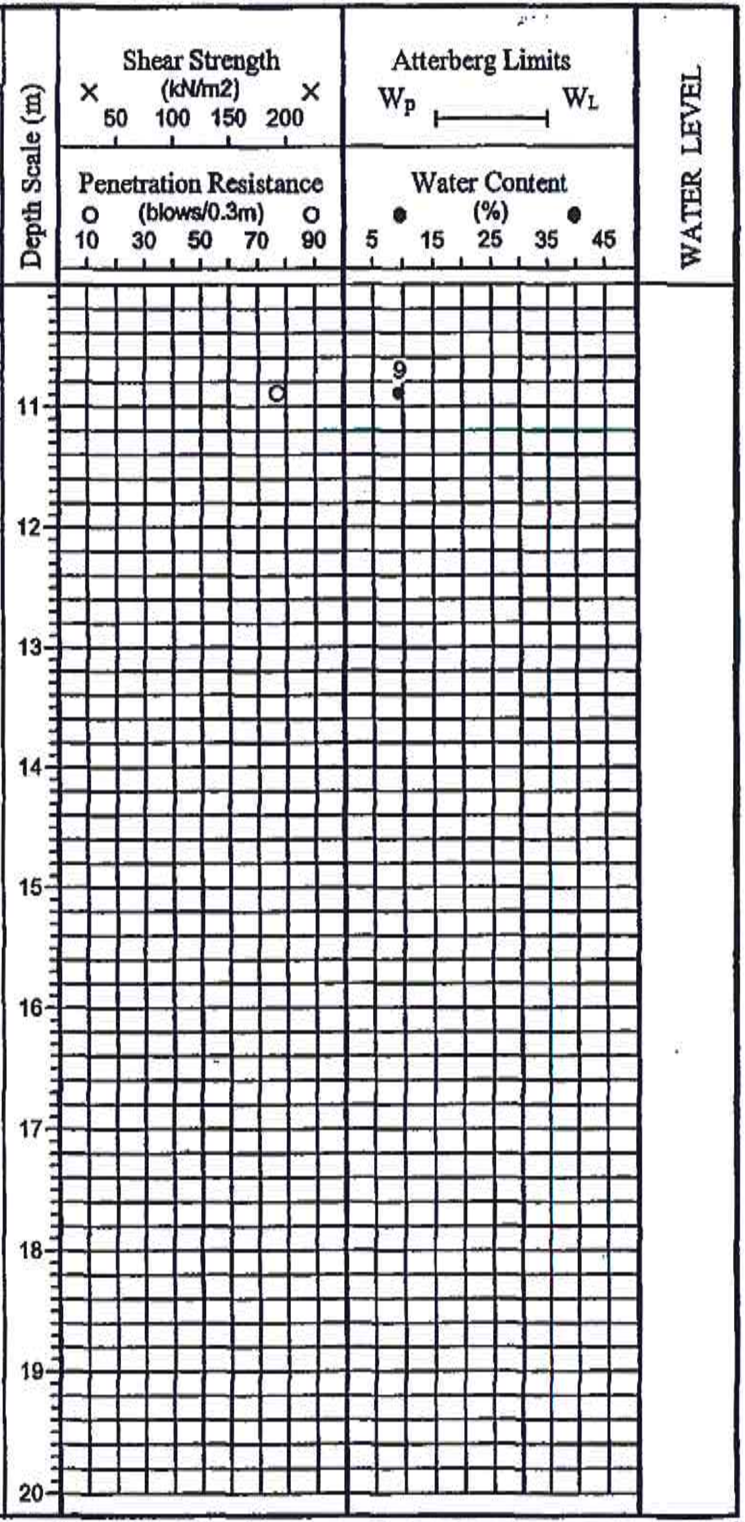
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m)	SOIL DESCRIPTION Cont'd	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
101.2				
10.0	Grey, very dense **SILTY SAND, Till** traces of gravel and clay occ. silt and clay seams and layers, cobbles and boulders	10	DO	77
100.1 11.1	**END OF BOREHOLE**			



Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 8

FIGURE NO.: 8

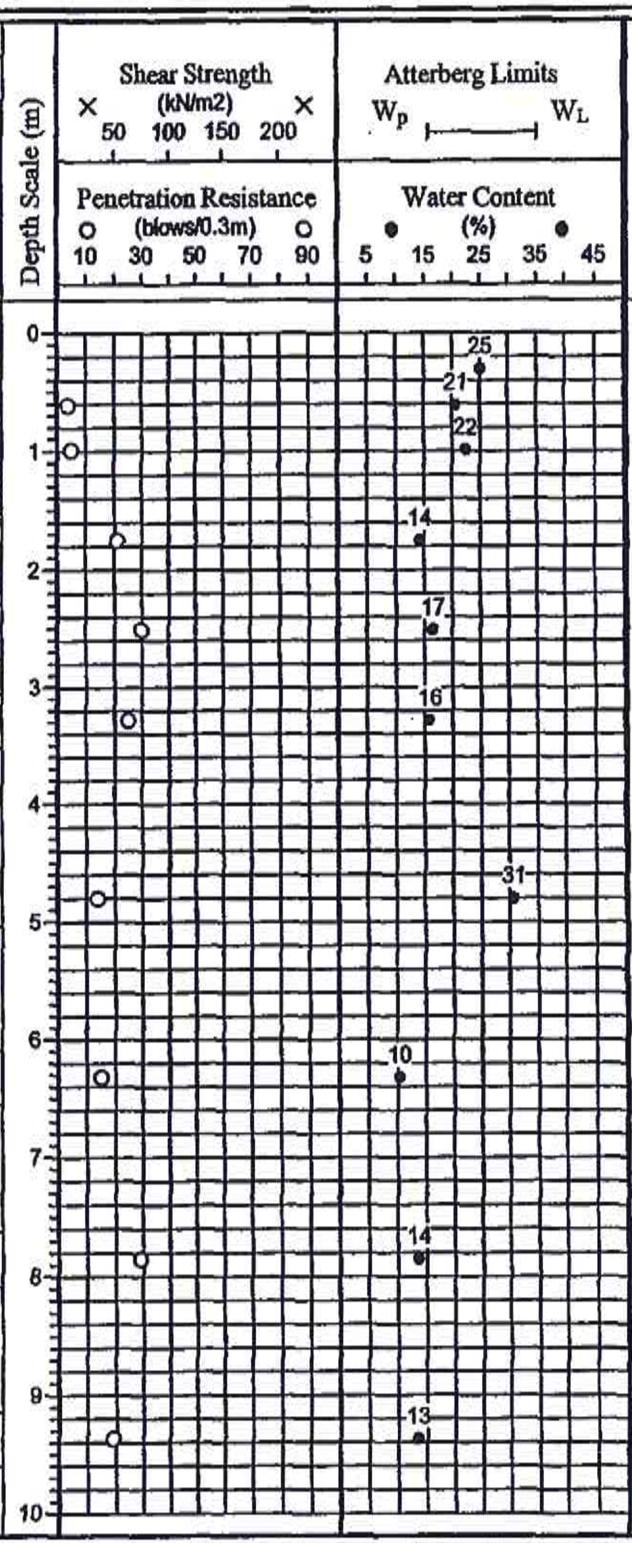
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
113.2 0.0	Ground Surface 28cm TOPSOIL			
		1A	DO	-
	Brown, firm to hard	1B	DO	4
		2	DO	5
	weathered SILTY CLAY	3	DO	21
		4	DO	30
	some sand occ. silt and sand seams and layers	5	DO	25
109.2 4.0	Very stiff to hard			
		6	DO	14
	brown grey			
	SILTY CLAY, Till	7	DO	15
		8	DO	29
	some sand a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	9	DO	19
103.2 10.0	Cont'd on Fig.8A			



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 8

FIGURE NO.: 8 A

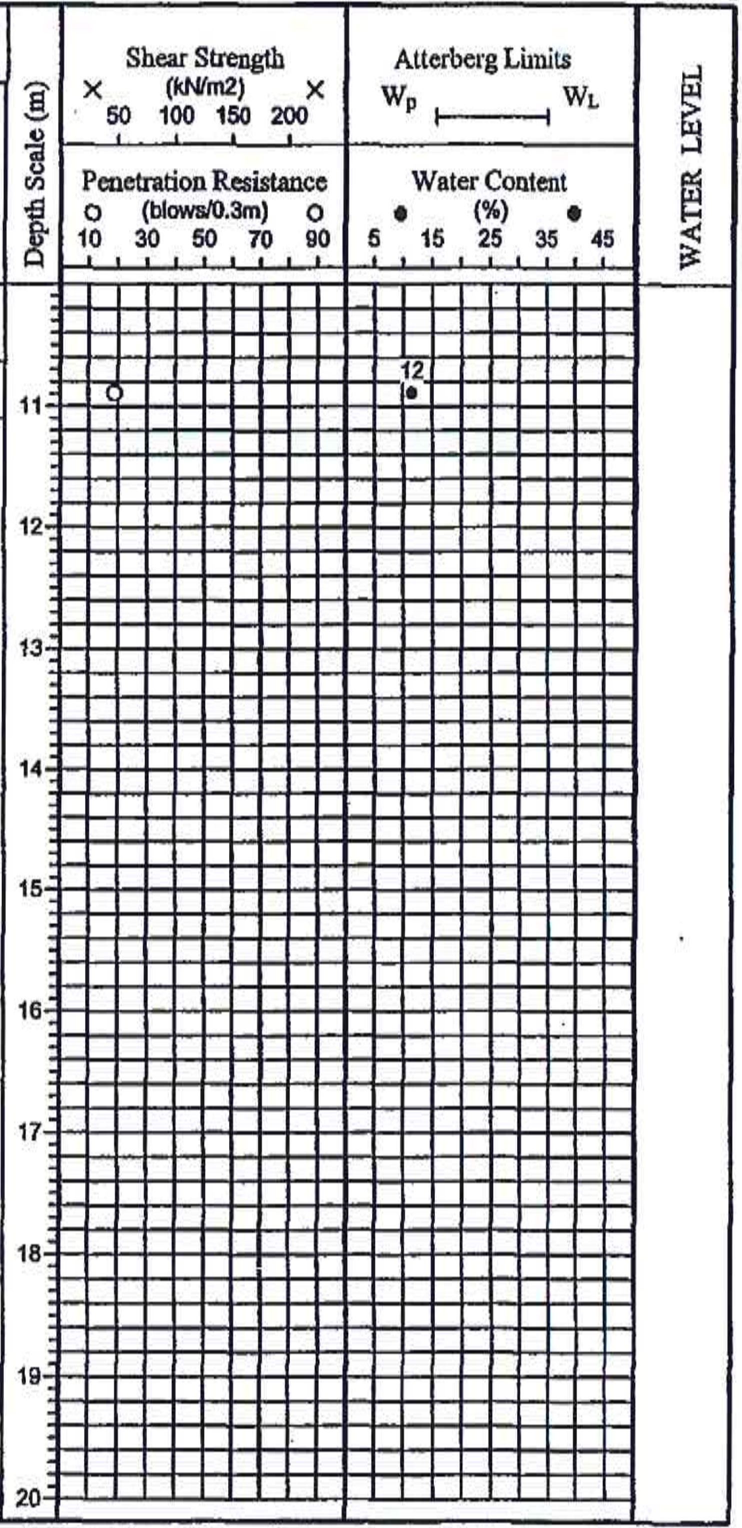
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m) 103.2	SOIL DESCRIPTION Cont'd	SAMPLES Number	 Type	 N-Value
10.0	Grey, very stiff **SILTY CLAY, Till** some sand a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	10	DO	19
102.1 11.1	**END OF BOREHOLE**			



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JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 9

FIGURE NO.: 9

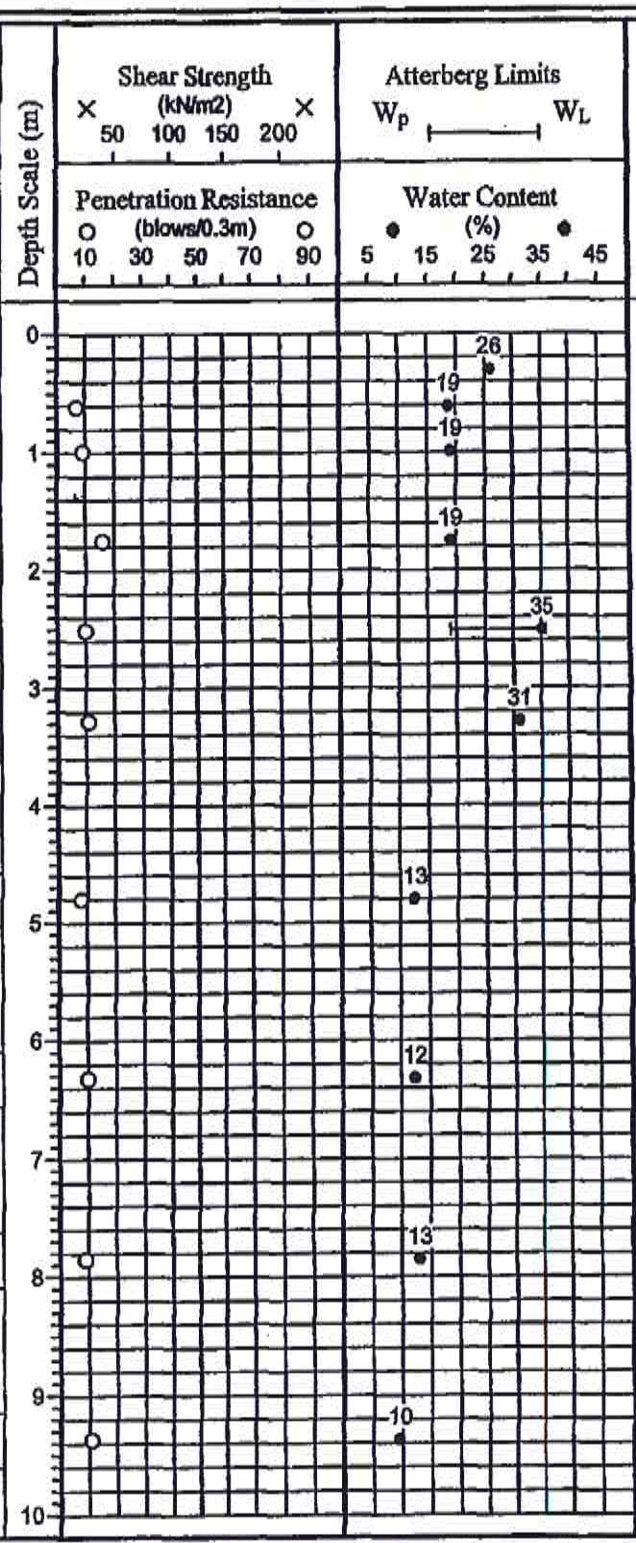
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
113.0 0.0	Ground Surface 36cm TOPSOIL			
		1A	DO	-
	Brown, firm to stiff	1B	DO	7
		2	DO	9
	SILTY CLAY weathered			
		3	DO	16
	some sand occ. silt and sand seams and layers	4	DO	10
110.0 3.0	Firm to stiff	5	DO	11
	brown grey			
		6	DO	8
	SILTY CLAY, Till			
		7	DO	10
		8	DO	9
	some sand a trace of gravel occ. sand and silt seams and layers, cobbles and boulders			
		9	DO	11
103.0 10.0	Cont'd on Fig.9A			



WATER LEVEL

Dry on completion

Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 9

FIGURE NO.: 9 A

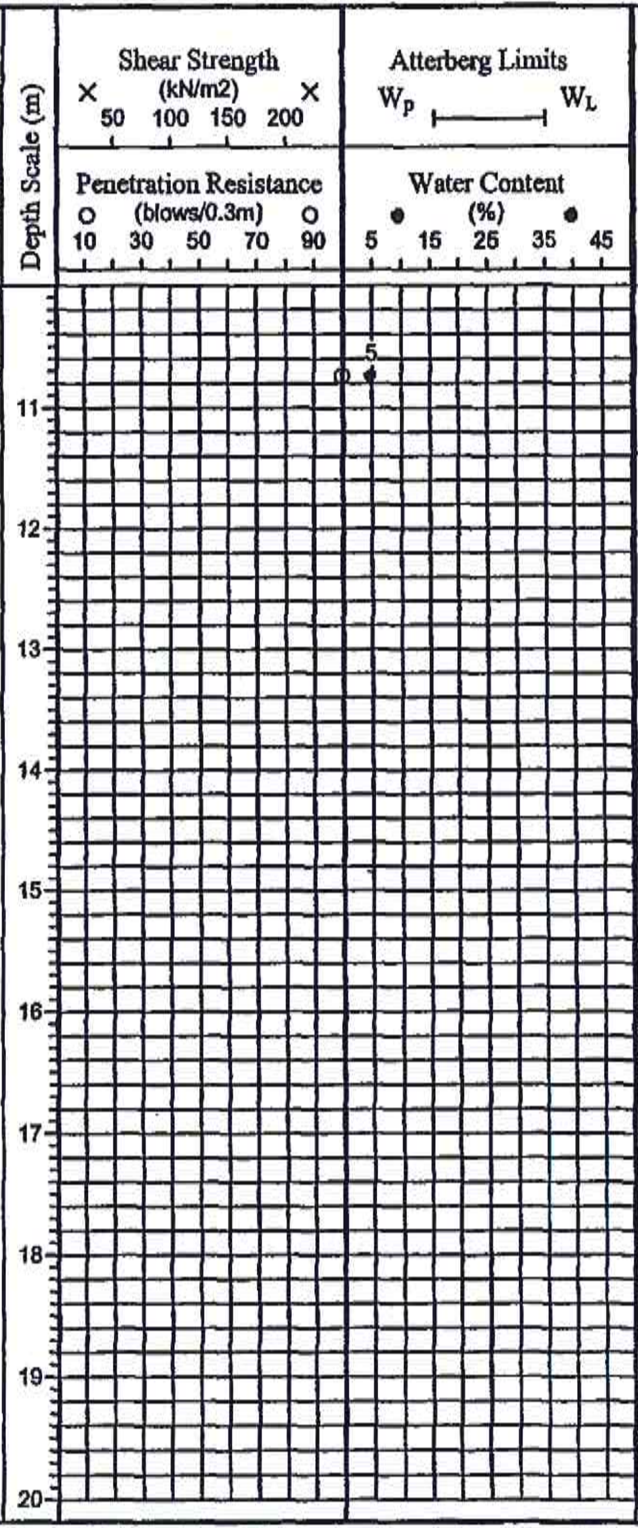
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 7, 2007

Elev. Depth (m)	SOIL DESCRIPTION Cont'd	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
103.0 10.0	Grey, very dense **SILTY SAND, Till** traces of gravel and clay occ. silt and clay seams and layers, cobbles and boulders	10	DO	100+	
102.2 10.8	**END OF BOREHOLE**				



Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 10

FIGURE NO.: 10

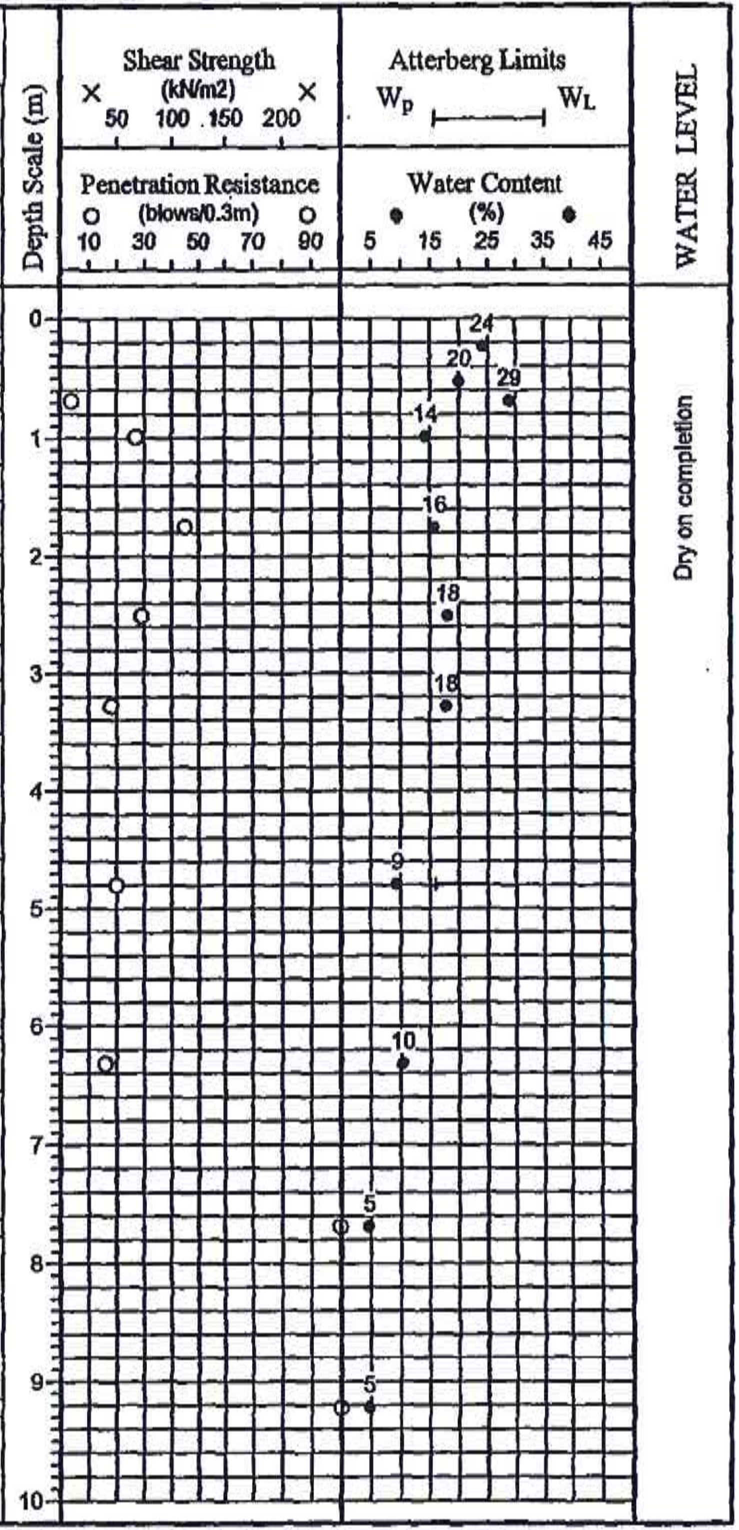
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 10, 2007

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
114.3	Ground Surface			
0.0	20cm TOPSOIL			
	Brown, firm to very stiff	1A	DO	-
		1B	DO	-
	weathered	1C	DO	4
		2	DO	27
	SILTY CLAY	3	DO	45
		4	DO	29
	some sand occ. silt and sand seams and layers	5	DO	16
110.3 4.0	Very stiff			
	SILTY CLAY, Till	6	DO	20
	brown grey			
	some sand a trace of gravel occ. sand and silt seams and layers, cobbles and boulders	7	DO	16
107.3 7.0	Grey, very dense			
	SILTY SAND, Till	8	DO	100+
	traces of gravel and clay occ. silt and clay seams and layers, cobbles and boulders	9	DO	100+
104.3 10.0	Cont'd on Fig.10A			



Soil Engineers Ltd.

JOB NO.: 0711-S052

LOG OF BOREHOLE NO.: 10

FIGURE NO.: 10 A

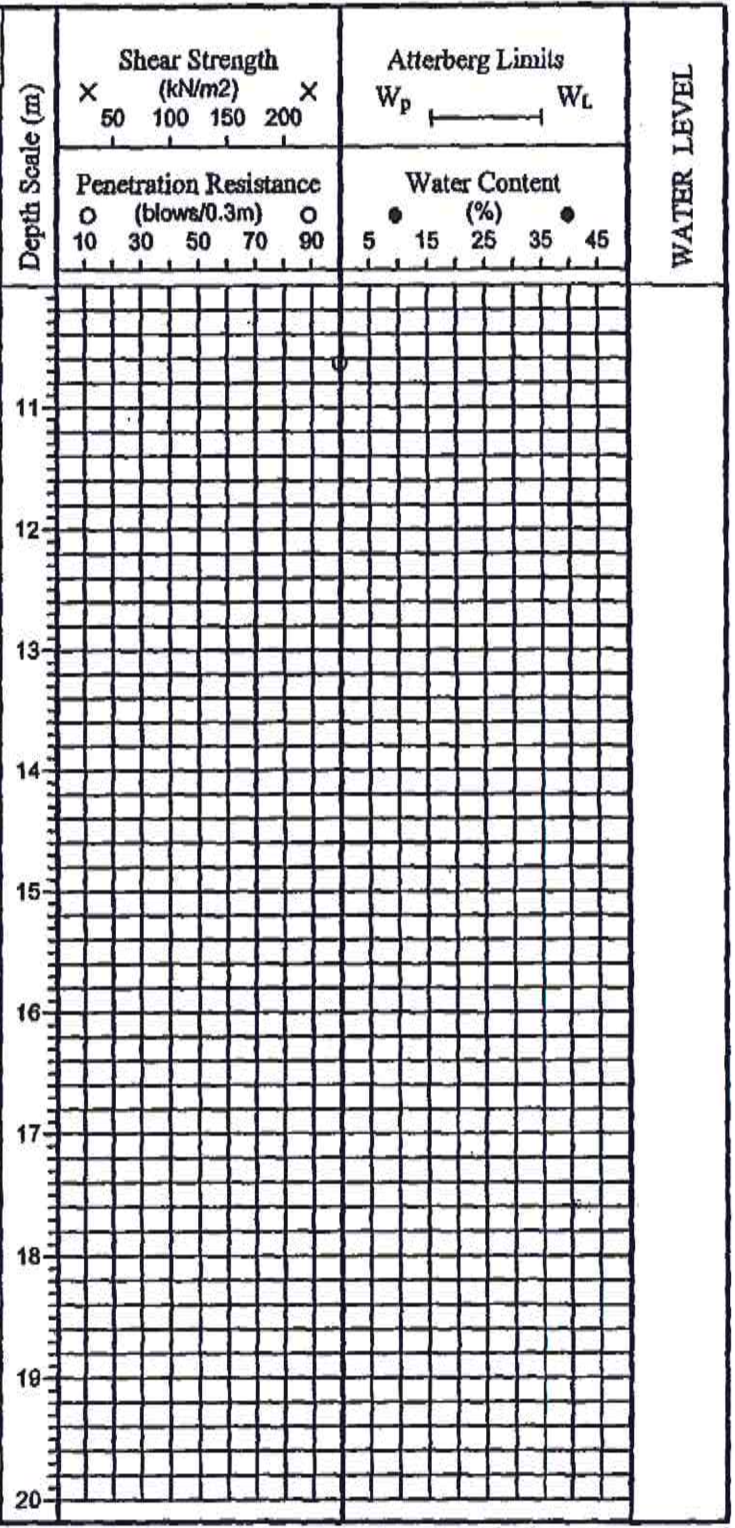
JOB DESCRIPTION: Proposed Exterior Servicing and Slope Stability Study

JOB LOCATION: Stevens Road, Town of Bowmanville

METHOD OF BORING: Flight-Auger

DATE: December 10, 2007

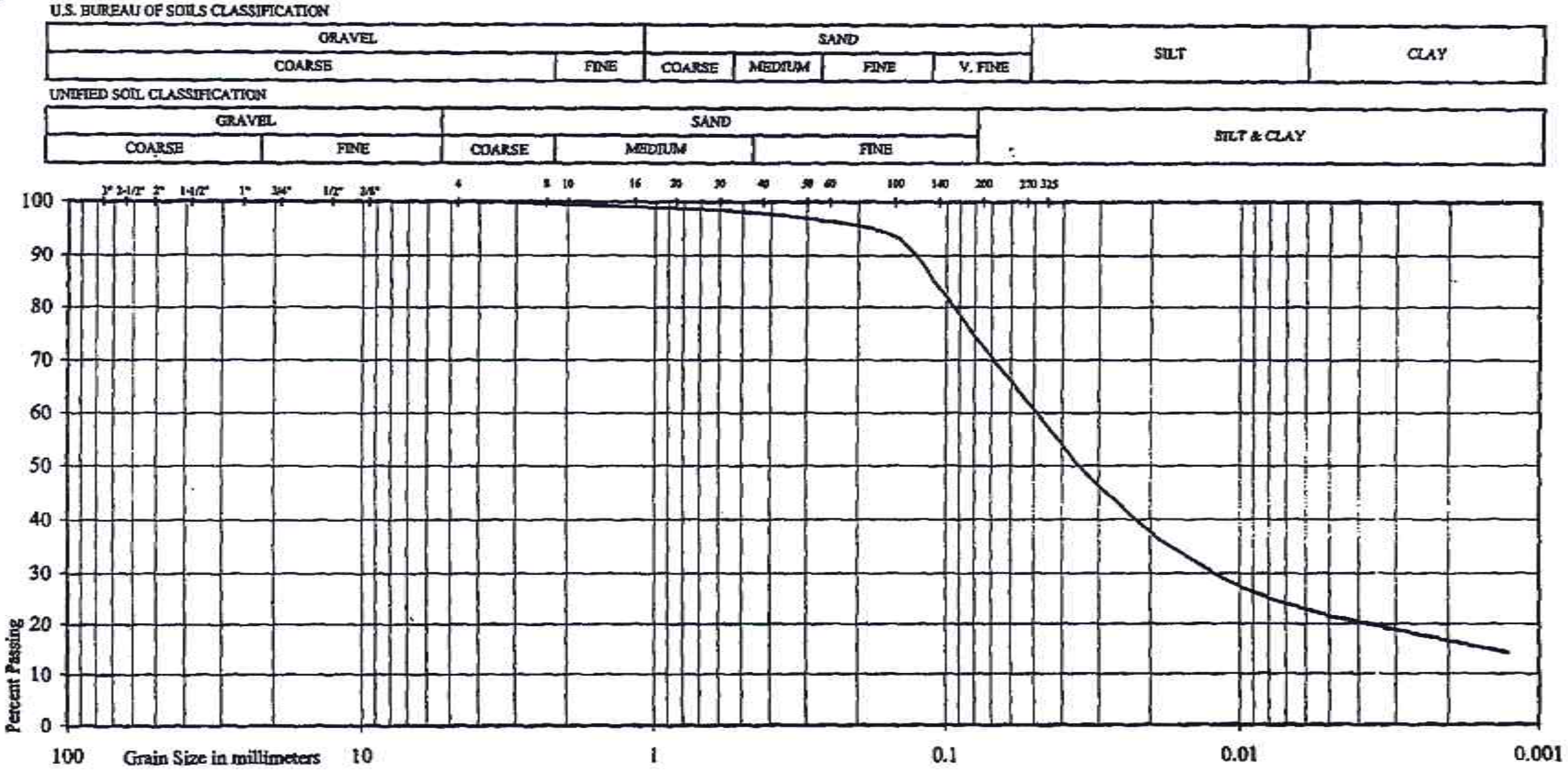
Elev. Depth (m)	SOIL DESCRIPTION Cont'd	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
104.3				
10.0	Grey, very dense SILTY SAND, Till	10	DO	100+
103.6 10.7	END OF BOREHOLE			



Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 0711-S052



Project: Proposed Exterior Servicing and Slope Stability Study

Location: Stevens Road, Town of Bowmanville

Borehole No: 1

Sample No: 4

Depth (m): 2.5

Elevation (m): 108.0

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 17

Estimated Permeability (cm./sec.) = 10^{-7}

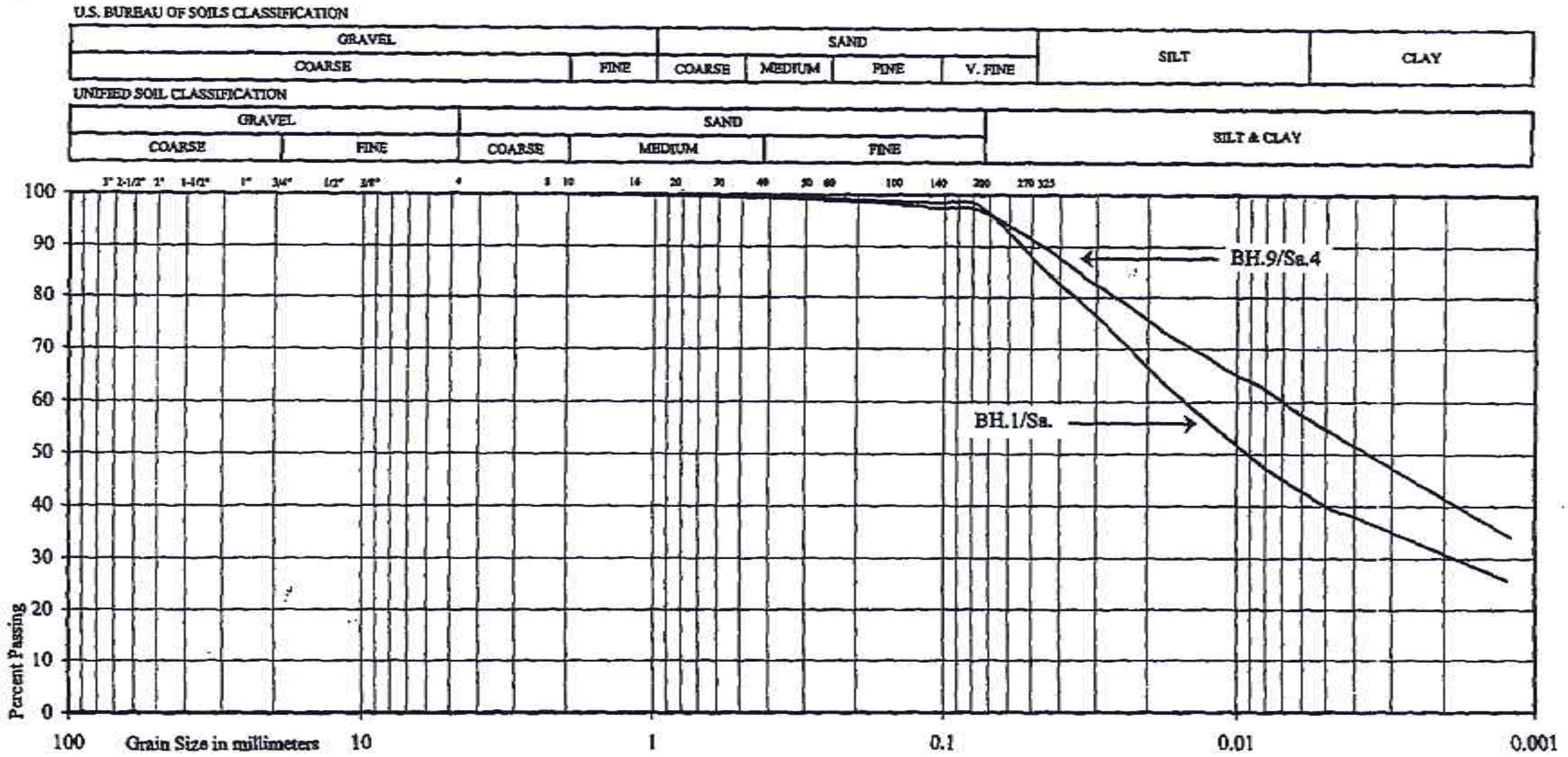
Classification of Sample [& Group Symbol]: SILTY CLAY, Till
some sand

Figure: 11

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 0711-S052



Project: Proposed Exterior Servicing and Slope Stability Study

Location: Stevens Road, Town of Bowmanville

Borehole No:	1	9
Sample No:	7	4
Depth (m):	4.8	2.6
Elevation (m):	105.7	110.4

BH./Sa.	1/7	9/4
Liquid Limit (%) =	31	36
Plastic Limit (%) =	17	19
Plasticity Index (%) =	14	17
Moisture Content (%) =	-	35
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

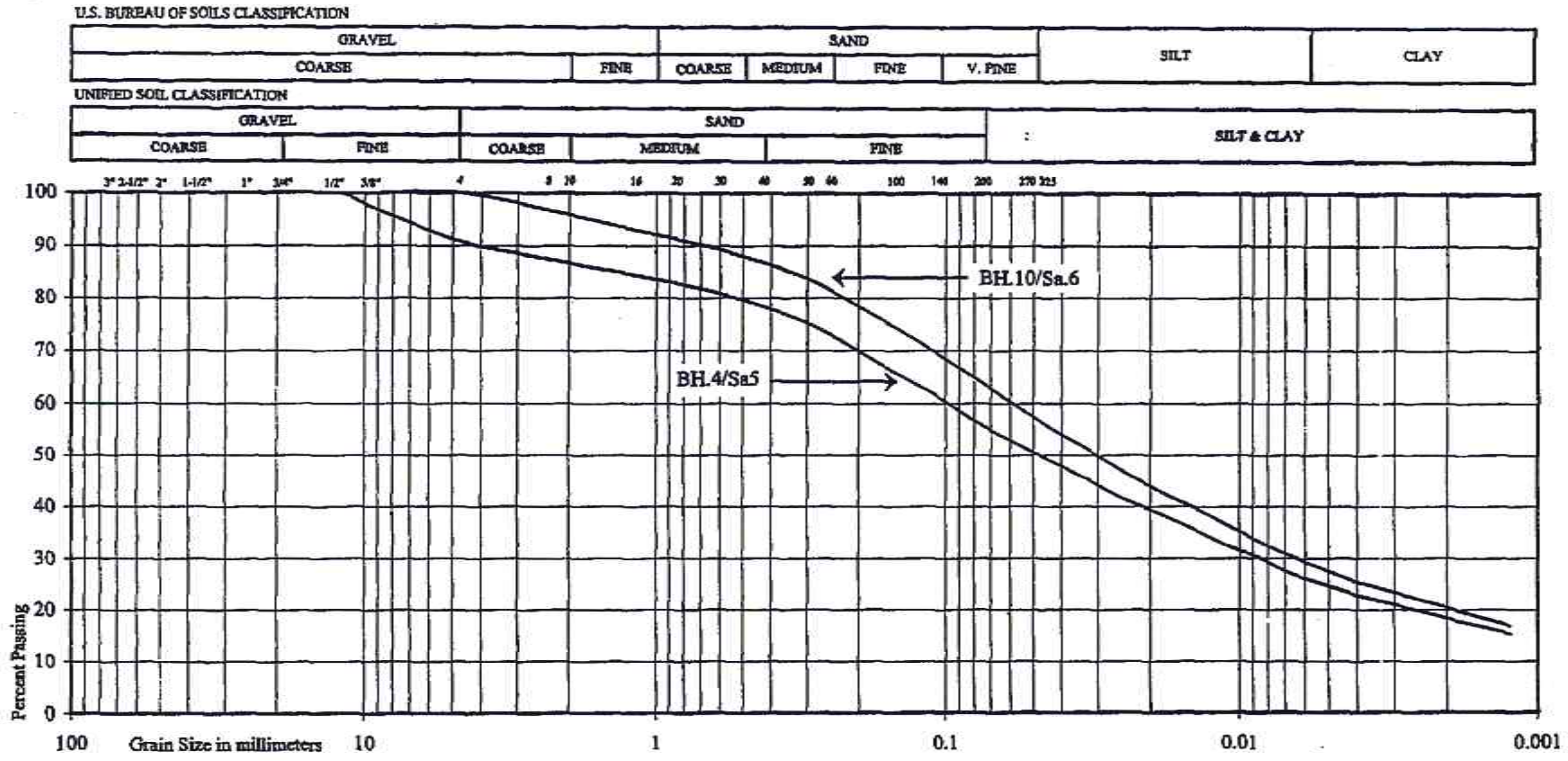
Classification of Sample [& Group Symbol]: SILTY CLAY

Figure: 12

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 0711-S052



Project: Proposed Exterior Servicing and Slope Stability Study

Location: Stevens Road, Town of Bowmanville

Borehole No:	4	10
Sample No:	5	6
Depth (m):	3.3	4.8
Elevation (m):	108.7	109.5

BH./Sa.	4/5	10/6
Liquid Limit (%) =	23	25
Plastic Limit (%) =	15	16
Plasticity Index (%) =	8	9
Moisture Content (%) =	10	9
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

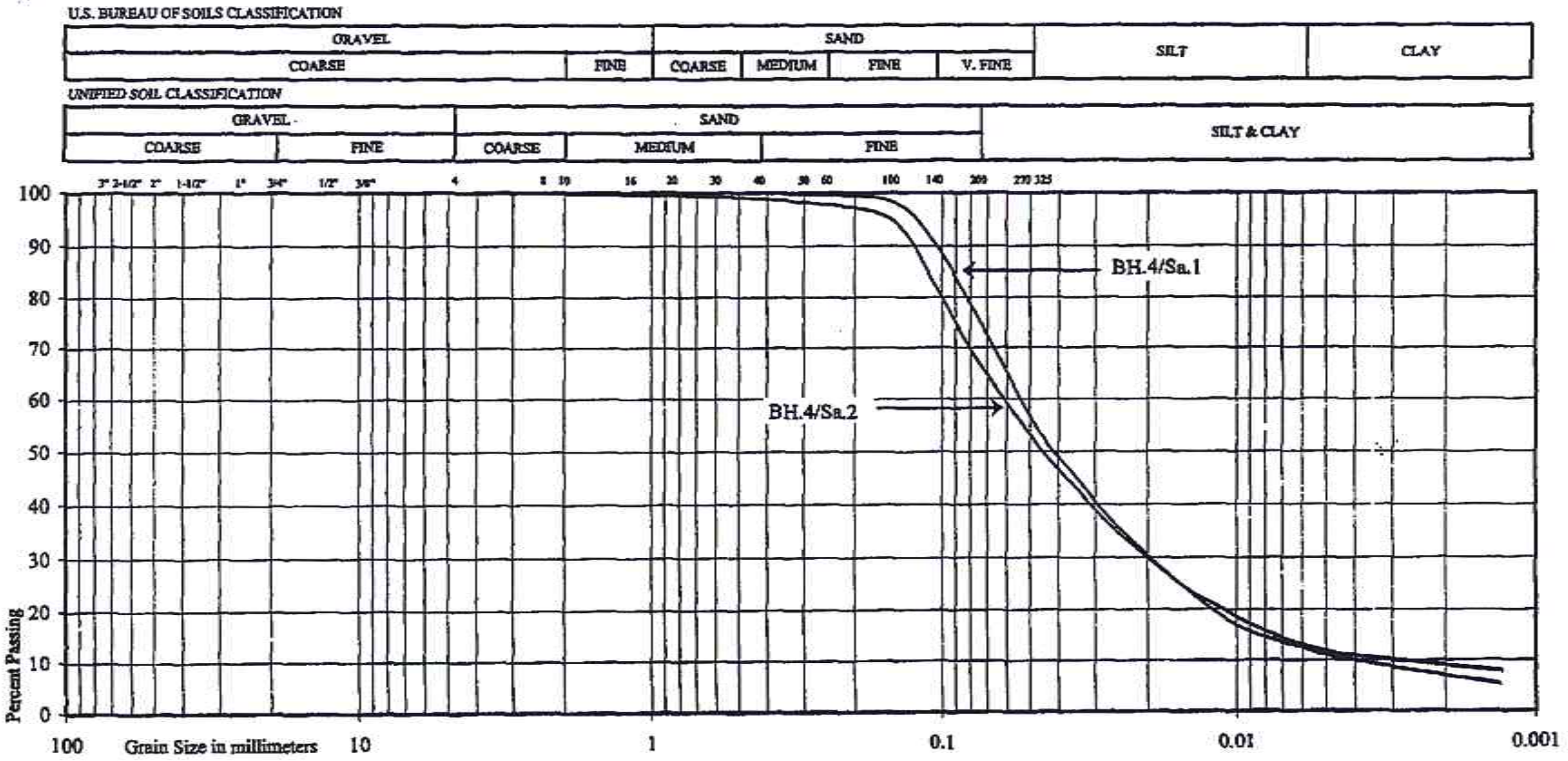
Classification of Sample [& Group Symbol]: SILTY CLAY, Till
some sand, a trace of gravel

Figure: 13

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 0711-S052



Project: Proposed Exterior Servicing and Slope Stability Study

Location: Stevens Road, Town of Bowmanville

Borehole No:	4	4
Sample No:	1	2A
Depth (m):	0.6	0.9
Elevation (m):	111.4	111.1

BH./Sa.	4/1	4/2A
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	20	8
Estimated Permeability (cm./sec.) =	10^{-6}	10^{-6}

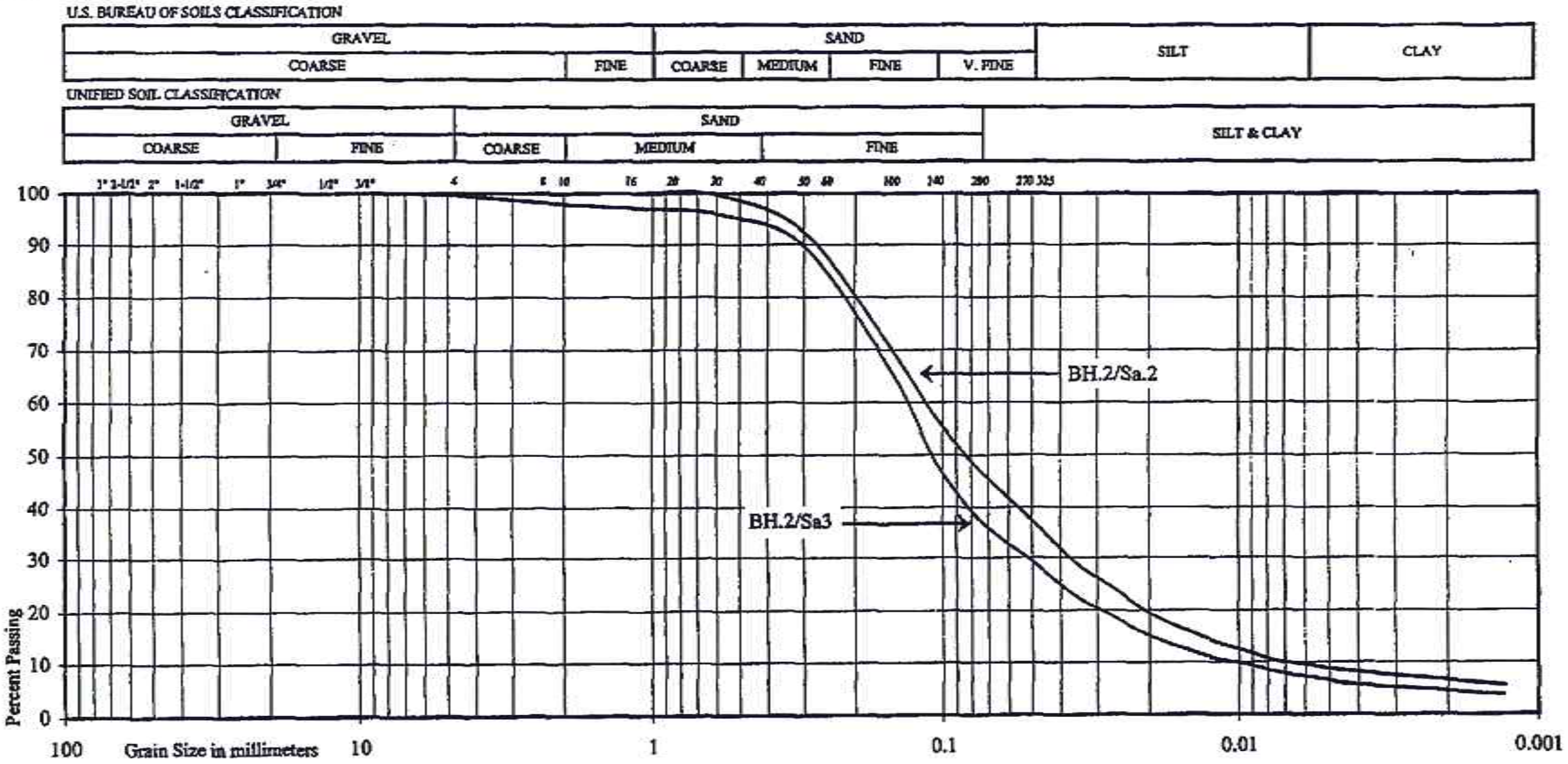
Classification of Sample [& Group Symbol]: SANDY SILT

Figure: 14

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 0711-S052



Project: Proposed Exterior Servicing and Slope Stability Study
Location: Stevens Road, Town of Bowmanville

Borehole No:	2	2
Sample No:	2	3
Depth (m):	1.2	1.8
Elevation (m):	96.3	95.7

BH./Sa.	2/2	2/3
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	20	27
Estimated Permeability (cm./sec.) =	10^{-4}	10^{-4}

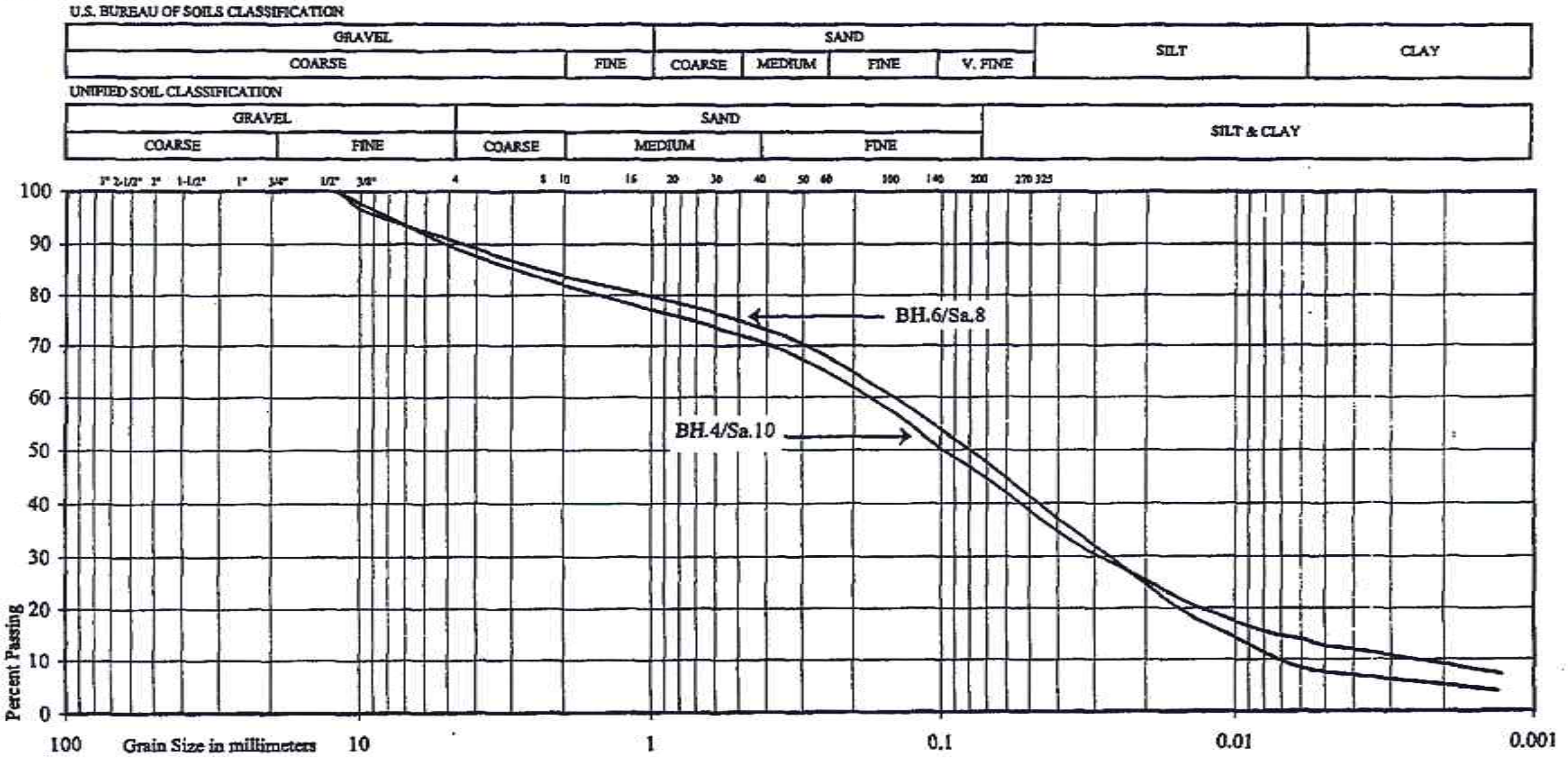
Classification of Sample [& Group Symbol]: SILTY FINE SAND

Figure: 15

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 0711-S052



Project: Proposed Exterior Servicing and Slope Stability Study

Location: Stevens Road, Town of Bowmanville

Borehole No:	4	6
Sample No:	10	8
Depth (m):	10.8	7.8
Elevation (m):	101.2	103.4

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

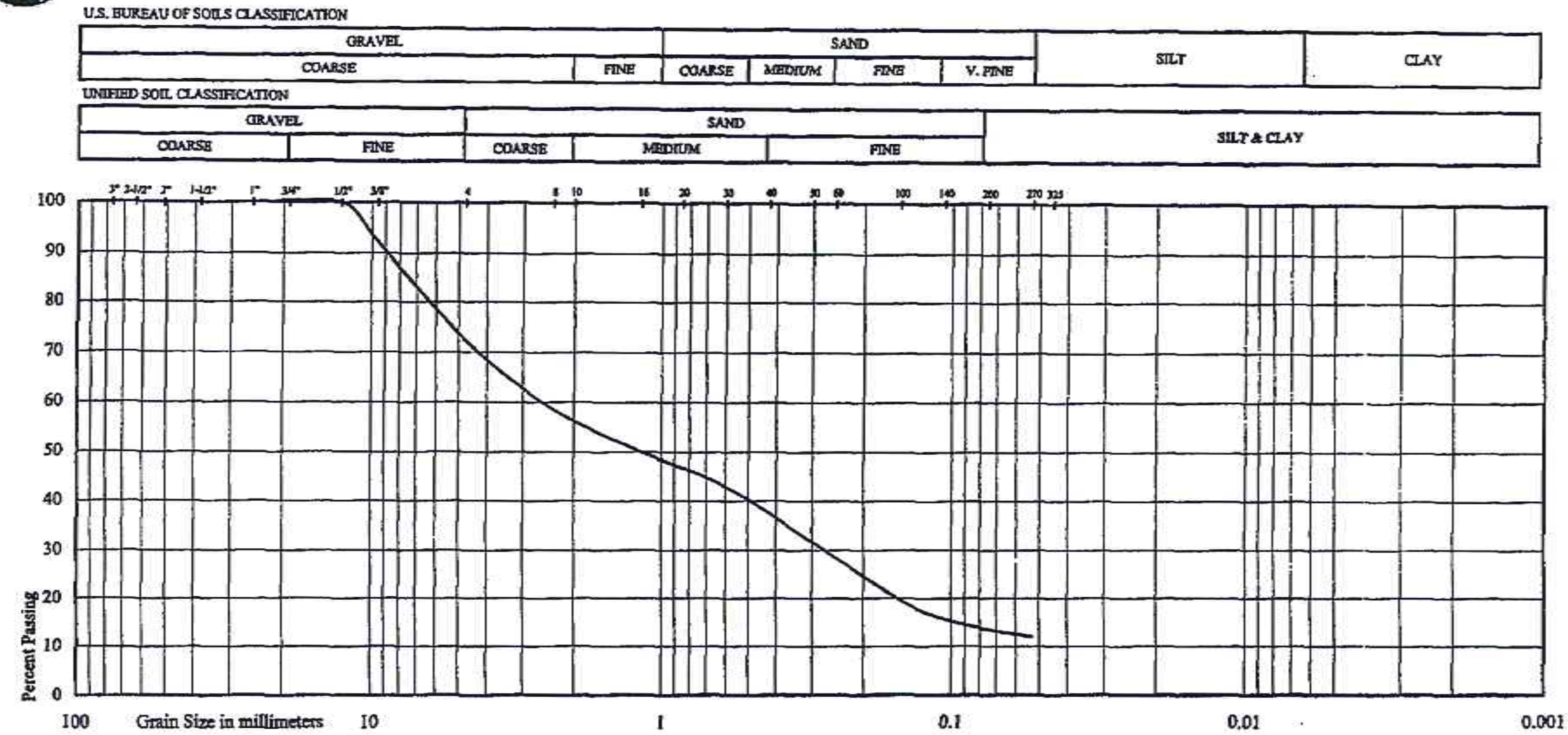
Classification of Sample [& Group Symbol]: SILTY SAND, Till

Figure: 16

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 0711-S052



Project: Proposed Exterior Servicing and Slope Stability Study

Location: Stevens Road, Town of Bowmanville

Borehole No: 3

Sample No: 3B

Depth (m): 2.1

Elevation (m): 96.4

Liquid Limit (%) = -

Plastic Limit (%) = -

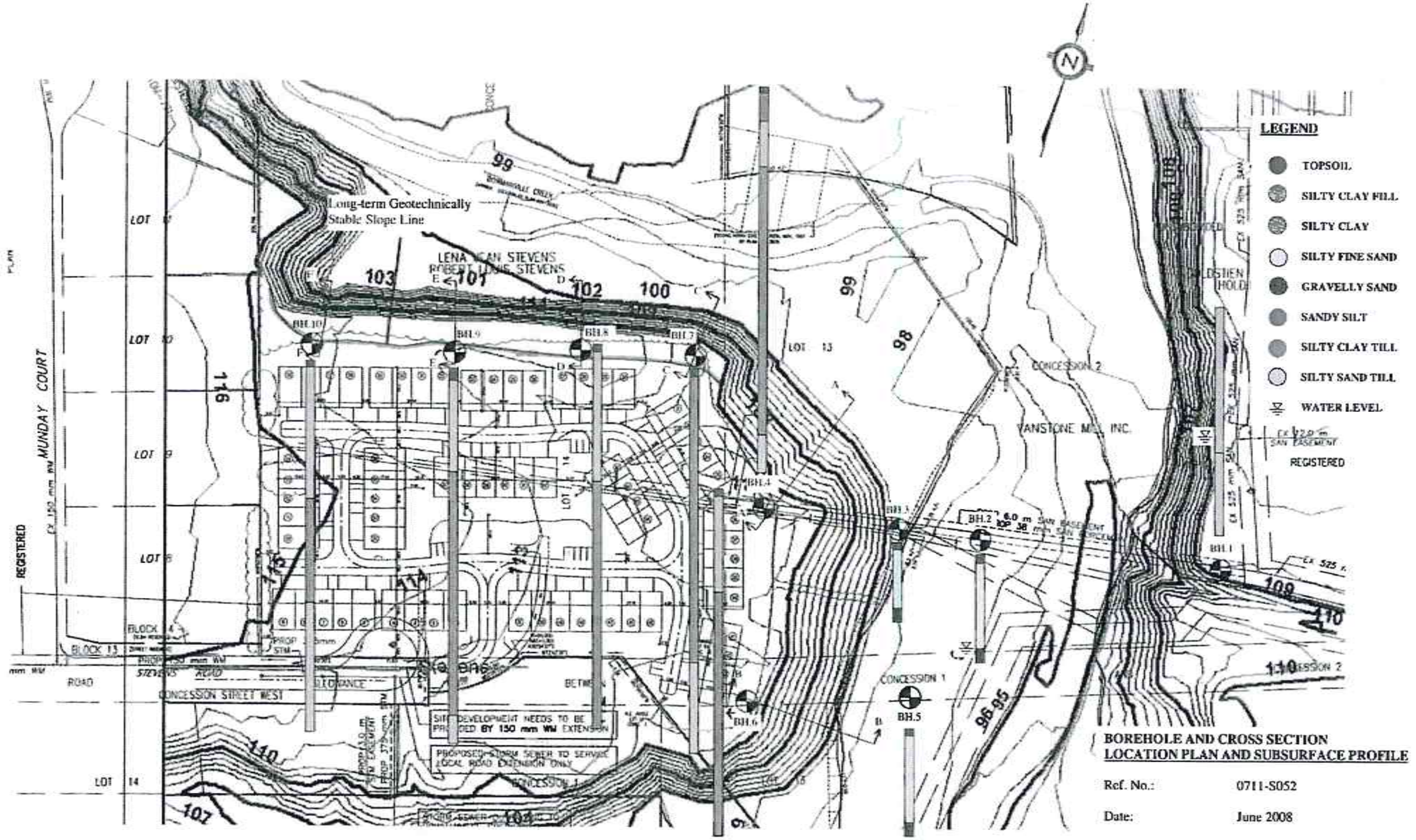
Plasticity Index (%) = -

Moisture Content (%) = -

Estimated Permeability (cm./sec.) = 10^{-3}

Classification of Sample [& Group Symbol]: GRAVELLY SAND

Figure: 17



BOREHOLE AND CROSS SECTION LOCATION PLAN AND SUBSURFACE PROFILE

Ref. No.:	0711-S052
Date:	June 2008
Drawing No.:	1
Scale:	Horiz.: 1:500

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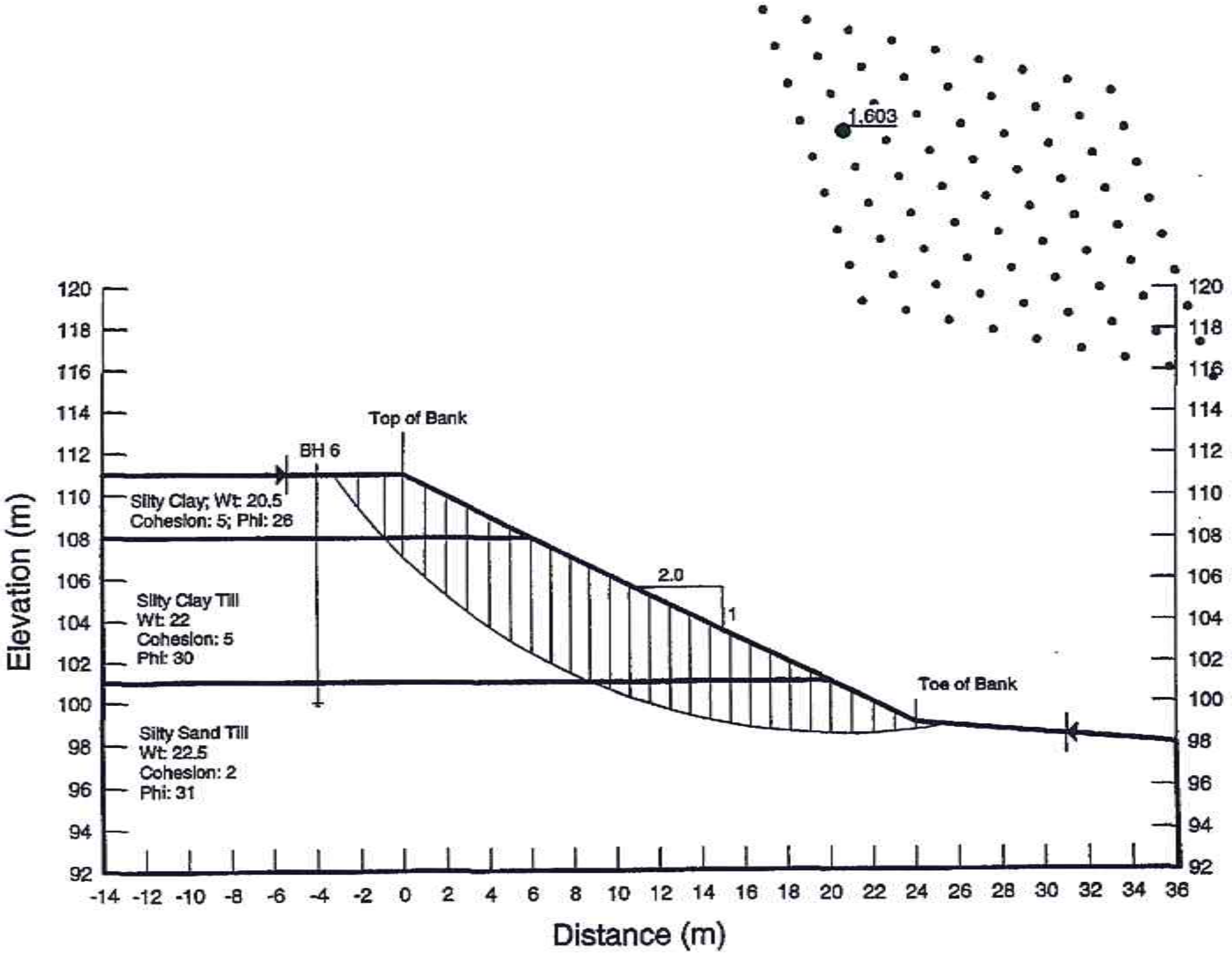
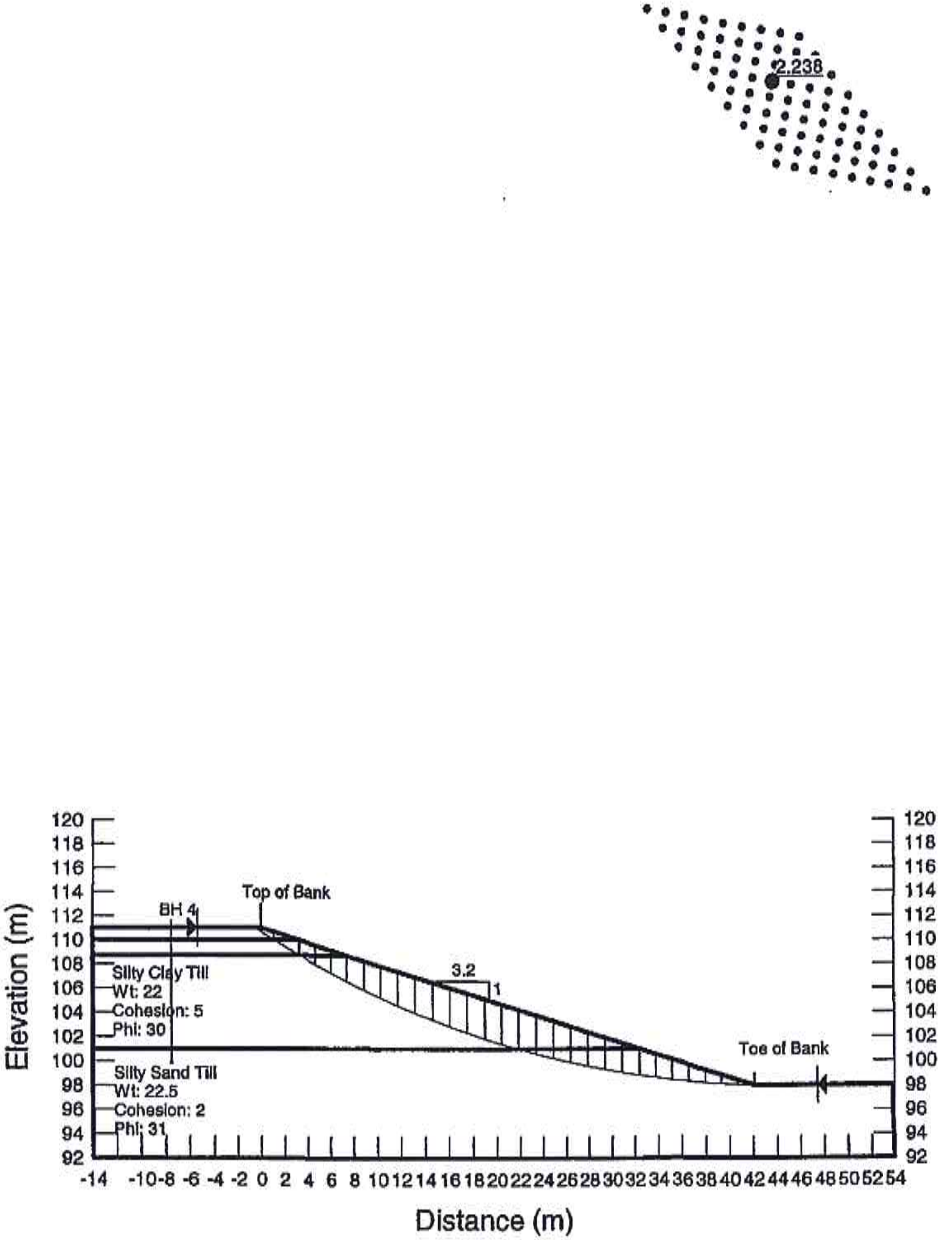


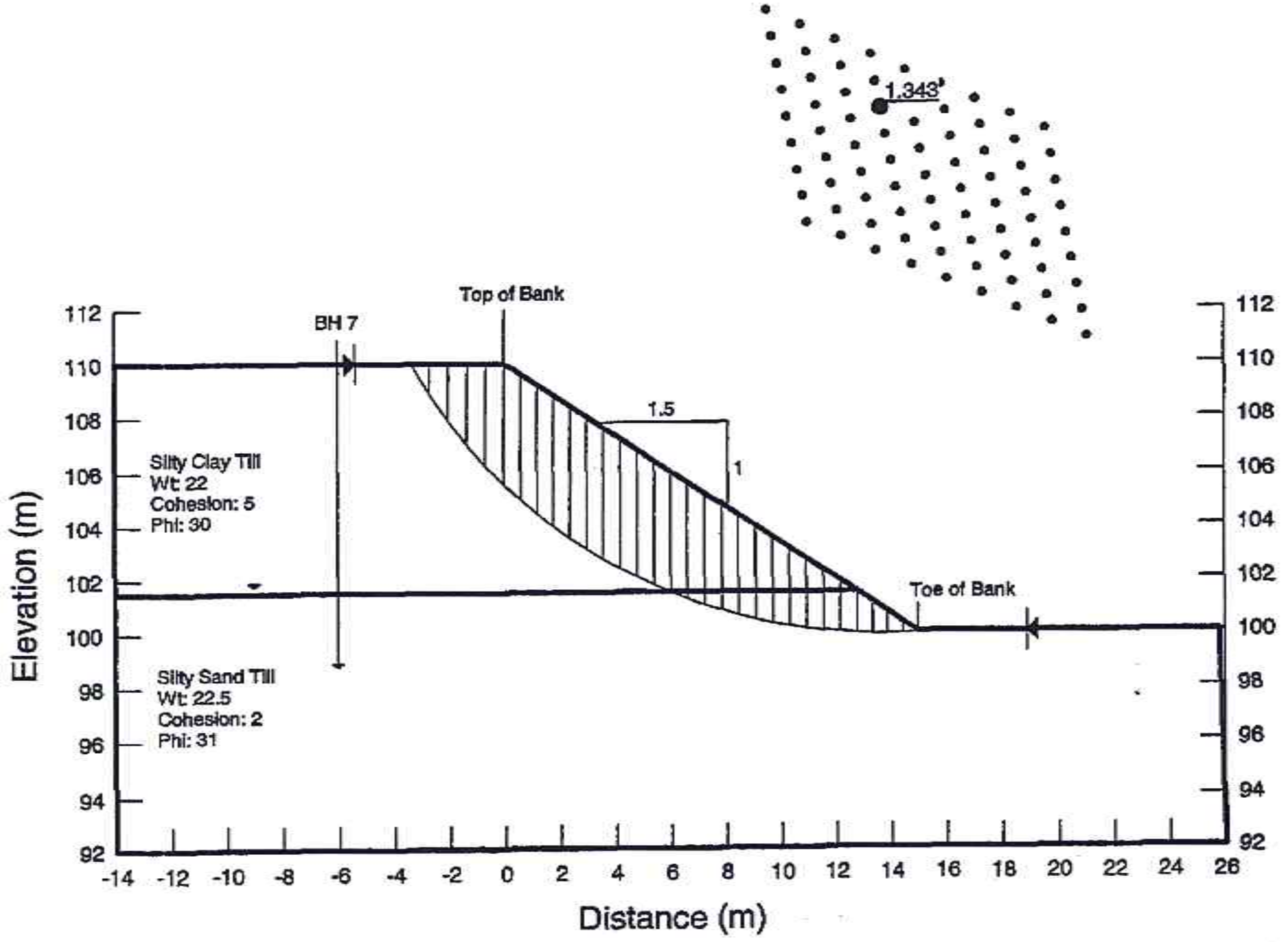
Cross-Section A-A

Drawing No.: 2
Reference No.: 0711-S052
Horizontal Scale: 1:300
Vertical Scale: 1:300



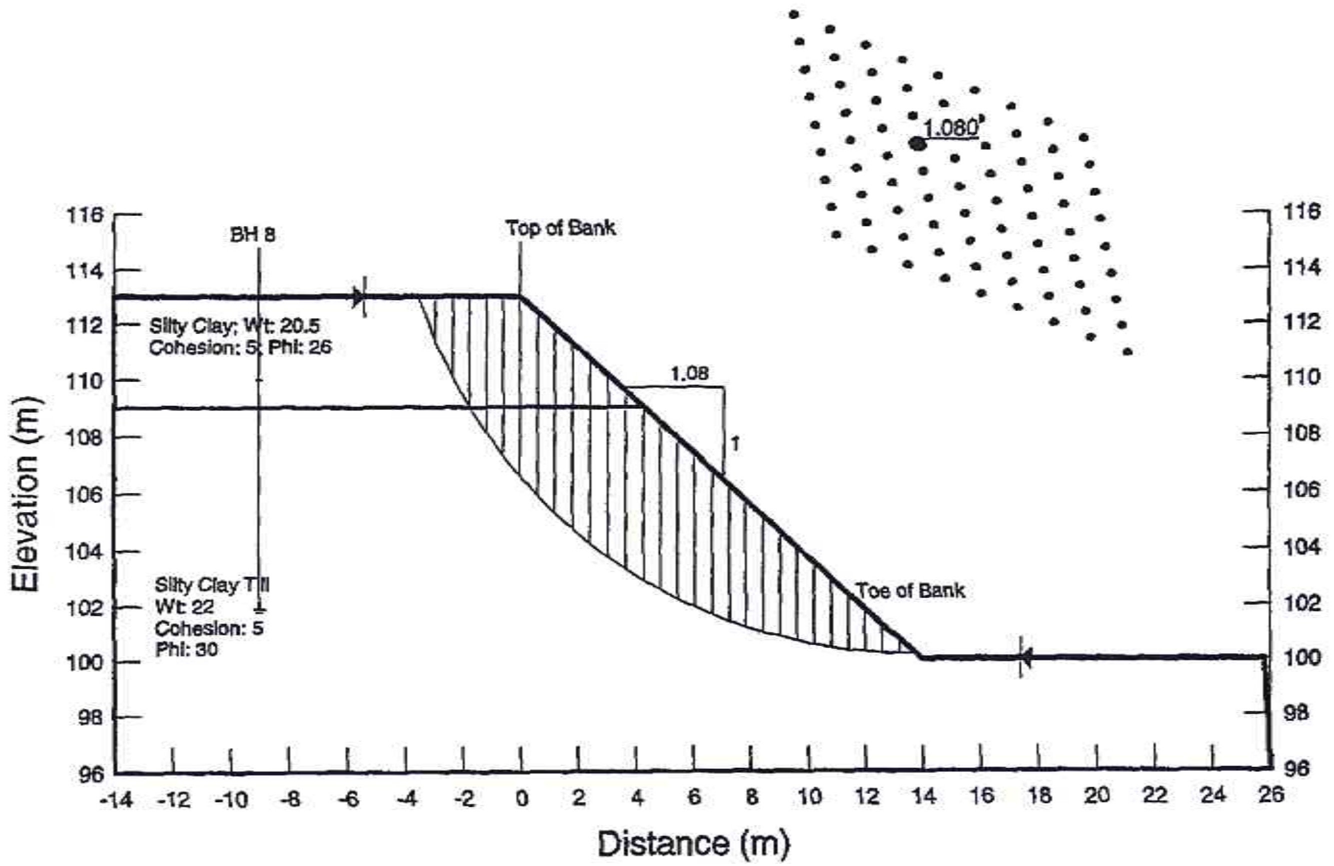
Cross-Section B-B

Drawing No.: 3
Reference No.: 0711-S052
Horizontal Scale: 1:500
Vertical Scale: 1:500



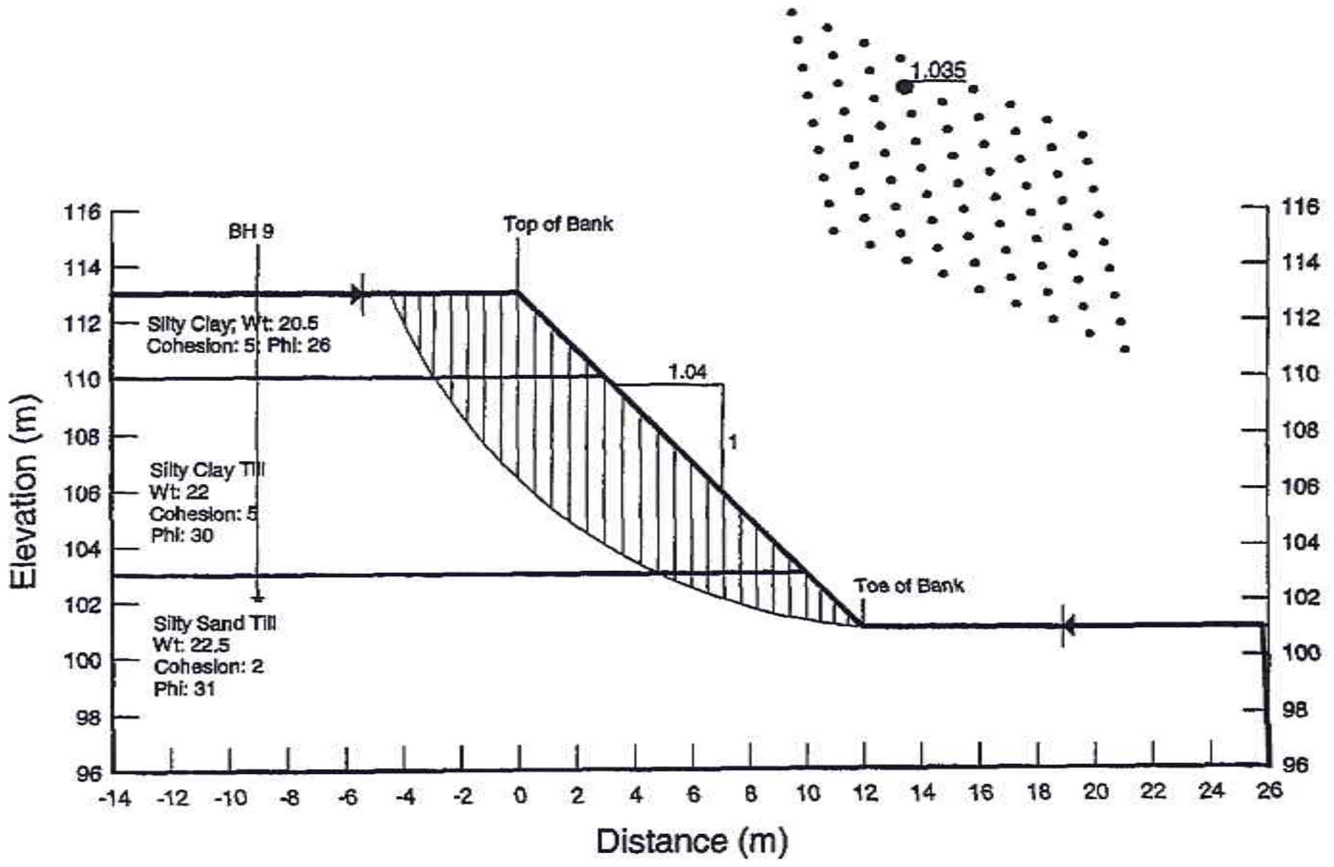
Cross-Section C-C

Drawing No.: 4
Reference No.: 0711-S052
Horizontal Scale: 1:250
Vertical Scale: 1:250



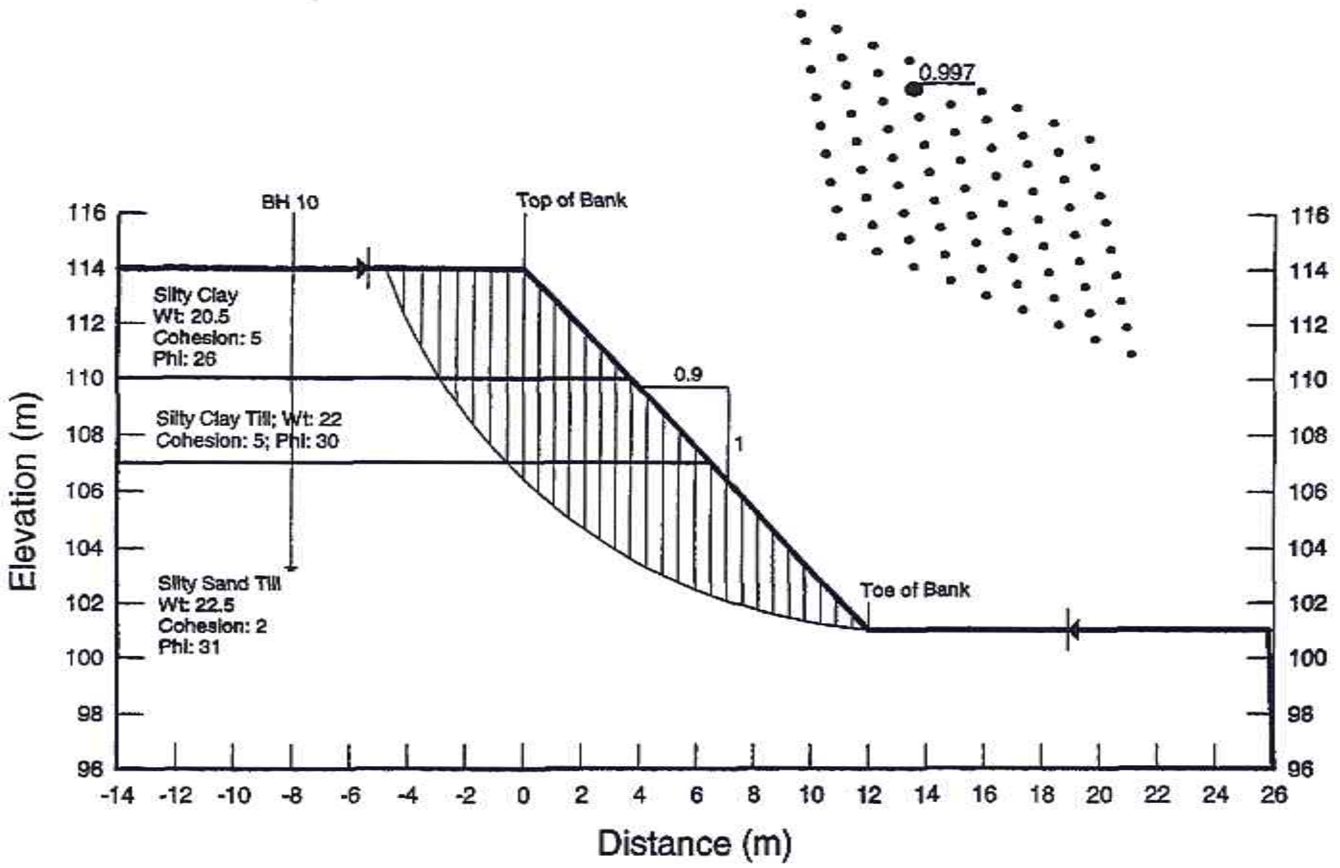
Cross-Section D-D

Drawing No.: 5
Reference No.: 0711-S052
Horizontal Scale: 1:250
Vertical Scale: 1:250



Cross-Section E-E

Drawing No.: 6
Reference No.: 0711-S052
Horizontal Scale: 1:250
Vertical Scale: 1:250



Cross-Section F-F

Drawing No.: 7
Reference No.: 0711-S052
Horizontal Scale: 1:250
Vertical Scale: 1:250