

**FOUNDATION INVESTIGATION REPORT  
PROPOSED HIGHWAY 17  
TRUNK ACCESS ROAD BRIDGES  
OVER THE BLACK CREEK  
SAULT STE. MARIE, ONTARIO  
G.W.P. 406-01-00  
GEOCRES NO. 41K-66**

**Prepared For:**

**McCORMICK RANKIN CORPORATION**

**Prepared by:**

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**Project: SPT1139  
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### **DRAWING**

### **DRAWING No.**

**BOREHOLE LOCATION PLAN & SOIL STRATA**

**1**

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## **1. INTRODUCTION**

The realignment of the existing Highway 17 between Black Road in Sault Ste. Marie and Bar River Road to the south-east of the City involves the construction of a Link Road (Trunk Road Access) which will connect the existing Highway 17 (Trunk Road) and Highway 17 (New). The new Link Road will cross Black Creek at about mid-point between Trunk Road and Highway 17 (New). Shaheen & Peaker Limited (S&P) was retained by McCormick Rankin Corporation (MRC) to conduct a foundation investigation for the proposed twin bridges at the Black Creek crossing.

In the Spring of 2003, a geotechnical foundation investigation was carried out by S&P for the proposed twin bridges at the existing Black Creek crossing location (refer to Project No. SPT1074, Geocres No. 41K-60, report dated September 3, 2003). Subsequently, these PDR structure locations were revised by the detail design team arising from the fact that the existing creek channel along the proposed alignment was relocated by some 70 m to the north. As a result of this relocation, S&P was retained to conduct a supplementary investigation consisting of three boreholes at the new proposed structure locations.

The site is located near the eastern limits of the City of Sault Ste. Marie, about 0.5 km north of Trunk Road.

This report presents the findings of the investigation.

## **2. SITE DESCRIPTION AND GEOLOGY**

The site is located near the eastern limits of the City of Sault Ste. Marie. The City of Sault Ste. Marie is located on the north shore of the St. Marys River which drains Lake Superior into Lake Huron, at St. Marys Rapids. The presence of these rapids is due to a ridge of Cambrian sandstone extending across the river. The area of the City itself and the lands immediately to the north, east, and west consist predominantly of a terraced clay lowland, which is bordered by a prominent belt of beach sand abutting on the Pre-Cambrian shield to the north and by the St. Marys River to the south. The prevalent hills of the topography of the City is typical of clay or till plains, levelled by the wave action of ancient lakes consisting of flats, beach scarps, and sharply-cut erosion channels. The sand belt increases in width towards the east, being more than 2.5 km wide at Peoples Road. The

northern part of the City is underlain by Archean intrusive-gneissic granitoid rocks, forming a rolling upland with thin drift.

The Physiography of the City is determined by the structure and topography of the bedrock and by variations in the character and thickness of the overlying Quaternary sediments. The ground slopes generally from north to south, but there is also a west to east gradient following the St. Marys River between Lake Superior and Lake Huron.

The soils of the Sault Ste. Marie region can be considered in three categories. The first two are of Pleistocene origin, i.e. well-compacted glacial tills; and lacustrine clays and poorly-compacted sands, silts and gravels. The third includes recent deposits such as peat, alluvium or river flood plains, and man-made fill.

The natural groundwater table varies considerably depending on location, but is often relatively shallow, particularly downtown and in other locations close to the St. Marys River.

Available information indicates that the surficial overburden at the site can be expected to consist of lacustrine sand deposits. The thickness of the overburden to the surface of the bedrock can be expected to be in excess of 60 metres. The bedrock probably consists of Cambrian Jacobsville Formation which is known to be mainly sandstone while the site is believed to be located close to the interface of this formation with Precambrian rocks which consist of mainly gneiss formations.

Black Creek meanders through the site, flowing from west to east into the Root River. The south bank of the creek at the original proposed bridges location site (i.e. some 70 m south of proposed location) is about 4 to 5 m above the creek level elevation of  $181.5 \pm m$  and stands at slopes of about 1.5H:1V. From the creek location, the grade slowly rises southerly to about El. 189 m towards the CPR tracks and Trunk Road, some  $\frac{1}{2}$  km away. On the other side, the north bank stands at steeper slopes (i.e. generally 1:1 or steeper) but only about 0.5 to 1 m high above the creek level (i.e. bank top elevation of about  $182$  to  $182.5 \pm m$ ). Further to the north, the grade rises very gradually to about El. 184 m within a distance of some 30 m.

About 50 m to the east of the proposed centerline of the bridges, a dirt logging road provides access to the creek.

### **3. INVESTIGATION PROCEDURES**

The fieldwork for the proposed twin bridges was performed during the period of January 4 through January 13, 2005 and as agreed to by MTO, it consisted of drilling and sampling two deep boreholes (Boreholes 101 and 102) and one relatively shallow borehole (Borehole 103), as well as performing Dynamic Cone Penetration Tests (DCPT). The plan location of the boreholes is shown on Drawing No. 1.



Walker Drilling Limited of Utopia, Ontario, drilling contractor, carried out the drilling, testing and sampling work under the direction and supervision of a Geotechnical Engineer from S&P. The boreholes were advanced using a track-mounted drilling rig, outfitted with tools and equipment for soil sampling and testing. Drilling started using hollow-stem augers. But in the deeper boreholes wash-boring method was used to advance the boreholes below a depth of 30 m. Considerable amounts of drilling mud were utilized to counter-balance the hydrostatic uplift due to water table; as well, the sampler and the rods were withdrawn slowly to reduce suction below the groundwater table. In spite of this, some inevitable disturbance may have occurred and may have affected the recorded N-values in the fine-grained cohesionless soils below a depth of about 6 m.

Samples in the boreholes were taken at frequent intervals of depth by the Standard Penetration Test method (SPT), in general accordance with ASTM D1586. The test consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm O.D. split barrel (SS – split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the N-value of the soil which is indicative of the compactness condition of granular (or cohesionless) soils (gravels, sands and silts) or the consistency of cohesive soils (clays and clayey soils).

Boreholes 101 and 102 were extended to depths of 49.2 m and 55.3 m, respectively. Borehole 103 was extended to a depth of 12.7 m below the ground surface. In addition, Dynamic Cone Penetration tests were performed from the bottom of all three boreholes, extending to depths of 58.1 m, 61.7 m and 30.3 m in Boreholes 101, 102 and 103, respectively. Adjacent to Boreholes 101 and 102, dynamic cone penetration tests (see Records of Boreholes 101A and 102A) were performed after augering to a depth of 1.5 m. The tests were extended from 1.5 to 10.5 m. After this, the holes were extended to 24.4 m by solid-stem augering and dynamic cone penetration tests were performed below this depth to 47.9 m and 50.1 m, respectively.

In Dynamic Cone Penetration Test (DCPT), a 51 mm diameter, 60 deg. apex cone point, screw-attached to the tip of A-size rods, is driven into the ground using the same driving energy as in the SPT method. By recording the number of blows to drive the cone/rod assembly into the soil every 0.3 m, a qualitative record of relative density/consistency is obtained. Although the interpretation of the test results is difficult because no samples are obtained by the DCPT method and the penetration resistances are not necessarily equal to the N-values, useful information is gained by the continuity of the results and by the elimination of unbalanced hydrostatic effects which in many cases affect the SPT values, especially in the fine-grained granular soils. The DCPT was generally terminated when the number of blows to drive the cone/rod assembly 0.3 m exceeded 100 several times.

In cohesive (clayey) deposits, where the consistency of the soil permitted, relatively undisturbed samples (TW) were taken with 70 mm diameter thin-walled (Shelby) tubes

which were pushed into the bottom of the borehole by the application of static weight by hydraulic pressure. The undrained shear strength of the soil was also measured in-situ by Field Vane tests. Where consistency permitted, MTO Field Vane was used to conduct the tests but when the soil became stiffer this was changed to small Field Vane.

Groundwater conditions in the boreholes were observed during drilling in the open boreholes, prior to introducing drilling mud. A piezometer was installed in Borehole 101, upon its completion, to enable us to monitor the groundwater level in the borehole over a prolonged period of time, without interference from surface water. Upon their completion, the boreholes were grouted using a cement/bentonite mixture as per MTO procedures. The piezometer in Borehole 101 was also decommissioned using a cement/bentonite mixture.

The soil profile and groundwater levels encountered in the boreholes, type of samples and sampling depths, N-values and Field Vane test results are presented on the Record of Borehole Sheets, in Appendix A of this report. The Record of Borehole F is also included as this borehole is located close to the proposed EBL Bridge location. The Record of Borehole Sheets from the previous investigation (i.e. Boreholes A through G are presented in Appendix B, along with Borehole 95-1, drilled by others at the site in 1995. The subsurface profiles prepared for the previous bridges site is also presented in Appendix B.

The borehole locations had been established in the field by surveyors (retained by MRC) prior to our field crew's arrival at the site, who also provided us with Geodetic ground surface elevations at the borehole locations.

A laboratory testing programme, consisting of natural moisture content measurements, Atterberg (liquid and plastic) Limits, grain-size analyses, one-dimensional consolidation (oedometer) and quick triaxial compression (undrained triaxial) and bulk unit weight tests, was performed on selected soil samples. The results of laboratory tests are presented on the appropriate Record of Borehole Sheets and also in Appendix C.

#### **4. SUBSURFACE CONDITIONS**

Underlying an approximately 0.15 to 0.2 m thick topsoil layer, Boreholes 101, 102 and 103 contacted a surficial silty clay to silt layer to a depth of about 1.3 m below the ground surface, which is underlain by a somewhat organic silt to clayey silt with peat and decomposed wood zones. This organic to semi-organic soil extends to a depth of about 3.2 m or to El. 181.2 m. In Borehole F, below a 0.35 m thick topsoil layer, silty fine sand with silt zones was contacted with organic inclusions to 1.0 m depth. Below these surficial soils, in general, all four boreholes contacted a sandy silt to silty fine sand deposit which extended to depths ranging between 7.5 and 10.0 m or El. 176.4 and 174.3 m.

Below this basically fine-grained granular soil deposit, the boreholes contacted an extensive clay deposit which extends to depths/elevations of 41.5 m/142.7 m and 41.0 m/143.5 m in

Boreholes 101 and 102, respectively. To a depth of about 16.0 m or to about El. 168 m, the clay is interlayered with sandy silt to silty fine sand layers or lenses.

At about 41.0 to 41.5 m (or about El. 143 m) underlying the clay deposit, Boreholes 101 and 102 (i.e. deep boreholes) contacted a lower sandy silt to silty fine sand sheet. Borehole 101 was terminated within this deposit at El. 135.0 m, after penetrating it by 7.7 m, while in Borehole 102, it was found to be underlain by clay at 54.0 m depth or El. 130.5 m.

Details of the subsurface conditions in Boreholes 101, 102, 103 and F are presented on the Record of Borehole Sheets in Appendix A, while an inferred stratigraphic profile is given in Drawing No. 1. The various soil strata encountered in the boreholes and their geotechnical properties are briefly described in the following subsections of this report.

Record of Borehole Sheets from our previous investigation at the location of the previously planned bridges location, some 70 m south of the present site, along with inferred stratigraphic profiles prepared for this previous investigation are given in Appendix B.

#### 4.1 TOPSOIL

Boreholes contacted a layer of topsoil layer which ranges in thickness from 0.15 to 0.35 m. It should be pointed out that the thickness of organic rich soils could be variable in between and beyond borehole locations.

#### 4.2 SURFICIAL SILTY CLAY WITH SILT AND CLAYEY SILT LAYERS

Below the topsoil, Boreholes 101, 102 and 103 contacted a surficial silty clay deposit with silt and clayey silt layers. This cohesive deposit was found to extend to 1.1 m (Borehole 101) to 1.3 m (Boreholes 102 and 103) or to El. 183.2 m to 183.0 m.

An Atterberg Limits test performed on a sample from this deposit yielded the following index values (also see Figure C-1 in Appendix C).

Liquid Limit:	32%
Plastic Limit:	16%
Plasticity Index:	16%

Natural moisture contents of samples recovered from the deposit ranged from 24 to 49%.

N-values recorded in this deposit range from 5 to 8 blows/0.3 m. Based on this, the consistency of this deposit can be described as being generally firm.

This deposit was not encountered in the previously drilled boreholes near the existing creek location, including Borehole F.

#### 4.3 ORGANIC SILT

At depths ranging from 1.1 m to 1.3 m below the ground surface Boreholes 101, 102 and 103 contacted an approximately 2.0 m thick silt to clayey silt layer, with a variable organic content which ranges from somewhat organic to highly organic. The presence of peat seams, decayed or charred wood remains was also noted. This indicates that possibly this was the former bed of the meandering Black Creek. As well, pre-historic fires may have occurred (i.e. charred wood remains). The colour of this cohesive soil ranges from brown/grey to darkish grey to black. Atterberg Limits tests performed on two samples from the deposit showed anon-plastic soil (i.e. non-cohesive).

The measured natural moisture contents range from 29 to 450%, indicating a wide range, together with our visual examination of the soil samples, these results are indicative of the highly variable nature of this deposit ranging from slightly organic to highly organic, as well as variable nature of composition from silt and clay-size particles to decomposed wood. Standard Penetration tests performed in the deposit yielded N-values which typically range from 1 to 3 blows/0.3 m. Based on these field and laboratory test results along with tactile and visual examinations of the soil samples, this deposit is considered of soft to very soft consistency with a highly compressible structure.

This deposit was encountered neither in Borehole F nor in the other boreholes put down during our previous investigation, but in Borehole F, the upper 1 m of the soil contained some organics.

#### 4.4 SAND SILTY TO SILTY FINE SAND

Underlying the topsoil in Borehole F at 0.35 m depth and the organic deposits (described in the preceding section of the report) in Borehole 101, 102 and 103, at depths between 3.0 and 3.2 m, the boreholes contacted a fine-grained granular soil deposit consisting of sandy silt to silty fine sand. The presence of occasional silt and very thin clay seams was also noted within this deposit. This unit was found to extend to depths of 7.5 m (Borehole F) to 10.0 m (Borehole 103) below the ground surface or to elevations ranging between 176.4 m (Borehole 101) and 174.3 m (Borehole 103). In the previously drilled boreholes to the south of the site, the deposit was found to extend to depths ranging 6.7 and 11.3 m below the ground surface or to elevations between 175.8 to 174.1 m. It should also be pointed out that, similar to the previous site, the underlying clay deposit was found to be interlayered with these fine-grained granular soils to a depth of about 16 m or to about Elevation 168 m.

The grain-size distribution of selected samples from the deposit is presented in Figure C-2 in Appendix C. These results indicate a predominantly fine-grained granular soil primarily in the silt to fine to very fine sand range with traces of clay-size particles. The following grain-size distribution is indicated.

Gravel:	0%
Sand	39 – 49%
Silt:	43 – 53%
Clay:	8%

Based on these results together with a visual and tactile examination of the soil samples, it is concluded that the grain-size distribution of the deposit at this site is somewhat finer than the grain-size distribution of the deposit encountered at the previous site. The grain-size distribution of samples from the previous investigation is given in Appendix D.

Standard Penetration tests yielded N-values ranging from 2 to 16 blows/0.3 m, but as shown in Figure E-1 (Appendix E) the majority of the N-values range from 2 to 6, indicating a generally very loose to loose soil. Dynamic Cone Penetration Tests (DCPT) performed adjacent to Boreholes 101 and 102 (see Record of Boreholes 101A and 102A) indicate the likely presence of an approximately 0.6 to 1.0 m thick compact to dense zone immediately above the underlying clay deposit, similar to the previous site. Variation of N-values with elevation from the previous site is given in Figure E-2, Appendix E.

#### 4.5 CLAY

At depths ranging from 7.5 m (Borehole F) and 10.0 m (Borehole 103) or below El. 176.4 to 174.3 m, all four boreholes contacted a clay deposit. In the deep boreholes (i.e. Boreholes 101 and 102) this cohesive deposit was found to extend to a depth of about 41.0 to 41.5 m or to El. 143.5 and 142.7 m in Boreholes 102 and 101, respectively. The shallow boreholes (i.e. Boreholes F and 103) were terminated after penetrating a short distance into this clay deposit.

As was mentioned before, the upper zones of the clay contains frequent sandy silt to silty fine sand interlayers or lenses, with recorded thicknesses ranging from about 1 to 2 m. These layers/lenses were found to extend to a depth of 16.0 m or to El. 168.2 to 168.5 m. The presence of such layers/lenses was also noted in the previous investigation. The grain-size of a sample recovered from Borehole 101 from a depth of about 9.5 m is given in Figure C-3.

The clay consists of irregular layers of highly plastic clay (CH and CI) with silty clay (CL) and thin clayey silt (CL-ML) and occasional very thin silt, sandy silt and silty very fine sand seams or lenses. The colour of the deposit is generally reddish grey with occasional grey zones changing to grey with some reddish zones below a depth of about 35 to 36 m.

The grain-size distribution of samples from this deposit is given in Figure C-4 in Appendix C. These indicate the following grain-size distribution.

Gravel:	0%
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Sand	1 – 4%
Silt:	7 -32%
Clay:	67-89%

As can be noted, the deposit has a high percentage of clay-size particles and therefore its mass permeability can be expected to be low.

Grain-size distribution of samples from the previous investigation is given in Appendix D.

Atterberg Limits tests performed in the laboratory gave the following index values, as shown in Figure C-5 in Appendix C.

Liquid Limit:	25 – 76%
Plastic Limit:	14 – 22%
Plasticity Index:	11 – 55%

These values are generally typical of clays of high to medium plasticity (i.e. CH to CI) with some in the low plasticity range (CL).

The measured natural moisture contents which typically range from 30 to 70% are closer to the measured liquid limits rather than the plastic limits with Liquidity Index values of generally between 0.8 and 1.4.

Standard Penetration tests conducted in this clay deposit gave N-values which range from 1 to 10 blows/0.3 m. Undrained shear strengths as measured by Field Vane tests range from 22 to in excess of 200 kPa. Two unconsolidated-undrained triaxial compression tests performed in the laboratory yielded undrained shear strengths of 40 and 62 kPa. As shown in Figure E-2 of Appendix E, the lower shear strength values were generally recorded in the upper zones of the clay, immediately below the upper sandy silt to silty fine sand deposit. Figure E-2 indicates the following generalization:

Elevation	General Range of Measured Undrained Shear Strength
176 – 162 m	40 - 100 kPa
162 – 143 m	115 - 160 kPa

These results are similar but somewhat higher than the shear strengths recorded during the previous investigations.

Figure E-3 of Appendix E shows the variation of measured undrained shear strengths ( $C_u$ ) with elevation in Boreholes 101 and 102. On this figure the effective overburden stresses ( $P'_o$ ) for these two boreholes are superimposed. For normally-consolidated clays in Northern Ontario, our experience shows that undrained shear strengths can be represented by a factor of 0.23 (i.e.  $C_u \cong 0.23 P'_o$ ) which is also shown in the same figure. As the

measured shear strengths are in excess of  $0.23 P'_o$ , the deposit is likely to be over-consolidated. This is probably due primarily to a phenomenon known as 'aging' rather than the removal of existing overburden.

Based on the field and laboratory test results, the consistency of this cohesive deposit in the upper zones is described as generally firm to stiff, becoming stiff to generally very stiff in the middle and lower zones.

The measured bulk unit weights of the clay range from  $15.4 \text{ kN/m}^3$  to  $17.2 \text{ kN/m}^3$ , with an average value of about  $16.5 \text{ kN/m}^3$ . The measured values during the previous work adjacent to this site ranged from  $15.4$  to  $18.9 \text{ kN/m}^3$  (average  $16.7 \text{ kN/m}^3$ ).

The consolidation characteristics of the deposit were investigated by means of three one-dimensional consolidation (oedometer) tests performed on Shelby tube samples from Boreholes 101 and 102. The test results are given in Figures C-6, C-7 and C-8 in Appendix C. These indicate probable pre-consolidation pressures of between about 10 and 100 kPa in excess of the existing overburden pressures ( $P'_o$ ). Previously, conducted consolidation tests (see Appendix D) indicated probable pre-consolidation pressures of about between 25 and 120 kPa in excess of the existing overburden pressures ( $P'_o$ ). The consolidation test results also indicate that the soil has a very compressible structure beyond the pre-consolidation pressure range, with  $C_c$  values in the range of 0.3 to 1.3, with an average of 1.0 (average of all seven tests).

#### 4.6 LOWER SANDY SILT TO SILTY FINE SAND

The deep boreholes (Boreholes 101 and 102) contacted at approximate depths of 41.0 to 41.5 m (El. 143.5 to 142.7 m) a sandy silt to silty fine sand deposit, underlying the clay deposit. Borehole 101 was terminated in this fine-grained granular deposit at a depth of 49.2 m (El. 135.0 m) after penetrating it for a distance of 7.7 m, while Borehole 102, which was extended deeper to about 55 m, this deposit was found to be underlain by a lower clay at a depth of 54.0 m (El. 130.5 m), indicating a thickness of about 13.0 m.

This is a layered deposit with interlayers of silty fine sand and sandy silt, with some silt and occasional thin clayey silt and very thin clay seams.

The grain-size distribution of four typical samples from the deposit is shown in Figure C-9 in Appendix C. The results indicate the following grain-size distribution.

Gravel:	0%	
Sand	30 – 47%	(mostly fine to very fine sand)
Silt:	45 – 64%	
Clay:	6 – 11%	

Based on these results, together with a visual examination of the soil samples, the grain-size distribution characteristic of this lower fine-grained granular deposit is considered to be similar to the upper sandy silt to silty fine sand deposit.

N-values recorded in this deposit ranged from 14 to 22 blows/0.3 m, indicating a compact soil. Observations made during the drilling and the piezometer installed in Borehole 101 indicates that the deposit is under excess hydrostatic pressure with a pressure head above the ground surface (i.e. artesian) because of this, some disturbance may have occurred in spite of the fact that heavy drilling mud was used when advancing the boreholes and thus N-values may be somewhat lower than the actual values. Nevertheless, an analysis of the values recorded in the DCPT tests performed in Borehole 101A and 102A indicate that the soil is likely to be compact. It is also noted that the recorded N-values during this investigation are somewhat lower than those recorded in the previous investigation.

#### 4.7 LOWER CLAY

In Borehole 102, which was extended deeper than Borehole 101 and the previously drilled boreholes, the lower sandy silt to silty fine sand deposit is underlain at 54.0 m below the ground surface or at El. 130.5 m by a lower clay deposit. The presence of silty clay some sandy silt, and silty sand interlayering was noted within this cohesive material. The borehole was terminated after penetrating this cohesive deposit by a vertical distance of 1.3 m at a depth of 55.3 m below the ground surface.

Atterberg Limits tests performed on a sample from the deposit yielded the following index values:

Liquid Limit:	41%
Plastic Limit:	16%
Plasticity Index:	25%

As shown on the Plasticity Chart presented in Figure C-10 in Appendix C, these results are characteristic of clays of intermediate plasticity (CI).

Standard Penetration test performed on this deposit yielded an N-value of 12 blows/0.3 m. Based on this value, the consistency of the soil is described as stiff.

#### 4.8 GROUNDWATER CONDITIONS

Groundwater conditions were observed in the open boreholes during the drilling and upon completion of each borehole. However, because wash-boring methods were used in the deep boreholes, water level conditions in these two boreholes may not be useful. In Boreholes F and 103, where no water was used to facilitate advancing of the boreholes, groundwater levels upon completion were recorded at 3.0 m and 6.1 m, respectively. Owing



#### 4.8 GROUNDWATER CONDITIONS

Groundwater conditions were observed in the open boreholes during the drilling and upon completion of each borehole. However, because wash-boring methods were used in the deep boreholes, water level conditions in these two boreholes may not be useful. In Boreholes F and 103, where no water was used to facilitate advancing of the boreholes, groundwater levels upon completion were recorded at 3.0 m and 6.1 m, respectively. Owing to the insufficient time for observations, these water limits are believed not to have been stabilized.

In Borehole 102, an artesian condition was noted when the borehole reached a depth of about 46 m or Elevation of about 138.5 m. In Borehole 101, an artesian condition was also encountered while advancing the borehole at about 47 m below the ground surface or at about El. 137.2 m. In this Borehole, a piezometer was installed at the bottom of the borehole at about 49 m depth or El. 135 m and the water level in the piezometer was recorded at 2.4 m above the ground surface (i.e. artesian condition) the day following the installation of the piezometer. From these results, it appears that the lower sandy silt to silty fine sand deposit is under an artesian pressure.

Based on the change of the colour of the soil from brown to grey and the moisture conditions of the soil samples it is our opinion that in the upper zones, the groundwater table at the time of our investigation was about 1.2 m below the ground surface.

In the piezometers installed at the adjacent site, (four piezometers with tip depths ranging from 8 to 17 m or El. 174 to 168 m, the water levels were recorded between 1.1 and 4.4 m or between El. 181.8 and 180.6 m. Subsequently, an artesian condition was reported in Borehole B with water level about 2 m above ground surface. This is believed to be emanating from a 3.0 m thick silty fine sand layer within the clay deposit at a depth of about 12 m or El. 171 m.

The groundwater table would be subject to seasonal fluctuations and in response to major weather events, as well as the water level in the Black Creek.

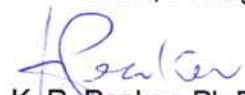
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# Drawing



## Appendix A

# Record of Borehole Sheets (Present Investigation) Geocres No. 41K-66

SPT 1139

# RECORD OF BOREHOLE No 101

1 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 573.9; E 287 024.9 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & Washboring & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/5/2005 to 1/8/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
184.2	Ground Surface													
0.0	0.15 m TOPSOIL SILTY CLAY with silt & clayey silt layers brown/reddish brown, firm to stiff		1	SS	5		184							
183.1			2	SS	9		183							
1.1	ORGANIC SILT with some peat seams/lenses & decayed wood inclusions dark grey to black, very soft	stiff	3	SS	2		182							
			4	SS	1		181							
181.2			5	SS	3		180							
3.0	CLAY reddish brown, soft		6	SS	6		179							
180.9			7	SS	3		178							
3.3	SANDY SILT to SILTY FINE SAND with occasional silt & clayey silt and very thin clay seams reddish grey, very loose to loose, wet		8	SS	2		177							
			9	SS	2		176							
176.4			10	SS	2		175							
7.8	CLAY with silty clay layers reddish grey, firm		11	SS	10		174							
175.4			12	SS	6		173							
8.8	SANDY SILT to SILTY FINE SAND reddish grey, loose, wet		13	SS	2		172							
			14	SS	16		171							
172.7							170							
11.5	CLAY with silty clay layers reddish grey, soft to firm													
170.5														
13.7	SANDY SILT to SILTY FINE SAND some clay layers reddish grey, compact, wet													

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE



SPT 1139

## 2 OF 4

METRIC

(%) STRAIN AT FAILURE

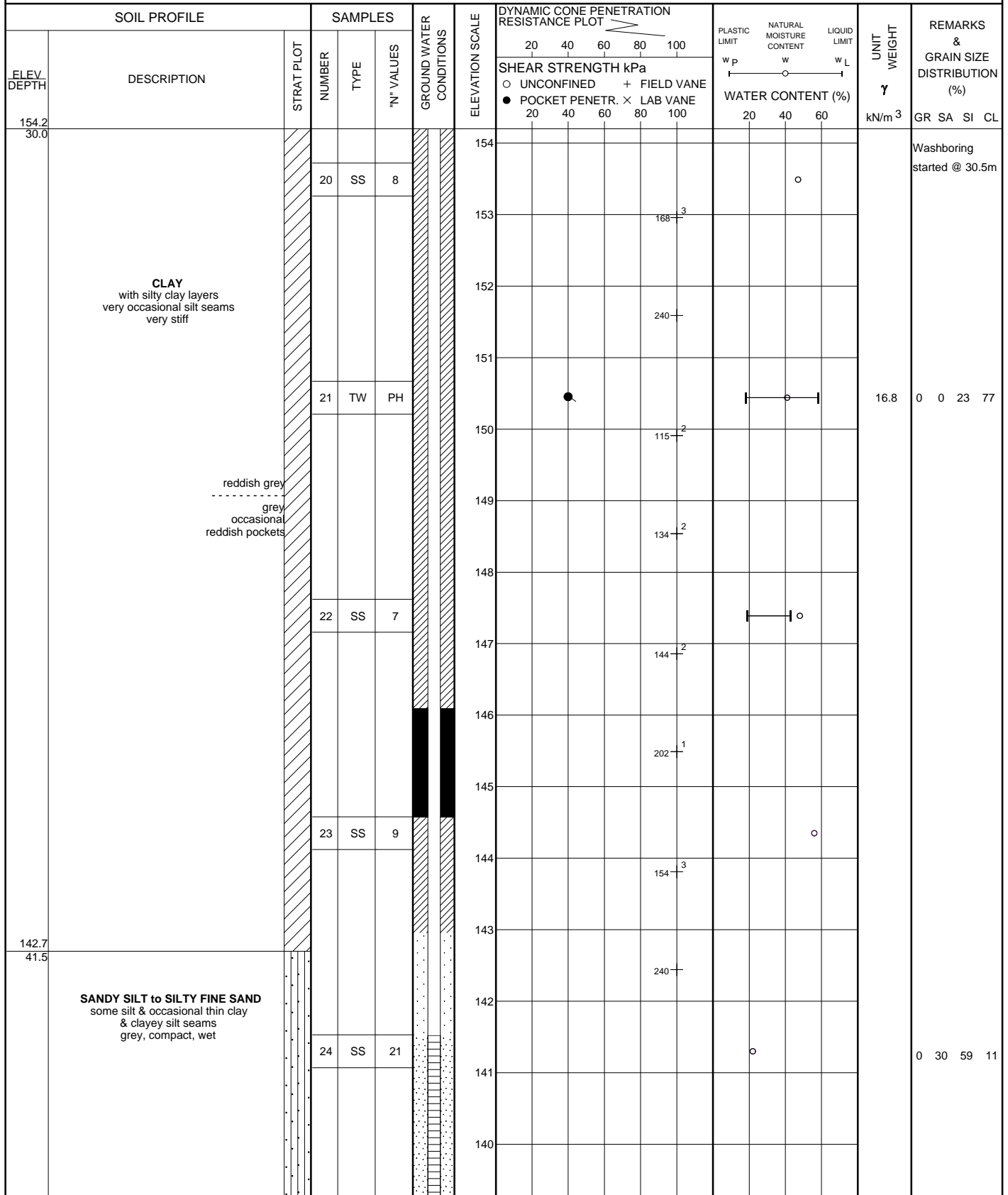
SPT 1139

# RECORD OF BOREHOLE No 101

3 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 573.9; E 287 024.9 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & Washboring & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/5/2005 to 1/8/2005 CHECKED BY Z.O.



Continued Next Page

105+ : Numbers refer to Shear Strength  
 great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
 Sensitivity

20  
 15 10 5  
 (%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 101

4 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 573.9; E 287 024.9 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & Washboring & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/5/2005 to 1/8/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	20 40 60			
139.2 45.0	SANDY SILT to SILTY FINE SAND some silt & occasional very thin clay seams grey, compact, wet		25	SS	16		139							Artesian condition noted @ 47m while drilling
135.0 49.2			26	SS	22		138							
126.1 58.1	End of Borehole.  *Borehole dry (water level not stabilized) and hole open to 5.5 m on completion.  Piezometer installed to 48.8 m. Water level on: Jan. 9, 2005 - + 2.4 m (El. 186.6 m) above ground surface (artesian condition).						137							
	End of D.C.P.T.  Dynamic Cone Penetration Test (D.C.P.T.) performed from 50.3 to 58.1 m						136							
							135							
							134							
							133							
							132							
							131							
							130							
							129							
							128							
							127							

105+ : Numbers refer to Shear Strength  
great than 100 kPa + 3, x 3 : Numbers refer to  
Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE



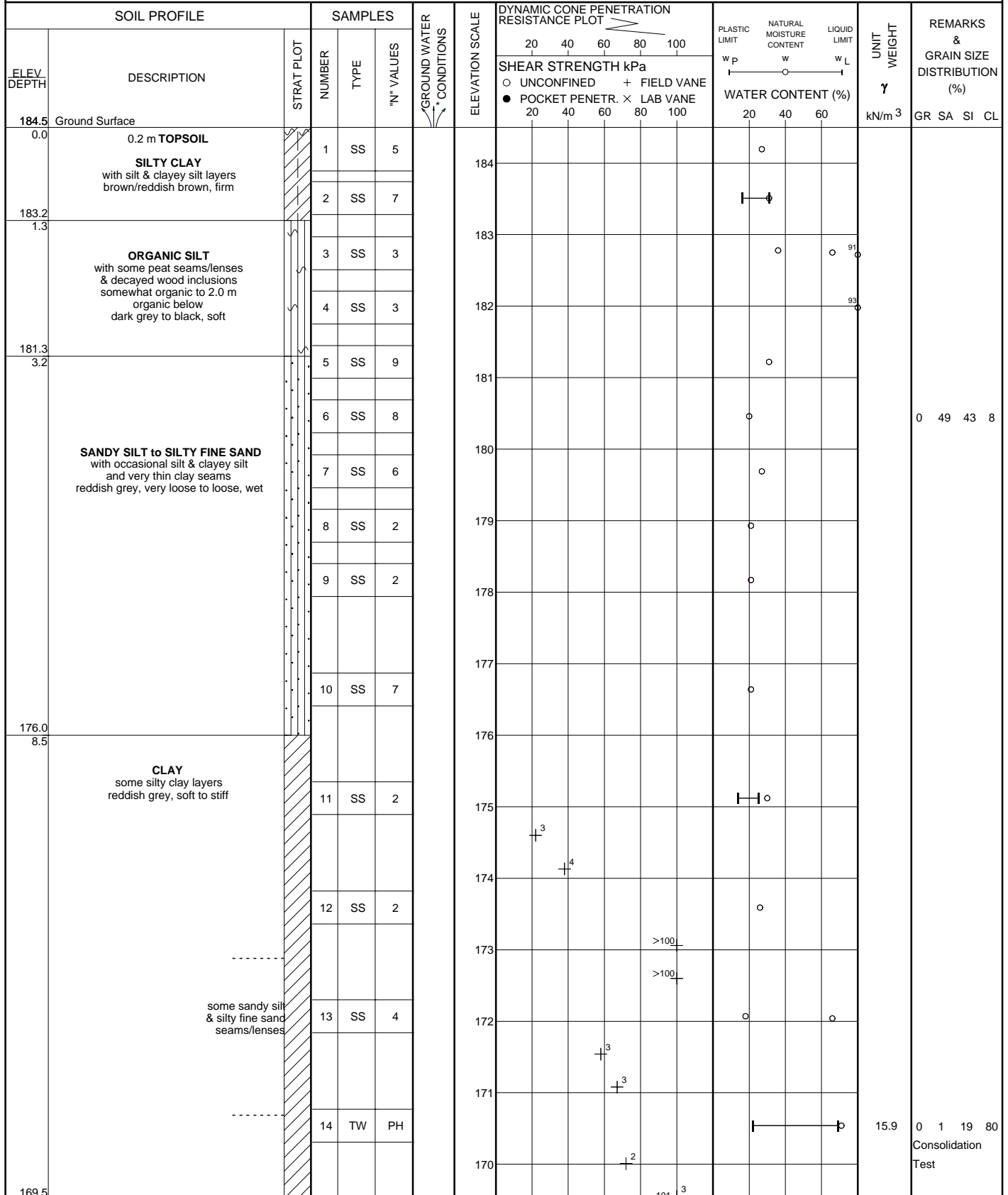
SPT 1139

# RECORD OF BOREHOLE No 102

1 OF 5

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 545.5; E 287 004.3 ORIGINATED BY G.I.  
DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & Washboring & D.C.P.T. COMPILED BY J.Z.  
DATUM Geodetic DATE 1/9/2005 to 1/11/2005 CHECKED BY Z.O.



Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 102

2 OF 5

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 545.5; E 287 004.3 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & Washboring & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/9/2005 to 1/11/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
169.5 15.0	SANDY SILT to SILTY FINE SAND reddish grey, compact, wet		15	SS	12		169							
168.5 16.0							168							
	CLAY with silty clay layers & occasional clayey silt seams reddish grey, stiff to very stiff		16	SS	7		167						16.2	0 4 7 89 Consolidation Test
							166							
							165							
							164							
			17	SS	2		163							
							162							
							161							
			18	TW	PH		160							
							159							
							158							
			19	SS	8		157							
							156							
							155							

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+ 3, × 3 : Numbers refer to  
Sensitivity

20  
15 5  
10  
(%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 102

3 OF 5

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 545.5; E 287 004.3 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & Washboring & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/9/2005 to 1/11/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED ● POCKET PENETR.	+ FIELD VANE × LAB VANE	W <sub>P</sub>	W	W <sub>L</sub>		
154.5 30.0	CLAY some silty clay layers		20	SS	10								Washboring started @ 30.5m	
					21	SS	7							

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT 1139

## METRIC

(%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 102

5 OF 5

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 545.5; E 287 004.3 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & Washboring & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/9/2005 to 1/11/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED    + FIELD VANE ● POCKET PENETR.    × LAB VANE							
124.5 60.0															
							124								
122.8 61.7	End of D.C.P.T.  Dynamic Cone Penetration Test (D.C.P.T.) performed from 55.8 m to 61.7 m.						123								

SPT 1139

# RECORD OF BOREHOLE No 103

1 OF 3

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 592.3; E 287 001.0 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/4/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
184.3	Ground Surface													
0.0	0.2 m <b>TOPSOIL</b>		1	SS	5		184							
	<b>SILTY CLAY</b> with silt & clayey silt layers brown/reddish brown, firm		2	SS	8									
183.0							183							
1.3	<b>ORGANIC SILT</b> with some silt layers and decayed wood inclusions grey/brown to dark grey and black, very soft		3	SS	2									
			4	SS	2		182							
181.3														
3.0	occasional organic seams		5	SS	5		181							
	<b>SANDY SILT to SILTY FINE SAND</b> with silt and occasional thin clayey silt & very thin clay seams reddish grey, loose to very loose, wet		6	SS	5									
			7	SS	2		180							
			8	SS	2		179							
	trace organics		9	SS	6		178							
							177							
			10	SS	2		176							
							175							
			11	SS	6									
174.3							174							
10.0	<b>CLAY</b> some silty clay layers reddish grey, soft to stiff		12	SS	1		173							
							172							
171.6			13	TW	PH									
12.7	End of Borehole.						171							
	*Water level at 6.1 m (not stabilized) and hole open to full depth on completion.						170							

Continued Next Page

105+ : Numbers refer to Shear Strength  
greater than 100 kPa

+ 3, × 3 : Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 103

2 OF 3

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 592.3; E 287 001.0 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/4/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES								
169.3 15.0													
169													
168													
167													
166													
165													
164													
163													
162													
161													
160													
159													
158													
157													
156													
155													

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 5  
10  
(%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 103

3 OF 3

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 592.3; E 287 001.0 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/4/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
154.3														
30.0														
154.0														
30.3	End of D.C.P.T.  Dynamic Cone Penetration Test (D.C.P.T.) performed from 13.7 m to 30.3 m.						154							



SPT 1139

# RECORD OF BOREHOLE No 101A

1 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 571.9; E 287 025.0 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE D.C.P.T. & Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/12/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	20 40 60			
184.2 0.0	Ground Surface													
	Advance by augering from ground surface to 1.5 m. Dynamic Cone Penetration Test (D.C.P.T.) conducted from 1.5 m to 10.5 m. Solid stem augering to 24.4 m. D.C.P.T. conducted from 24.4 m to 47.9 m.						184							
							183							
							182							
							181							
							180							
							179							
							178							
							177							
							176							
							175							
							174							
							173							
							172							
							171							
							170							

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

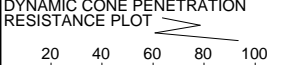
SPT 1139

# RECORD OF BOREHOLE No 101A

2 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 571.9; E 287 025.0 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE D.C.P.T. & Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/12/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE	PLASTIC LIMIT w <sub>p</sub> NATURAL MOISTURE CONTENT w LIQUID LIMIT w <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES							
169.2 15.0							169					
							168					
							167					
							166					
							165					
							164					
							163					
							162					
							161					
							160					
							159					
							158					
							157					
							156					
							155					

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

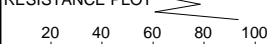
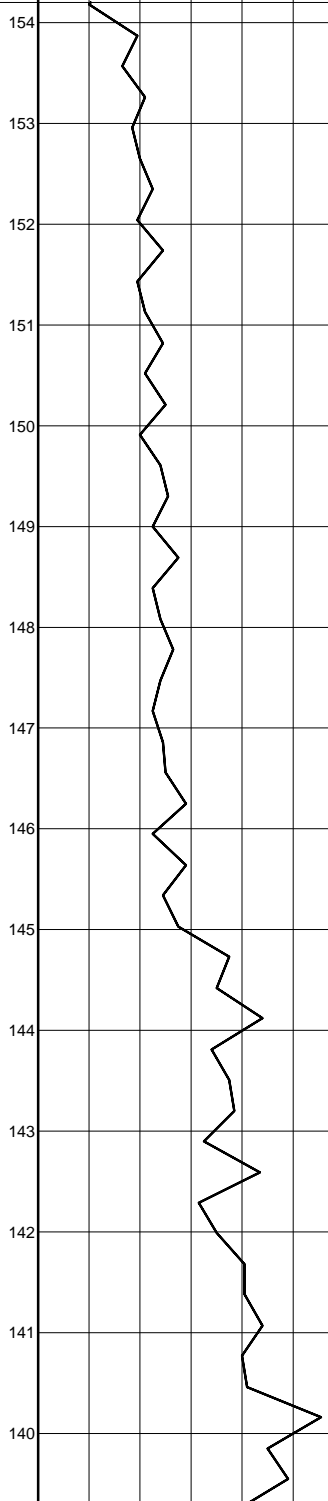
SPT 1139

# RECORD OF BOREHOLE No 101A

3 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 571.9; E 287 025.0 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE D.C.P.T. & Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/12/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE	PLASTIC LIMIT w <sub>p</sub> NATURAL MOISTURE CONTENT w LIQUID LIMIT w <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES						
154.2 30.0											

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 101A

4 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 571.9; E 287 025.0 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE D.C.P.T. & Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/12/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE							
139.2 45.0							139								
							138								
							137								
136.3 47.9	End of D.C.P.T.														
	Dynamic Cone Penetration Test (D.C.P.T.) performed from 1.5 m to 10.5 m.														
	Dynamic Cone Penetration Test (D.C.P.T.) performed from 24.4 m to 47.9 m.														
	*Water level at 5.8 m (not stabilized) and hole open to 5.8 m on completion.														

**METRIC**

(%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 102A

2 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 543.5; E 287 004.4 ORIGINATED BY G.I.  
DIST 62 HWY 17 (New) BOREHOLE TYPE D.C.P.T. & Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 1/13/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT <div> <div>20 40 60 80 100</div> <div> <div>○ UNCONFINED + FIELD VANE</div> <div>● POCKET PENETR. × LAB VANE</div> </div> </div>	<div> <div>PLASTIC LIMIT</div> <div>NATURAL MOISTURE CONTENT</div> <div>LIQUID LIMIT</div> </div>	<div> <div>W P</div> <div>W</div> <div>W L</div> </div>	<div> <div>WATER CONTENT (%)</div> <div>20 40 60</div> </div>	<div> <div>UNIT WEIGHT</div> <div>γ</div> <div>kN/m<sup>3</sup></div> </div>	<div> <div>REMARKS &amp; GRAIN SIZE DISTRIBUTION (%)</div> <div>GR SA SI CL</div> </div>
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES								
169.5 15.0													
169													
168													
167													
166													
165													
164													
163													
162													
161													
160													
159													
158													
157													
156													
155													

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT 1139

# RECORD OF BOREHOLE No 102A

3 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 543.5; E 287 004.4 ORIGINATED BY G.I.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE D.C.P.T. & Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 1/13/2005 CHECKED BY Z.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT <div> <div>20 40 60 80 100</div> <div> <div>○ UNCONFINED + FIELD VANE</div> <div>● POCKET PENETR. × LAB VANE</div> </div> </div>	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
154.5 30.0													

Continued Next Page

105+ : Numbers refer to Shear Strength  
great than 100 kPa

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1139

## 4 OF 4

METRIC

[illegible]

105+ : Numbers refer to Shear Strength  
great than 100 kPa      +<sup>3</sup>, ×<sup>3</sup> : Numbers refer to  
Sensitivity      15-20 : Numbers refer to  
10-15 : Numbers refer to      (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No F

1 OF 2

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 534.0; E 287 026.9 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/5/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	×						
								● QUICK TRIAXIAL	×	LAB VANE						
183.2	Ground Surface						20 40 60 80 100								GR SA SI CL	
0.0	0.35m <b>TOPSOIL</b> organics and topsoil inclusions to 1.0 m		1	SS	12		183									
	<b>SILTY FINE SAND</b> with sand silt zones brown to 1.5m reddish grey 1.5 to 3m, grey below moist to 1.5m, wet below		2	SS	9		182								0 72 (28)	
			3	SS	11		181									
			4	SS	6		180								0 65 27 8	
			5	SS	6		179								sampler wet@3m	
	loose to compact		6	SS	2		178									
	very loose		7	SS	2		177									
	frequent thin clay seams		8	SS	1		176									
			9	SS	5		175									
175.7			10	SS	1		174									
7.5	<b>CLAY</b> some silty clay silt and silty sand seams grey, firm		11	SS	1		173									
			12	SS	3		172									
172.8			13	SS	5		171									
10.4	<b>SILTY FINE SAND</b> reddish grey, very loose wet						170									
							169									
169.7																
13.5	<b>CLAY</b> reddish grey, firm															
168.2																

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

SPT 1074

# RECORD OF BOREHOLE No F

2 OF 2

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 534.0; E 287 026.9 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/5/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	20 40 60			
168.2 15.0														
167.5	CLAY reddish grey, firm		14	SS	2		168							
15.7	End of Borehole.  * Water level on completion: May, 5, 2003 - 3 m (not stabilized)													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

## Appendix B

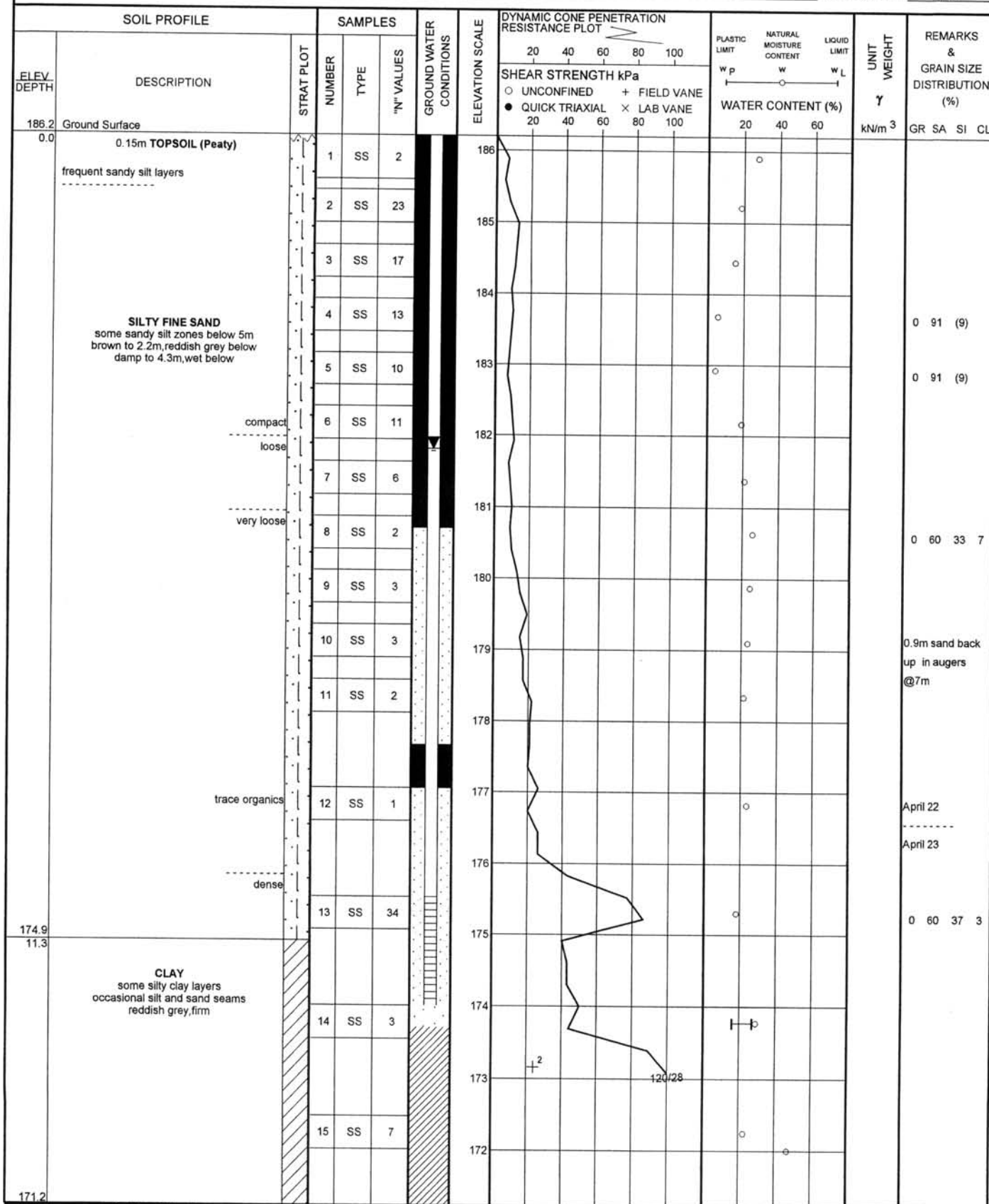
### Record of Borehole Sheets and Subsurface Profile (Previous Investigation) Geocres No. 41K-60

# RECORD OF BOREHOLE No A

1 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 469.6 ; E 287 009.3 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 4/22/2003 to 4/25/2003 CHECKED BY R.M.



Continued Next Page

+ 3, x 3; Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

SPT 1074

## 2 OF 4

METRIC

GWP	406-01-00	LOCATION	Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 469.6 ; E 287 009.3	ORIGINATED BY	Y.L.
DIST	62	HWY	17 (New)	BOREHOLE TYPE	Hollow Stem Augers, Casing & Washboring, D.C.P.T.
DATUM	Geodetic	DATE	4/22/2003 to 4/25/2003	COMPILED BY	J.Z.
				CHECKED BY	R.M.

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Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

SPT 1074

# RECORD OF BOREHOLE No A

3 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 469.6 ; E 287 009.3 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 4/22/2003 to 4/25/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)
156.2 30.0	CLAY some silty clay zones reddish grey, stiff to very stiff		21	SS	11									
			22	SS	11									
			23	SS	14									
			24	SS	27									
			25	SS	16									

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity  
 20  
 15 10 5  
 (%) STRAIN AT FAILURE

SPT 1074

# RECORD OF BOREHOLE No A

4 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 469.6 ; E 287 009.3 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 4/22/2003 to 4/25/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
141.2 45.0	SILTY FINE SAND grey, compact, wet	[ ]	26	SS	31	[ ]	141	[ ]	[ ]	[ ]	[ ]	[ ]	April 24 ----- April 25 0 72 (28)
140.0 46.2													
133.0 53.2	End of Borehole.  Dynamic Cone Penetration Test (D.C.P.T.) performed from 0 to 13.2m and 46.0m to 53.2m						140						
							139						
							138						
							137						
							136						
							135						
							134						
							133						
	End of D.C.P.T.  Piezometer installed to 12.2 m. Water level on: April, 25, 2003 - 4.3 m (El. 181.9 m) June, 3, 2003 - 4.4 m (El. 181.8 m)												

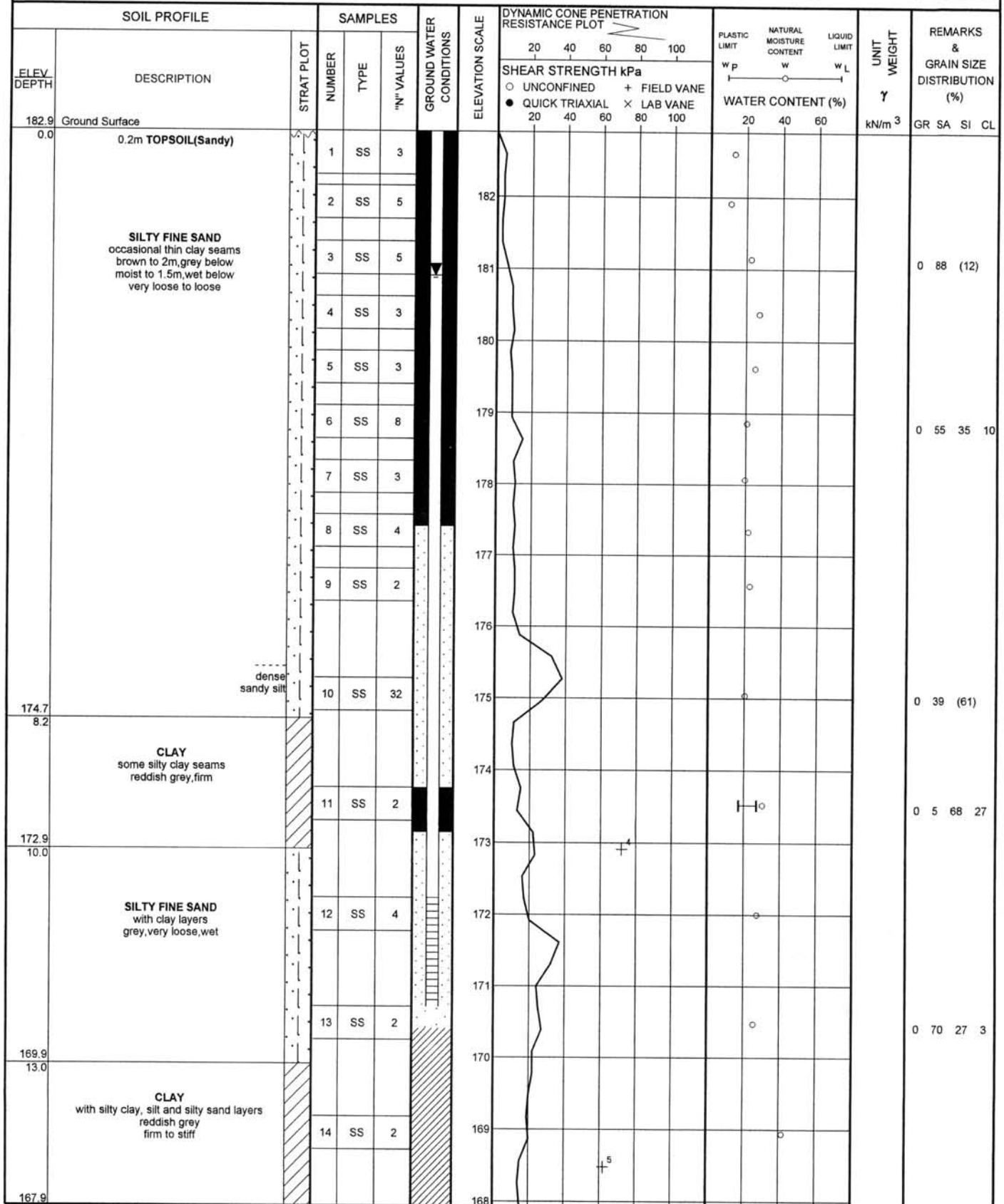
SPT 1074

# RECORD OF BOREHOLE No B

1 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 492.6; E 287 007.7 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/9/2003 to 5/11/2003 CHECKED BY R.M.



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+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



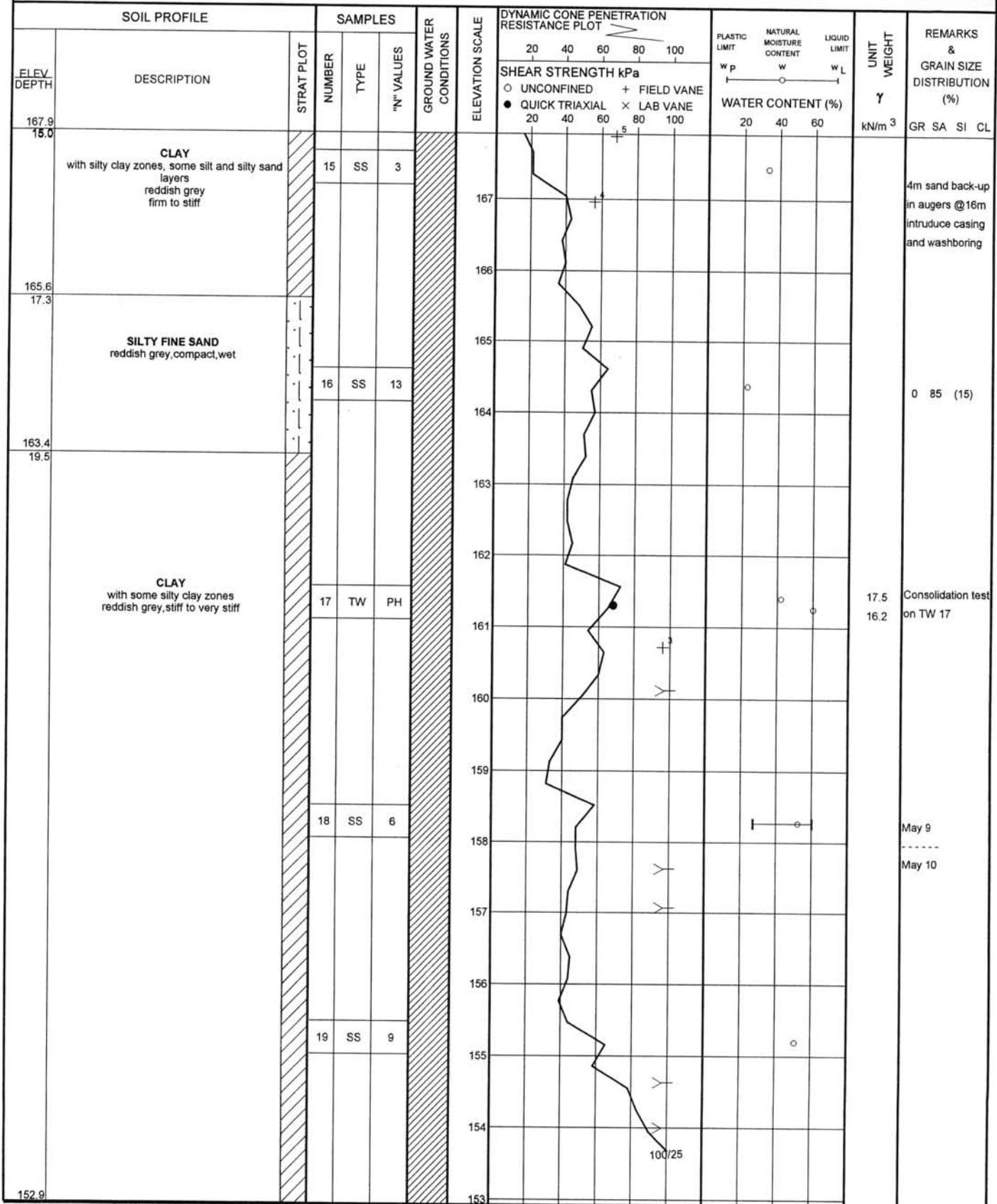
SPT 1074

# RECORD OF BOREHOLE No B

2 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 492.6; E 287 007.7 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/9/2003 to 5/11/2003 CHECKED BY R.M.



Continued Next Page

+ 3, x 3; Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

SPT 1074

# RECORD OF BOREHOLE No B

3 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 492.6; E 287 007.7 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/9/2003 to 5/11/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	
152.9 30.0	CLAY stiff to very stiff		20	SS	8		152					15.4
							151					
			21	TW	PH		150					
							149					
	reddish grey greenish grey						148					
			22	SS	8		147					
							146					
							145					
			23	SS	9		144					
							143					
							142					
							141					
140.4 42.5	SILTY FINE SAND with some thin clay seams greenish and reddish grey compact, wet		24	SS	16		140					
							139					
							138					

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

SPT 1074

# RECORD OF BOREHOLE No B

4 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 492.6; E 287 007.7 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/9/2003 to 5/11/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
137.9 45.0	<b>SILTY FINE SAND</b> with some sandy silt and thin clay seams grey, wet  compact dense		25	SS	30						0 44 52 4 May 10 ----- May 11		
132.8 50.1			26	SS	31								
End of Borehole.  Dynamic Cone Penetration Test (D.C.P.T.) performed from 0 to 29.2m and 46.0m to 49.6m  Piezometer installed to 12.2 m. Water level on: May, 11, 2003 - 1.7 m (El. 181.2 m) May, 12, 2003 - 1.8 m (El. 181.1 m) Jun, 3, 2003 - 2.0 m (El. 180.9 m)													

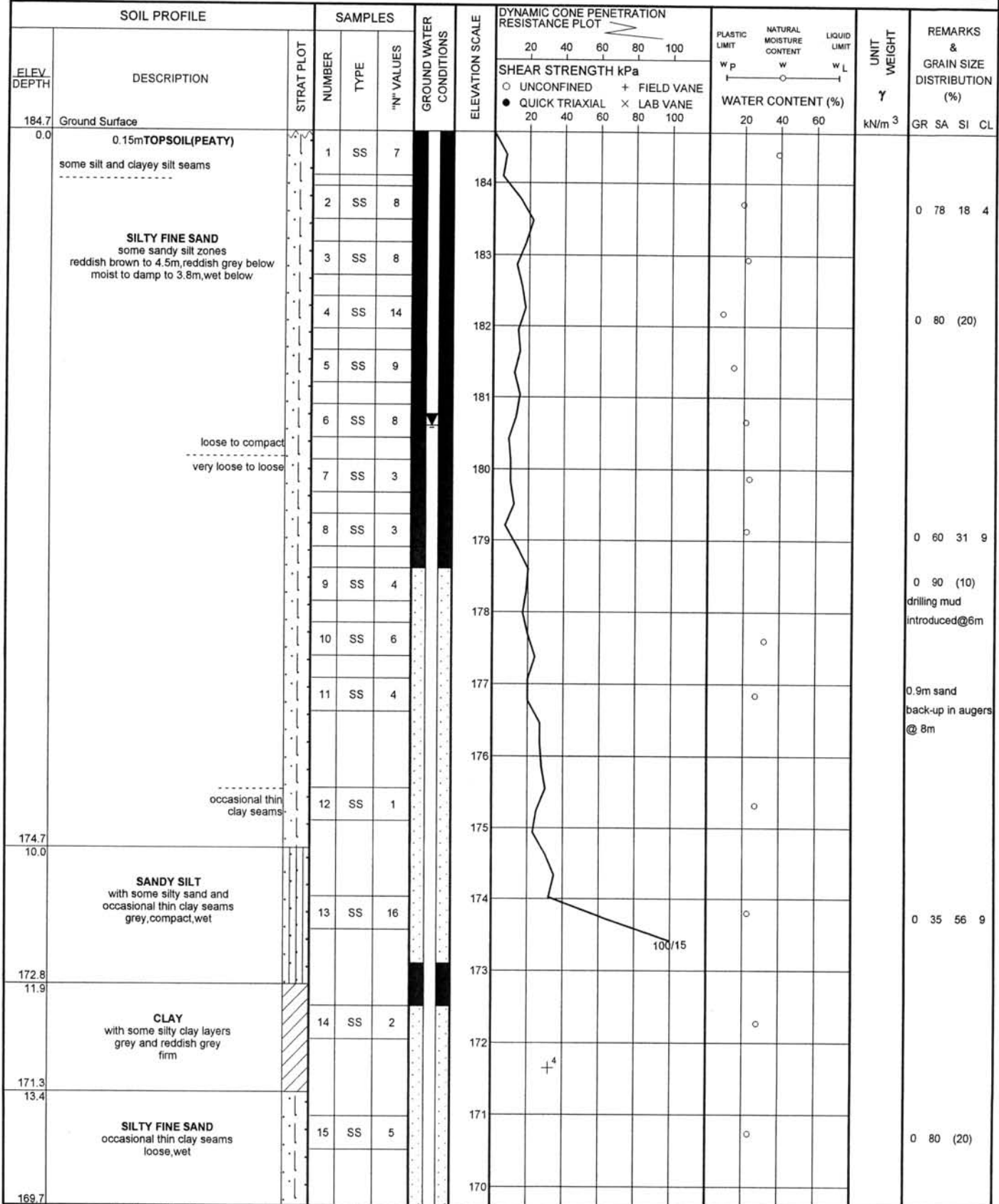
SPT 1074

# RECORD OF BOREHOLE No C

1 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 486.9; E 287 028.1 ORIGINATED BY Y.L.  
DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
DATUM Geodetic DATE 4/26/2003 to 4/28/2003 CHECKED BY R.M.



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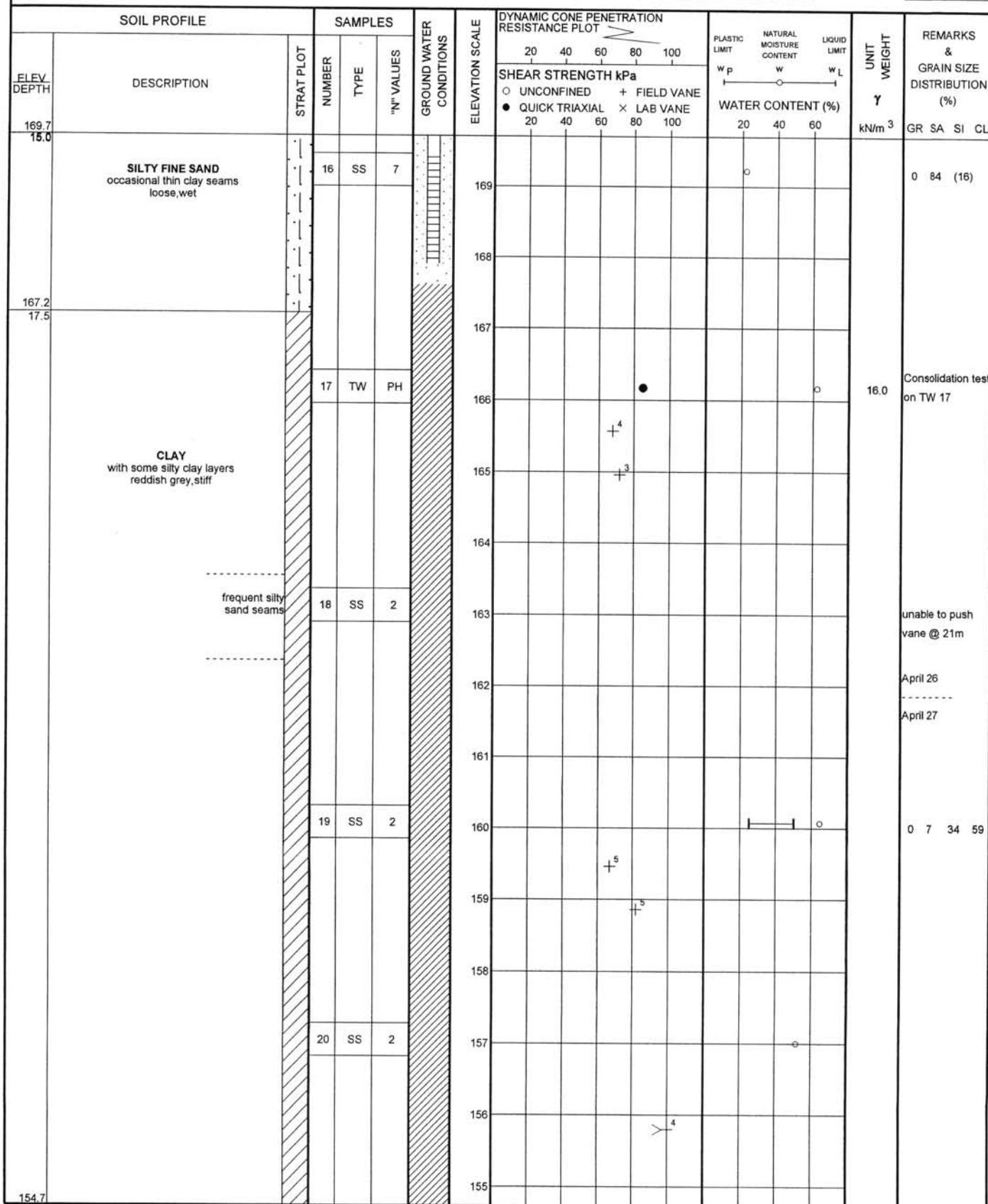
+ 3, x 3: Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No C

2 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 486.9; E 287 028.1 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 4/26/2003 to 4/28/2003 CHECKED BY R.M.



Continued Next Page

+ 3 . × 3 : Numbers refer to Sensitivity  
 20  
 15 10 5  
 (%) STRAIN AT FAILURE

SPT 1074

## 3 OF 4

METRIC

GWP	406-01-00	LOCATION	Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 486.9; E 287 028.1	ORIGINATED BY	Y.L.
DIST	62	HWY	17 (New)	BOREHOLE TYPE	Hollow Stem Augers, Casing & Washboring, D.C.P.T.
DATUM	Geodetic	DATE	4/26/2003 to 4/28/2003	COMPILED BY	J.Z.
				CHECKED BY	R.M.

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

SPT 1074

## 4 OF 4

METRIC

ORIGINATED BY Y.L.

COMPILED BY J.Z.

CHECKED BY R.M

+ 3, × 3: Numbers refer to Sensitivity



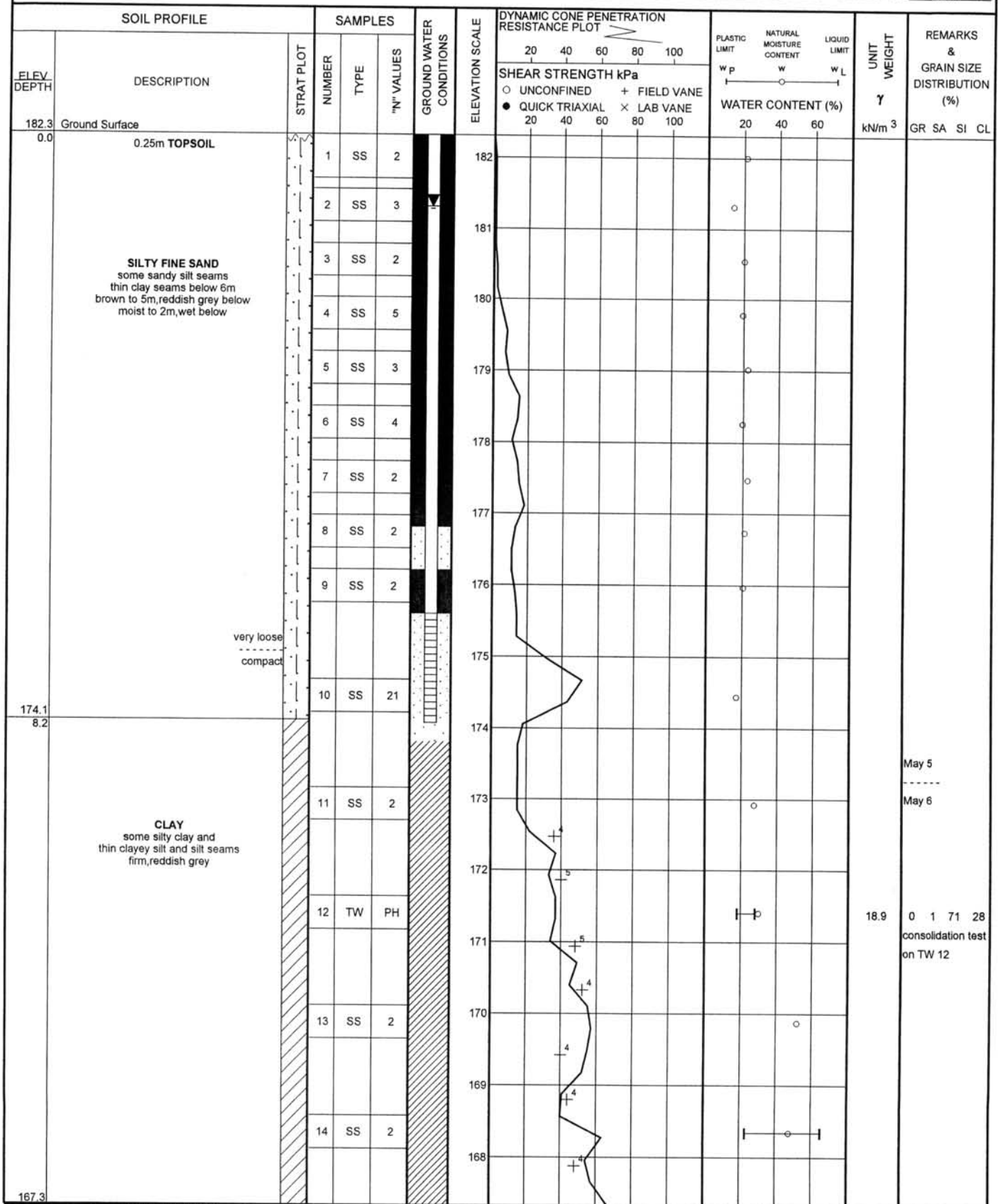
SPT 1074

# RECORD OF BOREHOLE No D

1 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 514.0; E 287 028.3 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/5/2003 to 5/8/2003 CHECKED BY R.M.



Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE



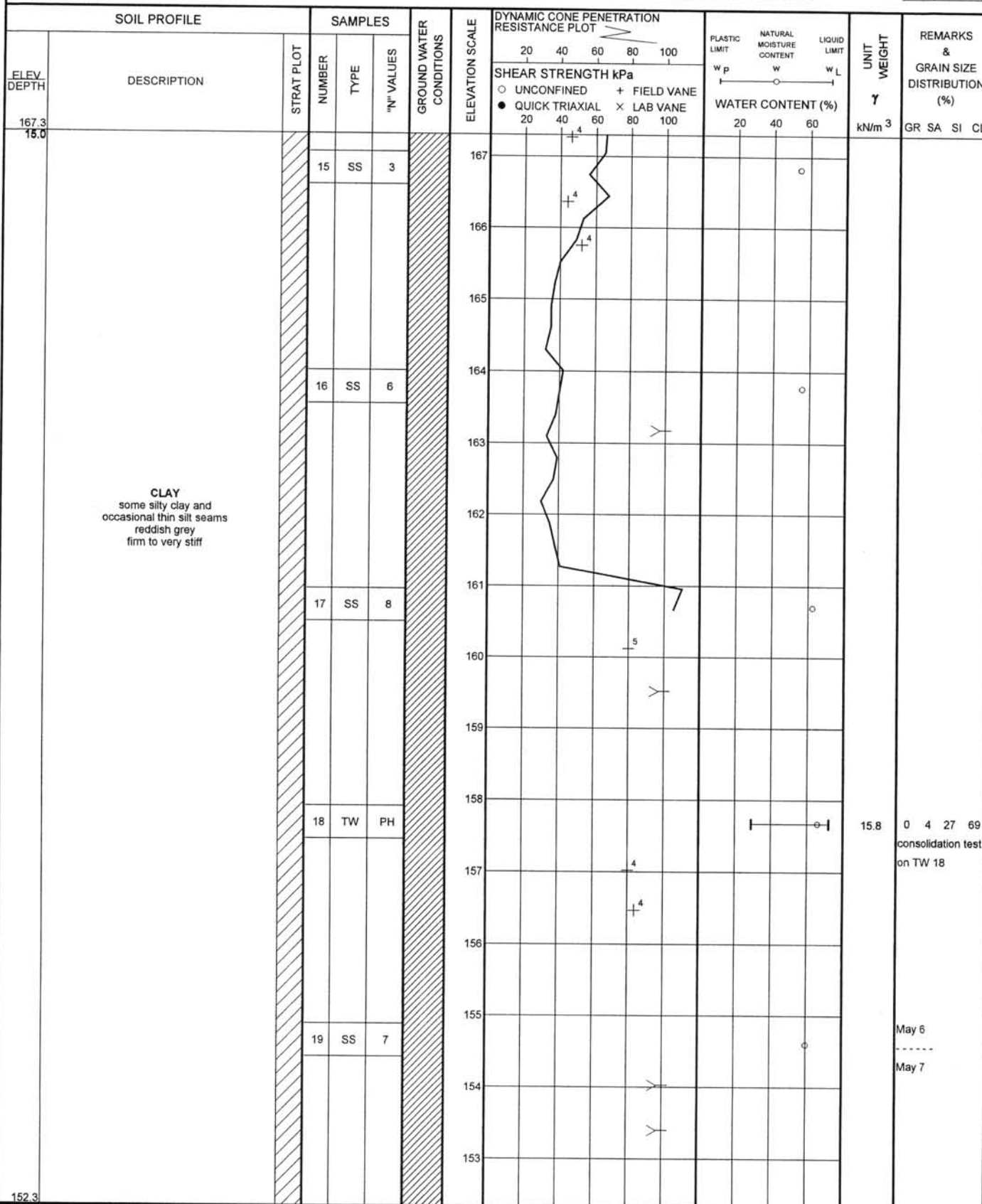
SPT 1074

# RECORD OF BOREHOLE No D

2 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 514.0; E 287 028.3 ORIGINATED BY Y.L.  
DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
DATUM Geodetic DATE 5/5/2003 to 5/8/2003 CHECKED BY R.M.



Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No D

3 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 514.0; E 287 028.3 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/5/2003 to 5/8/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
152.3 30.0	CLAY some silty clay and occasional thin silt seams reddish grey to 3.5m greenish grey/reddish grey below stiff to very stiff		20	SS	3									GR SA SI CL	
			21	SS	6										
			22	SS	11										

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1074

# RECORD OF BOREHOLE No D

4 OF 4

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 514.0; E 287 028.3 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers, Casing & Washboring, D.C.P.T. COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/5/2003 to 5/8/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL			× LAB VANE
137.3 45.0	SILTY FINE SAND with sandy silt layers some thin clay seams wet		25	SS	16								
131.3 51.0	End of Borehole.		26	SS	40								
	Dynamic Cone Penetration Test (D.C.P.T.) performed from 0 to 21.6m and 46.0m to 50.5m												
	Piezometer installed to 8.2 m. Water level on: May, 8, 2003 - 0.9 m (El. 181.4 m) May, 12, 2003 - 0.8 m (El. 181.5 m) June, 3, 2003 - 1.1 m (El. 181.2 m)												

SPT 1074

# RECORD OF BOREHOLE No E

1 OF 1

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 452.7; E 287 010.5 ORIGINATED BY Y.L.  
DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 4/29/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								UNCONFINED		FIELD VANE		QUICK TRIAXIAL			
187.3 0.0	Ground Surface						20	40	60	80	100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	
	0.1m TOPSOIL some clayey silt seams to 0.7m	loose	1	SS	6										
		compact	2	SS	21										
			3	SS	22										
	SILTY FINE SAND some sandy silt zones brown to 4.5m,reddish grey below moist to 4.5m,wet below		4	SS	20										
			5	SS	18										
			6	SS	16										
		loose	7	SS	8										
180.7 6.6	End of Borehole.		8	SS	7										
	* Water level on: April, 29, 2003 - 4.5 m (El. 182.8 m)														

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1074

# RECORD OF BOREHOLE No F

1 OF 2

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 534.0; E 287 026.9 ORIGINATED BY Y.L.  
DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 5/5/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
183.2	Ground Surface							20 40 60 80 100	20 40 60					
0.0	0.35m <b>TOPSOIL</b> organics and topsoil inclusions to 1.0 m		1	SS	12		183							
	<b>SILTY FINE SAND</b> with sand silt zones brown to 1.5m reddish grey 1.5 to 3m, grey below moist to 1.5m, wet below		2	SS	9		182							0 72 (28)
			3	SS	11									
			4	SS	6									0 65 27 8
			5	SS	6									sampler wet@3m
			6	SS	2									
			7	SS	2									
			8	SS	1									
			9	SS	5									
175.7	<b>CLAY</b> some silty clay silt and silty sand seams grey, firm		10	SS	1		176							
7.5			11	SS	1		175							
172.8	<b>SILTY FINE SAND</b> reddish grey , very loose wet		12	SS	3		174							
10.4			13	SS	5		173						0 75 22 3	
169.7	<b>CLAY</b> reddish grey, firm						172							
13.5							171							
168.2							170							
							169							

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT 1074

# RECORD OF BOREHOLE No F

2 OF 2

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 534.0; E 287 026.9 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/5/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
168.2 15.0							20 40 60 80 100						
167.5 15.7	CLAY reddish grey, firm		14	SS	2		20 40 60 80 100						
	End of Borehole.  * Water level on completion: May, 5, 2003 - 3 m (not stabilized)												

SPT 1074

# RECORD OF BOREHOLE No G

1 OF 2

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 512.5; E 287 006.3 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/8/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
182.5 0.0	Ground Surface						20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>		
	0.1mTOPSOIL some organics to 2m		1	SS	3		20 40 60 80 100	○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE	WATER CONTENT (%)		
			2	SS	4							
			3	SS	4							
	SILTY FINE SAND with sandy silt zones brown to 1.5m, grey below very loose to 6m, compact below		4	SS	3							
			5	SS	5							
			6	SS	3							
		some clay seams	7	SS	2							
			8	SS	5							
			9	SS	23							
175.8 6.7												
			10	SS	4							
	CLAY some silty clay silt and sandy silt seams reddish grey, stiff		11	SS	12							
			12	SS	5							
			13	SS	17							
167.5												

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

SPT 1074

# RECORD OF BOREHOLE No G

2 OF 2

METRIC

GWP 406-01-00 LOCATION Black Creek, Sault Ste. Marie, ON - Coords: N 5 156 512.5; E 287 006.3 ORIGINATED BY Y.L.  
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 5/8/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100			W <sub>p</sub>
167.5 15.0	CLAY reddish grey, stiff		14	SS	5										
165.7 16.8	End of Borehole.														
	* Water level on: May, 8, 2003 - 0.6 m (El. 181.9 m)														

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5  
(%) STRAIN AT FAILURE



PROJECT: 941-1364

## RECORD OF BOREHOLE 95-1

SHEET 1 OF 2

LOCATION: SEE FIGURE 2A

BORING DATE: SEPT. 27-28/95

DATUM: GEODETIC

SAMPLER HAMMER: 63.5kg; DROP: 760mm

PENETRATION TEST HAMMER: 63.5kg; DROP: 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + rem V - ⊗			O - ● U - ○	WATER CONTENT, PERCENT Wp — W — Wl
0		GROUND SURFACE		186.20									
		TOPSOIL		0.00									
		Silty sand, some rootlets Very loose Oxidized appearance		0.10	1	50 DO	1				CUTTINGS		
				185.50							BENTONITE SEAL		
				0.70	2	50 DO	9						
1													
		Fine sand, fine, some silt, trace clay Loose Greyish to reddish brown			3	50 DO	8						
2					4	50 DO	9						
					5	50 DO	10				CUTTINGS		
3					6	50 DO	7						
4				181.70									
				4.50	7	50 DO	2			MH			
5					8	50 DO	1						
		Fine sand, some silt, trace clay, occasional organic silt partings Very loose Brownish grey			9	50 DO	WH						
6					10	50 DO	1				CAVED		
7				177.50							BENTONITE SEAL		
				8.70	11	50 DO	1						
		Silty sand with sandy silt interlayers, trace organics Very loose Grey											
											CAVED		

CONTINUED ON NEXT PAGE

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: GEB

CHECKED: ASP

PROJECT: 9411-1364

## RECORD OF BOREHOLE 95-1

SHEET 2 OF 2

LOCATION: SEE FIGURE 2A

BORING DATE: SEPT 27, 1995

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT	
								net V - + Cu, kPa	rem V - S U - O			Wp	W
10	TRACK MOUNTED CME 35 POWER AUGER 108mm ID HOLLOW STEEL AUGER	CONTINUED FROM PREVIOUS PAGE											
			176.00 10.20										
11		Fine sand, some silt, trace clay, Grey		12	SO DO	20							
			174.50 11.70										
12		Sand, some silt with layers of sandy silt, silty sand and silty clay Very loose Grey to reddish brown		13	SO DO	WH							
13													
14				14	SO DO	1							
			171.40 14.80										
15		Irregularly layered silty clay to clay and clayey silt, trace sand Very soft Greyish to reddish brown		15	SO DO	WH							
16		END OF BOREHOLE	170.35 15.85										
17		Water level in piezometer @ 4.3m (El. 181.9m) on April 29, 2003 (measured by Shaheen & Peaker Limited personnel).											
18													
19													
20													

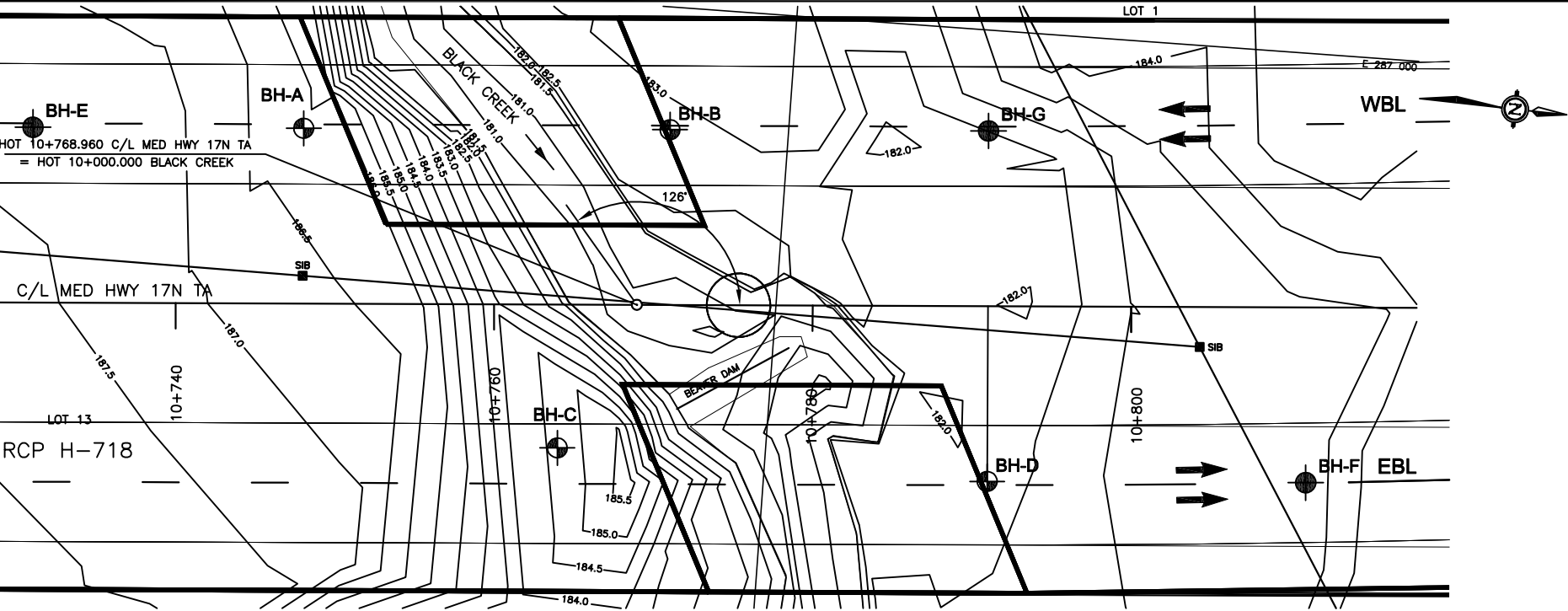
DEPTH SCALE

Golder Associates

LOGGED: GEB

CHECKED: ASP

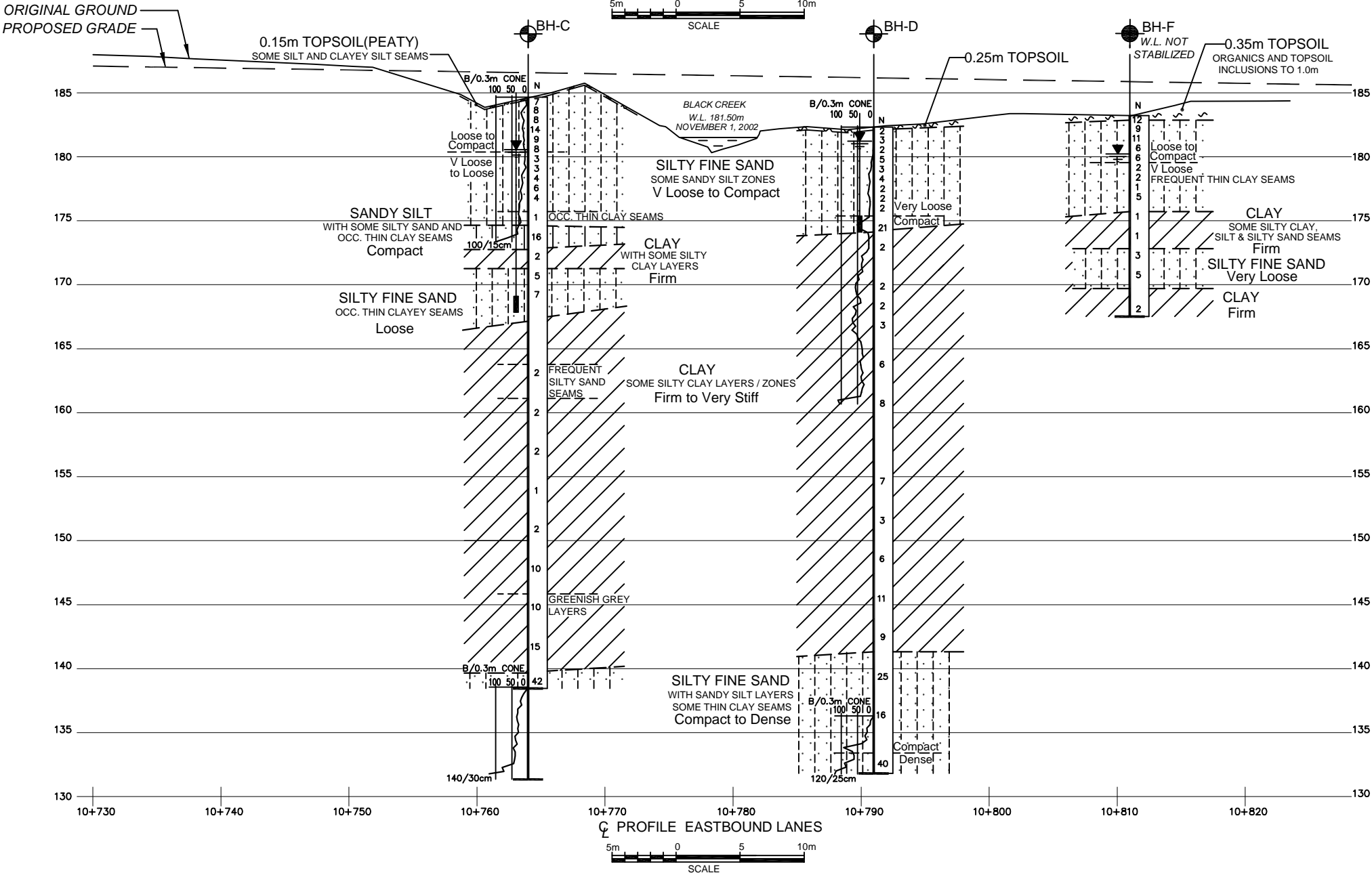
Water level in  
augers at about  
12.3m depth below  
ground surface  
upon completion  
of drilling.  
Water level in  
piezometer at  
elevation 181.2m  
depth on  
October 5, 1995.



# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
ARE IN KILOMETRES + METRES.

- NOTES:
- FOR DETAILED SUBSURFACE CONDITIONS AND DYNAMIC CONE PENETRATION TESTS REFER TO RECORD OF BOREHOLE SHEETS.
  - FOR WESTBOUND LANES PROFILE REFER TO DRAWING 2.

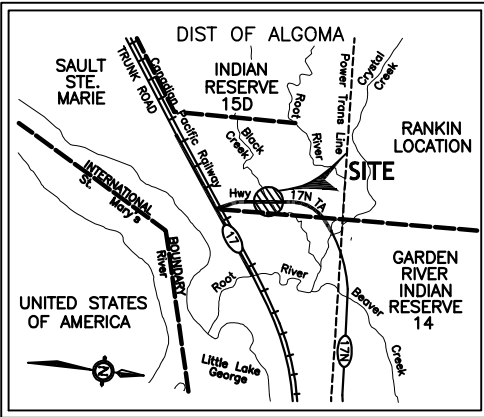


CONT No.  
GWP: 406-01-00

HIGHWAY 17 (NEW)  
BLACK CREEK  
BORE HOLE LOCATIONS & SOIL STRATA



## SHAHEEN & PEAKER LIMITED



KEY PLAN  
N.T.S

### LEGEND

- Bore Hole
- Bore Hole & Cone
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation  
Apr. , May. and Jun. , 2003
- Water Level in Piezometer
- Piezometer

No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
BH-C	184.7	5 156 486.9	287 028.1
BH-D	182.3	5 156 514.0	287 028.3
BH-F	183.2	5 156 534.0	287 026.9

**NOTE**  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

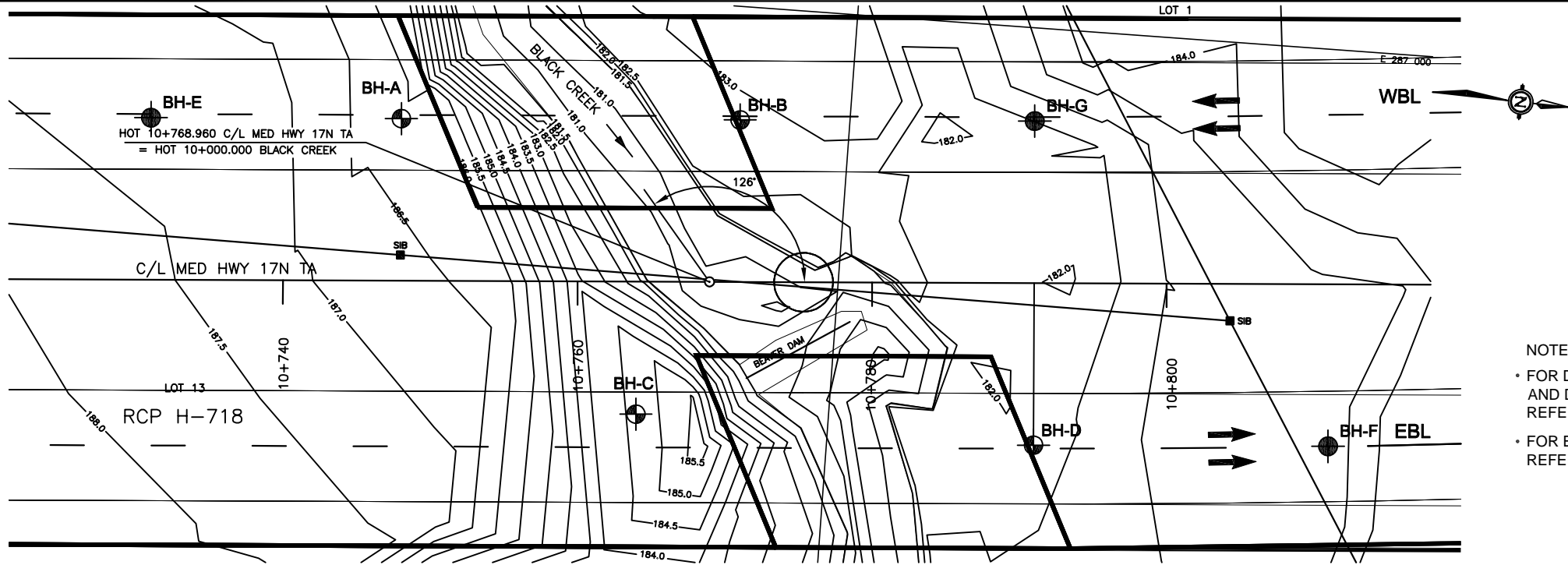
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REV.	DATE	BY	DESCRIPTION

Geocres No. 41K00-060

HWY No. 17 (New)			DIST 62
SUBM'D ZO	CHECKED JP	DATE Jul, 2003	SITE
DRAWN JZ	CHECKED	APPROVED	DWG 1

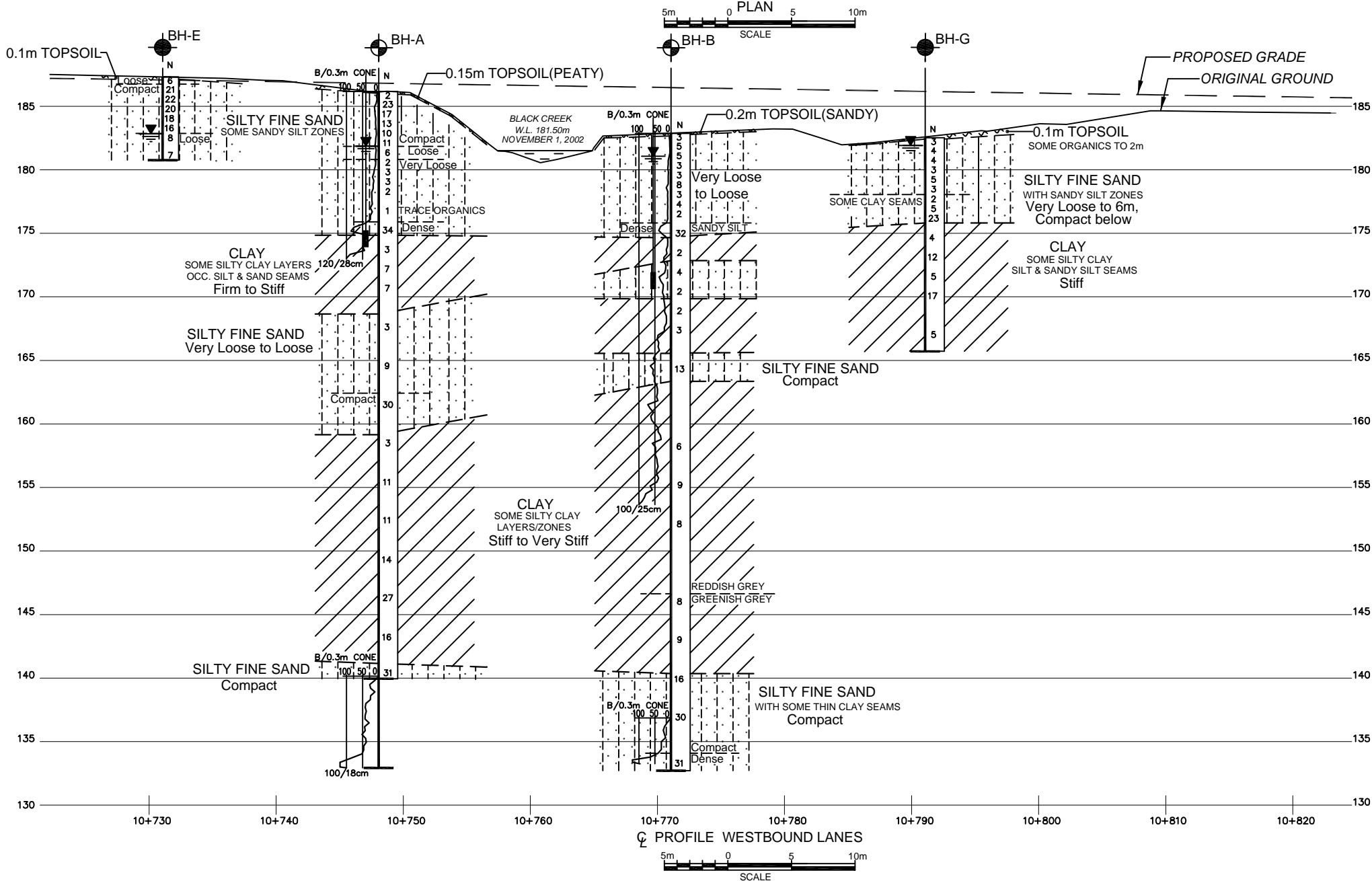




METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
ARE IN KILOMETRES + METRES.

- NOTES:
- FOR DETAILED SUBSURFACE CONDITIONS AND DYNAMIC CONE PENETRATION TESTS REFER TO RECORD OF BOREHOLE SHEETS.
  - FOR EASTBOUND LANES PROFILE REFER TO DRAWING 1.

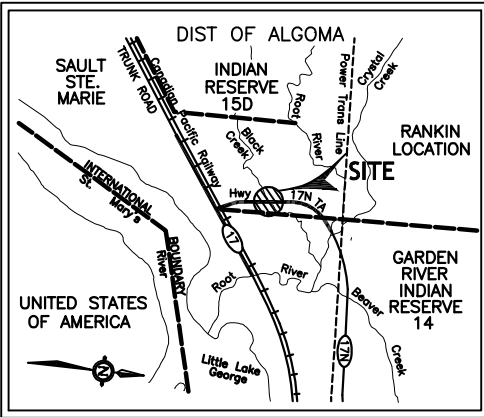


CONT No.  
GWP: 406-01-00



HIGHWAY 17 (NEW)  
BLACK CREEK  
BORE HOLE LOCATIONS & SOIL STRATA

SHAHEEN & PEAKER LIMITED



KEY PLAN  
N.T.S

LEGEND

- Bore Hole
- Bore Hole & Cone
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation  
Apr. , May. and Jun. , 2003
- Water Level in Piezometer
- Piezometer

No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
BH-A	186.2	5 156 469.6	287 009.3
BH-B	182.9	5 156 492.6	287 007.7
BH-E	187.3	5 156 452.7	287 010.5
BH-G	182.5	5 156 512.5	287 006.3

NOTE:-  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

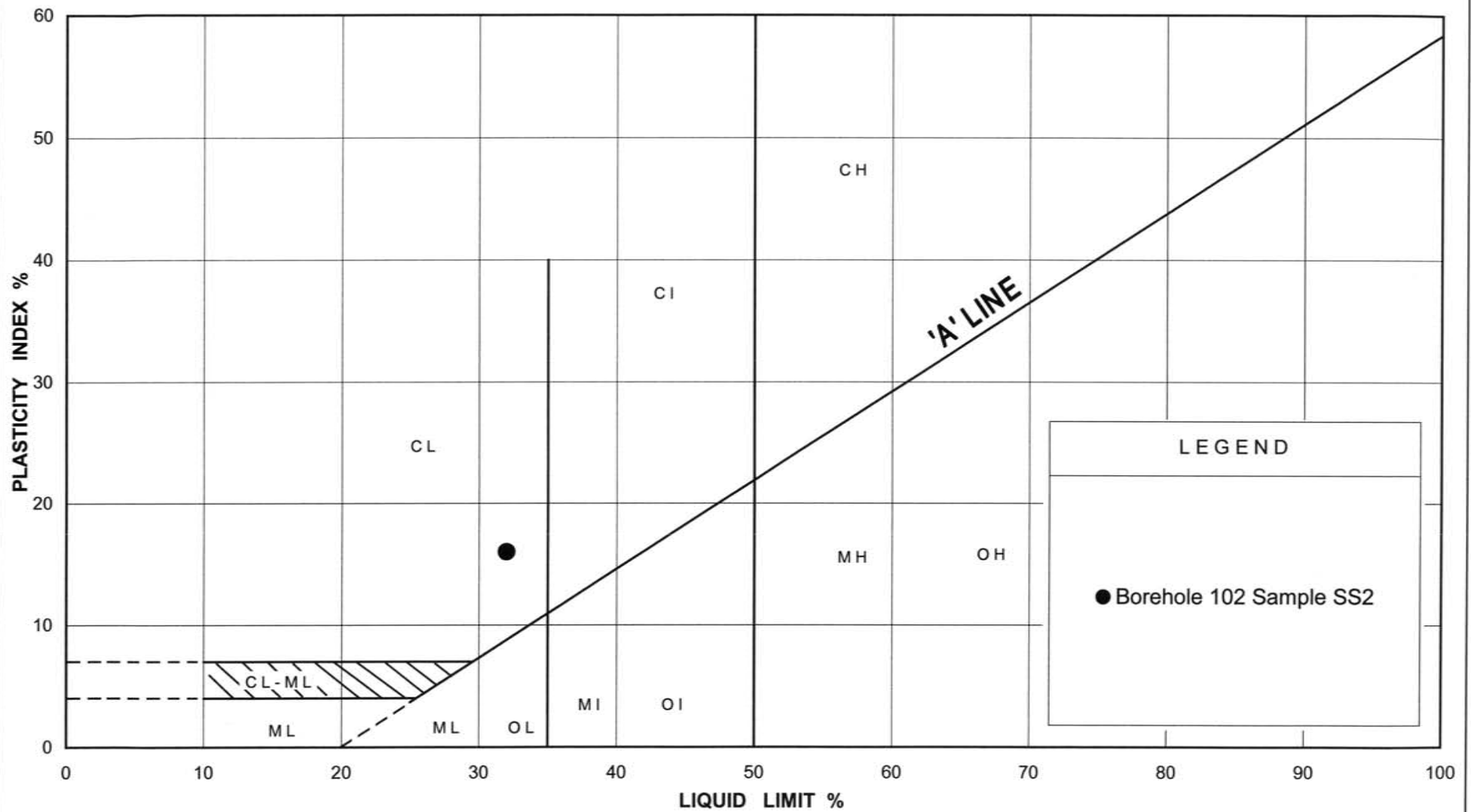
REV.	DATE	BY	DESCRIPTION

Geocres No. 41K00-060

HWY No. 17 (New)			DIST 62
SUBM'D ZO	CHECKED JP	DATE Jul, 2003	SITE
DRAWN JZ	CHECKED	APPROVED	DWG 2

# Appendix C

## Laboratory Test Results (Present Investigation) Geocres No. 41K-66



SHAHEEN & PEAKER LIMITED

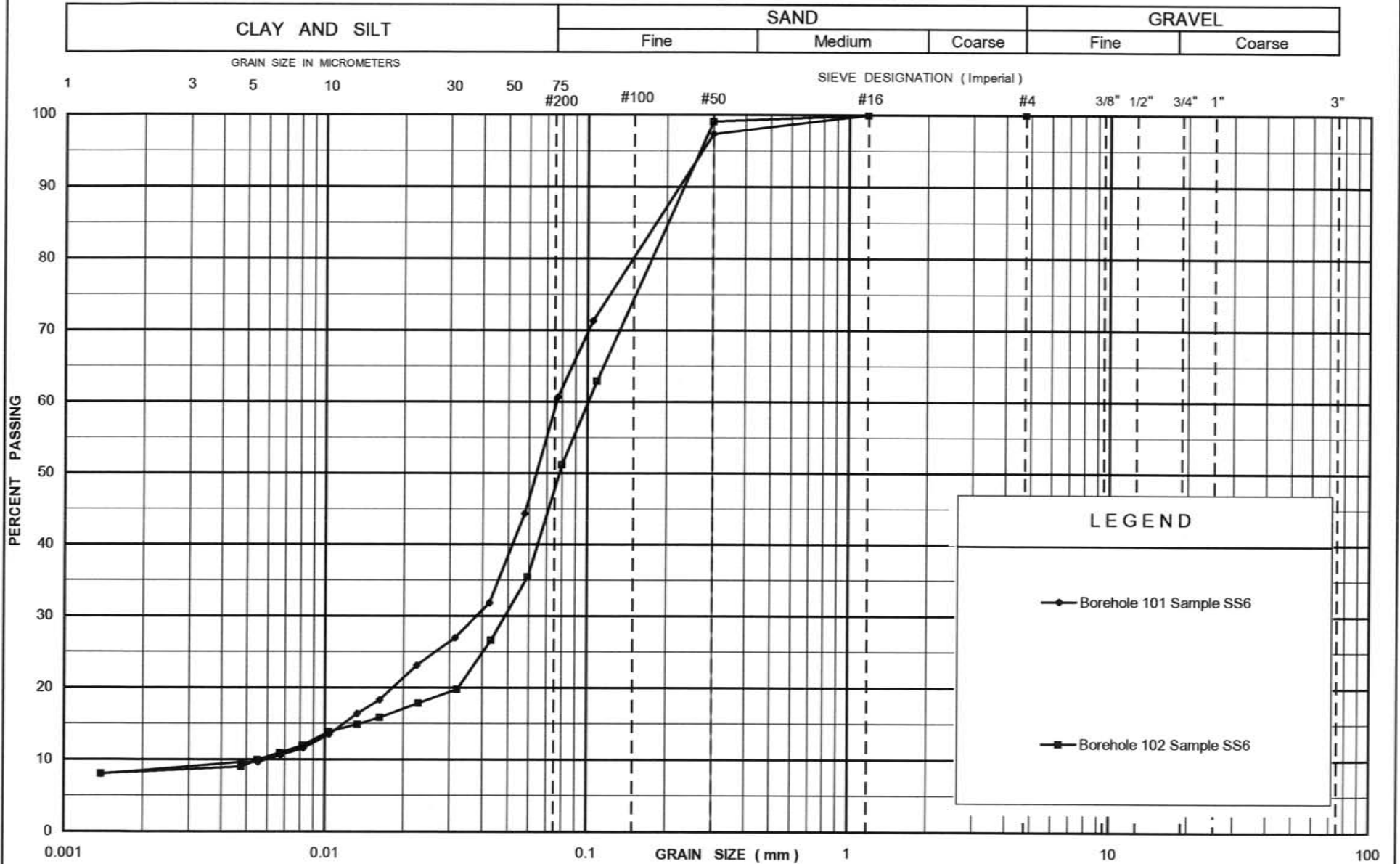
PLASTICITY CHART  
SURFICIAL SILTY CLAY

FIG No C-1

G.W.P. 406-01-00

REF No SPT 1139

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

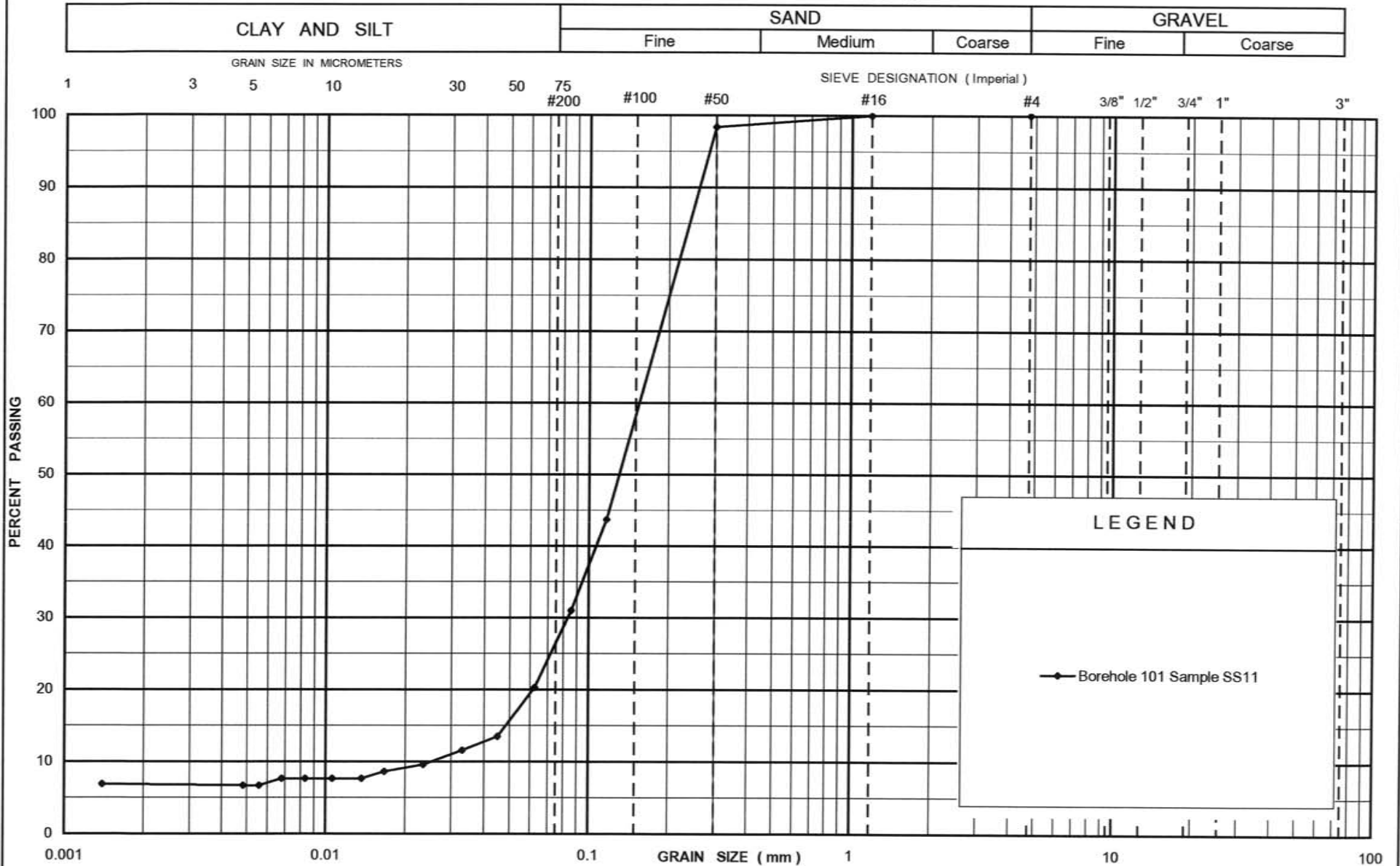
**GRAIN SIZE DISTRIBUTION**  
SANDY SILT to SILTY FINE SAND

FIG. No. C-2

REF. No. SPT 1139

G.W.P. 406-01-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

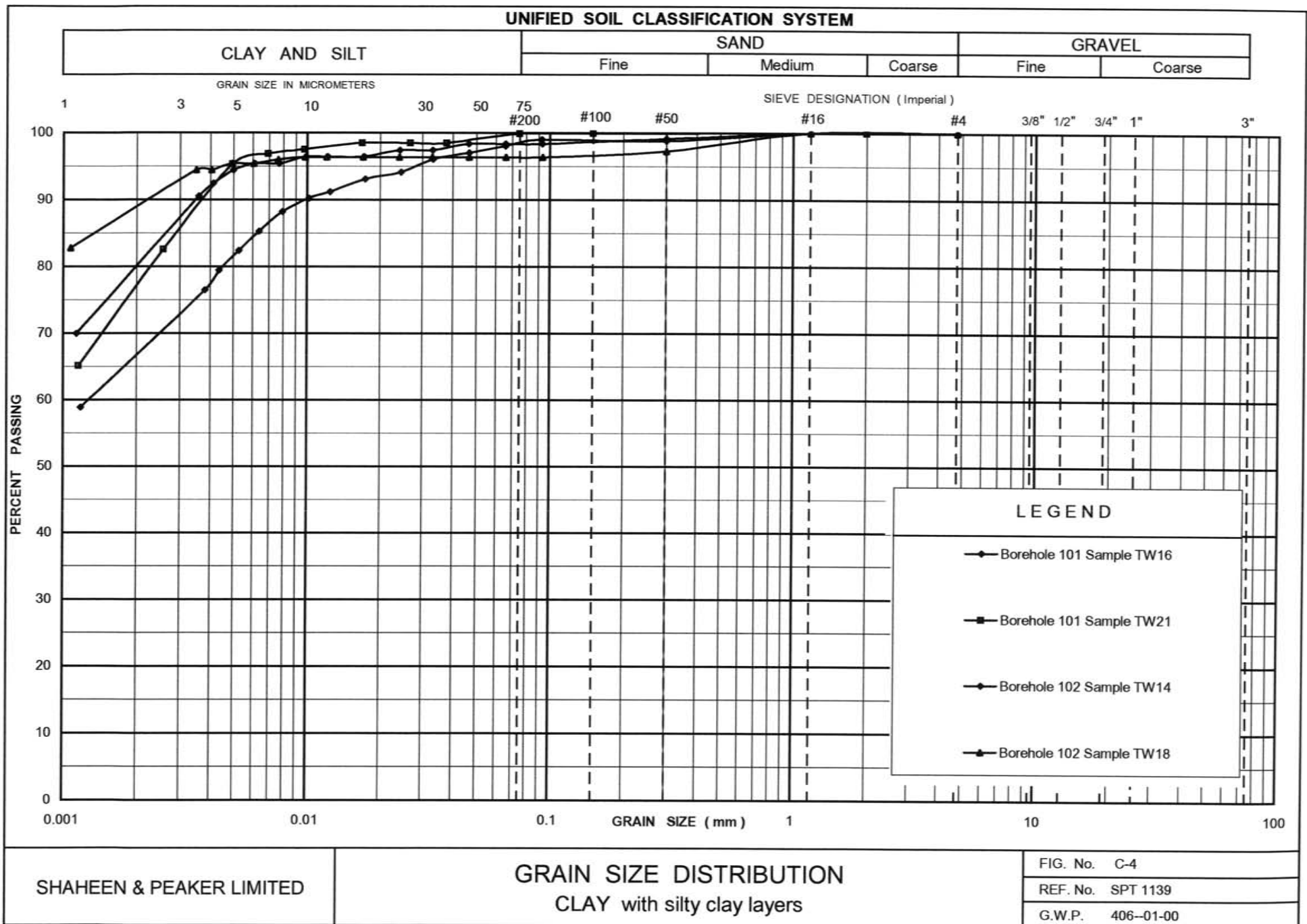
**GRAIN SIZE DISTRIBUTION**  
SANDY SILT to SILTY FINE SAND INTERLAYERS in the upper zones of clay

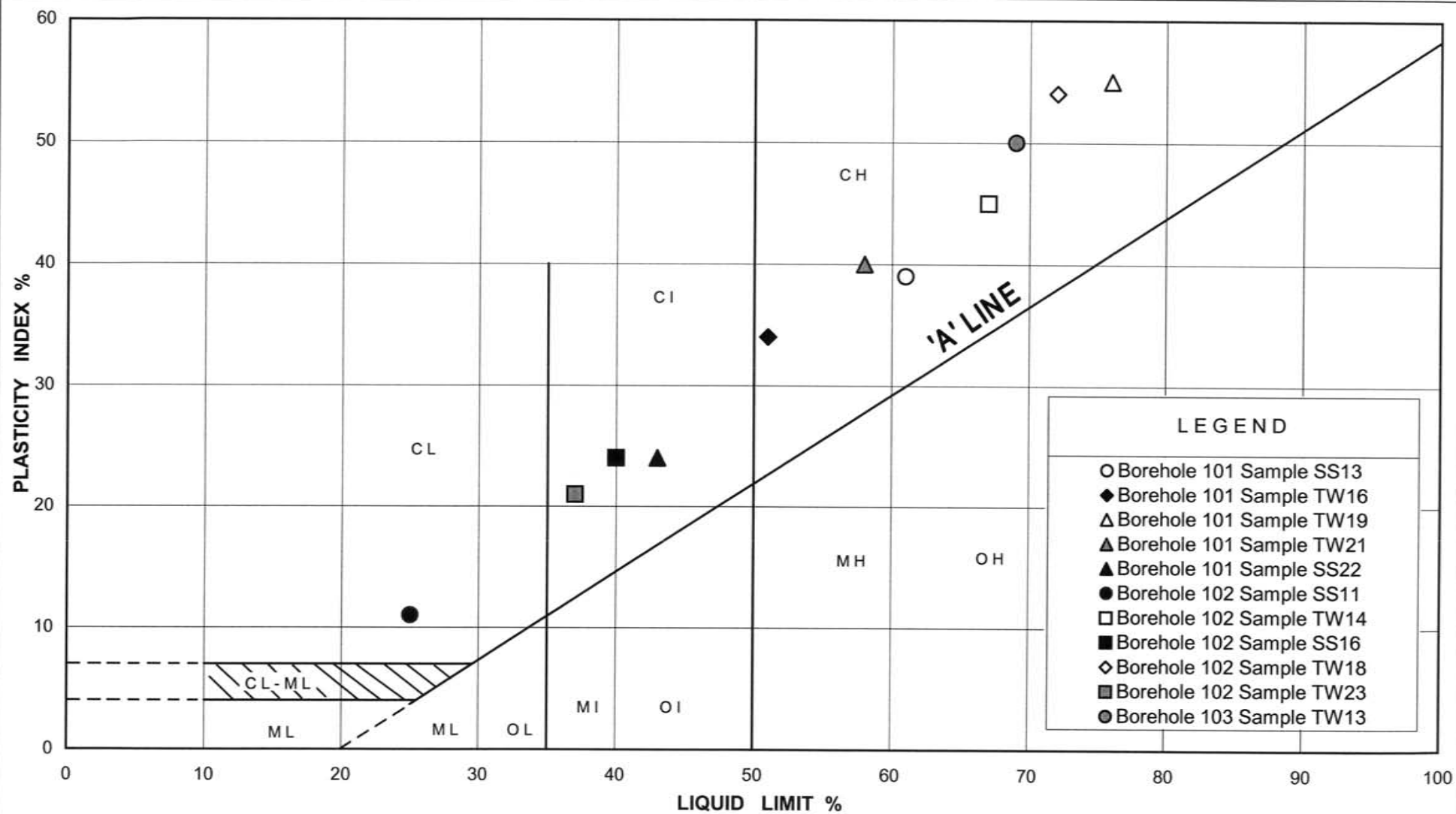
FIG. No. C-3

REF. No. SPT 1139

G.W.P. 406-01-00







SHAHEEN & PEAKER LIMITED

PLASTICITY CHART  
CLAY with silty clay layers

FIG No C-5

G.W.P. 406-01-00

REF No SPT 1139

FIGURE C-6

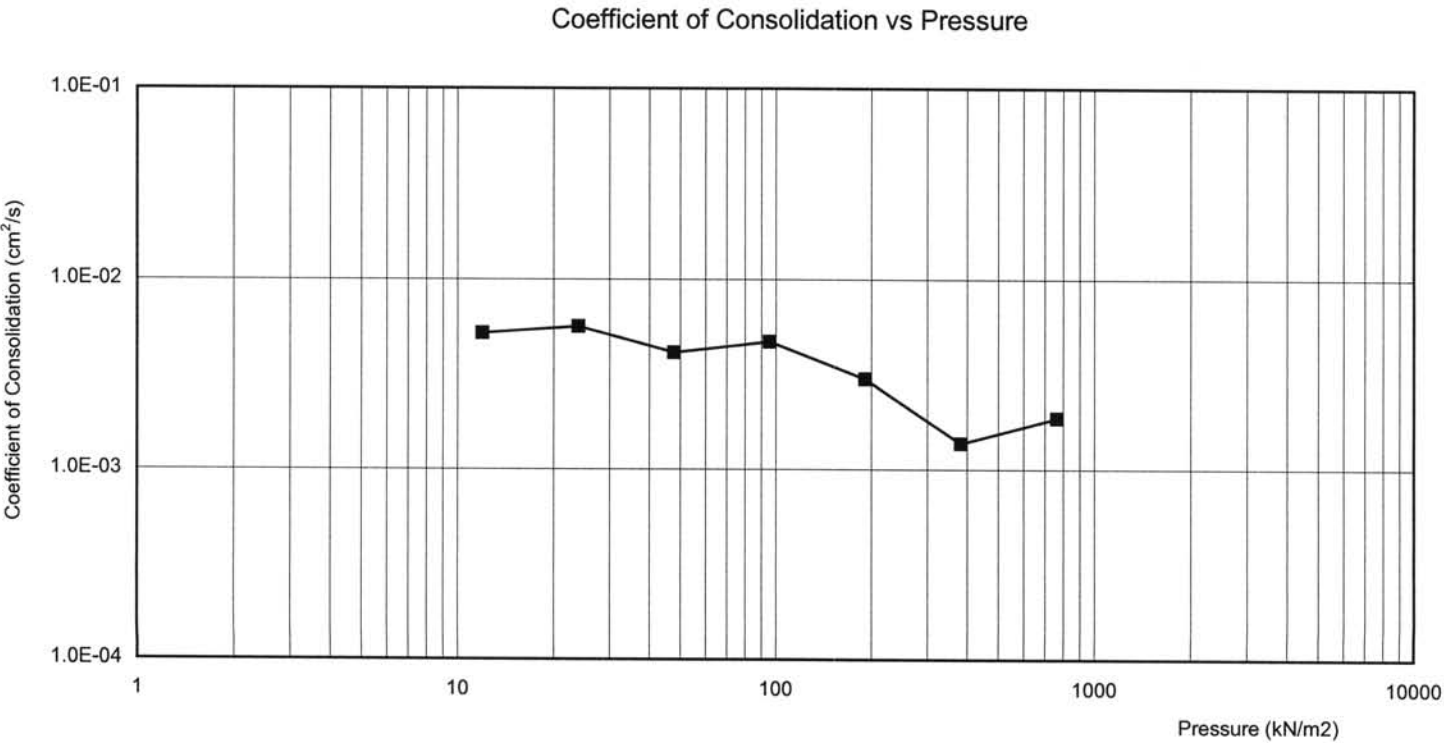
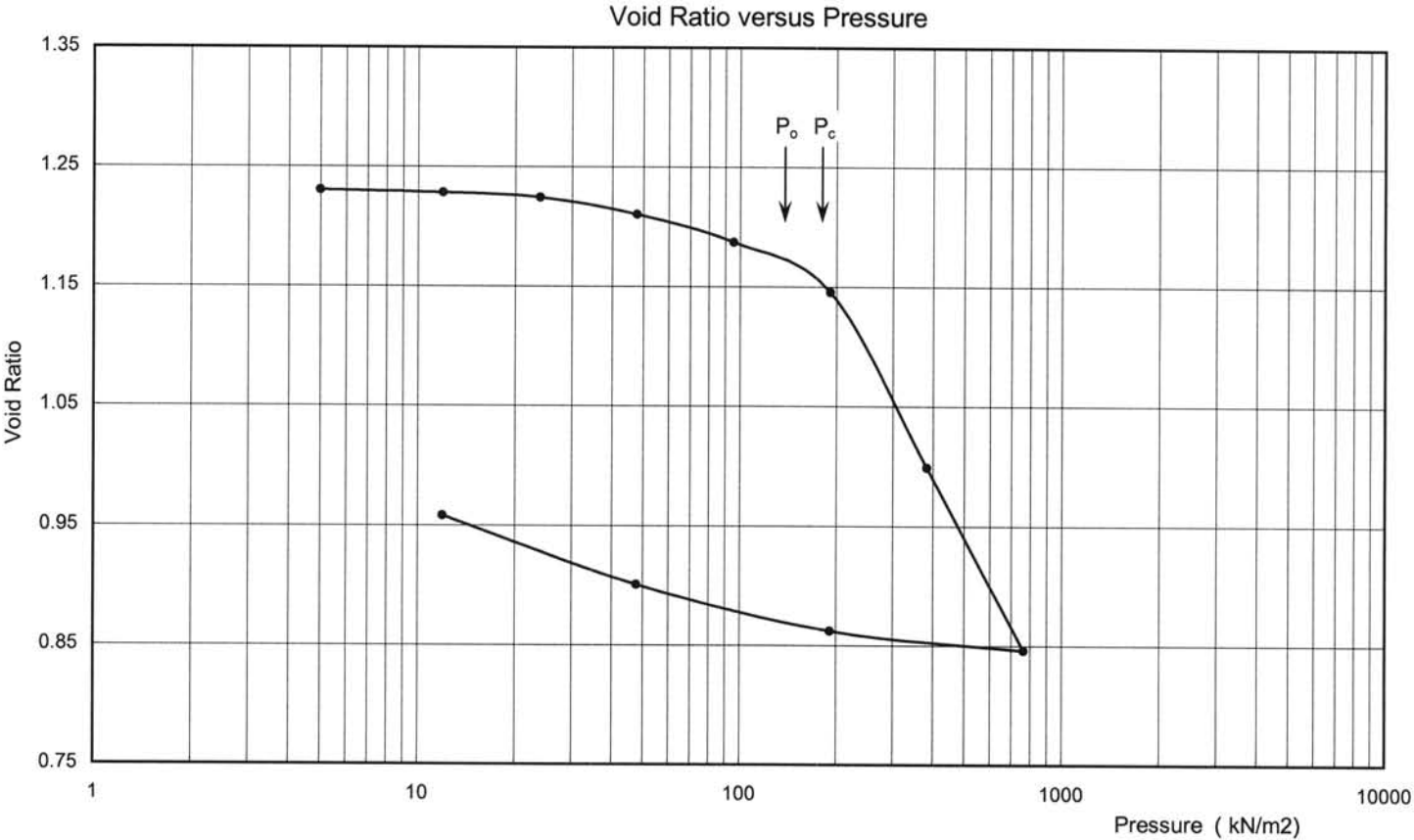


FIGURE C-7

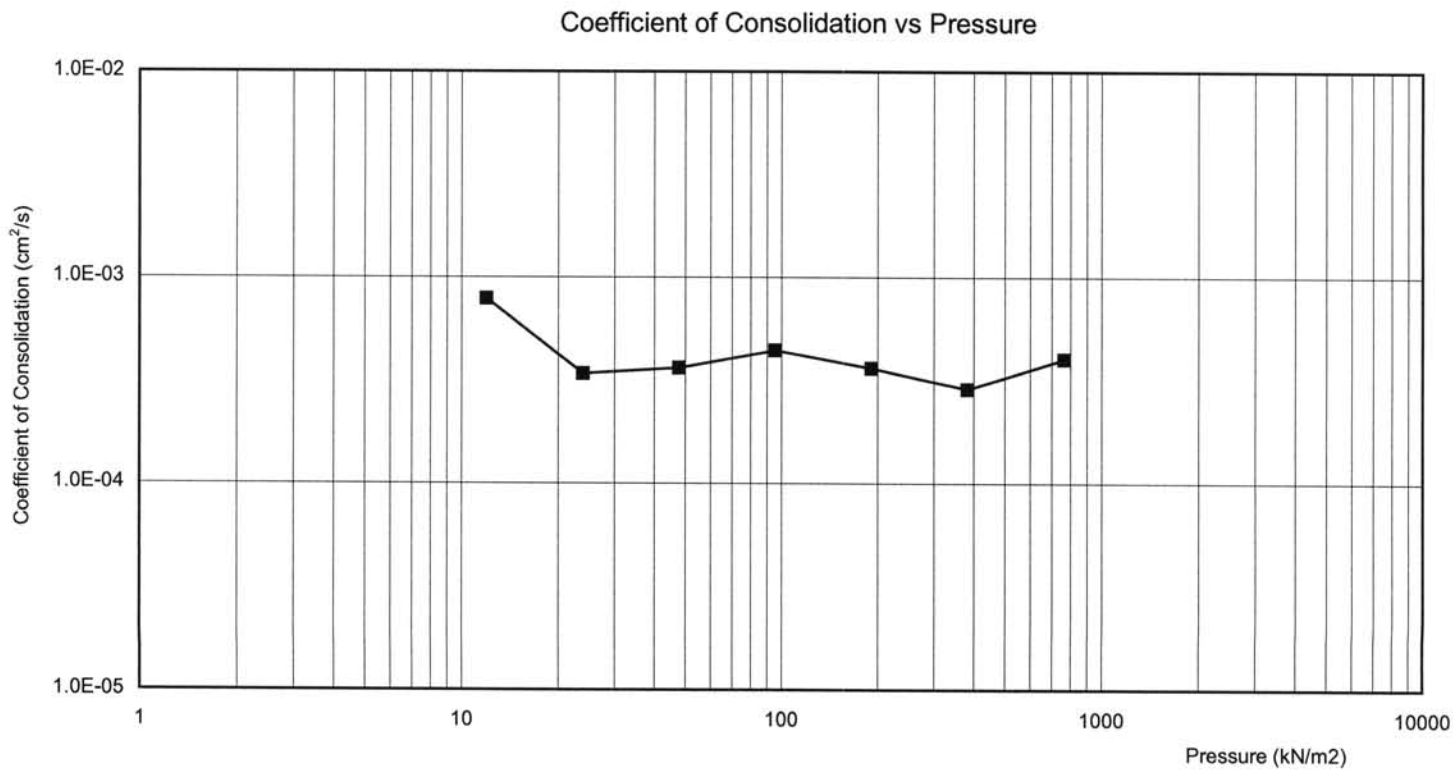
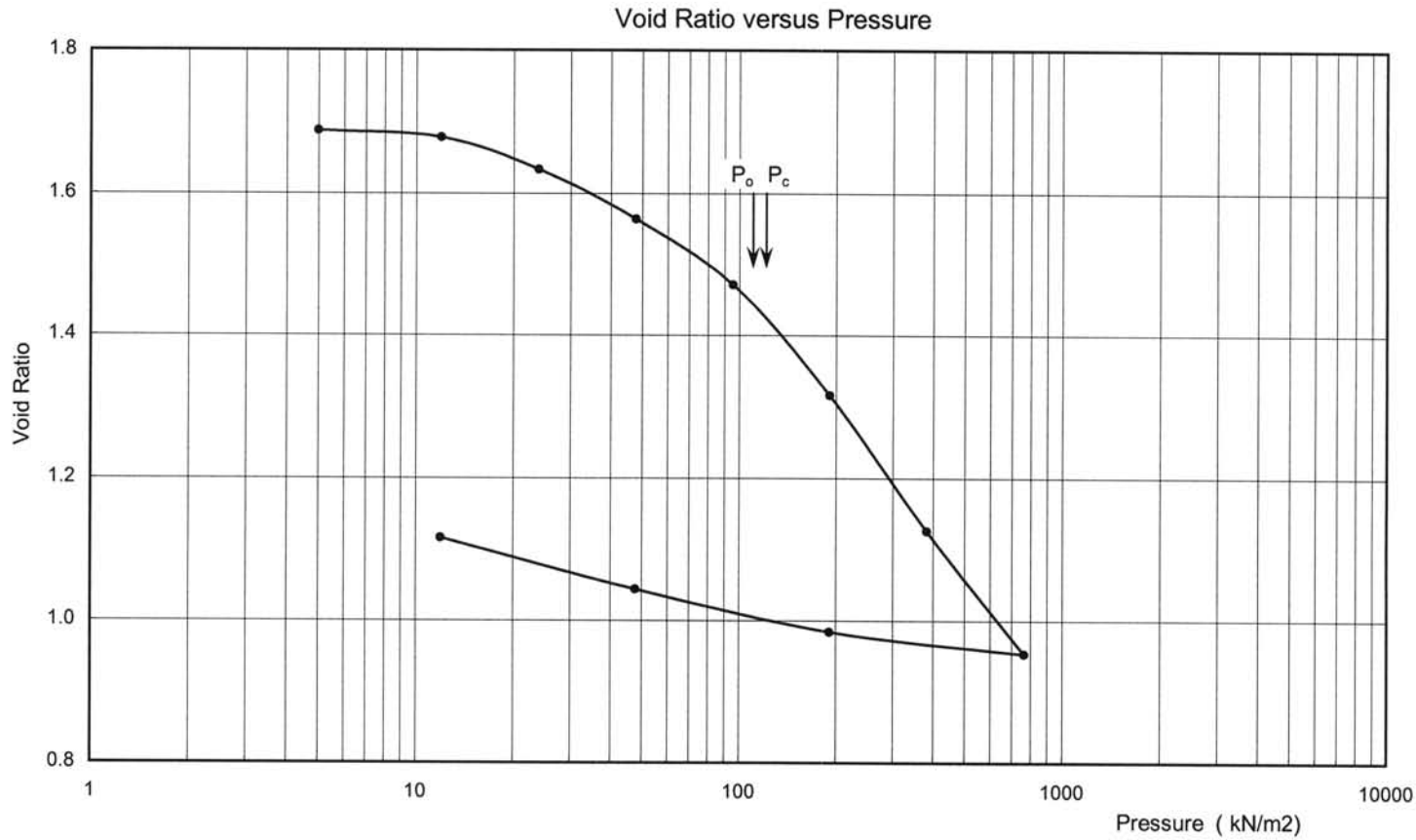
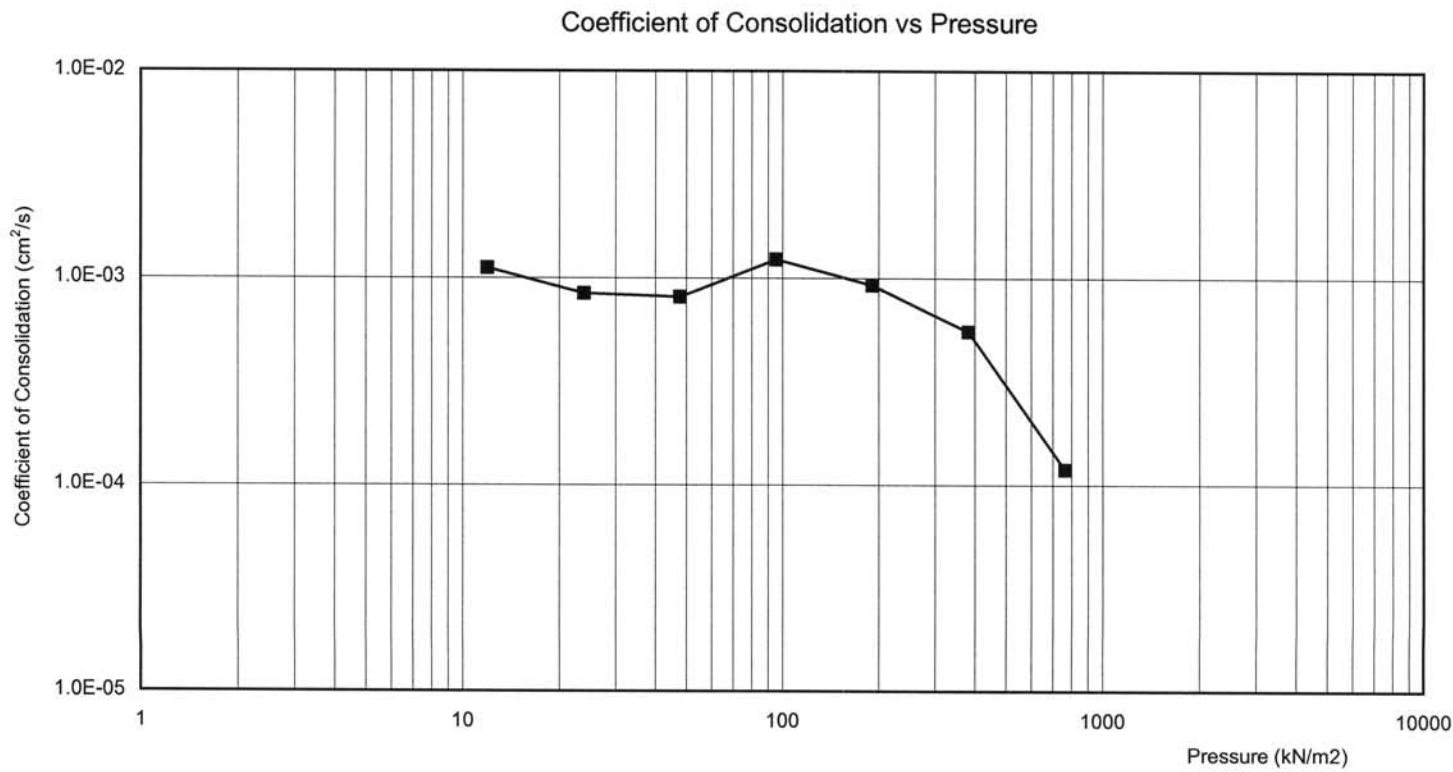
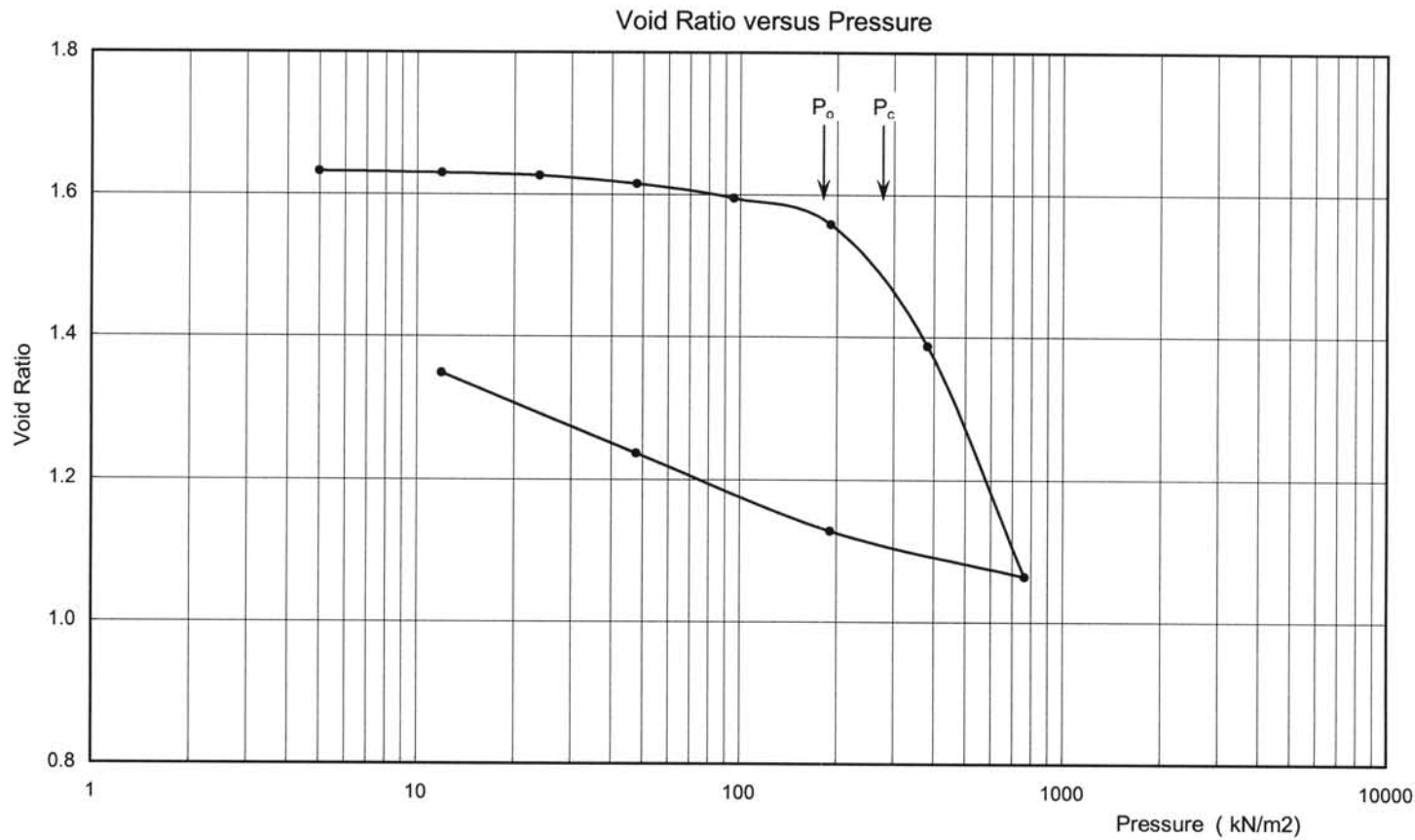
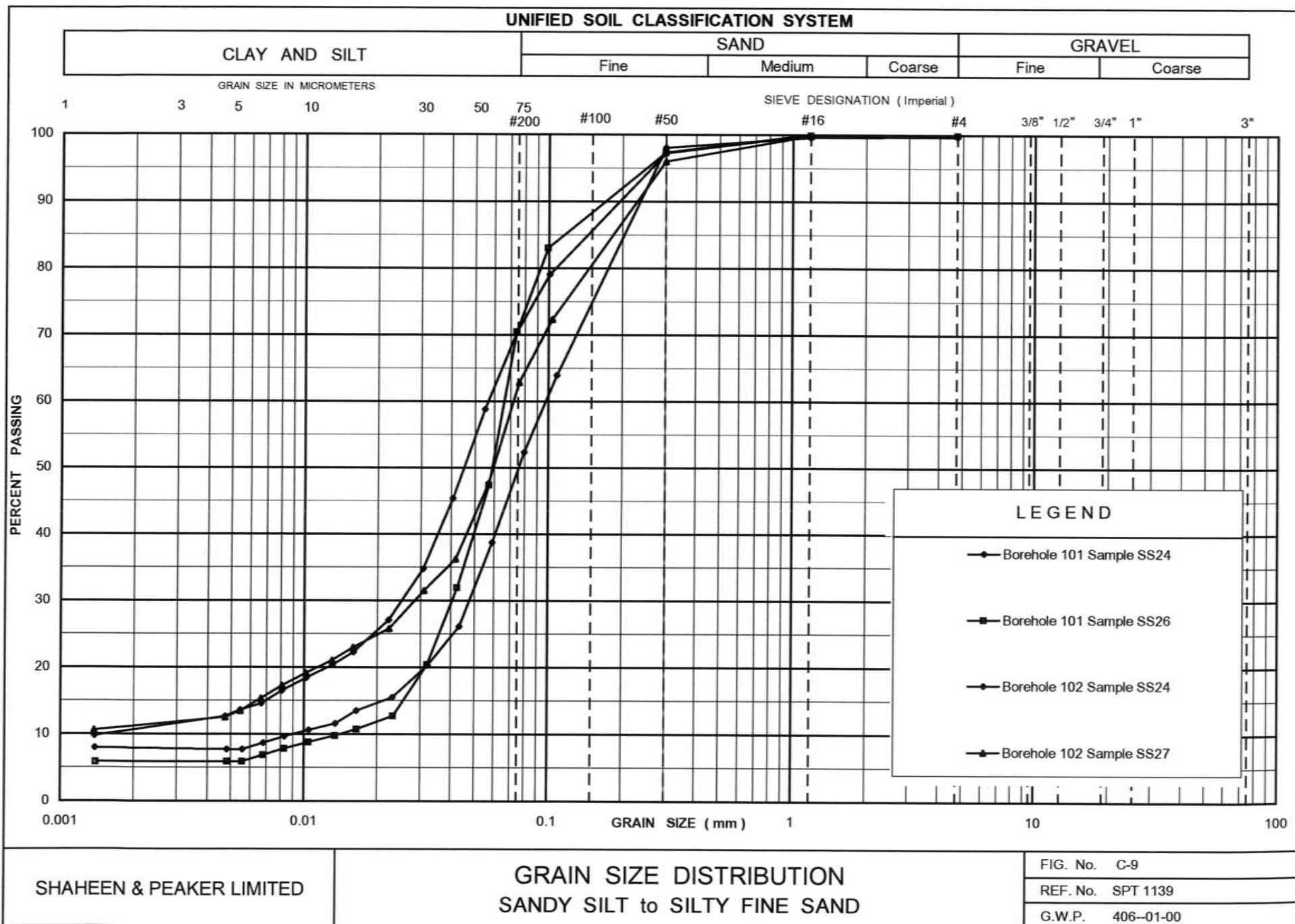
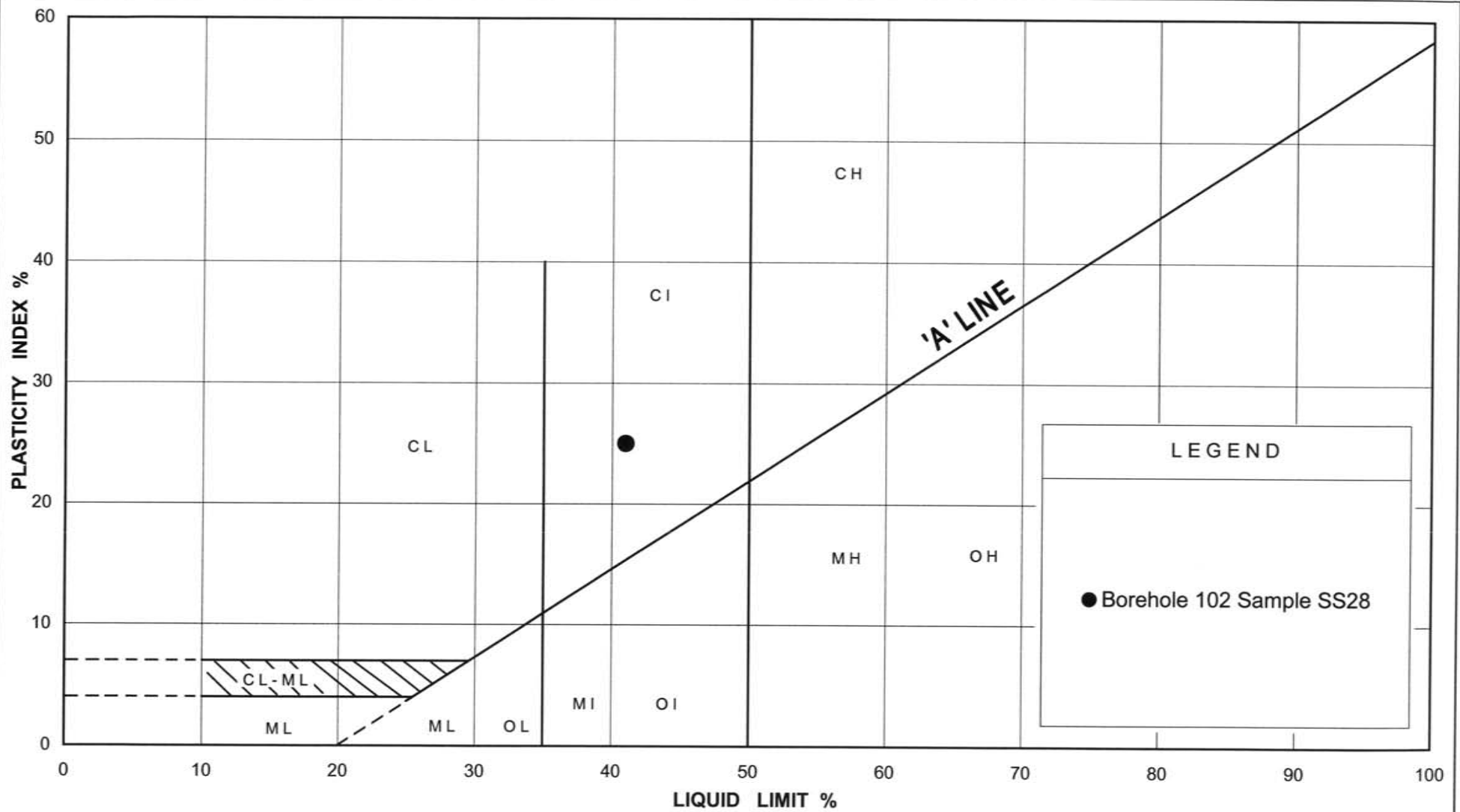


FIGURE C-8







SHAHEEN & PEAKER LIMITED

PLASTICITY CHART  
LOWER CLAY with silty clay layers

FIG No C-10

G.W.P. 406-01-00

REF No SPT 1139

# Appendix D

## Laboratory Test Results (Previous Investigation) Geocres No. 41K-60



# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

SAND

GRAVEL

Fine

Medium

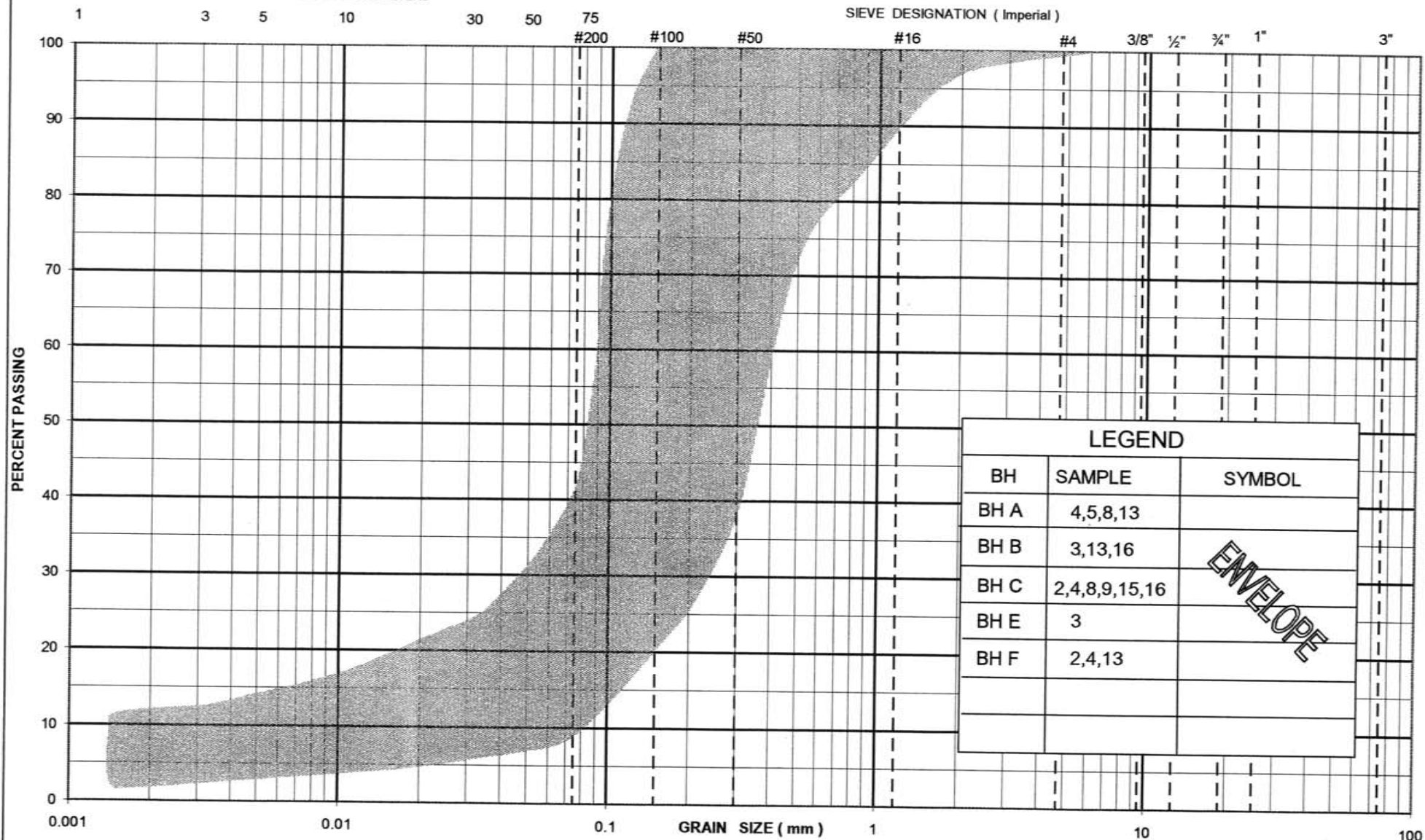
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION ( Imperial )



## LEGEND

BH	SAMPLE	SYMBOL
BH A	4,5,8,13	
BH B	3,13,16	
BH C	2,4,8,9,15,16	
BH E	3	
BH F	2,4,13	

ENVELOPE

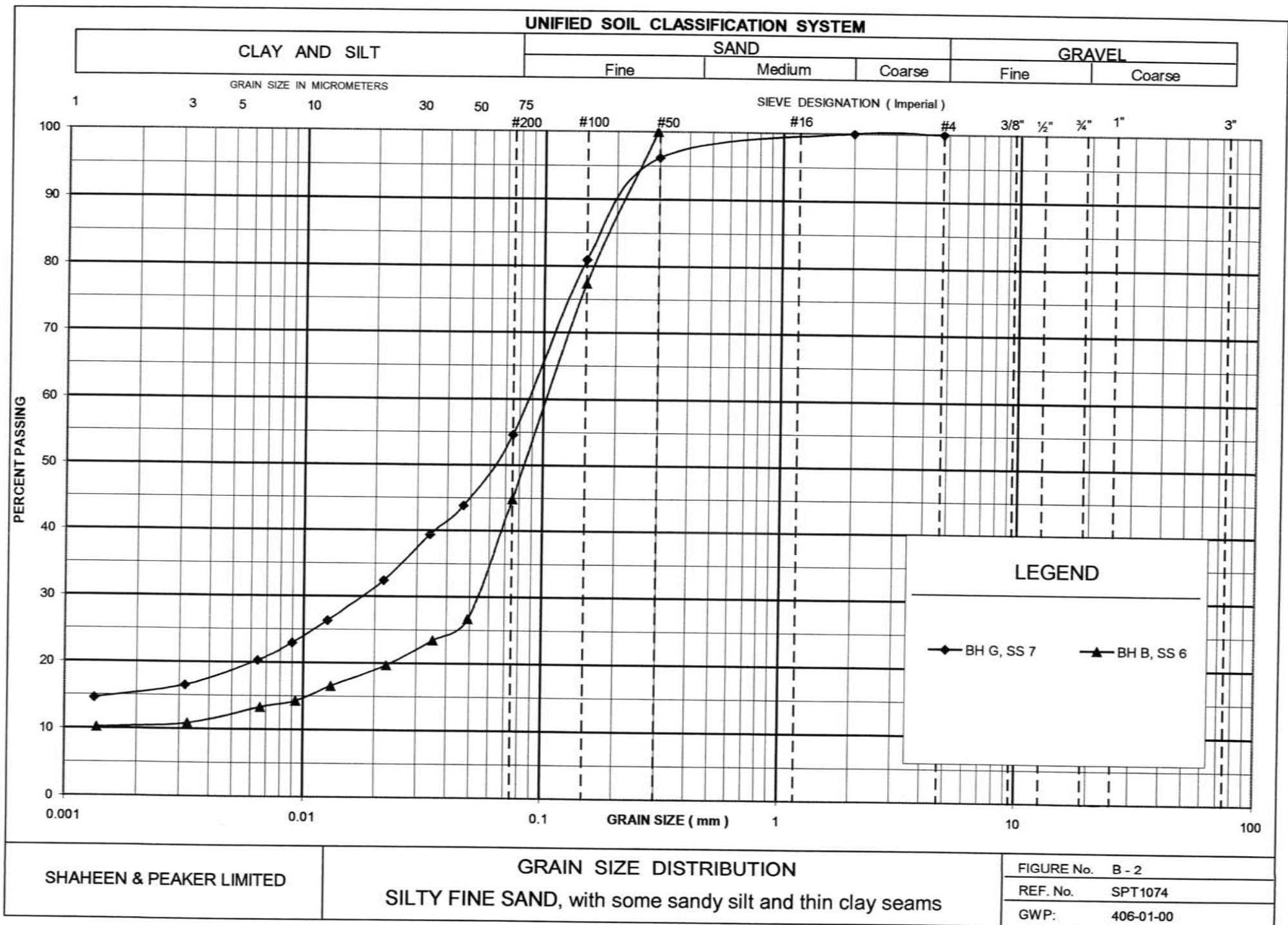
SHAHEEN & PEAKER LIMITED

GRAIN SIZE DISTRIBUTION  
SILTY FINE SAND

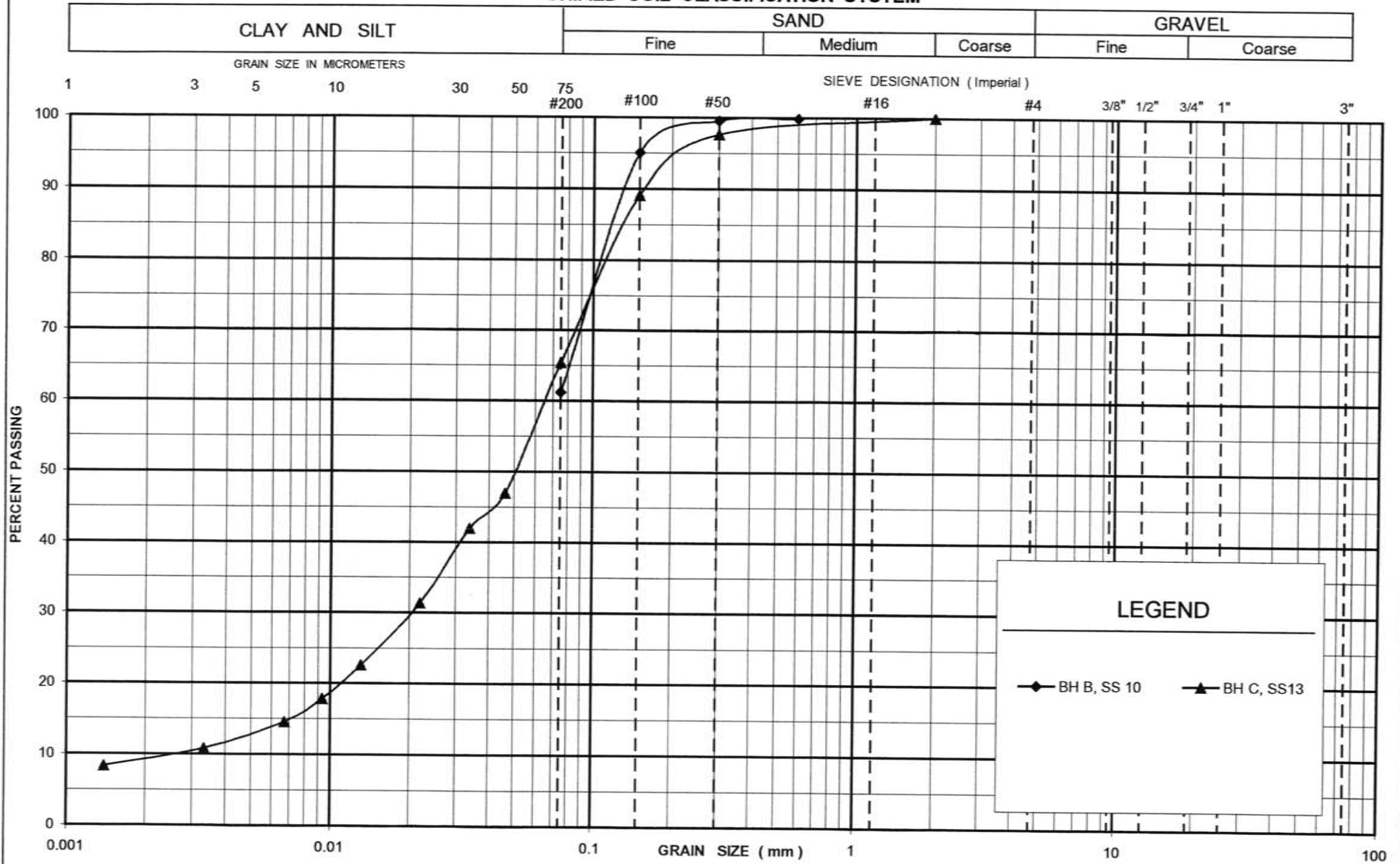
FIGURE No. B - 1

REF. No. SPT1074

GWP: 406-01-00



# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

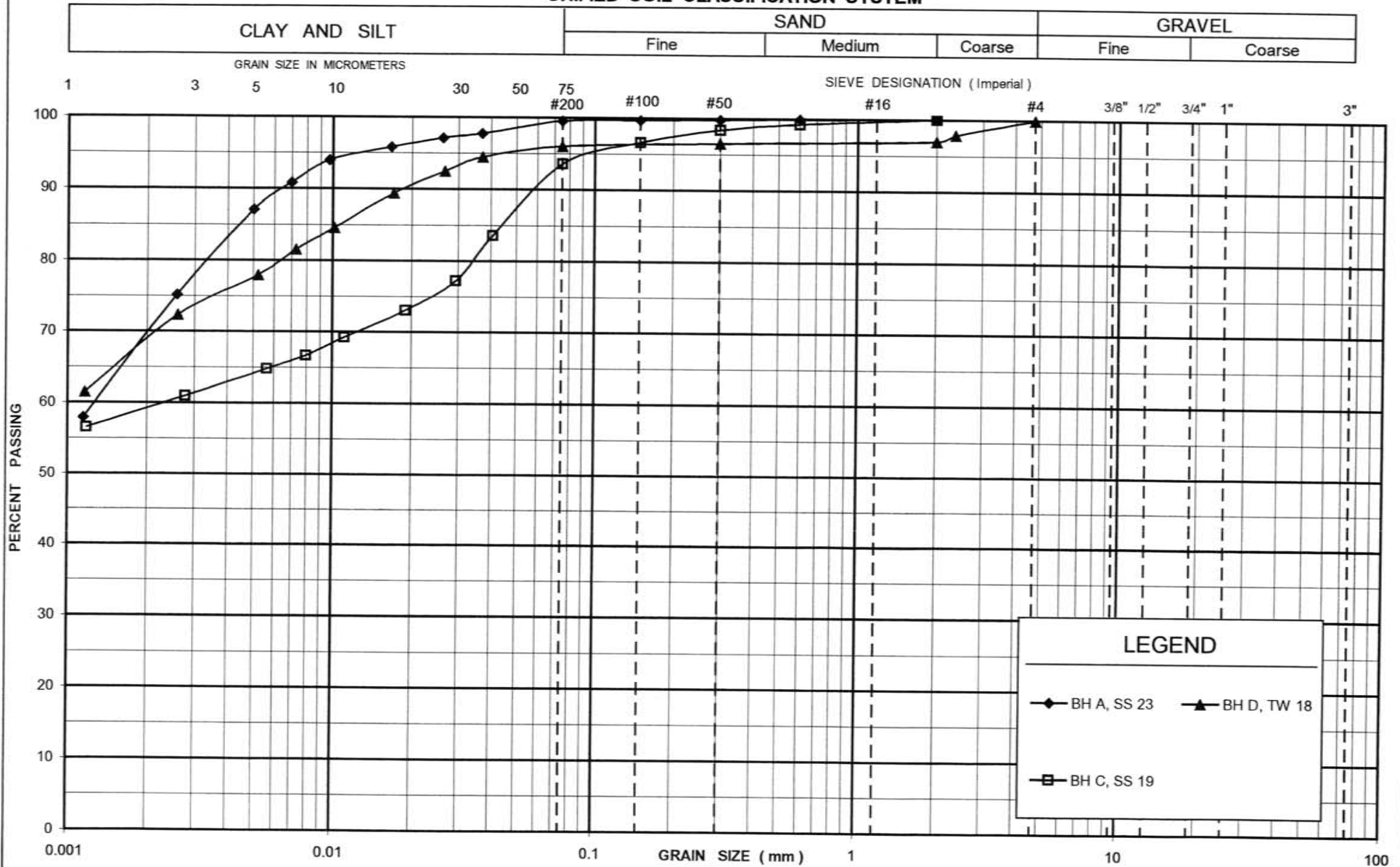
GRAIN SIZE DISTRIBUTION  
SANDY SILT

FIGURE No. B - 3

REF. No. SPT 1074

GWP: 406-01-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

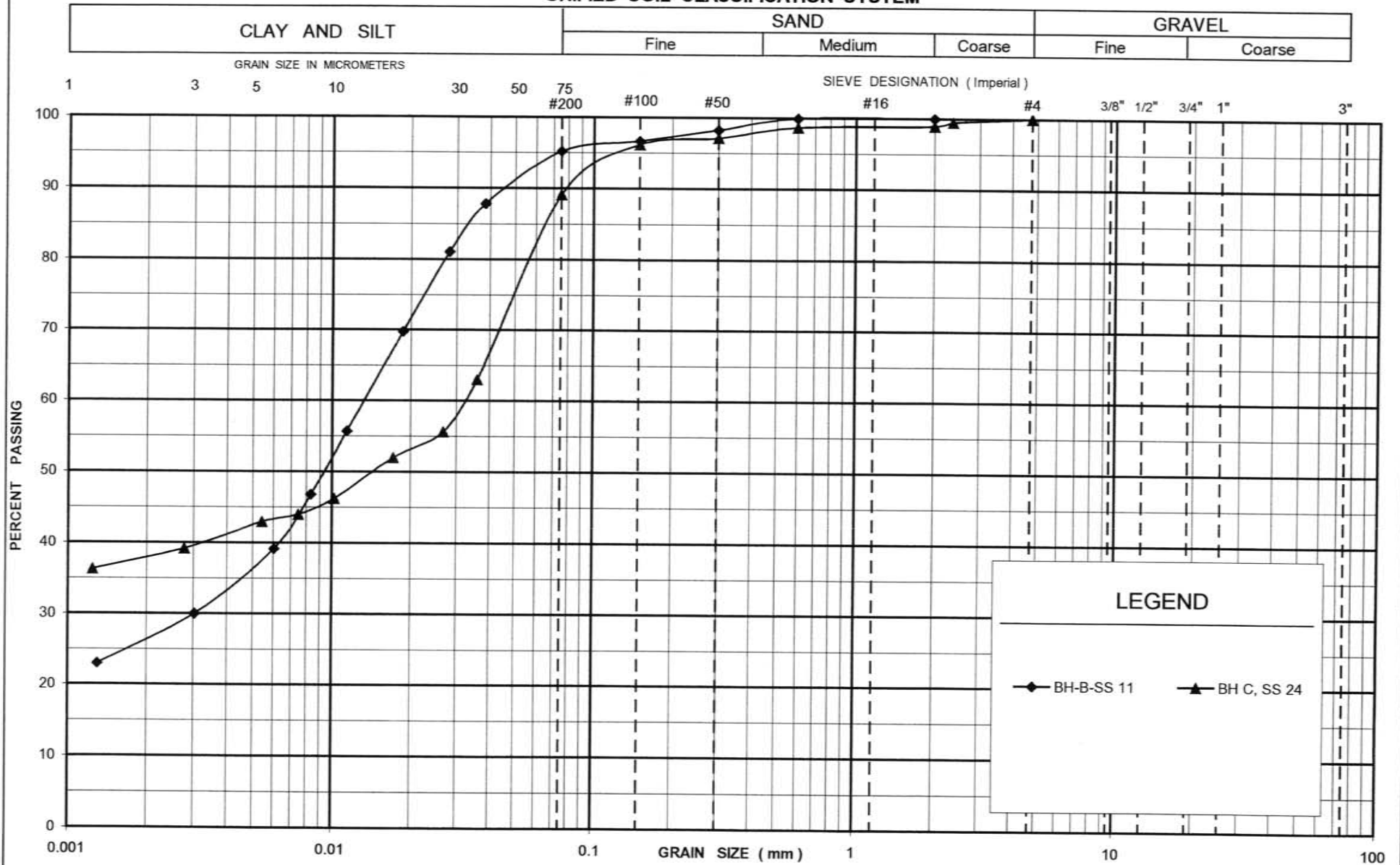
GRAIN SIZE DISTRIBUTION  
CLAY

FIGURE No. B - 4

REF. No. SPT 1074

GWP: 406-01-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

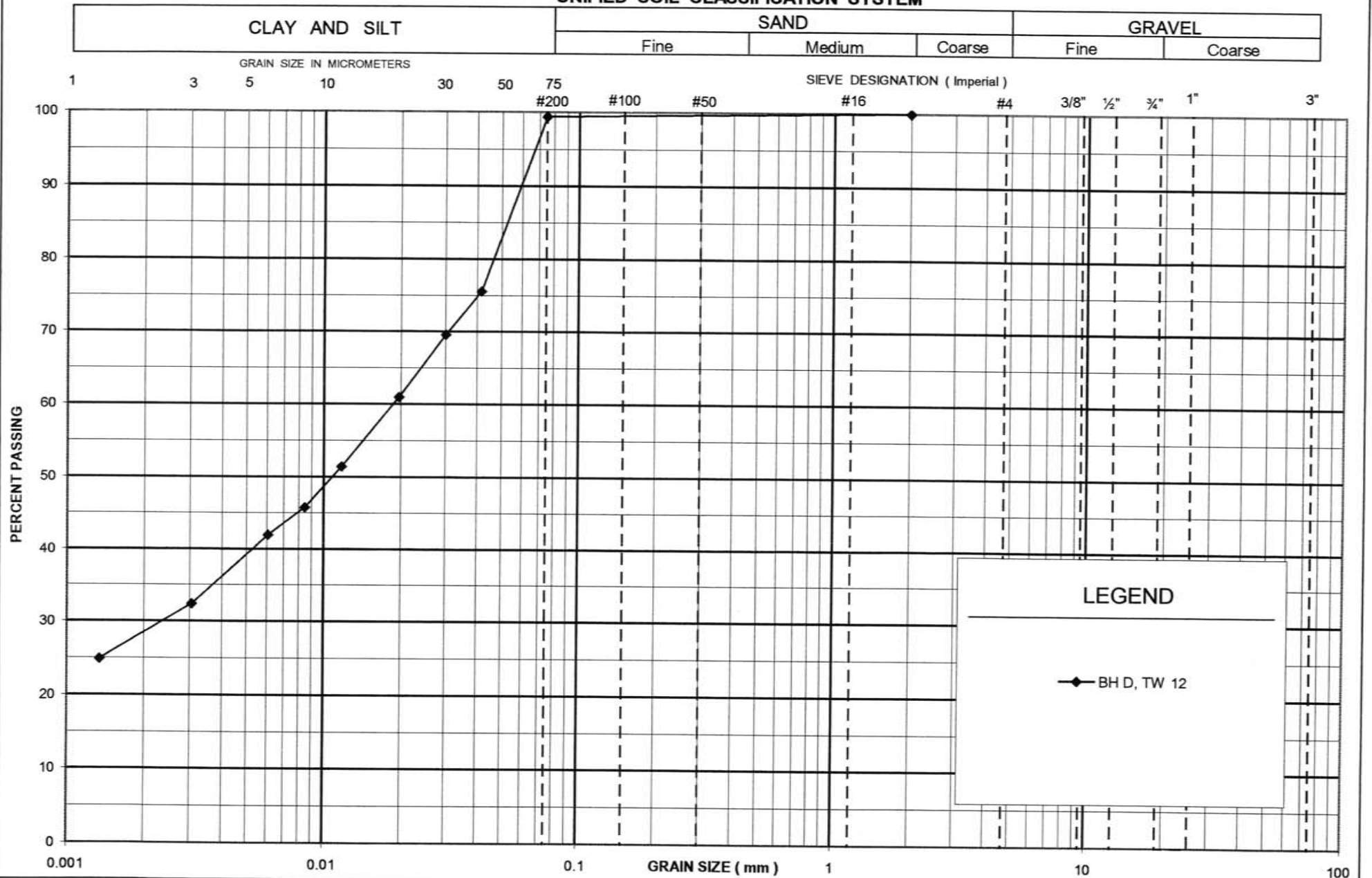
GRAIN SIZE DISTRIBUTION  
CLAY

FIGURE No. B - 5

REF. No. SPT 1074

GWP: 406-01-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



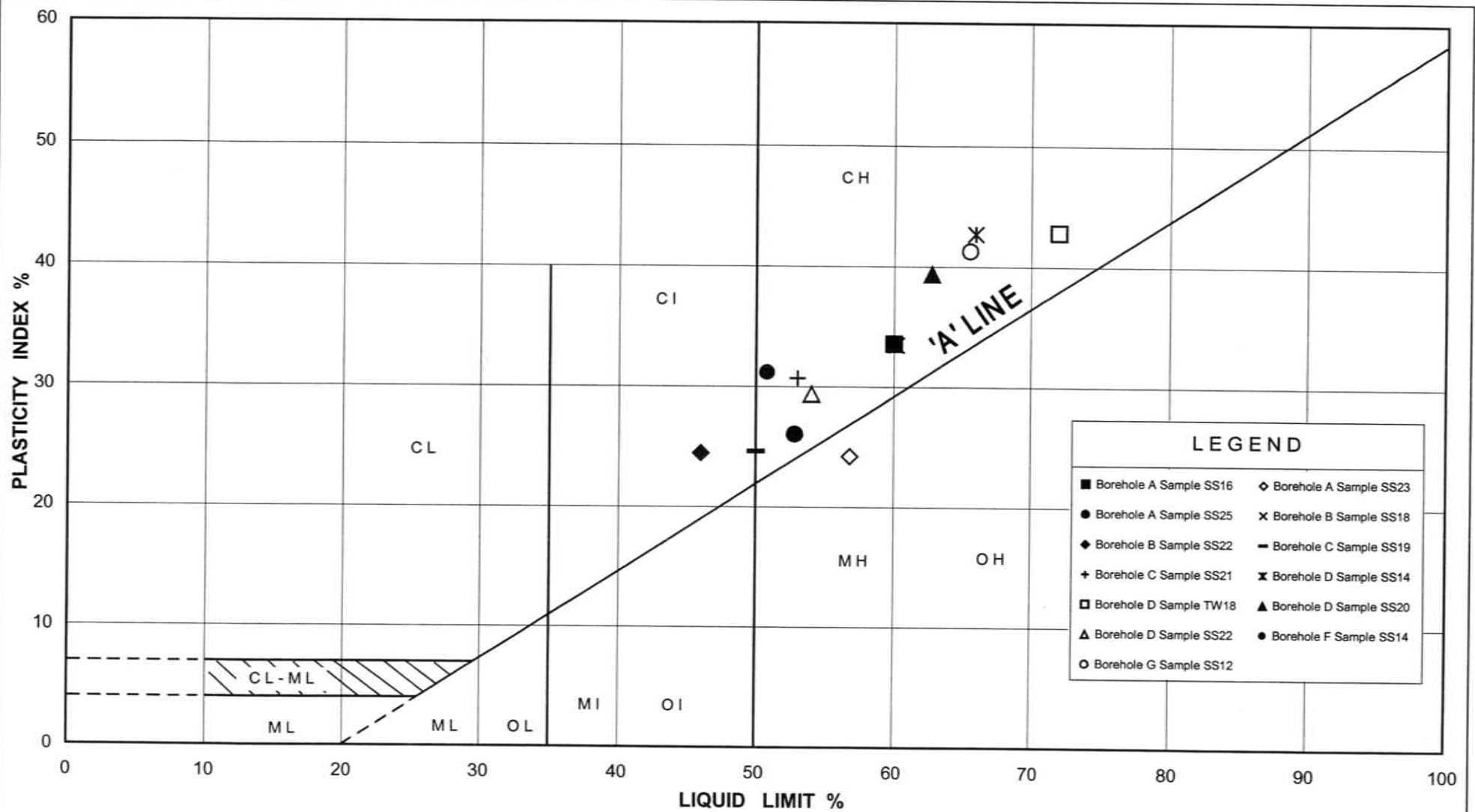
SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION**  
CLAY, with silty clay, clayey silt and silt seams

FIGURE No. B - 6

REF. No. SPT 1074

GWP: 406-01-00



SHAHEEN & PEAKER LIMITED

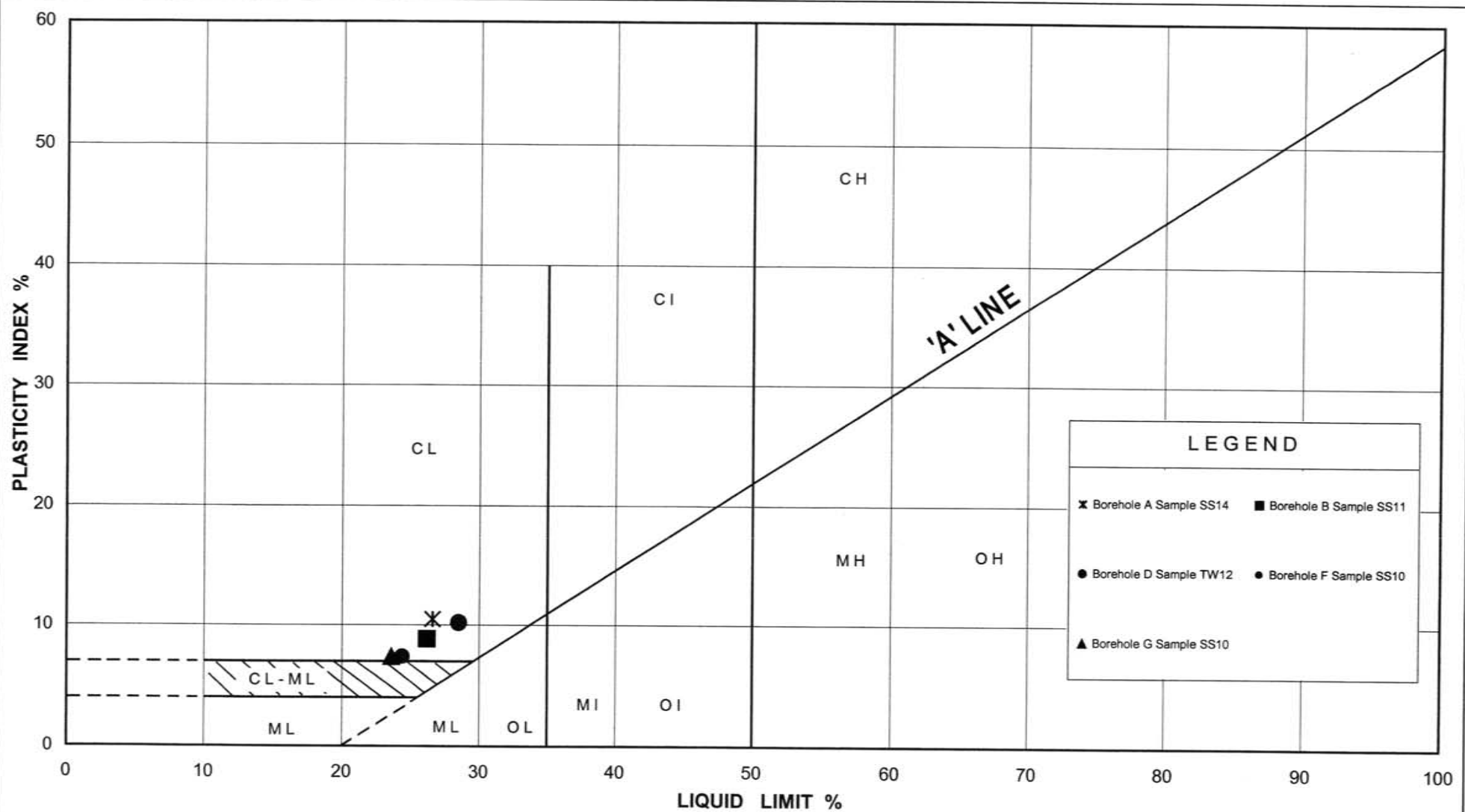
PLASTICITY CHART  
CLAY

FIG No B-7

G.W.P. 406-01-00

SPT 1074





SHAHEEN & PEAKER LIMITED

PLASTICITY CHART

CLAYEY SILT TO SILTY CLAY LAYERS in the Clay Deposit

FIG No B-8

G.W.P. 406-01-00

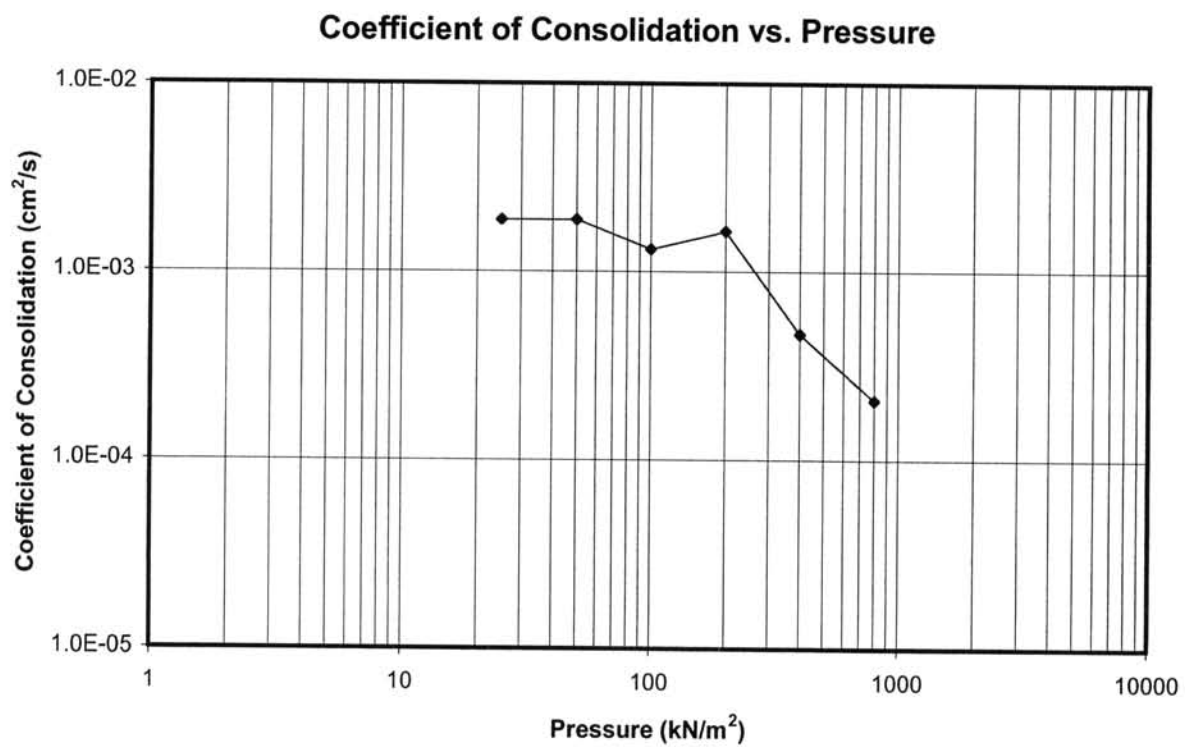
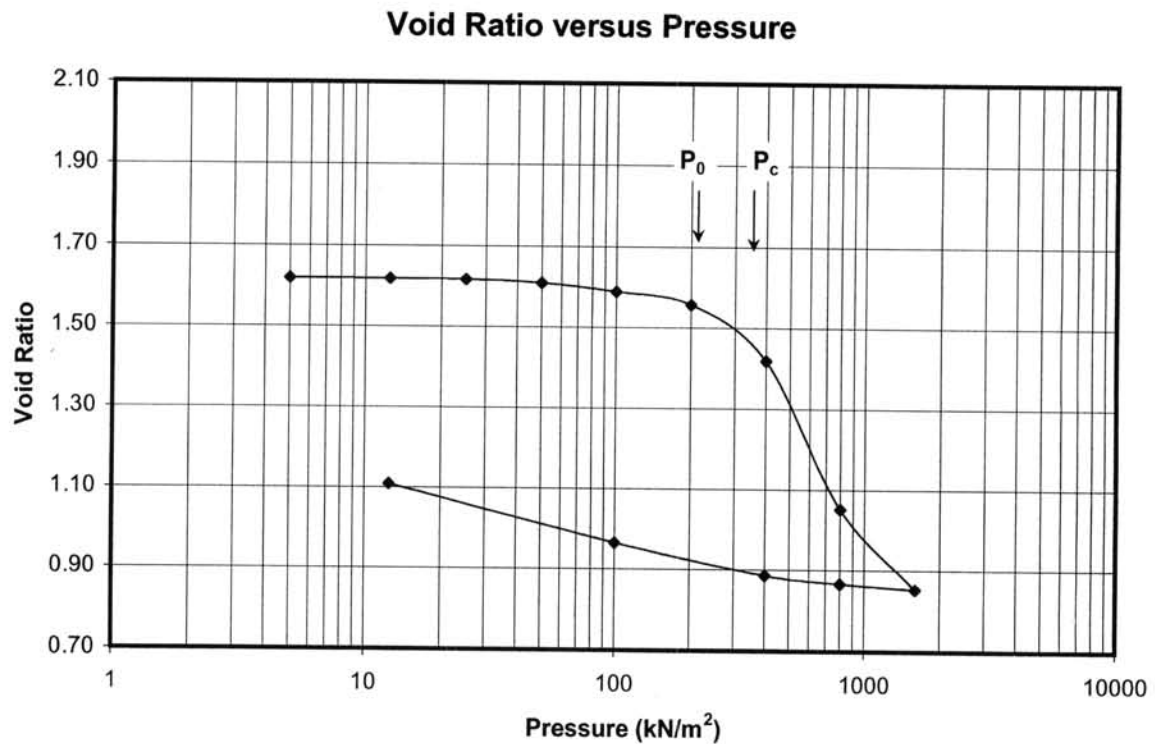
SPT 1074



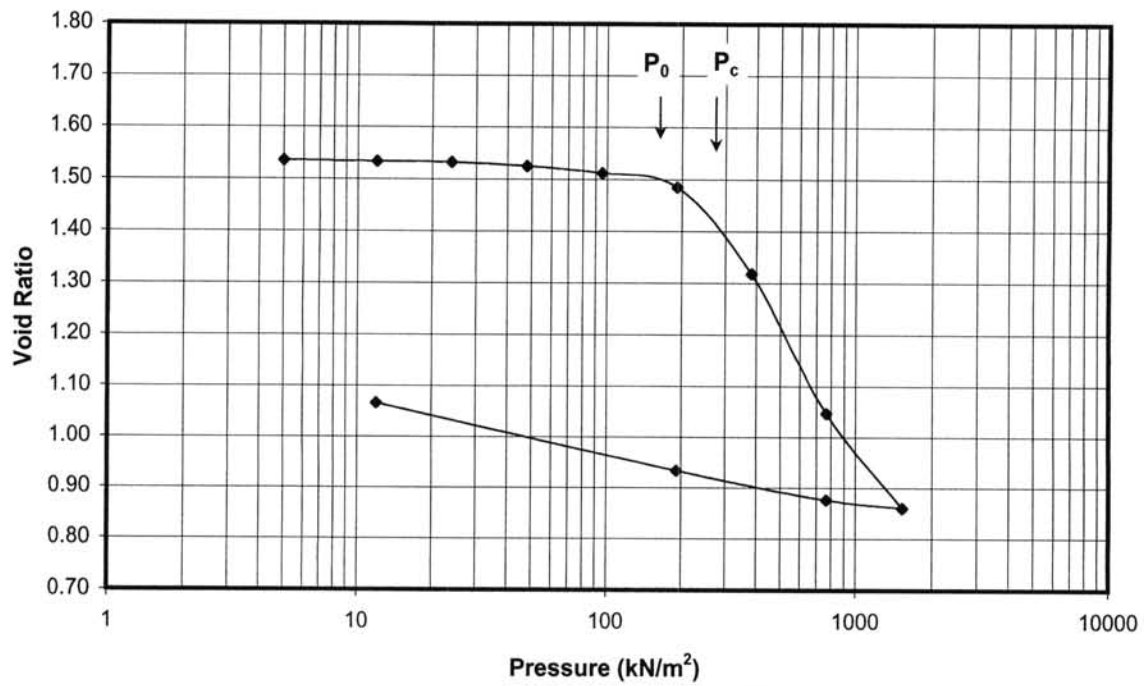
BH B

TW17 Depth 21.5 m

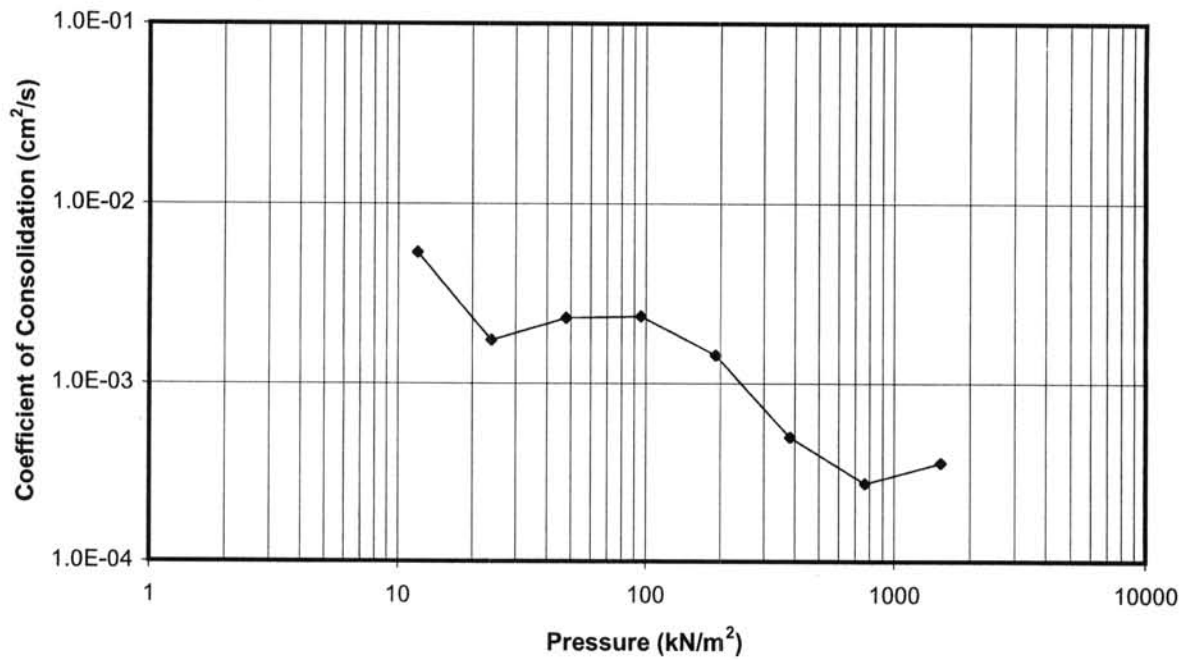
Fig. B - 9



### Void Ratio versus Pressure



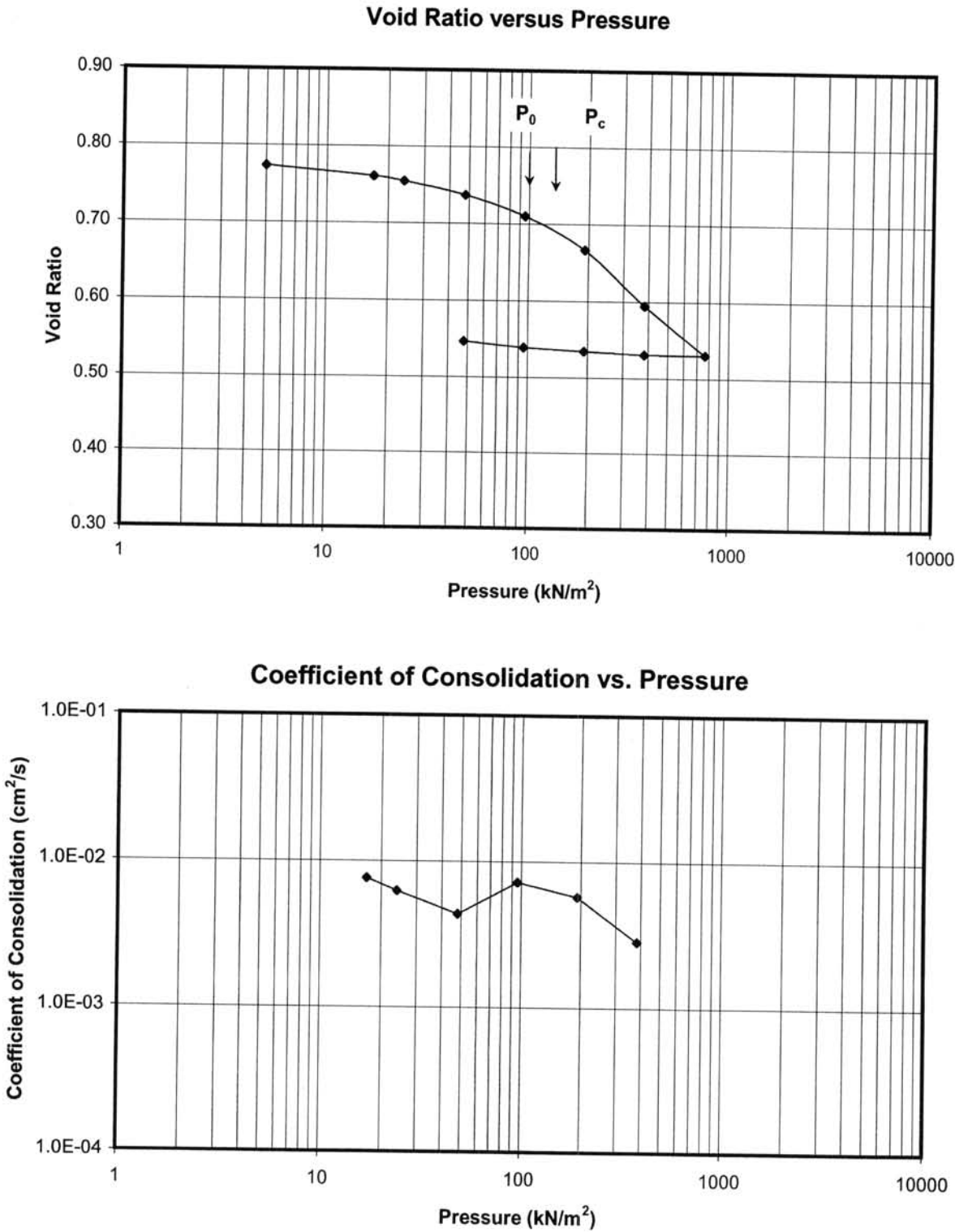
### Coefficient of Consolidation vs. Pressure



BH D

TW12 10.9 m

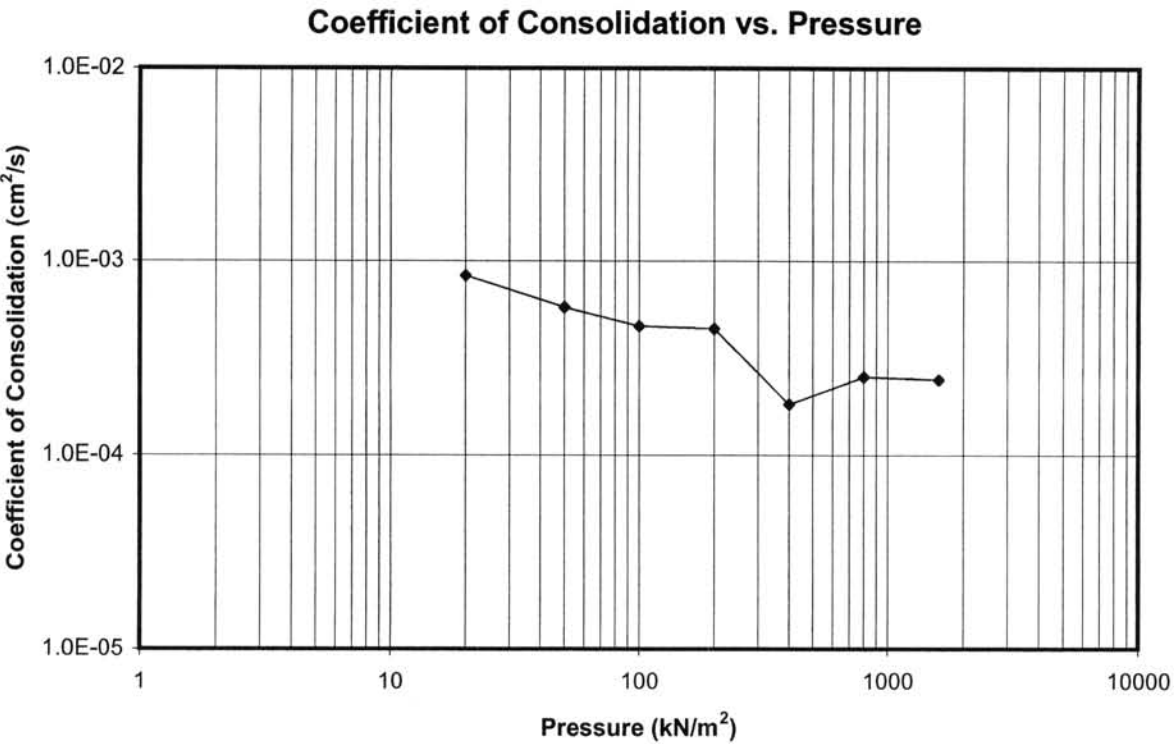
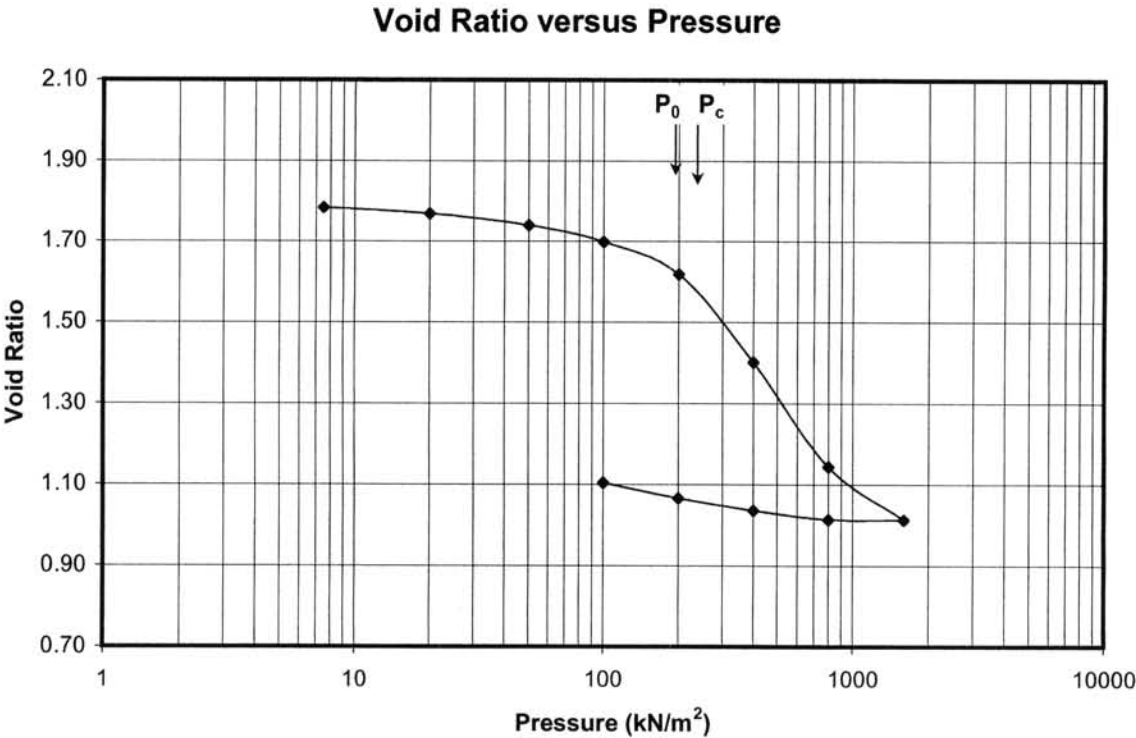
Fig. B - 11



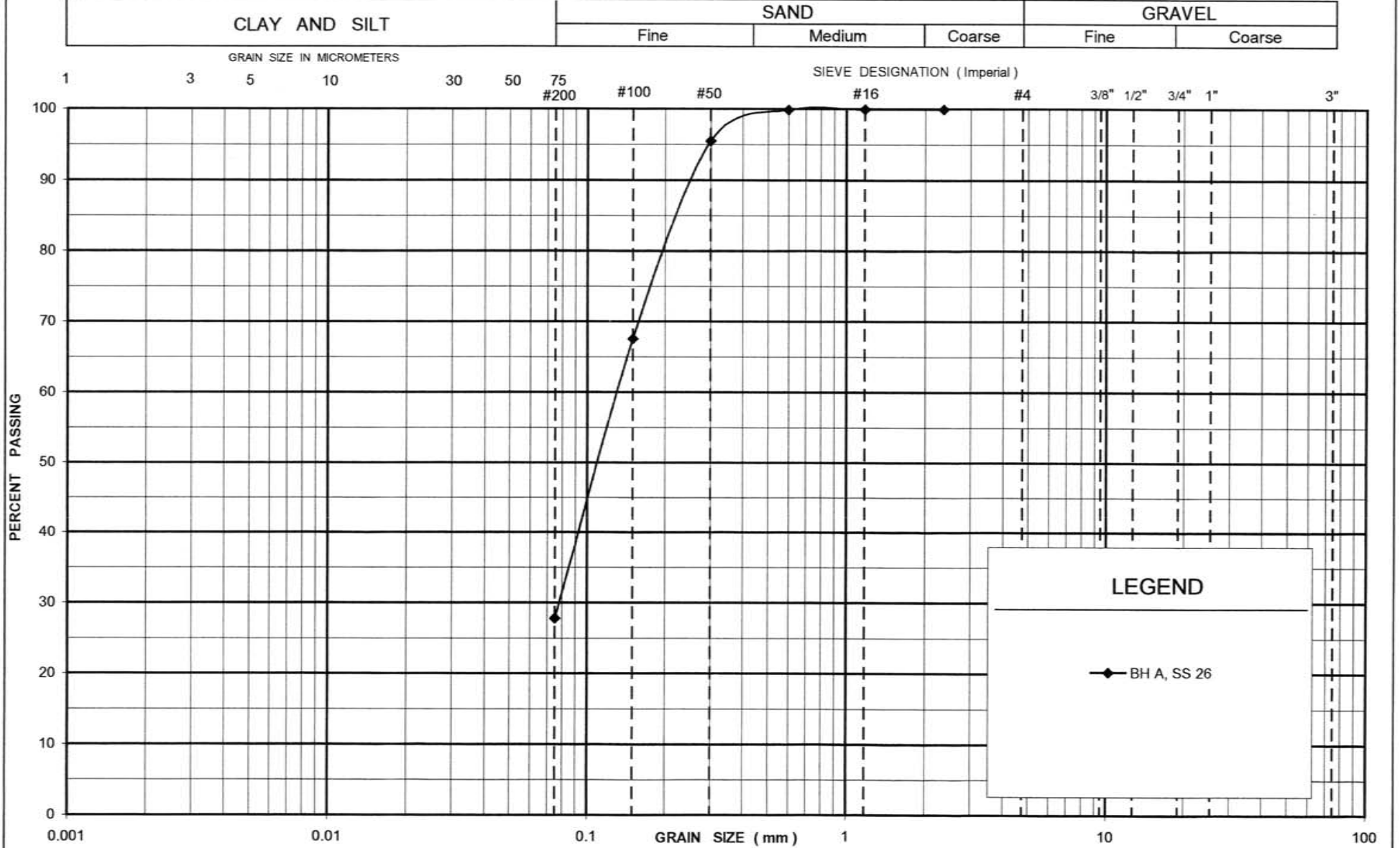
BH D

TW18 Depth 24.6 m

Fig. B -12



# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

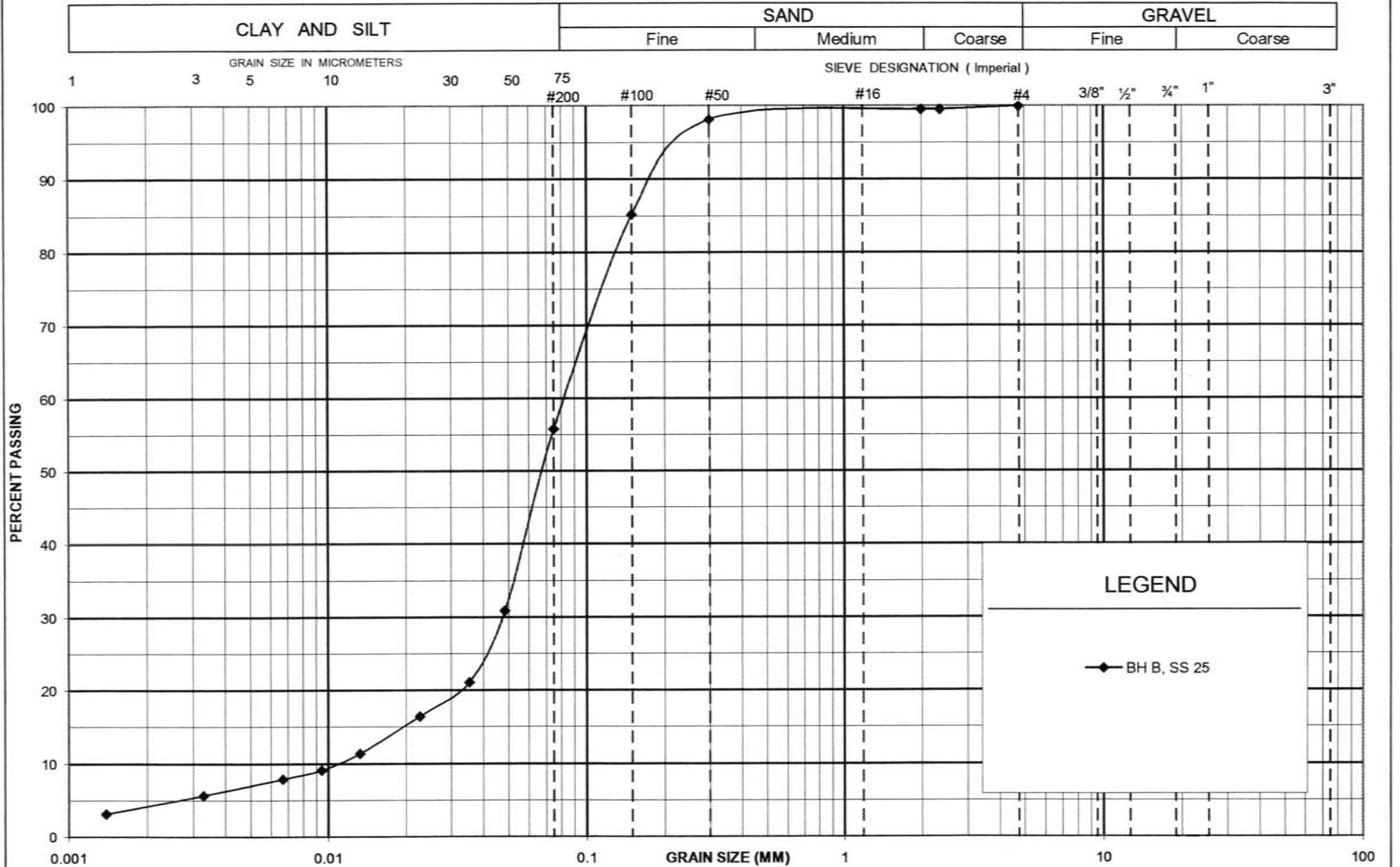
**GRAIN SIZE DISTRIBUTION  
SILTY FINE SAND**

FIGURE No. B - 13

REF. No. SPT 1074

GWP: 406-01-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



## Appendix E

### Standard Penetration Test Results and Measured Undrained Shear Strength Results

Figures E-1 to E-3  
(Present Investigation)  
Geocres No. 41K-66

Figures E-4 to E-6  
(Previous Investigation)  
Geocres No. 41K-60

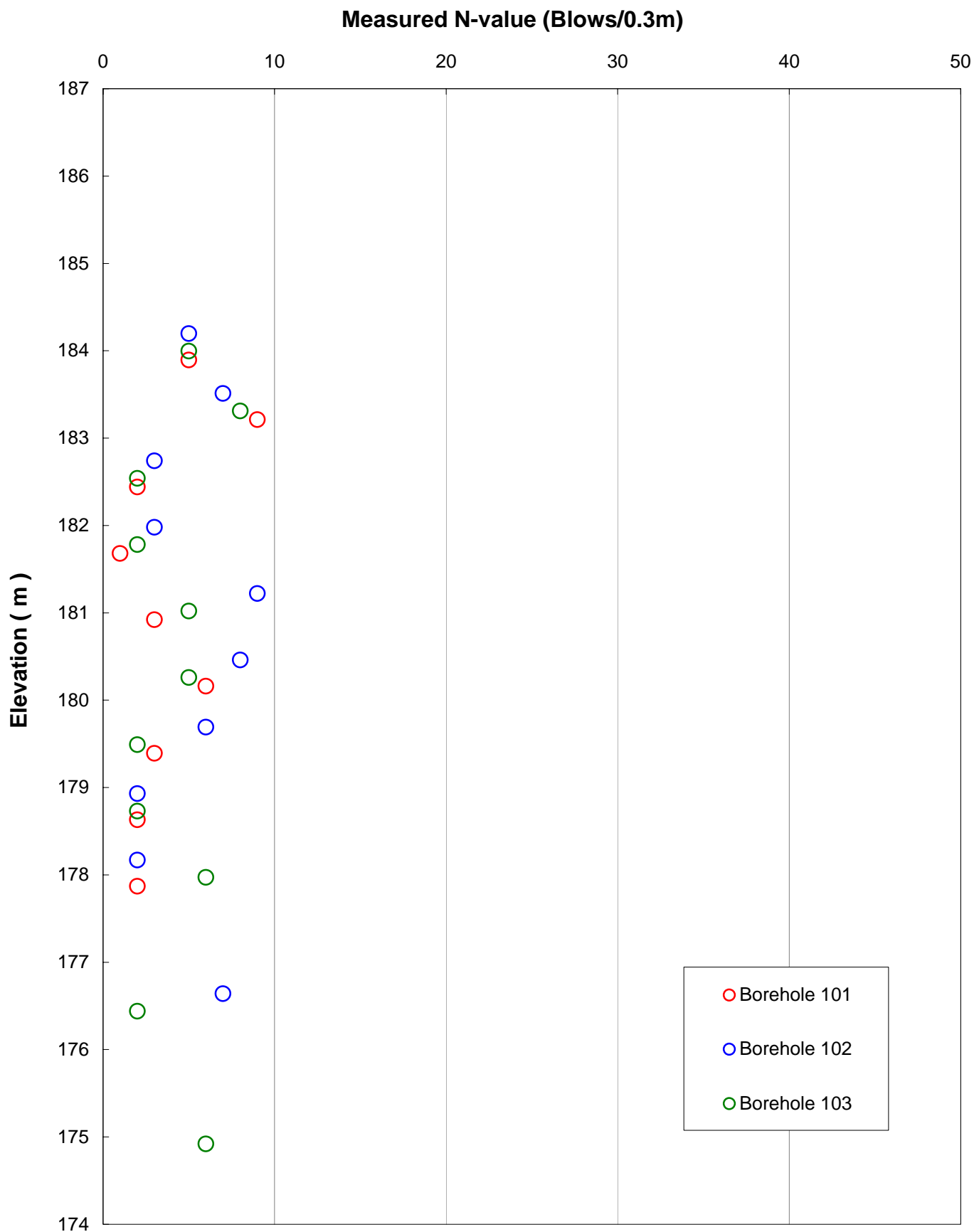


FIGURE E-1: Variation of N-values in the Sandy Silt to Silty Fine Sand Deposit  
(as measured by Standard Penetration Tests) with Elevation



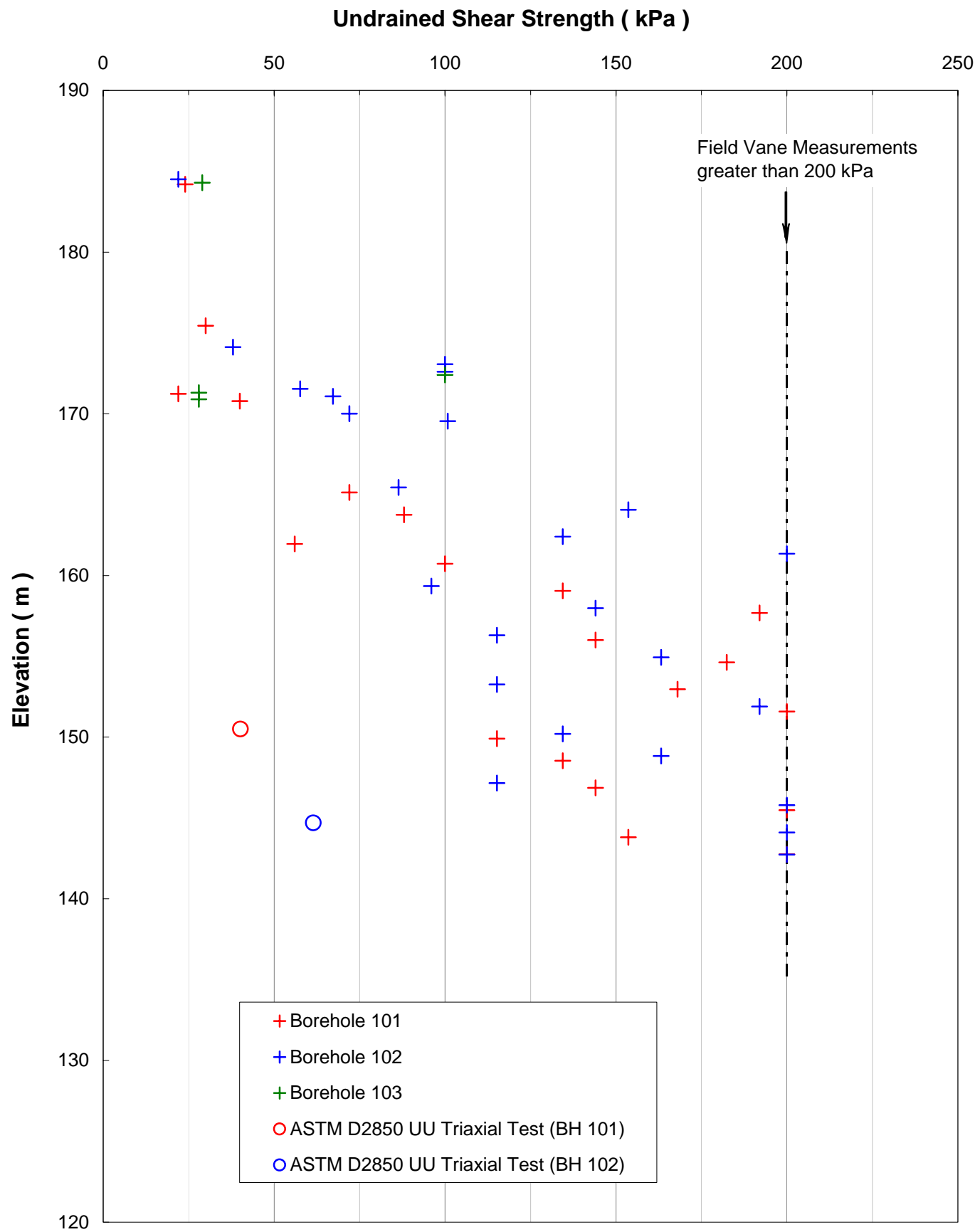


FIGURE E-2: Variation of Undrained Shear Strength (as measured by Field Vane Tests) with Elevation

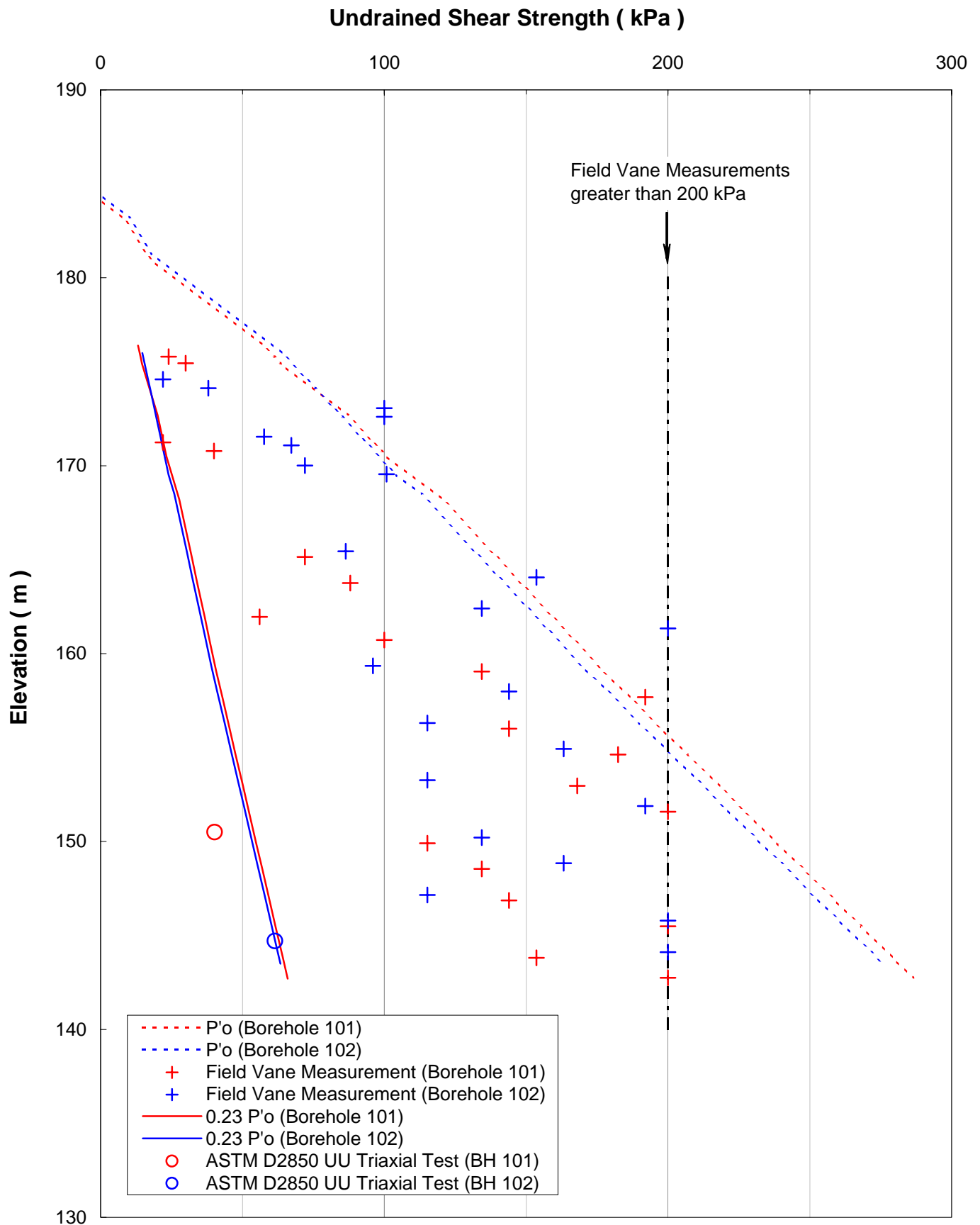


FIGURE E-3: Variation of Undrained Shear Strength (as measured by Field Vane Tests) with Elevation

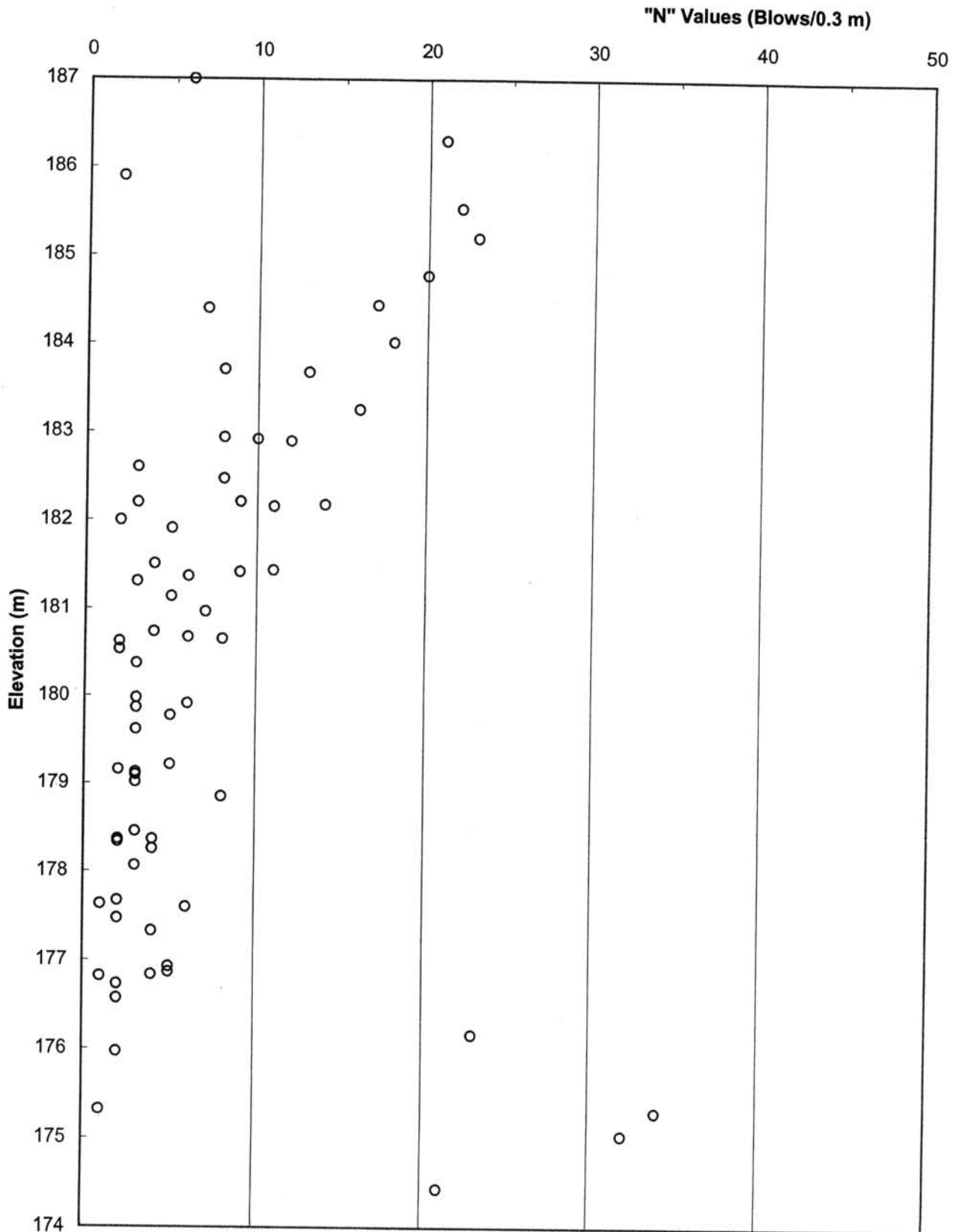


Fig. C-1: Variation of "N" Values in the Upper Silty Fine Sand Deposit (as measured by Standard Penetration Tests) with Elevation

FIGURE E-4: Variation of Measured N-values with Elevation  
from Previous Investigation (Geocres No. 41K-60)

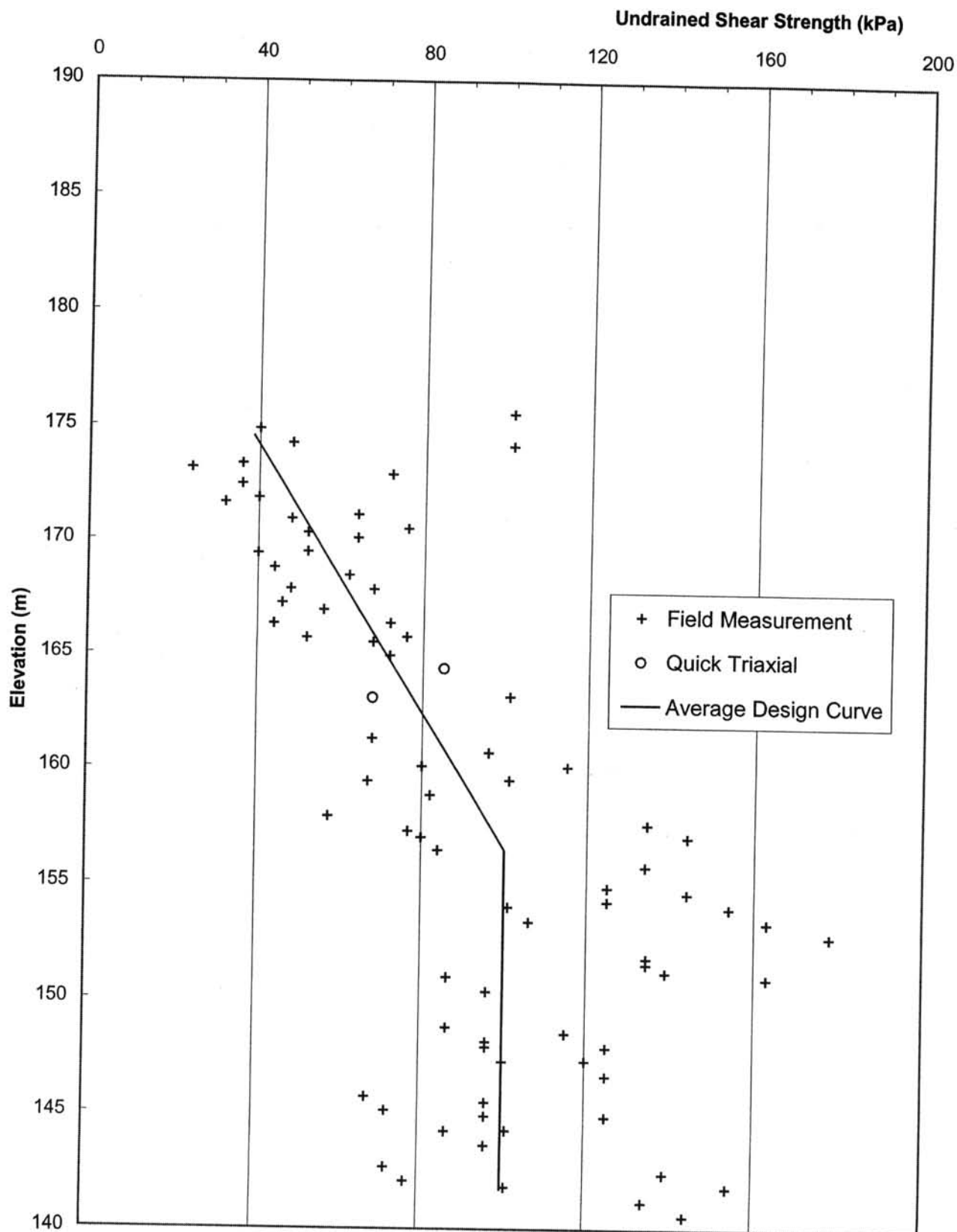


Fig. C-2: Variation of Undrained Shear Strength (as measured by field vane tests, and quick triaxial tests) with Elevation (Boreholes A, B, C, D, F and G)

FIGURE E-5: Variation of Undrained Shear Strength with Elevation from Previous Investigation (Geocres No. 41K-60)

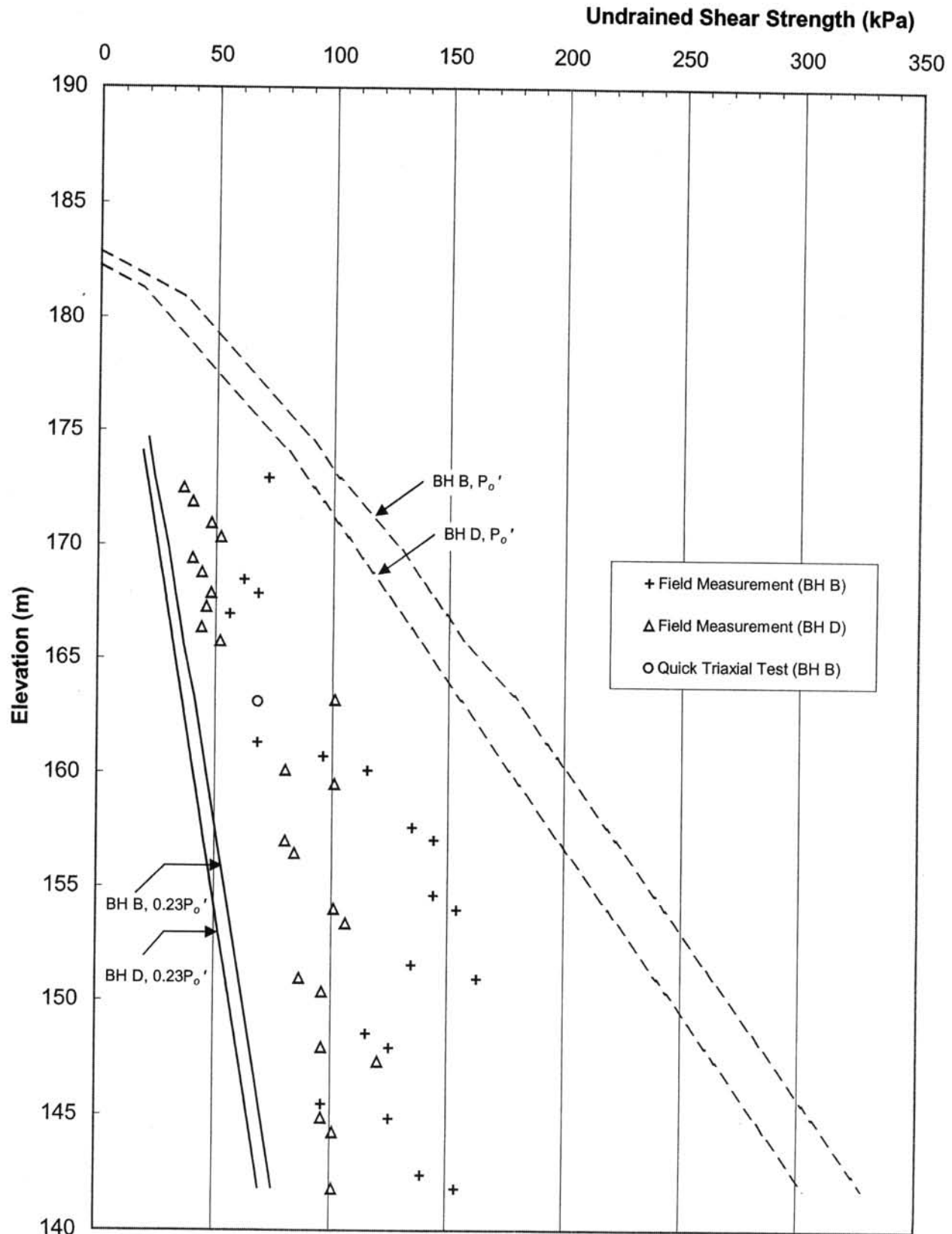


Fig. C-3: Variation of Undrained Shear Strength (as measured by field vane tests, and quick triaxial test) with Elevation (Boreholes B and D)

FIGURE E-6: Variation of Undrained Shear Strength with Elevation from Previous Investigation (Geocres No. 41K-60)

# Appendix F

## Site Photographs





Photograph F-1 Area downstream of the creek re-alignment



Photograph F-2 Area downstream of the creek re-alignment





Photograph F-3 Looking downstream at approximate Station 10+800



Photograph F-4 Looking upstream at approximate Station 10+900



## Appendix G

# Explanation of Terms Used in Report

## EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS  $\bar{N}$ .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$C_u$ (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCUTRAL FEATURES AND/OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINT AND BEDDING:**

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICALL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$c_c$	1	COMPRESSION INDEX
$c_s$	1	SWELLING INDEX
$c_a$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $c_u / \tau_r$

## PHYSICAL PROPERTIES OF SOIL

$P_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$j_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$P_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$j_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$s_r$	%	DEGREE OF SATURATION	$D_n$	mm	N PERCENT – DIAMETER
$P$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$j$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$P_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$j_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $(W_L - W_p) / I_p$	v	m/s	DISCHARGE VELOCITY
$P_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $(W - W_p) / I_p$	i	1	HYDAULIC GRADIENT
$j_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_c$	1	CONSISTENCY INDEX = $(W_L - W) / 1_p$	k	m/s	HYDRAULIC CONDUCTIVITY
$P'$	kg/m <sup>3</sup>	DENSITY OF SUBMERED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m <sup>3</sup>	SEEPAGE FORCE
$j'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						