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A REPORT TO
BAYOU DEVELOPMENTS

A SOIL INVESTIGATION FOR PROPOSED RESIDENTIAL DEVELOPMENT

GRAND TAMARACK CRESCENT, EAST OF HIGHWAY 11

TOWNSHIP OF SEVERN (CUMBERLAND BEACH)

REFERENCE NO. 1411-S001

FEBRUARY 2015

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1.0 INTRODUCTION

In accordance with written authorization dated October 30, 2014, from Ms. Vera Cameron-van Amelsvoort, President, of Bayou Developments, a soil investigation was carried out on a parcel of land located along Grand Tamarack Crescent, east of Highway 11, in the Township of Severn (Cumberland Beach), for a Proposed Residential Development.

The purpose of the investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of the proposed project.

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

2.0 SITE AND PROJECT DESCRIPTION

The site is located within the periphery of Lake Simcoe basin where the glacial till has been partly eroded in places by glacial Lake Algonquin and filled with lacustrine sands, silts, clay and reworked till.

The subject site is irregular in shape. It is situated on the north and south sides of Grand Tamarack Crescent, east of Highway 11. At the time of investigation, the site was vacant and covered with trees, bushes and grasses. The prevailing site gradient was relatively flat.

It is understood that a residential subdivision is planned for this site, with municipal services and roadway meeting urban standards.

3.0 **FIELD WORK**

The field work, consisting of 8 boreholes to depths of 3.5 m to 5.0 m, was performed on December 2 and 3, 2014, at the locations shown on the Borehole Location Plan, Drawing No. 1. Three monitoring wells were installed at selected borehole locations for future groundwater monitoring.

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

The field work was supervised and the findings were recorded by a Geotechnical Technician.

The elevation at each of the borehole locations was determined using GPS (Trimble 6000 GeoXH), which is accurate to within 10 cm. However, due to the dense tree growth in the area of Borehole 2, the ground elevation could not be established and the depth of the soil strata are referenced to the prevailing ground surface at this borehole location.

4.0 SUBSURFACE CONDITIONS

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 8, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2, and the engineering properties of the disclosed soils are discussed herein.

The investigation has revealed that beneath a layer of topsoil or a veneer of topsoil fill and a layer of earth fill, the site is underlain by strata of silty clay, silt and sandy silt, and silty fine sand at various depths and locations.

4.1 **Topsoil and Topsoil Fill** (All Boreholes, except Borehole 7)

The revealed topsoil and topsoil fill veneers range from 5 to 23 cm in thickness. At Borehole 1, a layer of buried topsoil was contacted below the earth fill, between depths of 0.7 and 1.4 m. The topsoil and topsoil fill are dark brown in colour, indicating that they contain appreciable amounts 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, they will generate an offensive odour and may produce volatile gases under anaerobic conditions. Therefore, the topsoil and topsoil fill must not be buried deeper than 1.2 m below the external finished grade or within the house envelopes. This is to avoid an adverse impact on the environmental well-being of the proposed project.

Since the topsoil and topsoil fill are considered void of engineering value, they can only be used for general landscaping and landscape contouring purposes. A fertility analysis should be carried out to determine the suitability of the topsoil and topsoil fill for use as general planting materials.

4.2 **Earth Fill** (Boreholes 1, 5 and 7)

The fill extends to depths of 0.5 m and 0.7 m. It is amorphous and consists of sandy silt or silty clay with variable amounts of sand, gravel and topsoil. This indicates the fill is spoil from vicinal construction.

The original topsoil was detected beneath the earth fill at Borehole 1, indicating that the site may have been partially stripped prior to fill placement and buried topsoil may occur at other areas of the site.

Test pits can be performed to define the extent of the fill.

The water content of the fill samples was determined, and the results are plotted on the Borehole Logs; the values, 16% (sandy silt fill) and 22% (silty clay fill), show the fill is generally in a wet condition.

The obtained ‘N’ values are 4, 8 and 16 blows per 30 cm of penetration, indicating that the fill was loosely placed or non-uniformly compacted, but has partially self-consolidated.

As noted, the fill contains topsoil inclusions and its density is non-uniform; therefore, it is unsuitable for supporting structures. In using the fill for structural backfill, or in pavement and slab construction, it should be subexcavated, inspected, sorted free of serious topsoil inclusions, and properly recompacted.

The fill is amorphous in structure; it will ravel and is susceptible to collapse in steep cuts. Where it is free of deleterious materials, its engineering properties are generally similar to those of silty clay or sandy silt, which are described in the following sections.

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.

One must also be aware that the sides of cuts in the fill will be prone to sudden collapse, particularly if the fill is in a wet condition.

4.3 **Silty Clay** (All Boreholes, except Borehole 3)

The silty clay was found at various depths and locations, and extends to the maximum investigated depth at Boreholes 2, 7 and 8. It is laminated with silt and occasional sand layers, with a varved structure, showing the soil is a lacustrine deposit.

The obtained ‘N’ values range from 3 to 19, with a median of 6 blows per 30 cm penetration, showing the consistency of the clay is soft to very stiff, being generally firm.

In situ vane shear tests were performed in the soft clay where ‘N’ values of 3 and 4 were obtained, giving shear strength values of 36 and 53 kPa, and sensitivity values of 2 and 5. This shows that the clay is moderately sensitive to remoulding.

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

Liquid Limit	24% and 29%
Plastic Limit	15% and 16%
Natural Water Content	15% to 43% (median 28%)

The values show that the silty clay is low in plasticity. The natural water content values of the samples range from their plastic limits to above their liquid limits, confirming the generally firm to soft consistency as determined by the ‘N’ values.

Grain size analyses were performed on 2 representative samples; the results are plotted on Figure 9.

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

- Highly frost susceptible and high in soil-adfreezing potential.
- The laminated silt layers are highly water erodible.
- 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-frictional soil, its shear strength is derived from consistency and augmented by the internal friction of the silt. Its shear strength is moisture dependent and, due to the dilatancy of the silt, the overall shear strength of the silty clay is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction of shear strength.
- The soft to firm clay will consolidate under area surcharge loads.

- In steep excavations to depths of 2.0 to 3.0 m, the sides may fail and the bottom may heave due to overstressing.
- In steep cuts, the weathered clay will slough readily and a cut face in the sound clay may collapse as the wet silt slowly sloughs.
- A poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 3%.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 3000 ohm·cm.

4.4 **Silt and Sandy Silt** (All Boreholes, except Borehole 7)

This deposit was found at various depths and locations, and extends to the maximum investigated depths in Boreholes 1, 3, 4, 5 and 6. It contains a trace to some clay and variable amounts of sand.

Sample examinations show that the silt is slightly cemented, displaying some cohesion. The samples are wet and display a high dilatancy when shaken by hand.

The natural moisture content of the samples was found to range from 20% to 30% with a median of 24%, confirming the deposit is in a wet condition and is water bearing.

The obtained 'N' values range from 2 to 13 with a median of 8 blows per 30 cm penetration, indicating that the relative density of the silt is very loose to compact, being generally loose.

Grain size analyses were performed on 2 representative samples, and the gradations are plotted on Figure 10.

Accordingly, the engineering properties relating to the project are given below:

- Highly frost susceptible, with high soil-adfreezing potential.
- Highly water erodible; it is susceptible to migration through small openings under seepage pressure.
- Relatively pervious, with an estimated coefficient of permeability of 10^{-4} to 10^{-5} cm/sec, and runoff coefficients of:

Slope	
0% - 2%	0.07 to 0.11
2% - 6%	0.12 to 0.16
6% +	0.18 to 0.23

- The soil has a high capillarity and water retention capacity.
- A frictional soil, its shear strength is density dependent. Due to its dilatancy, the strength of the wet silt is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction in shear strength.
- In excavation, the wet silt will slough and run slowly with seepage bleeding from the cut face. It will boil with a piezometric head of 0.4 m.
- A poor pavement-supportive material, with an estimated CBR value of 3%.
- Moderately corrosive to buried metal, with an estimated electrical resistivity of 4500 ohm·cm.

4.5 **Silty Fine Sand** (Boreholes 4, 7 and 8)

The sand overlies the silty clay at Boreholes 4 and 8, and is interstratified within the silty clay at Borehole 7. Sample examinations show that the sand is non-cohesive. It is generally in a wet condition and became highly dilatant when shaken by hand. The laminated structure of the sand shows that it is a lacustrine deposit.

The obtained ‘N’ values in the silty fine sand are 8, 9 and 12 blows per 30 cm penetration, from which the relative density of the sand is inferred as loose to compact.

The natural water content of the samples was determined and the results are plotted on the Borehole Logs. The values are 21% and 28%, indicating the sand is in a wet condition, and is water bearing.

A grain size analysis was performed on 1 representative sample and the result is plotted on Figure 11.

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

- Highly frost susceptible with high soil-adfreezing potential.
- Highly water erodible.
- Relatively pervious, with an estimated coefficient of permeability of 10^{-4} cm/sec, and runoff coefficients of:

Slope	
0% - 2%	0.07
2% - 6%	0.12
6% +	0.18

- A frictional soil, its shear strength is derived from internal friction and is density dependent. Due to its dilatancy, the shear strength of the wet sand is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction of shear strength.
- In relatively steep cuts, the sand will slide and will slough if it is wet and run with water seepage. It will boil with a piezometric head of 0.4 m.
- A fair material to support pavement, with an estimated CBR value of 8%.

- Moderately low corrosivity to buried metal, with an estimated electrical resistivity of 6000 ohm·cm.

4.6 Compaction Characteristics of the Revealed Soils

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

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

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	19 to 22	12	8 to 16
Silty Clay	15 to 43 (median 28)	14 to 16	10 to 21
Silt and Sandy Silt	20 to 30 (median 24)	12 to 13	8 to 16
Silty Fine Sand	21 and 28	11	6 to 14

The above values show that in situ soils are generally too wet and will require aeration prior to structural compaction. Aeration can be carried out by spreading the soils thinly on the ground during dry, warm weather.

The clay and clay fill should be compacted using a heavy-weight, kneading-type roller. The silts and silty fine sand can be compacted by a smooth 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.

One should be aware that with considerable effort a 90%± Standard Proctor compaction of the wet silts and silty fine sand is achievable. Further densification is prevented by the pore pressure induced by the compactive effort; however, large random voids will have been 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 rest, the density of the compacted mantle has increased to over 95% of its maximum Standard Proctor dry density.

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. This is unsuitable for pavement construction since each component of the pavement structure is to be placed under dynamic conditions which will induce the rolling action of the subgrade surface and cause structural failure of the new pavement.

The foundations for buildings and utilities will be placed on a subgrade which will not be subjected to impact loads. Therefore, the structurally compacted soil mantle with the water content on the wet side or dry side of the optimum will provide an adequate subgrade for the construction.

5.0 GROUNDWATER CONDITIONS

The boreholes were checked for the presence of groundwater upon their completion. The data are plotted on the Borehole Logs and summarized in Table 2.

Table 2 - Groundwater Levels

		Soil Colour Changes Brown to Grey	**Seepage Encountered During Augering**		**Measured Groundwater On Completion/ On December 10, 2014**	
BH No.	**Borehole Depth (m)**	**Depth (m)**	**Depth (m)**	**Amount**	**Depth (m)**	**El. (m)**
1	5.0	4.0	-	-	0.9/1.2	220.5/220.2
2	3.5	2.9	-	-	1.5	Not established
3	3.5	3.5+	0.5	Appreciable	0.9	219.3
4	3.8	3.8+	-	-	0.6	219.6
5	3.5	0.7	1.0	Some	2.2	217.6
6	3.5	3.5+	0.5	Some	1.5	218.6
7	5.0	4.0	1.5	Moderate	3.0/1.2	217.4/219.2
8	5.0	5.0+	0.2	Appreciable	1.5/0.2	218.9/220.2

As shown above, groundwater was encountered at depths ranging from 0.2± to 3.0± m below the prevailing ground surface, or at El. 217.4± m to El. 220.5± m.

Groundwater levels in the monitoring wells at Boreholes 1, 7 and 8 were recorded on December 10, 2014, at depths of 0.2 m and 1.2 m below the prevailing ground surface, or at El. 219.2 m and El. 220.2 m. The groundwater level will fluctuate with the seasons.

In four of the boreholes, the soil colour changed from brown to grey at depths ranging from 0.7± to 4.0± m below the prevailing ground surface. In the other boreholes, the soil colour remained brown over the entire investigated depth.

The groundwater yield from the clay will be slight to some. From the silts and sand, the yield of groundwater will be appreciable and persistent.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has revealed that beneath topsoil, topsoil fill and a layer of earth fill, the site is underlain by strata of soft to very stiff, generally firm silty clay; very loose to compact, generally compact silt and sandy silt; and loose to compact silty fine sand at various depths and locations.

Groundwater was detected at depths ranging from 0.2 to 3.0± m below the prevailing ground surface. The groundwater yield from the clay will be slight. From the silts and sand, the groundwater yield will be appreciable and persistent.

The geotechnical findings which warrant special consideration are presented below:

1. The topsoil and topsoil fill contain appreciable amounts of humus and may generate volatile gases under anaerobic conditions; therefore, they are unsuitable for engineering applications. For the environmental as well as the geotechnical well-being of the future development, the topsoil and topsoil fill should not be buried deeper than 1.2 m below the external finished grade or within the house envelopes.
2. The natural soils are suitable for the construction of normal, lightly loaded spread and strip footing designed with a Maximum Allowable Soil Bearing Pressure of 50 to 100 kPa (SLS).
3. Due to the presence of topsoil, earth fill, and loose and soft soils, the footing subgrade must be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, or by a building inspector who has geotechnical experience, to ensure that its condition is compatible with the design of the foundation.
4. Where extended footings are required, and where cut and fill is required for site grading, substantial savings can be realized by placing the fill in an

engineered manner suitable for foundation, underground services and road construction. This must, however, be properly planned and implemented during the site grading stage. It is noted that where fill is to be placed to raise the site, the site must be properly preloaded and settlement plates are to be installed to monitor the rate and magnitude of the settlement and confirm that consolidation of the underlying soft/loose soils is complete prior to underground service and foundation construction.

5. For slab-on-grade construction, the slab should be constructed on a granular base, 20 cm thick, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to its maximum Standard Proctor dry density.
6. Perimeter subdrains, floor subdrains and waterproofing of the foundation walls will be required. This can be assessed at the time of construction. The subdrains should be shielded by a fabric filter to prevent blockage by silting, and they must be connected to a positive outlet.
7. Curb subdrains will be required for road construction.
8. A Class ‘B bedding, consisting of compacted 20-mm Crusher-Run Limestone, is recommended for the construction of the underground services. Where water-bearing sand, silt and sandy silt occur, the sewer joints should be leak-proof, or wrapped with an appropriate waterproof membrane to prevent subgrade migration. If subgrade stabilization is required, the stone immersion technique may be applied. In areas where more extensive dewatering is required for sewer construction, a Class ‘A’ bedding should be considered.
9. The revealed soils are highly frost susceptible, with high soil-adfreezing potential. Where they are used to backfill against foundation walls, special measures must be incorporated into the building construction to prevent serious damage due to soil adfreezing.
10. Bottom heaving will likely occur in trenches cut steeply to depths of more than 2.0 m into the very soft to firm silty clay. Therefore, the spoil from the

excavations should be placed at a distance from the edge of the excavation at least equal to 2 times the height of the excavation and the sides should be cut at 1 vertical:2 + horizontal.

11. Excavation should be carried out in accordance with Ontario Regulation 213/91. Excavation into water bearing sand and silt will require proper dewatering.

The recommendations appropriate for the project described in Section 2.0 are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should this become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

6.1 **Foundations**

Based on the borehole findings, the normal spread and strip footings for the house structures must be placed below the topsoil and earth fill onto the sound, natural native soil. As a general guide, the recommended soil pressures for use in the design of the footings, together with the corresponding suitable founding levels, are presented in Table 3.

Table 3 - Founding Levels

Borehole No.	Recommended Maximum Allowable Soil Pressure (SLS)/ Factored Ultimate Soil Bearing Pressure (ULS) and Suitable Founding Level			
	50 kPa (SLS) 75 kPa (ULS)		**100 kPa (SLS) 150 kPa (ULS)**	
	Depth (m)	**El. (m)**	**Depth (m)**	**El. (m)**
1	-	-	1.6 or +	219.8 or -
2	0.5 or +		-	-
3	0.5 or +[A]	219.7 or -[A]	-	-
4	0.5 or +	219.7 or -	-	-
5	-	-	0.9 or +	219.7 or -
6	0.5 or +	219.6 or -	-	-
7	-	-	0.5 or +[B]	219.9 or -[B]
8	0.5 or +	219.9 or -	-	-

[A] The very loose condition of the silt was likely due to disturbance by the sampling. Further testing in the field is recommended to verify the bearing capacity at a depth of 1.6 m (El. 218.6 m).

[B] The Maximum Allowable Soil Pressure (SLS) must be reduced to 50 kPa at a depth below 3.5 m.

In areas where the extended footings are required, it may be more cost effective to subexcavate to a size 20% to 30% larger than the designed footing width, and fill with lean concrete up to the normal footing elevation immediately after the suitable founding soil is exposed. In order to allow the incidental loose material to remain on the approved subgrade prior to construction, the concrete must be readily available. Therefore the sequence of foundation construction, consisting of footing excavation, subgrade inspection and concreting, must be carried out on a continuous basis.

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

It should be noted that if groundwater or groundwater seepage is encountered in the footing excavations, or where the subgrade of the normal foundations is found to be wet, the subgrade should be protected by a concrete mud-slab immediately after exposure. This will prevent construction disturbance and costly rectification.

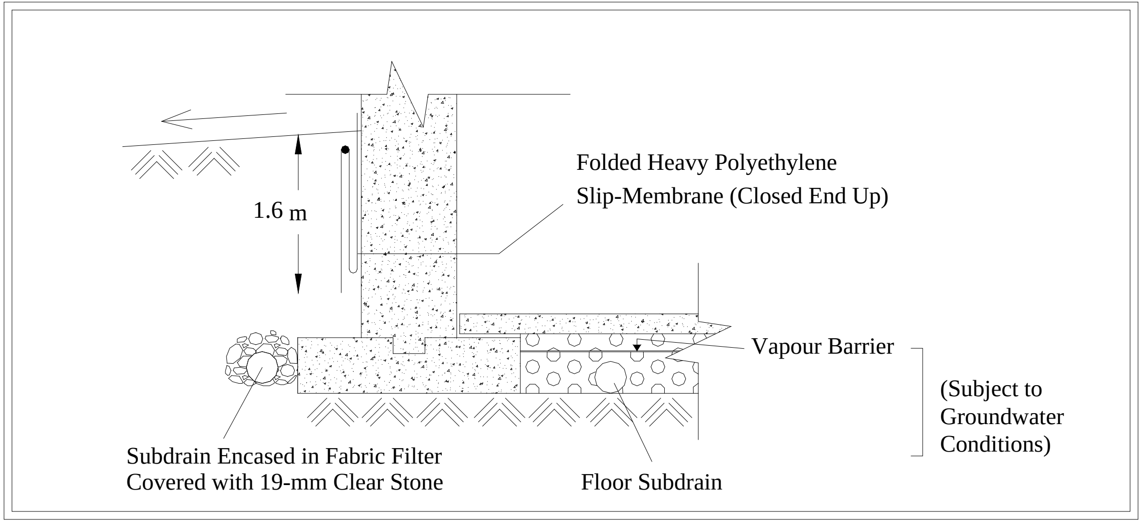
The footings must meet the requirements specified in the latest Ontario Building Code. As a guide, the structure should be designed to resist an earthquake force using Site Classification ‘E’ (soft soil).

Due to the presence of topsoil, earth fill, and loose and soft soils, the footing subgrade must be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, or by a building inspector who has geotechnical experience, to assess its suitability for bearing the designed foundations.

Foundations exposed to weathering or in unheated areas should be protected against frost action by a minimum of 1.6 m of earth cover.

The occurring soils are high in frost heave and soil-adfreezing potential. If these are to be used for the foundation backfill, the foundation walls should be shielded by a polyethylene slip-membrane for protection against soil adfreezing. The recommended measures are schematically illustrated in Diagram 1.

Diagram 1 - Frost Protection Measures (Foundations)



The necessity to implement the above recommendations should be further assessed by a geotechnical engineer at the time of construction.

Perimeter and floor subdrains and dampproofing of the basement walls will be required. All the subdrains must be encased in a fabric filter to protect them against blockage by silting, and must be connected to a positive outlet. Where the basement lies below the groundwater, waterproofing will be required and the basement must be designed to resist the hydrostatic pressure and uplift, and construction will be costly and difficult unless the groundwater can be properly controlled to ensure that it will be below the basement level at all times. This must be properly assessed at the time of investigation.

Where earth fill is required to raise the site, or extended footings are necessary, or where cut and fill may be required for lot grading, it is generally more practical and economical to place engineered fill suitable for a Maximum Allowable Soil Pressure (SLS) of 75 kPa for normal footing construction. A stress analysis is required to review the earth pressure increase in the soft strata to ensure that there is no overstressing of the underlying subsoils. The requirements and procedures for engineered fill construction are discussed in Section 6.2.

6.2 **Engineered Fill**

In areas where earth fill is required to raise the site, or where extended footings are necessary, it is generally more economical to place engineered fill for normal footing, underground services and pavement construction. Due to the presence of loose and soft soil strata, a stress analysis will be required with the proposed grading and the structure locations. This is to ensure that there is no overstressing of the underlying subsoils which would load to consolidation of the subsurface soils. In addition, the engineered fill must be left in place for a suitable period of time prior to the start of any construction. This must be confirmed by the installation of settlement plates to ensure that the consolidation of the soft to firm and/or very loose to loose soils is completed prior to the start of construction.

The engineering requirements for a certifiable fill for pavement construction, municipal services, slab-on-grade, and footings designed with a Maximum Allowable Soil Pressure (SLS) of 75 kPa and a Factored Ultimate Soil Bearing Pressure (ULS) of25Pa are presented below:

1. All of the topsoil and organics must be removed. The soft and loose soils and existing fill must be subexcavated, sorted free of topsoil inclusions and deleterious materials, if any, aerated and properly compacted. The subgrade must be inspected and proof-rolled prior to any fill placement.
2. Inorganic soils must be used, and they must be uniformly compacted in lifts 20 cm thick to 98% or + of their maximum Standard Proctor dry density up to the proposed finished grade and/or slab-on-grade subgrade. The soil moisture must be properly controlled on the wet side of the optimum. If the house

foundations are to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% of the maximum Standard Proctor compaction.

3. If imported fill is to be used, the hauler is responsible for its environmental quality and must provide a document to certify that the material is free of hazardous contaminants.
4. If the engineered fill is to be left over the winter months, adequate earth cover, or equivalent, must be provided for protection against frost action.
5. The engineered fill must extend over the entire graded area; the engineered fill envelope and the finished elevations must be clearly and accurately defined in the field, and they must be precisely documented by qualified surveyors. Foundations partially on engineered fill must be reinforced by two 15-mm steel reinforcing bars in the footings and upper section of the foundation walls, or be designed by a structural engineer, to properly distribute the stress induced by the abrupt differential settlement (estimated to be 15± mm) between the natural soils and engineered fill.
6. The engineered fill must not be placed during the period from late November to early April, when freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice or snow.
7. Where the ground is wet due to subsurface water seepage, an appropriate subdrain scheme must be implemented prior to the fill placement.
8. Where the fill is to be placed on sloping ground steeper than 1 vertical: 3 horizontal, the face of the sloping ground must be flattened to 3 + so that it is suitable for safe operation of the compactor and the required compaction can be obtained.
9. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.

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

6.3 **Underground Services**

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

A Class ‘B’ bedding, consisting of compacted 20-mm Crusher-Run Limestone, is recommended for the construction of the underground services. Where the services are constructed in water-bearing sand and silts, the pipe joints should be leak-proof or wrapped with an appropriate waterproof membrane to prevent subgrade migration. If subgrade stabilization is required, the stone immersion technique may be applied. In areas where extensive dewatering is required for sewer construction, a Class ‘A’ bedding should be considered.

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

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

Since the silty clay has moderately high corrosivity to buried metal, water main and accessories should be protected against corrosion. In determining the mode of protection, an electrical resistivity of 3000 ohm·cm should be used. This, however, should be confirmed by testing the soil along the water main alignment at the time of sewer construction.

6.4 **Backfilling in Trenches and Excavated Areas**

The on-site inorganic soils are generally suitable for trench backfill. However, most of the soils will require aeration prior to backfilling.

The backfill in service trenches 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 materials should be compacted with the water content 2% to 3% drier than the optimum, and the compaction should be increased to at least 98% of the respective maximum Standard Proctor dry density. This is to provide the required stiffness for pavement construction. In the lower zone, the compaction should be carried out on the wet side of the optimum; this allows a wider latitude of lift thickness.

Backfill below any slab-on-grade which is sensitive to settlement must be compacted to at least 98% of its maximum Standard Proctor dry density.

In normal construction practice, the problem areas of settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns. In areas which are inaccessible to a heavy compactor, imported sand backfill should be used. Unless compaction of the backfill is carefully performed, the interface of the native soils and the sand backfill will have to be flooded for a period of several days.

The narrow trenches for service 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.

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

- When construction is carried out in freezing winter weather, allowance should be made for these following conditions. Despite stringent backfill monitoring, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in situ soils have a water content on the dry side of the optimum, it would be impossible to wet the soils due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction. Furthermore, the freezing condition will prevent flooding of the backfill when it is required, such as in a narrow vertical trench section, or when the trench box is removed. The above will invariably cause backfill settlement that may become evident within 1 to several years, depending on the depth of the trench which has been backfilled.

- In areas where the underground service construction is carried out during the winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement and the slab-on-grade.
- To backfill a deep trench, one must be aware that future settlement is to be expected, unless the side of the cut is flattened to at least 1 vertical: 1.5+ horizontal, and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 95% of the maximum Standard Proctor dry density, with the moisture content on the wet side of the optimum.
- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand. In a trench stabilized by a trench box, the void left after the removal of the box will be filled by the backfill. It is necessary to backfill this sector with sand, and the compacted backfill must be flooded for 1 day, prior to the placement of the backfill above this sector, i.e., in the upper sloped trench section. This measure is necessary in order to

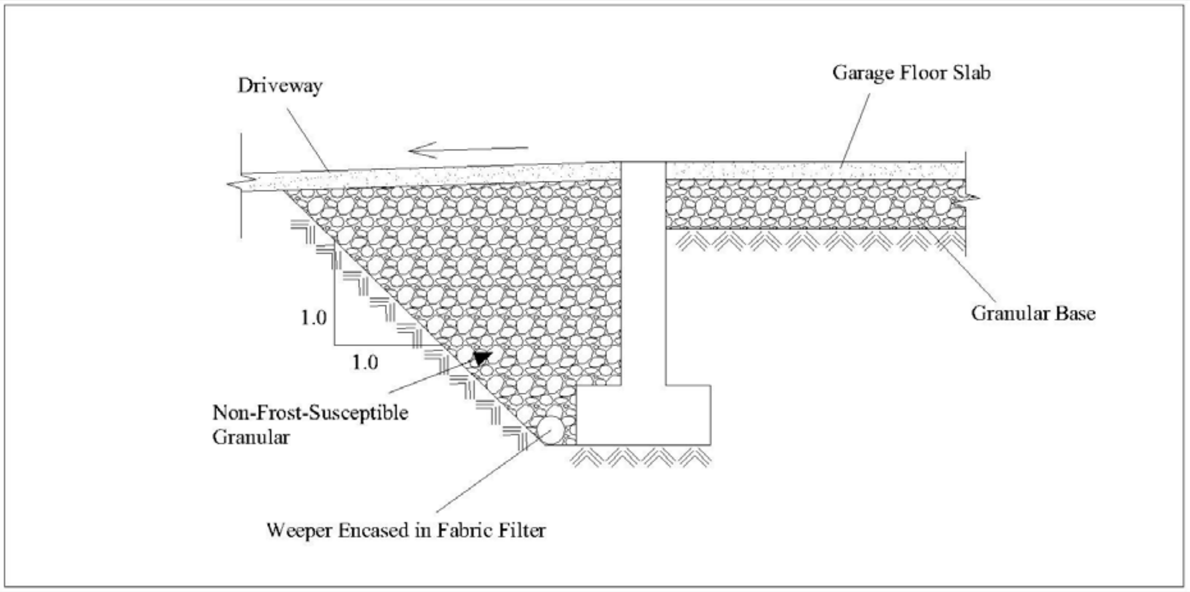
prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section. In areas where groundwater movement is expected in the sand fill mantle, anti-seepage collars should be provided.

6.5 Garages, Driveways, Interlocking Stone Pavement and Landscaping

Due to the high frost susceptibility of the in situ soils, some heaving of the pavement is expected to occur during the cold weather.

The driveways at the entrances to the garages can be backfilled with non-frost-susceptible granular material, with a frost taper at a slope of 1 vertical:1 horizontal. The recommended scheme is illustrated in Diagram 2.

Diagram 2 - Frost Protection Measures (Garage)



Interlocking stone pavement, slab-on-grade and landscaping structures in areas which are sensitive to frost-induced ground movement, such as in front of building entrances, must be constructed on a free-draining, non-frost-susceptible granular material such as Granular ‘B’. This material must extend to at least 0.3 to 1.6 m below the slab or pavement surface, depending on the degree of tolerance for ground movement, and be provided with positive drainage, such as weeper subdrains connected to manholes or catch basins. Alternatively, the landscaping structures, slab-on-grade and interlocking stone pavement should be properly insulated with 50-mm Styrofoam, or equivalent.

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

6.6 Pavement Design

Based on the borehole findings, the recommended pavement design for any new subdivision roads is presented in Table 4.

Table 4 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	50	HL-8
Granular Base	150	Granular ‘A’ or equivalent
Granular Sub-base	450	Granular ‘B’ or equivalent

In preparation of the subgrade, the topsoil and must be stripped, and the subgrade surface must be proof-rolled. Any soft subgrade, organics, deleterious materials and foreign matter should be subexcavated and replaced by properly compacted, organic-free earth fill. All the granular bases should be compacted to their maximum Standard Proctor dry density.

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

The pavement subgrade will suffer a strength regression if water is allowed to saturate the mantle. The following measures should, therefore, be incorporated in the construction procedures and pavement design:

- If the pavement construction does not immediately follow the trench backfilling, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- Areas adjacent to the pavement should be properly graded to prevent ponding of large amounts of water during the interim construction period.
- Curb subdrains will be required. The subdrains should consist of filter-sleeved weepers to prevent blockage by silting.
- If the pavement is to be constructed during wet seasons and extensively soft subgrade occurs, the granular sub-base should be thickened in order to compensate for the inadequate strength of the subgrade. This can be assessed during construction.

6.7 **Soil Parameters**

The recommended soil parameters for the project design are given in Table 5.

Table 5 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**		**Estimated Bulk Factor**	
	Bulk	**Submerged**	**Loose**	**Compacted**
Earth Fill	20.0	11.0	1.20	1.00
Silty Clay	20.5	11.5	1.30	1.00
Silt and Sandy Silt	21.0	10.5	1.20	1.00
Silty Fine Sand	20.5	11.0	1.20	1.00

Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_0**	**Passive K_p**
Earth Fill (compacted) and Silty Clay	0.40	0.55	2.50
Silt, Sandy Silt and Silty Fine Sand	0.35	0.52	2.88

Maximum Allowable Soil Pressure (SLS) For Thrust Block Design	
Sound Natural Soil and Engineered Fill	35 kPa

6.8 Excavation

Excavation in excess of 1.2 m should be carried out in accordance with Ontario Regulation 213/91.

For excavation purposes, the types of soils are classified in Table 6.

Table 6 - Classification of Soils for Excavation

Material	Type
Stiff Clay	2
Earth Fill, firm Clay and dewatered Silts and Sand	3
Soft Clay and water-bearing Silts and Sand	4

The groundwater yield from the silty clay, due to its low to permeability, will be small and can be controlled by pumping from sumps. In the silts and sands, the groundwater yield is expected to be moderate to appreciable and persistent. Groundwater may be controllable by vigorous pumping from closely spaced sumps in shallow excavations into the wet sand and silts (0.5 m below groundwater). Deep excavations (more than 1 m into the groundwater regime) will be prone to side collapse and bottom heaving, and should be stabilized by the use of a well-point dewatering system.

Prospective contractors must assess the in situ subsurface conditions prior to excavation by digging test pits to at least 1.0 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 2041320 Ontario Inc. and for review by its designated consultants and government agencies. The material in it reflects the judgement of Benjamin Shindman, M.A.Sc., and Bennett Sun, 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, is the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

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Feb 13, 2015
PROVINCE OF ONTARIO

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

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

SAMPLE TYPES

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

PENETRATION RESISTANCE

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 '○'

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

SOIL DESCRIPTION

Cohesionless Soils:

'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

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

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0	Field vane test in borehole; the number denotes the sensitivity to remoulding
△	Laboratory vane test
□	Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

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

JOB NO: 1411-S001

LOG OF BOREHOLE NO: 1

FIGURE NO: 1

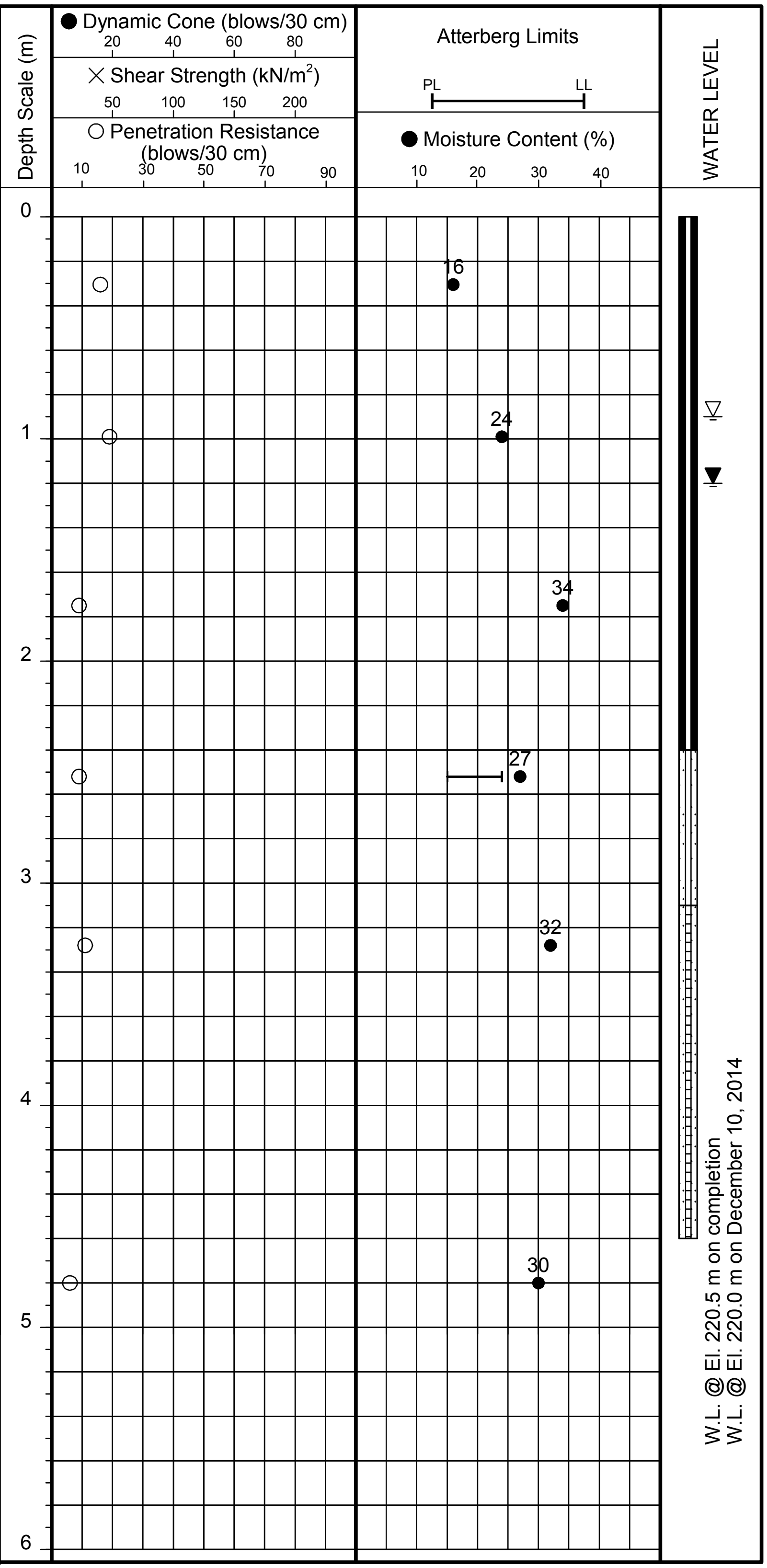
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

METHOD OF BORING: Solid-Stem Auger

DATE: December 3, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
221.4	**5 cm TOPSOIL, Fill** Brown **SANDY SILT, Fill** a trace of clay	1	DO	16
0.7 220.7	**TOPSOIL**	2	DO	19
1.4 220.0	Brown and grey, stiff **SILTY CLAY** a trace of sand	3 4 5	DO DO DO	9 9 11
4.0 217.4	Grey, loose **SILT and SANDY SILT** some sand to sandy a trace to some clay	6	DO	6
5.0 216.4	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 4.6 m (1.5 m screen) Sand backfill from 2.4 to 4.6 m Bentonite seal from 0.0 to 2.4 m Provided with monument casing			



Soil Engineers Ltd.

JOB NO: 1411-S001

LOG OF BOREHOLE NO: 2

FIGURE NO: 2

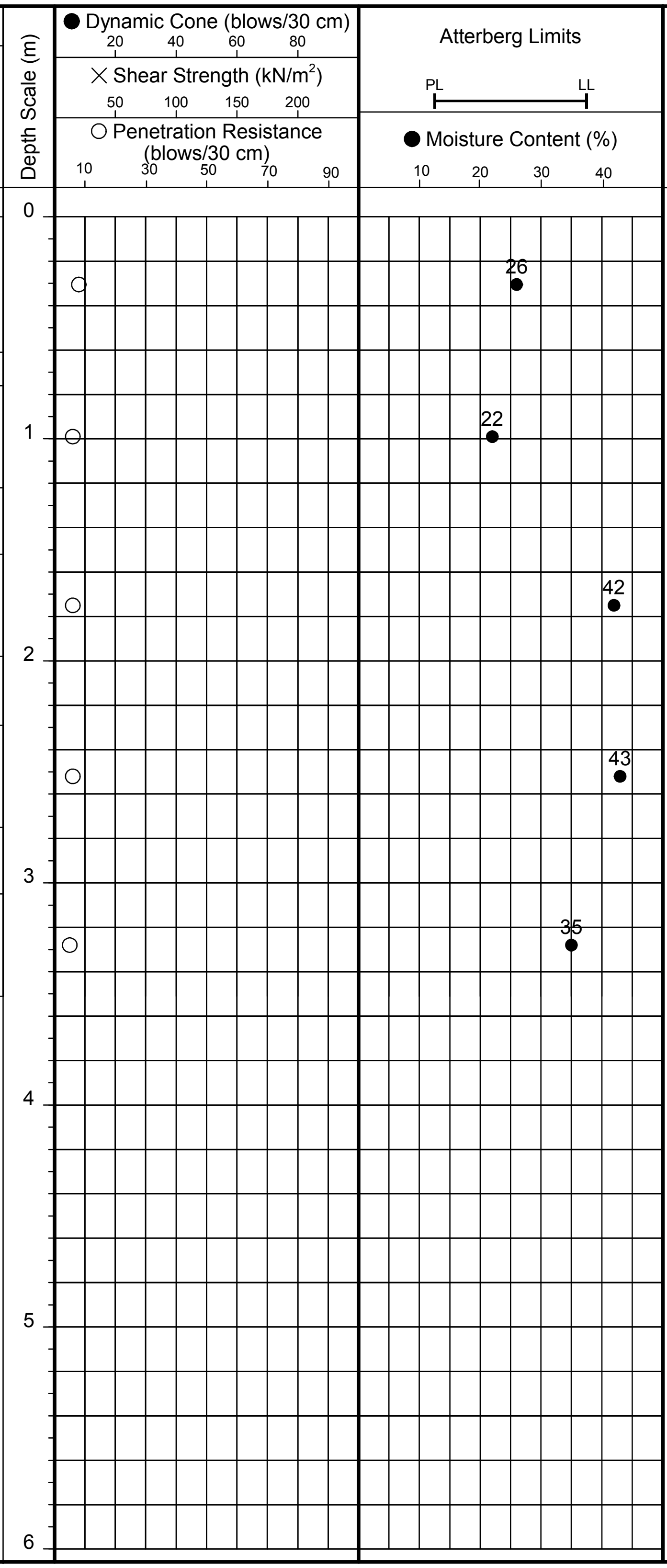
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

METHOD OF BORING: Solid-Stem Auger

DATE: December 2, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
	18 cm TOPSOIL			
	Brown, loose **SANDY SILT** traces of clay and topsoil	1	DO	8
0.7	Firm **SILTY CLAY** a trace of sand	2	DO	6
		3	DO	6
		4	DO	6
	brown grey			
		5	DO	5
3.5	**END OF BOREHOLE**			



WATER LEVEL

∇

W.L. @ depth 1.5 m on completion

Soil Engineers Ltd.

JOB NO: 1411-S001

LOG OF BOREHOLE NO: 3

FIGURE NO: 3

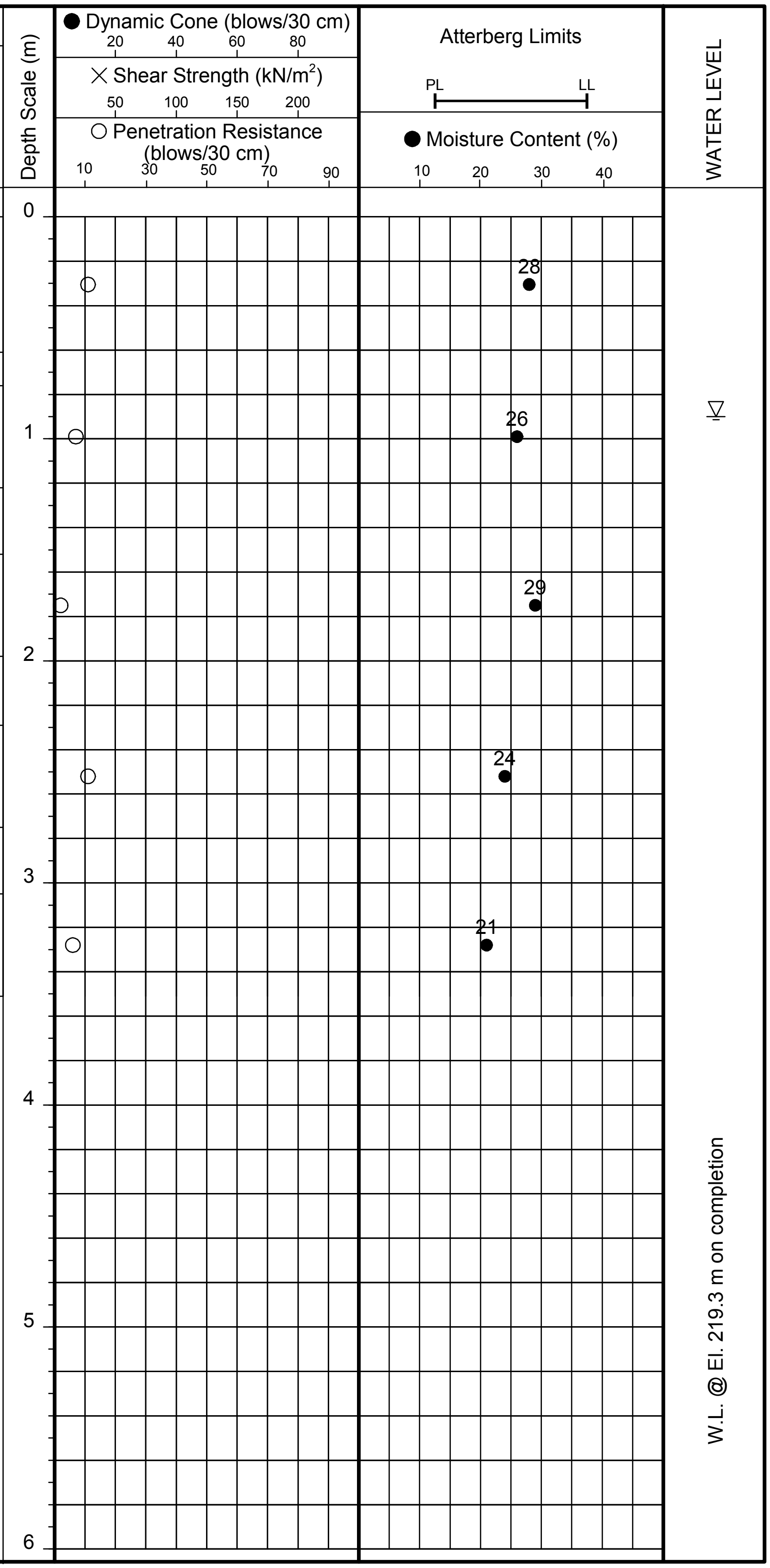
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

METHOD OF BORING: Solid-Stem Auger

DATE: December 2, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
220.2	**28 cm TOPSOIL**			
	Brown, very loose to compact **SILT and SANDY SILT** some sand to sandy a trace to some clay	1	DO	11
		2	DO	7
		3	DO	2
		4	DO	11
		5	DO	6
3.5 216.7	**END OF BOREHOLE**			



W.L. @ El. 219.3 m on completion

JOB NO: 1411-S001

LOG OF BOREHOLE NO: 4

FIGURE NO: 4

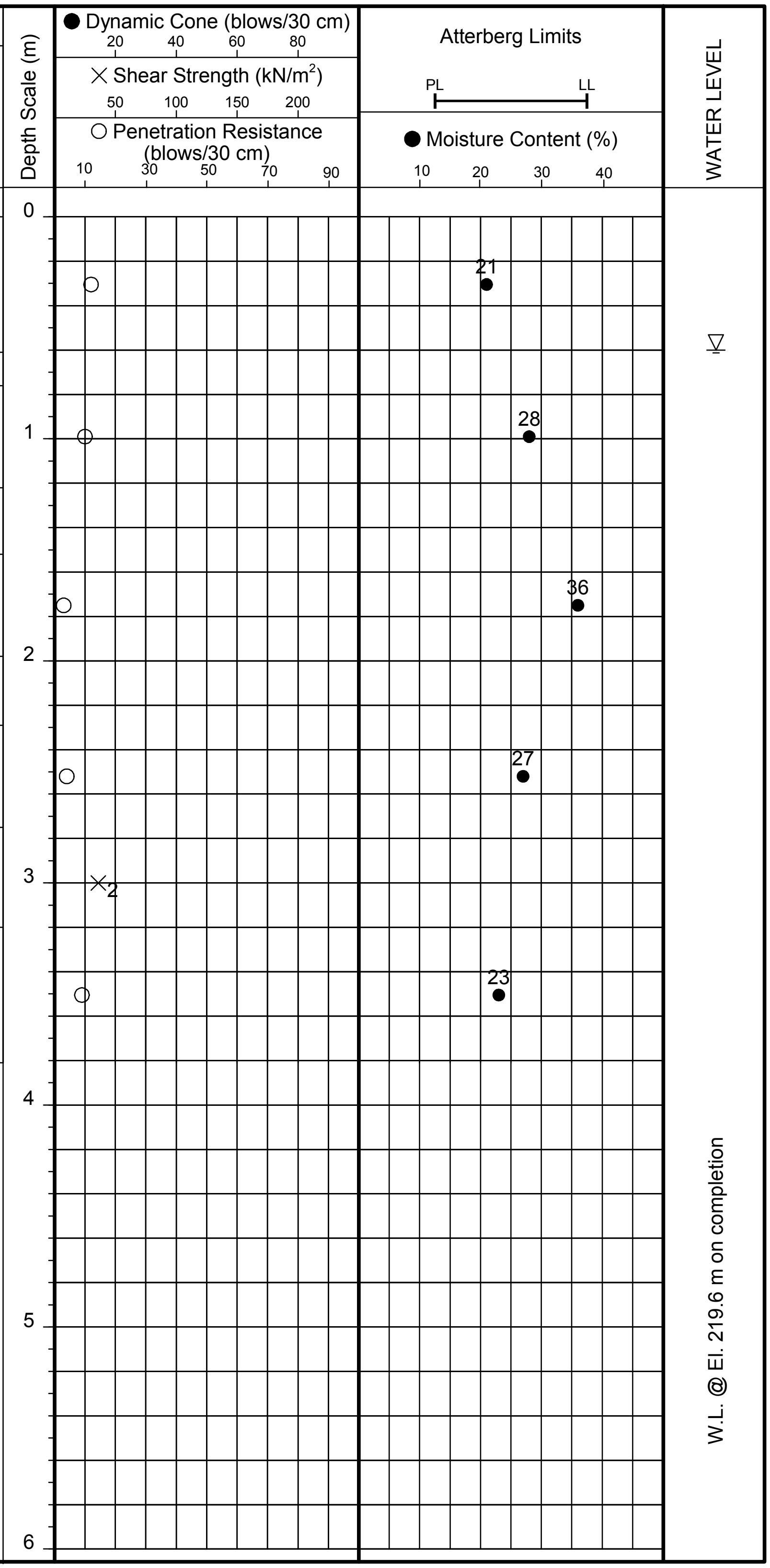
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

METHOD OF BORING: Solid-Stem Auger

DATE: December 2, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
220.2	**20 cm TOPSOIL**			
	Brown, compact **SILTY FINE SAND** traces of clay and medium sand	1	DO	12
0.7 219.5	Brown, soft to stiff **SILTY CLAY** a trace of sand	2	DO	10
		3	DO	3
		4	DO	4
3.1 217.1	Brown, loose **SILT and SANDY SILT** some sand to sandy a trace to some clay	5	DO	9
3.8 216.4	**END OF BOREHOLE**			



W.L. @ El. 219.6 m on completion

Soil Engineers Ltd.

JOB NO: 1411-S001

LOG OF BOREHOLE NO: 5

FIGURE NO: 5

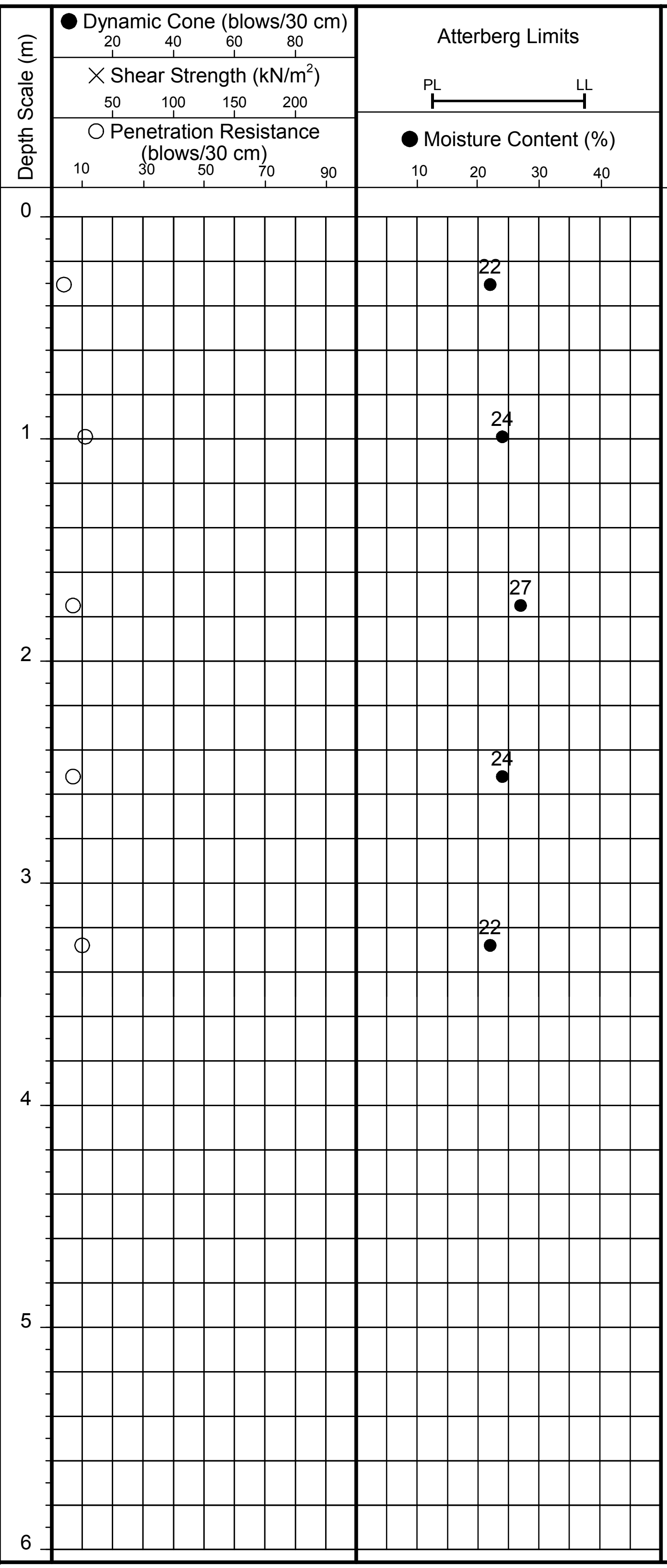
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

METHOD OF BORING: Solid-Stem Auger

DATE: December 3, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
220.6	**13 cm TOPSOIL, Fill** Grey **SILTY CLAY, Fill** a trace to some sand occ. topsoil inclusions	1	DO	4
0.7 219.9	Grey, firm to stiff **SILTY CLAY** a trace of sand	2	DO	11
		3	DO	7
2.2 218.4	Grey, loose **SILT and SANDY SILT** some sand to sandy a trace to some clay	4	DO	7
		5	DO	10
3.5 217.1	**END OF BOREHOLE**			



WATER LEVEL

∇

W.L. @ El. 218.4 m on completion

Soil Engineers Ltd.

JOB NO: 1411-S001

LOG OF BOREHOLE NO: 6

FIGURE NO: 6

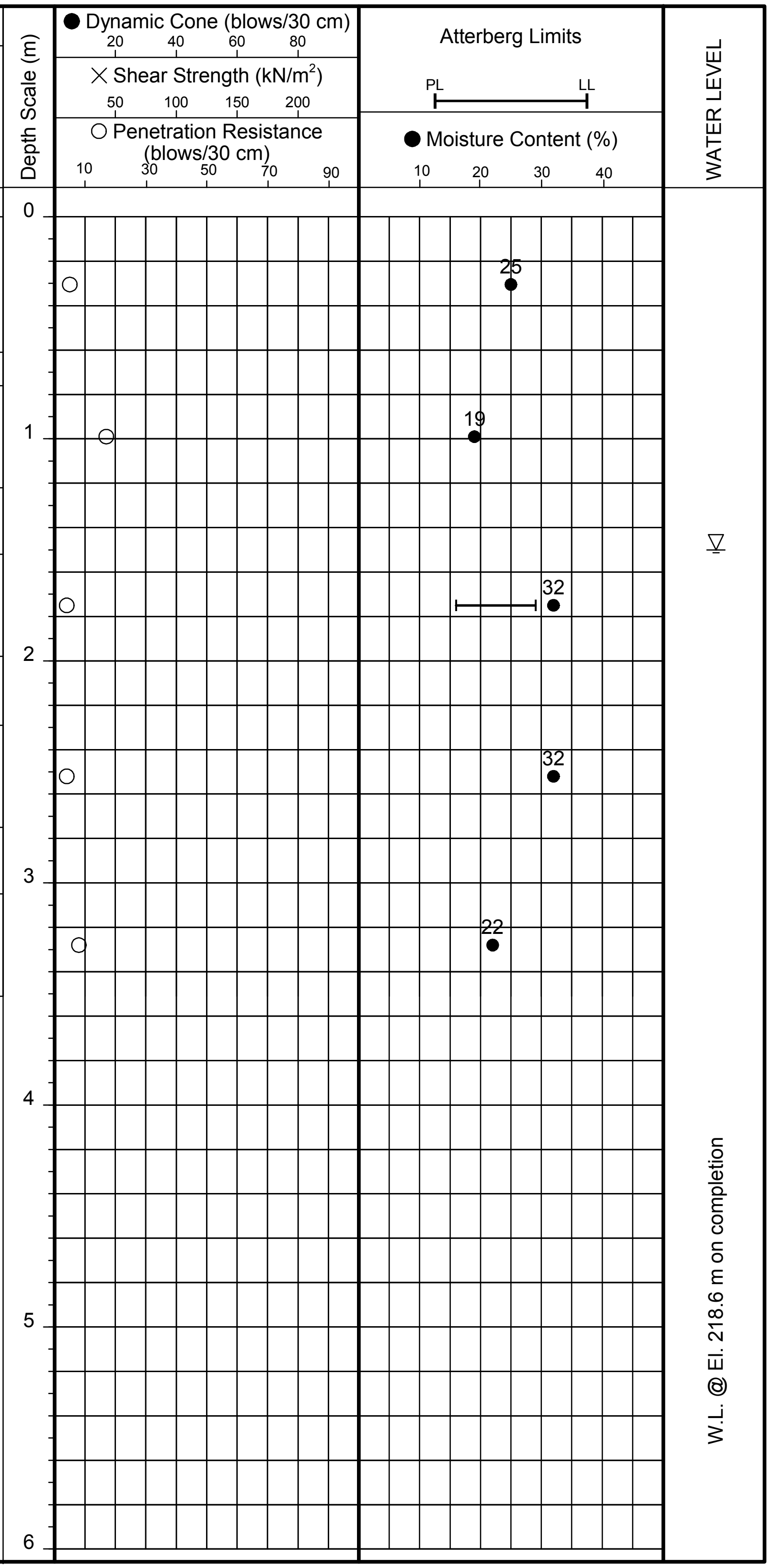
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

METHOD OF BORING: Solid-Stem Auger

DATE: December 3, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0 220.1	Ground Surface **25 cm TOPSOIL**			
	Brown, firm to very stiff **SILTY CLAY** a trace of sand	1	DO	5
		2	DO	17
		3	DO	4
		4	DO	4
2.9 217.2	Brown, loose **SILT and SANDY SILT** some sand to sandy a trace to some clay	5	DO	8
3.5 216.6	**END OF BOREHOLE**			



JOB NO: 1411-S001

LOG OF BOREHOLE NO: 7

FIGURE NO: 7

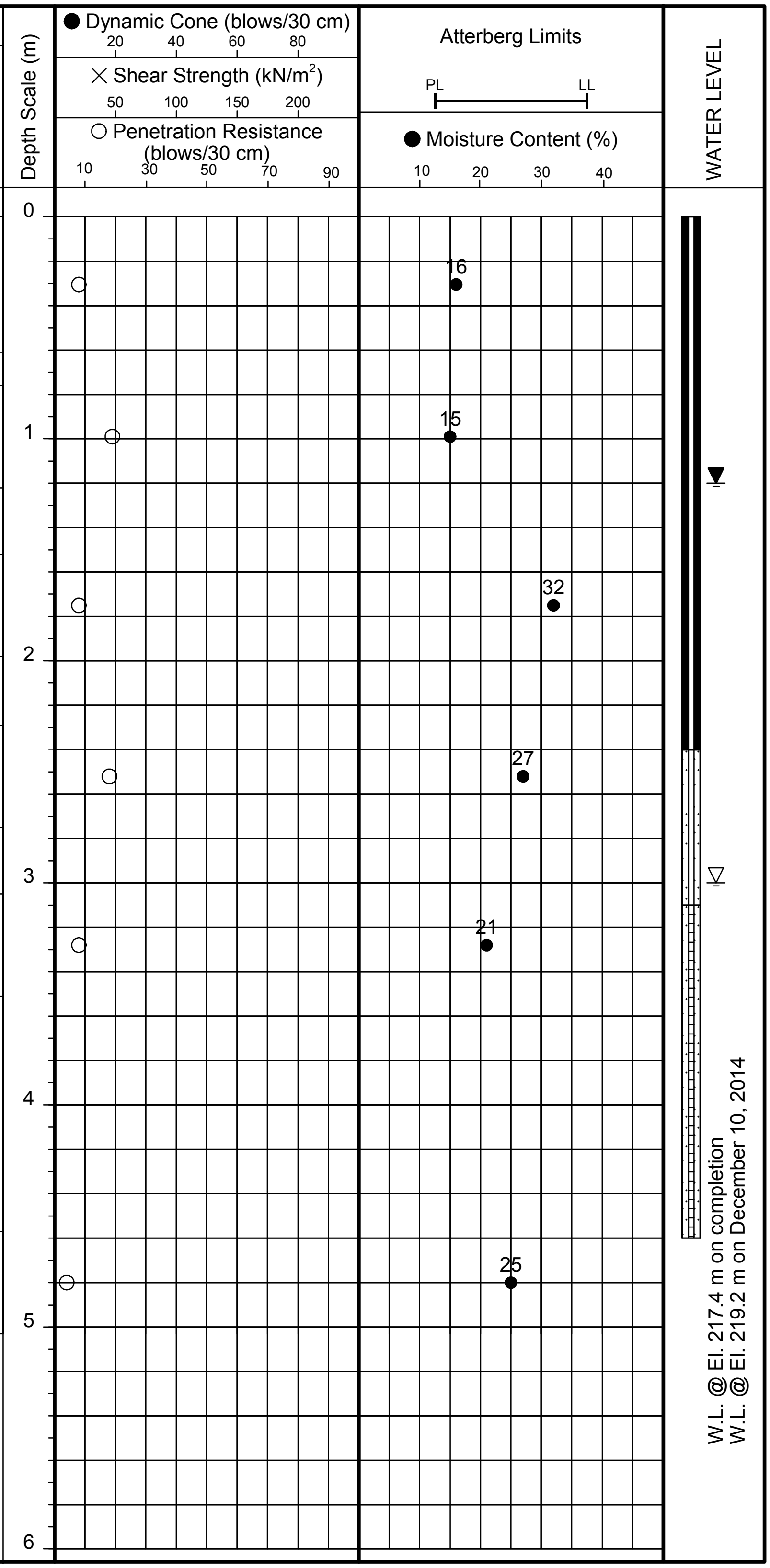
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

METHOD OF BORING: Solid-Stem Auger

DATE: December 3, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
220.4	Brown **SANDY SILT, Fill** traces of gravel and topsoil	1	DO	8
0.5 219.9	Brown, stiff to very stiff **SILTY CLAY** a trace of sand	2	DO	19
		3	DO	8
		4	DO	18
2.9 217.5	Brown, loose **SILTY FINE SAND** traces of clay and medium sand	5	DO	8
4.0 216.4	Grey, firm **SILTY CLAY** a trace of sand	6	DO	4
5.0 215.4	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 4.6 m (1.5 m screen) Sand backfill from 2.4 to 4.6 m Bentonite seal from 0.0 to 2.4 m Provided with monument casing			



W.L. @ El. 217.4 m on completion
W.L. @ El. 219.2 m on December 10, 2014

Soil Engineers Ltd.

JOB NO: 1411-S001

LOG OF BOREHOLE NO: 8

FIGURE NO: 8

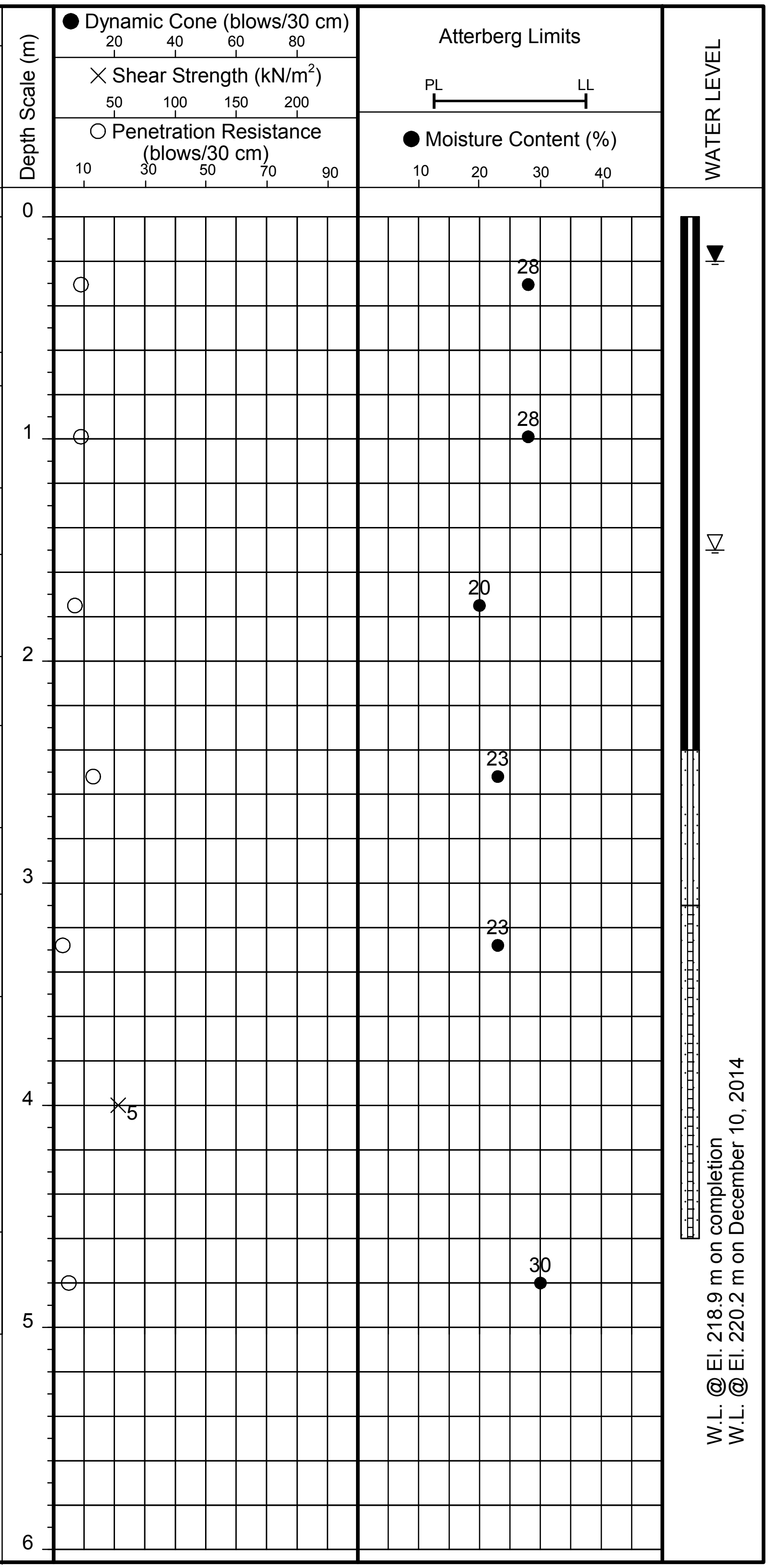
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

METHOD OF BORING: Hollow-Stem Auger

DATE: December 3, 2014

Depth Elev. (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
0.0	Ground Surface			
220.4	**23 cm TOPSOIL**			
	Brown, loose **SILTY FINE SAND** traces of clay and medium sand	1	DO	9
0.7 219.7	Brown, loose to compact **SILT and SANDY SILT** some sand to sandy a trace to some clay	2	DO	9
		3	DO	7
		4	DO	13
2.9 217.5	Grey, soft to firm **SILTY CLAY** a trace of sand	5	DO	3
		6	DO	5
5.0 215.4	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 4.6 m (1.5 m screen) Sand backfill from 2.4 to 4.6 m Bentonite seal from 0.0 to 2.4 m Provided with monument casing			



W.L. @ El. 218.9 m on completion
W.L. @ El. 220.2 m on December 10, 2014

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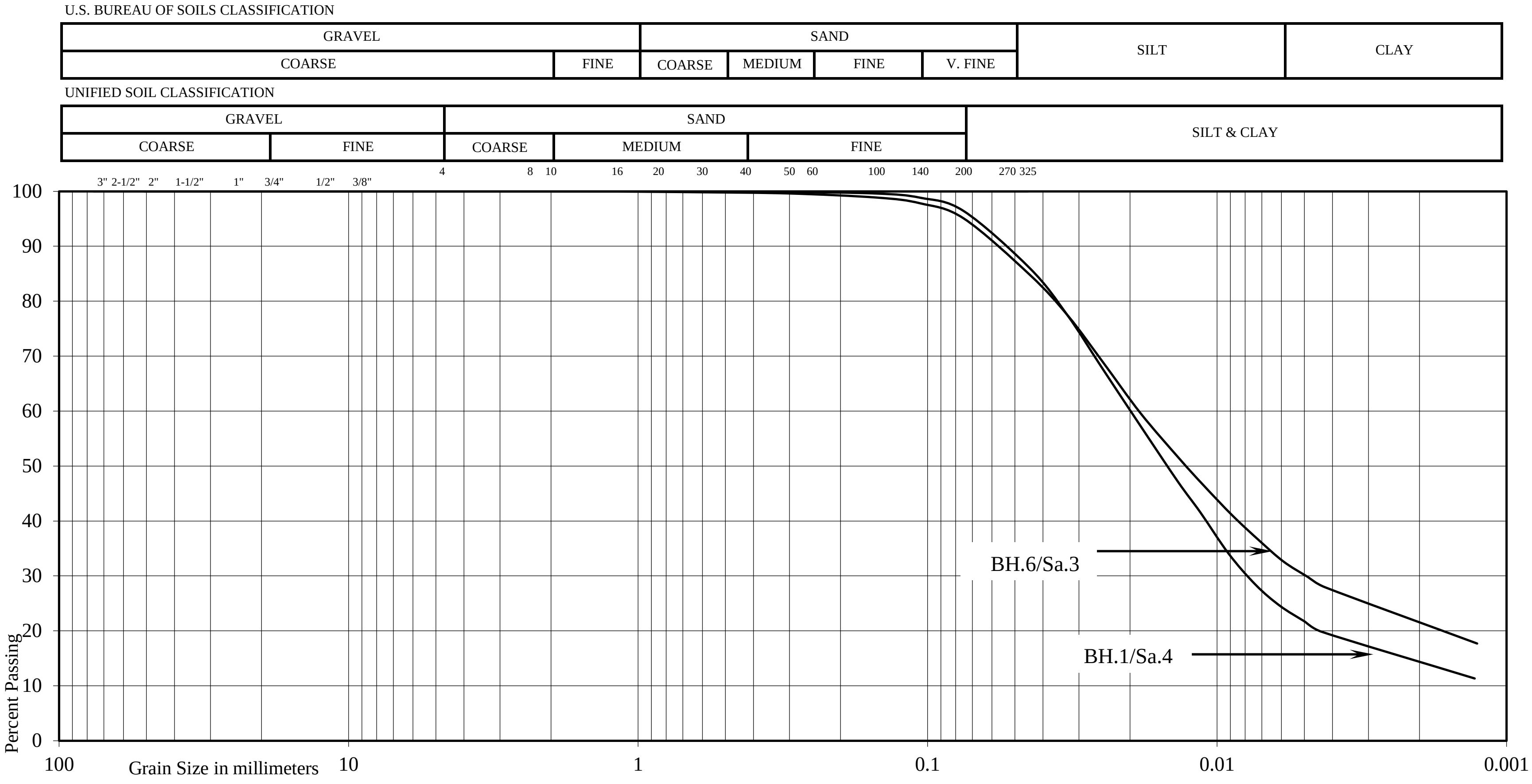
GRAIN SIZE DISTRIBUTION

Reference No: 1411-S001



Project: Proposed Residential Development

Location: Grand Tamarack Crescent, East of Highway 11

Township of Severn (Cumberland Beach)

Borehole No: 1 6

Sample No: 4 3

Depth (m): 2.5 1.8

Elevation (m): 218.9 218.3

BH./Sa.	1/4	6/3
Liquid Limit (%) =	24	29
Plastic Limit (%) =	15	16
Plasticity Index (%) =	9	13
Moisture Content (%) =	27	32
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY

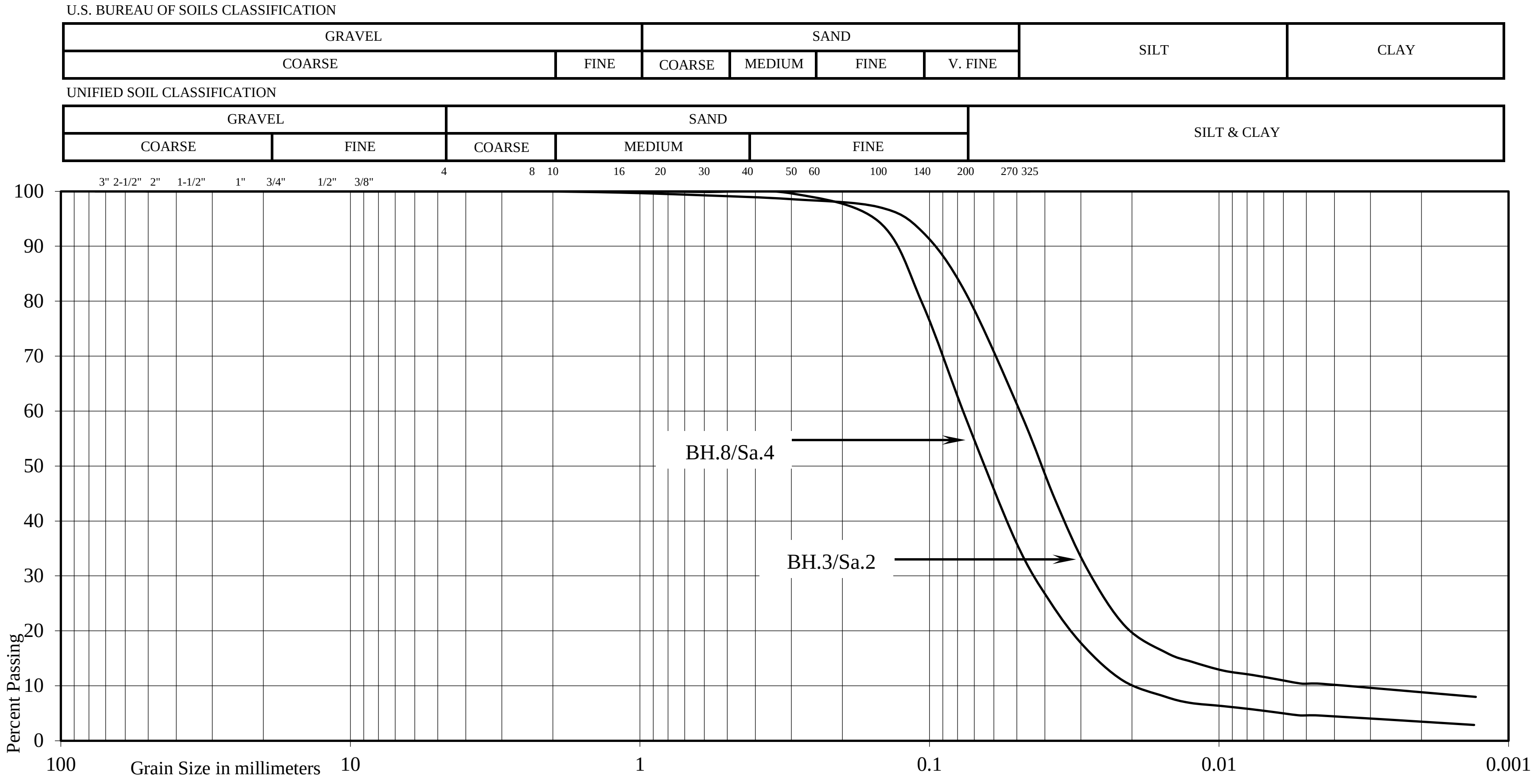
a tr. of sand

Figure: 9

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1411-S001



Project: Proposed Residential Development

Location: Grand Tamarack Crescent, East of Highway 11
Township of Severn (Cumberland Beach)

Borehole No:	3	8
Sample No:	2	4
Depth (m):	1.8	2.5
Elevation (m):	218.4	217.9

BH./Sa.	3/2	8/4
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	29	23
Estimated Permeability (cm./sec.) =	10^{-5}	10^{-4}

Classification of Sample [& Group Symbol]: SANDY SILT
some sand; a tr. to some clay

Figure: 10

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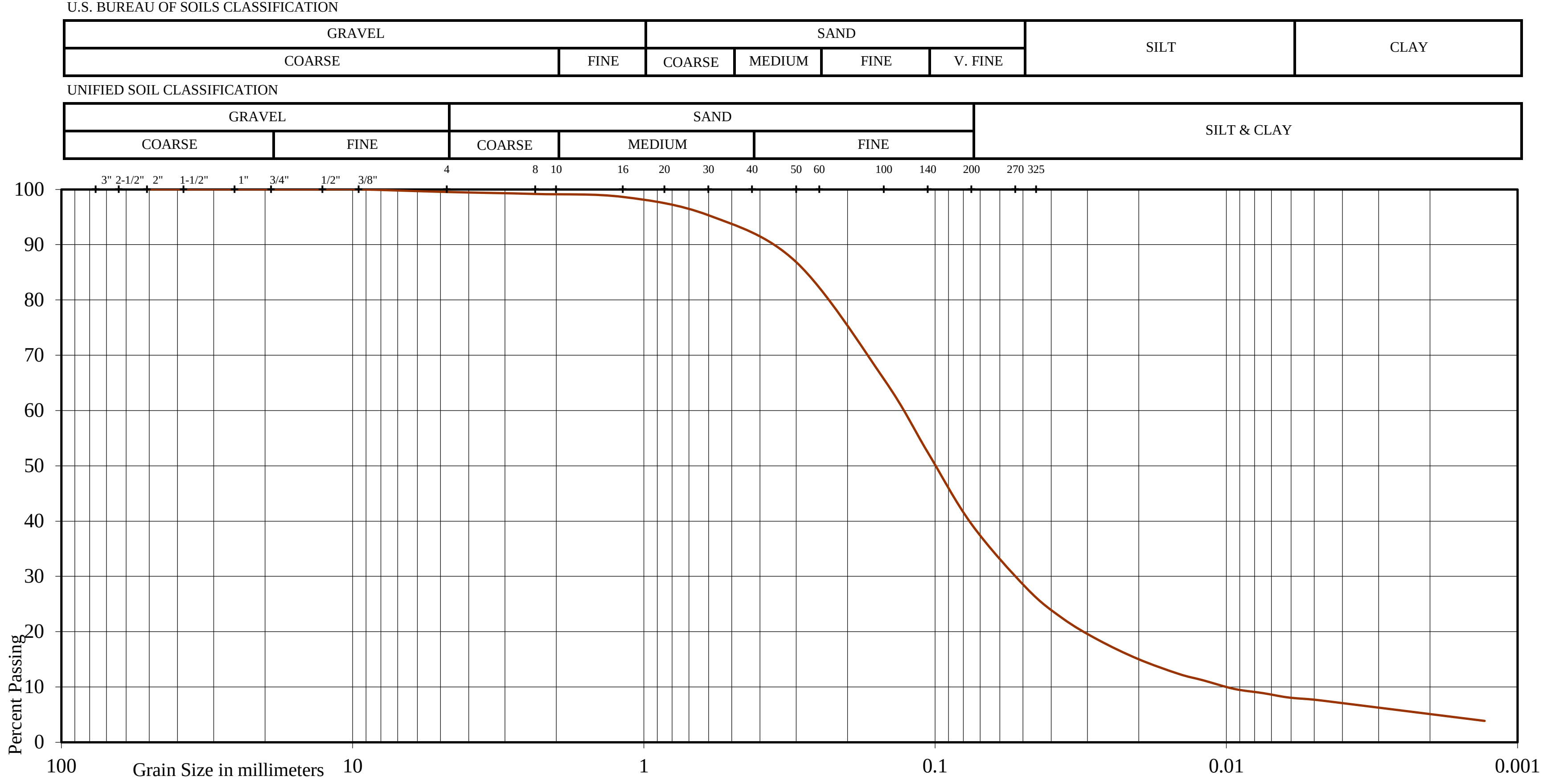
GRAIN SIZE DISTRIBUTION

Reference No: 1411-S001



Project: Proposed Residential Development

Location: Grand Tamarack Crescent, East of Highway 11

Township of Severn (Cumberland Beach)

Borehole No: 7

Sample No: 5

Depth (m): 3.3

Elevation (m): 271.1

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 21

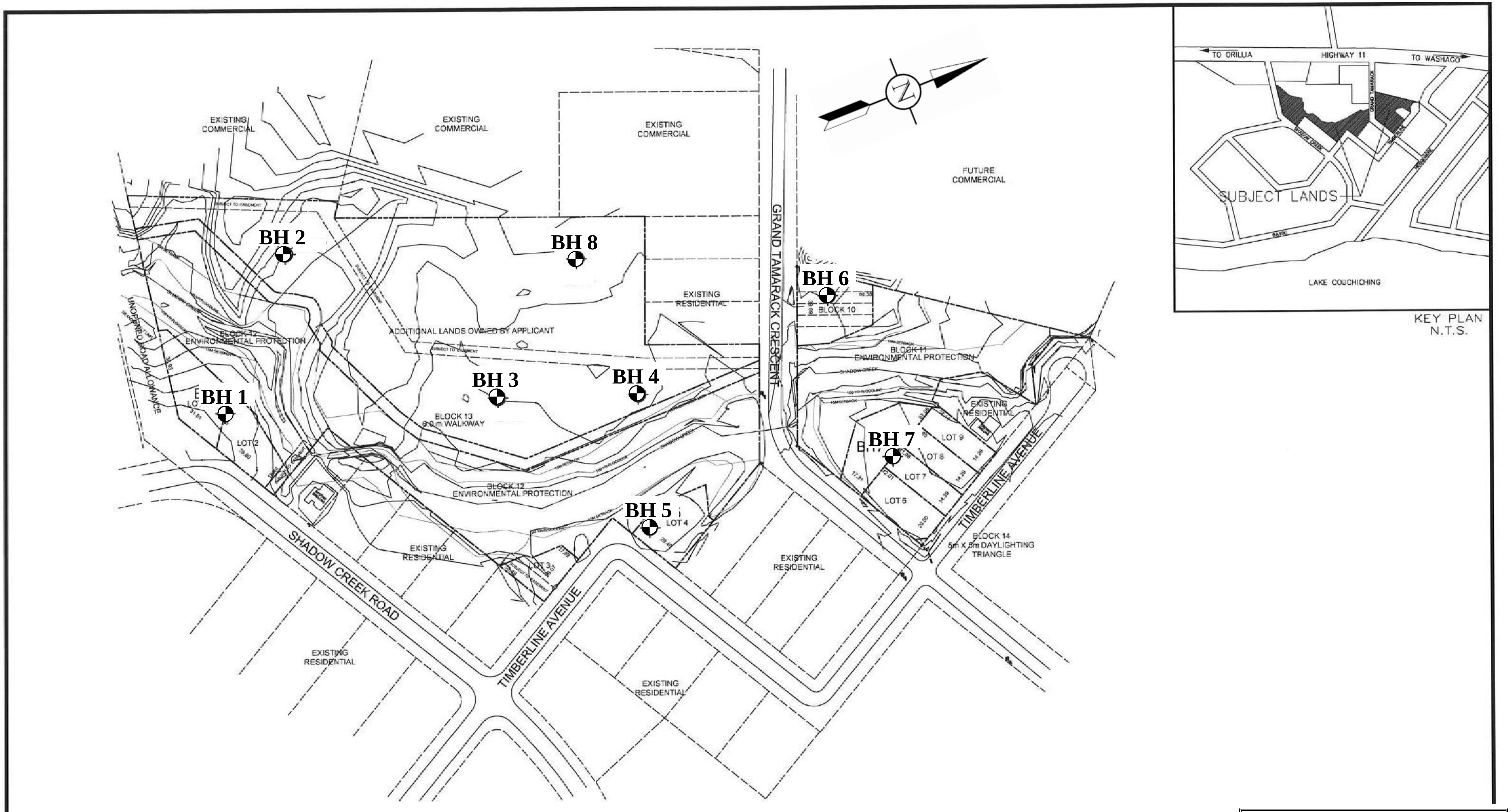
Estimated Permeability

(cm./sec.) = 10^{-4}

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

trs. of clay and medium sand

Figure: 11



CONTRACT DRAWINGS

CONTRACTOR MUST VERIFY ALL DIMENSIONS AND BE RESPONSIBLE FOR SAME. ANY DISCREPANCIES MUST BE REPORTED TO THE ENGINEER BEFORE COMMENCING WORK. DRAWINGS ARE NOT TO BE SCALED.

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C.C.Tatham & Associates Ltd.
Consulting Engineers
Collingwood Bracebridge Orillia Barrie

BAYOU DEVE
TOWNSHIP
PROPOSED BOREHC
SCALE: 1:2000

BOREHOLE LOCATION PLAN

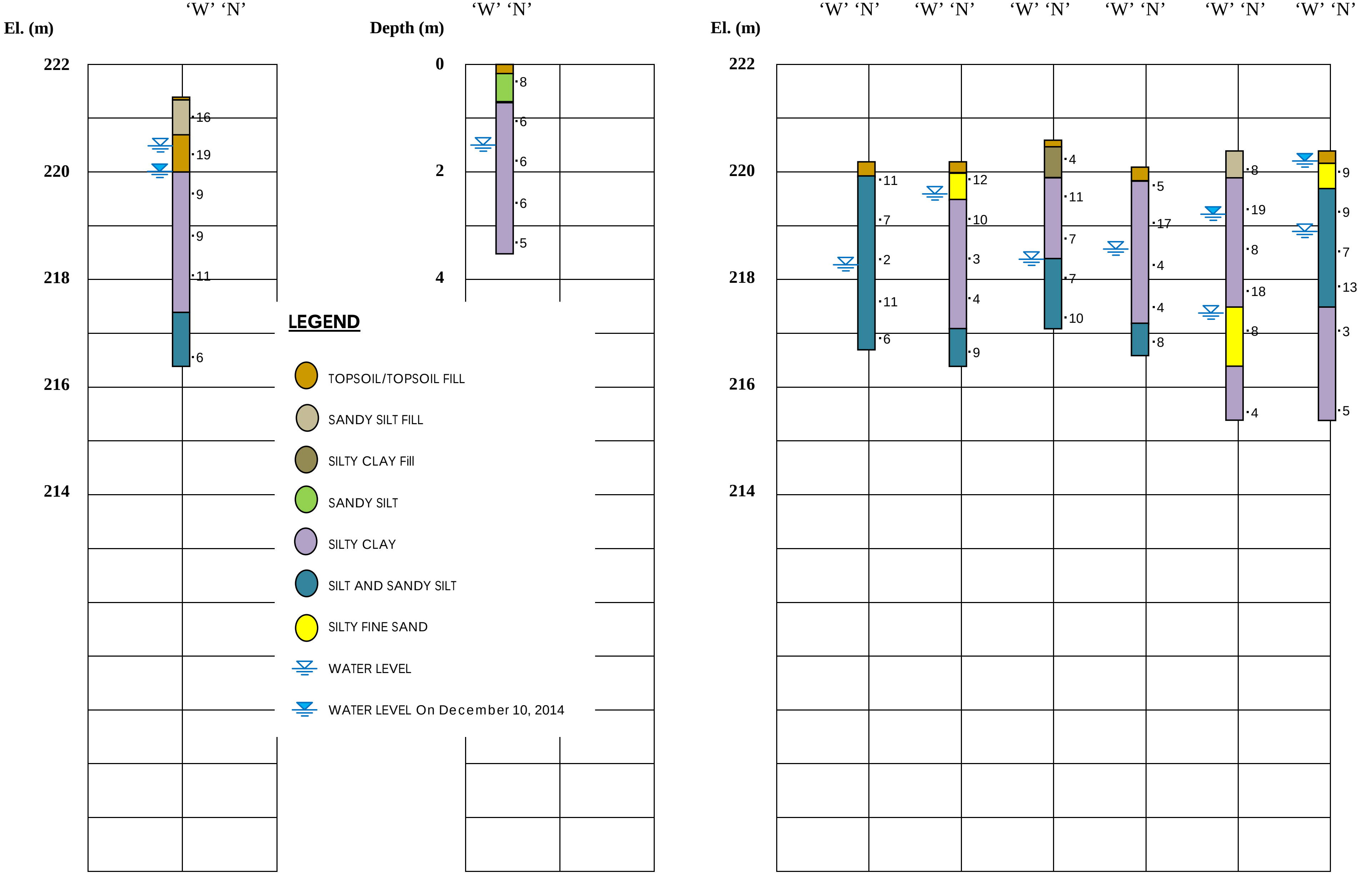
Reference No.:	1411-S001
Date:	February 2015
Drawing No.:	1
Scale:	1:2000

SOIL ENGINEERS LTD.

BH. No.	1
Topsoil/Topsoil Fill (cm)	5
Elevation (m)	221.4

BH. No.	2
Topsoil (cm)	18
Elevation (m)	-

BH. No.	3	4	5	6	7	8
Topsoil/Topsoil Fill (cm)	28	20	13	25	-	23
Elevation (m)	220.2	220.2	220.6	220.1	220.4	220.4



SOIL ENGINEERS LTD.

SUBSURFACE PROFILE

Scale: Horiz.: N.T.S.

Vert.: 1:100

Ref. No.: 1411-S001

Drawing No. 2