



**THURBER** ENGINEERING LTD.

## **MEMORANDUM**

To: Christopher Schueler, P.Eng.  
URS Canada Inc.

Date: October 21, 2014

From: Alastair Gorman, P.Eng.  
(Reviewed by P.K. Chatterji, P.Eng.)

File: 19-4406-20

### **PRELIMINARY FOUNDATION ASSESSMENT W-N/S RAMP BUTLER CREEK (SITE 21-609/C)**

#### **1 INTRODUCTION**

This memo presents a brief summary of the geotechnical assessment of the concrete box culvert that conducts Butler Creek under the Ramp Hwy 401 W – N/S County Road 30. It also presents preliminary geotechnical recommendations for use in assessment of the existing foundations at the site. It is noted that the proposed rehabilitation alternatives are not yet defined.

The recommendations provided in this memorandum are for planning, structure evaluation and preliminary design purposes only. Additional investigation and analysis may be required in any subsequent detail design phase of the project.

The following reference numbers apply to this site:

- Current W.P. 4016-13-01
- Site No. 21-609/C
- GEOCRES No. 31C-171 (adjacent structure retaining walls)
- Historic W.P. N/A

#### **2 SITE DESCRIPTION**

The site is located in the southwest quadrant of the intersection of Northumberland County Road 30 and Highway 401 in Lot 4, Concession IV, geographic Township of Brighton, County of Northumberland. Based on the description in Section 6.3.3 of the RFP, the existing culvert is cast-in-place, rigid frame, open-footing culvert constructed in 1960. It has a span of 3.1 m and an overall length of 45 m. The approximate height of fill over the culvert is 10 m.

The mapping in the Physiography of Southern Ontario by Chapman and Putnam shows that the site lies in a drumlinized till plain just above the Lake Iroquois shorecliff. The rolling nature of the terrain in the vicinity of the site is consistent with this mapping and the steep grade of County Road 30 to the south of the site also confirms the presence of the shorecliff.



### 3 SUBSURFACE CONDITIONS

No geotechnical information was found for this culvert site. The closest information is available from a 2005 investigation carried out for retaining walls associated with the adjacent underpass structure, with the closest boreholes in the order of 200 m from the culvert. However, this information has been accepted as providing a general indication of the ground conditions expected to prevail below the culvert.

In the closest borehole from that investigation, Borehole No. 6, the soil stratigraphy is described as follows.

**Fill** - The upper 2.9 m of material is described as silty sand to sand fill, loose to compact, brown and moist. The base of the fill lies at Elevation 194.6.

**Organic Silt** – The fill is underlain by a 500 mm layer of organic silt, extending to Elevation 194.1, and described as having peat inclusions and silty sand zones. The SPT value of 18 blows for 0.3 m of penetration suggests compact conditions.

**Sand and Gravel** – The organic silt is underlain by a thin layer of sand and gravel that extends to Elevation 193.7. This material, together with the overlying organic silt are considered to represent the original surface soils at the site.

**Silty Sand to Sandy Silt Till** – The predominant soil stratum underlying the site is a silty sand to sandy silt till that is loose at the top, becoming compact to dense and very dense below Elevation 190.

The 2005 GEOCRE file for the retaining walls in the adjacent interchange is attached in Appendix A.

### 4 SITE OBSERVATIONS

Foundations engineering staff from Thurber visited the site to observe conditions related to the general geotechnical performance. The inspection was limited to observations of the embankment over the culvert and no attempt was made to examine the interior of the culvert.

The approach embankments slopes appeared to be stable, with no obvious signs of instability, bulging or erosion. The lower slopes, around the ends of the culvert are heavily vegetated, see attached photograph in Appendix B.

### 5 ASSESSMENT OF EXISTING FOUNDATIONS

There are neither historic drawing nor site-specific subsurface geotechnical information on which to base an assessment of the culvert foundations. The investigation at the underpass structure by Shaheen and Peaker indicated that the native soils in the area consist of cohesionless deposits ranging from silt to sandy silt to sand and gravel that the soils are in a compact to dense state. Very dense silty sand till was encountered at greater depth. Soft or loose organic silt and stream deposits may have existed over the site prior to highway construction.



## THURBER

No reports have been presented to suggest that the foundations have experienced any movement and the overlying embankment appears to be performing well. Accordingly, it can be surmised that the existing culvert and its foundations were appropriately designed and can safely carry the imposed loads.

Provided there is no increase in the loads applied to the culvert, it can be assumed that the culvert foundations will continue to perform satisfactorily. The RFP document suggested that the required rehabilitation work consists of repair to the deteriorated concrete visible at the ends of the culvert. In this case, there will be no appreciable increase in the loading.

However, if replacement of the culvert becomes necessary, or there is an increase in loading, it will be necessary to carry out site investigation and field testing to support the preparation of foundation design recommendations.

## 6 EXCAVATION AND ROADWAY PROTECTION

If the selected rehabilitation strategy requires excavation to expose the culvert, it is recommended that site investigation and field testing be carried out through the embankment fill in order to characterize the fill and to select parameters for geotechnical design, including roadway protection. For replacement or full length rehabilitation, three boreholes are considered to be appropriate. The boreholes should extend through the embankment and to sufficient depth to obtain the information required for the planning of the rehabilitation. This typically would require drilling to 10 m below the culvert invert, or stream bed.



## 7 CLOSURE

The factual subsurface information used in the preparation of this memorandum was taken from the report by Shaheen and Peaker Limited titled "Foundation Investigation and Design Report, Proposed Retaining Structures, Highway 401 at County Road 30. Brighton, Ontario, G.W.P. 4322-04-00, GEOCRETS No. 31C-171" and dated September 30, 2005.

This memorandum was prepared by Mr. Alastair Gorman, P.Eng., Senior Foundations Engineer and was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Alastair Gorman, P.Eng.  
Associate, Senior Foundation Engineer

P.K. Chatterji, P.Eng.  
Review Principal, Designated MTO Contact

Attachment

**Appendix A**  
**GEOCRES File**

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
PROPOSED RETAINING STRUCTURES  
HIGHWAY 401 AT COUNTY ROAD 30  
BRIGHTON, ONTARIO  
G.W.P. 4322-04-00**

**GEOCRES NO. 31C-171**

**Prepared For:**

**TOTTEN SIMS HUBICKI ASSOCIATES**

**Prepared by:**

**SHAHEEN & PEAKER LIMITED**

**Project: SPT1131  
September 30, 2005**



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**FOUNDATION INVESTIGATION REPORT  
PROPOSED RETAINING STRUCTURES  
HIGHWAY 401 AT COUNTY ROAD 30  
BRIGHTON, ONTARIO  
G.W.P. 4322-04-00**

**1. INTRODUCTION**

As part of the planned rehabilitation of the existing County Road 30 Underpass structure at Highway 401, retaining walls are proposed to be constructed in front of the north and south abutment walls to facilitate the future ramp improvements and widening of Highway 401.

An original geotechnical investigation for the existing structure was carried out in 1958 by MTO and this consisted of drilling four boreholes at the site (see Appendix B). Shaheen & Peaker Limited (S&P) was retained by Totten Sims Hubicki Associates (TSH) to carry out an additional foundation investigation for the proposed retaining walls. The purpose of the present investigation was to obtain subsurface information at and near the locations of the proposed retaining walls by means of boreholes and provide geotechnical recommendation for the design of the structures.

The work was performed in accordance with Consultant Assignment Agreement No. 4005-A-000300.

The findings of the investigation are presented in this report.

**2. SITE DESCRIPTION AND GEOLOGY**

The site is located along Highway 401, Lot 4, Concession IV, Geographic Township of Brighton, County of Northumberland, as shown on the Key Map (Drawing No. 1). The existing 4-lane structure, which was constructed in 1959 on County Road 30 over Highway 401, is a three-span (approx. 15.8 m; 37.1 m; 15.8 m) cast-in-place concrete bridge. The structure is supported by concrete piers and abutments at a 6°30' skew to the roadway alignment. The perched abutments and piers are founded on steel H-piles.

The forward slope on the north side of the bridge has a slope of about 3H:1V while the south forward slope has a gradient of about 2H:1V. Both forward slopes have concrete panel facing. The side slopes are approximately 2H:1V. There is an existing concrete culvert on the north side of the bridge, between the pier and the abutment as shown in Drawing No.1. This culvert is approximately 1.7 m wide and 1.1 m deep.

Highway 401 has an elevation of about 196 to 197 m while County Road 30 has an elevation of 204 m, indicating a height of embankment of about 7 to 8 m.

The study area is located in the physiographic region known as the "Iroquois Plain." The plain consists of drumlins and sand plains (Ref: Chapman and Putnam, 1984).

Glacio-lacustrine lake plain deposits of silt and clay with gently rolling terrain characterize the soils of the immediate area. Characteristics of the soil types are imperfect drainage, smooth to gently sloping topography, free of stones. The upper lacustrine silt and clay were deposited on clayey glacial tills underlain by sandy tills.

The lowermost bedrock in the general area (i.e. Northumberland County) consists of Precambrian rock, with upper layers of limestone. These limestone layers are made up of the Trenton Group bedrock formations and were deposited during the Middle Ordovician Period, during the Paleozoic Era, some 480 million years ago.

### **3. INVESTIGATION PROCEDURES**

The fieldwork for this project was conducted on October 19, 20 and 21, 2004 and consisted of drilling and sampling eight boreholes. The plan locations of the boreholes, along with the stratigraphic sections, are shown on Drawing Nos. 1 and 2.

Boreholes 1 through 6 were drilled with solid-stem continuous-flight augers using a track mounted drilling rig, while Boreholes 3A and 4A were extended using hand-drilling methods, due to inaccessibility at the forward slopes with a vehicle. The drill rig was owned and operated by Eastern Soil Investigation Limited of Courtice, Ontario, who also effected Boreholes 3A and 4A by hand-drilling methods. All fieldwork was performed under the full-time supervision of a geotechnical engineer from S&P.

Boreholes 1 through 6 were advanced to depths of 12.3 to 21.6 m. Sampling in these boreholes was effected at frequent intervals of depth by the Standard Penetration test (SPT) method, as specified in ASTM D1586. This 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 (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 and this gives an indication of the consistency or the compactness condition of the soil deposit.

Boreholes 3A and 4A were extended to depths of 3.7 to 4.3 m by manual (hand) drilling methods by driving a standard split-spoon sampler into the undisturbed ground by means of a 31.8 kg hammer a vertical distance of 0.76 m, similar to the SPT method. After driving the sampler into the ground, the sampler was withdrawn, the soil samples were retrieved and the sampler was put back in the hole to drive it further. The number of blows of the hammer was counted and this number was halved to obtain an approximately equivalent 'N' value,

similar to an SPT and the resulting values are shown on the Record of Borehole Nos. 3A and 4A.

Water level observations in the open boreholes were made during the drilling and at the completion of each borehole. Piezometers were also installed in Boreholes 1, 3A, 4A and 6 to enable us to monitor groundwater levels over a prolonged period of time without interference from surface water. The water levels in these piezometers were measured during a subsequent site visit made on October 29, 2004, about one week after the completion of the boreholes.

The fieldwork was carried out under the full-time supervision of a geotechnical engineer from S&P who observed the work, directed the sampling and testing, kept records of subsurface profile and field tests and cared for the samples. Upon their completion, the boreholes were grouted with a cement/bentonite mixture, in accordance with MTO procedures and MOE Regulation 903.

The ground surface elevations at the boreholes were obtained by S&P personnel and their corresponding coordinates were supplied to us by TSH.

The subsurface profiles, sampling data, field tests and other pertinent data are given on the Record of Borehole Sheets in Appendix A.

The soil samples recovered from the boreholes were shipped to our laboratory in Toronto for further examination and classification. A laboratory testing programme, consisting of natural moisture contents, bulk unit weight tests and grain-size analyses, was performed on selected soil samples. The results of laboratory tests are presented on the appropriate Record of Borehole Sheets in Appendix A. The grain-size distribution curves are presented in Appendix C.

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

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix A. The conditions are further described in the following paragraphs.

##### **4.1 TOPSOIL**

The boreholes, except Boreholes 3 and 4, were drilled off the road and these encountered surficial topsoil ranging in depth from 0.15 m to 0.25 m below ground surface. In Boreholes 1, 2, 3 and 4, buried topsoil was also contacted and the thickness of this lower topsoil layer ranges from about 0.1 to 0.3 m.

## 4.2 PAVEMENT

Boreholes 3 and 4 were put down on the pavement on County Road 30 and these contacted 200 to 225 mm of asphalt.

## 4.3 FILL

### 4.3.1 SAND SOME GRAVEL (GRANULAR FILL)

Boreholes 3 and 4, drilled on the pavement of County Road 30, contacted a granular fill layer of sand with some gravel that extends to a depth of 1.0 and 1.8 m, respectively, below ground surface.

A Standard Penetration test conducted in this granular deposit yielded N-values of 10 to 24 blows for 0.3 m penetration. From these values, the relative density of this deposit is described as compact. The measured moisture contents of samples from this deposit varied from 2 to 5%.

### 4.3.2 SILTY SAND TO SANDY SILT (EMBANKMENT FILL)

The granular fill at Boreholes 3 and 4 is underlain by a 4.5 to 5.8 m thick layer of silty sand to sandy silt fill (embankment fill) that extends to a depth of about 5.5 m in Borehole 3 and to a depth of 7.6 m below ground surface in Borehole 4. In Borehole 3, the silty sand to sandy silt fill is further underlain by a sand and gravel layer to a depth of 7.5 m, similar to the extent of fill in Borehole 4.

Boreholes 3A and 4A were drilled at the sides of the forward slopes of the embankment and these, below the topsoil, also encountered silty sand to sandy silt fill extending to the full depth of the boreholes of 3.7 to 4.3 m.

Boreholes 1, 2, 5 and 6 were drilled at the toes of the embankment, beside Highway 401, and these also encountered silty sand to sand fill below the topsoil, extending to depths of 1.7 to 2.9 m below the ground surface.

This fill generally consists of silty sand to sandy silt mixed with some sand, traces of gravel and clay and occasional topsoil/organic inclusions. It is classified as a basically cohesionless soil. The results of grain-size distribution analyses carried out on four selected samples are given in Figures C-1 and C-2 of Appendix C. The results indicate the following grain size distribution:

Gravel:	3 – 19 %
Sand:	54 – 93 %
Silt & Clay:	4 – 42 %

N-values recorded in this fill material widely ranged from 1 to 24 blows/0.3 m, indicating a very loose to compact relative density. These recorded N-values also indicate that the fill did not receive a systematic compaction when the embankment was built.

The measured natural moisture content of samples recovered from this fill material ranged from 4 to 19%.

#### 4.4 ORGANIC SILT

Boreholes 5 and 6 were drilled on the north side of Highway 401, adjacent to a concrete culvert, and these, below the fill, encountered 0.5 to 2.1 m thick organic silt extending to depths of 3.8 m and 3.4 m, respectively, below the existing ground surface. This organic layer contains peat inclusions, silt and silty sand zones. Measured N-values in this layer in Borehole 5 ranged from 2 to 6 blows/0.3 m with measured undrained shear strengths of 20 and 40 kPa, indicating that the organic silt is soft to firm in consistency. Measured N-value of 18 blows/0.3 m was recorded in Borehole 6 indicating a very stiff consistency, however, this value is not considered representative due to the presence of sand and gravel layer immediately below.

The measured natural moisture content of samples recovered from this organic silt material ranged from 33 to 74%.

#### 4.5 SILT TO SANDY SILT

Below the fill, buried topsoil and organic silt, Boreholes 1, 2, 3, 4 and 5 contacted silt to sandy silt deposit extending to depths of 5.8 to 10.0 m below the ground surface (El. 191.2 to 193.9 m in Boreholes 4 and 5) near the north abutment, and to depths of 7.3 to 15.0 m (El. 188.8 to 189.0 m in Boreholes 1, 2 and 3) near the south abutment.

This deposit contains occasional silty sand seams or layers and clay seams. This material is generally moist to wet with measured natural moisture contents of about 18 to 20%. The silt to sandy silt soil is considered a dilatant material.

Grain-size distribution analyses were carried out on selected samples from this deposit retrieved from Boreholes 1, 2 and 5. The results, illustrated in Figure C-3 of Appendix C indicate the following grain size distribution:

Sand:	14 to 19 %
Silt:	71 to 77 %
Clay:	9 to 10 %

Standard Penetration tests carried out in this fine-grained granular deposit yielded N-values of 8 to 39 blows/0.3 m, indicating a loose to dense relative density.

#### 4.6 GLACIAL TILL (SILTY SAND TO SANDY SILT TILL)

In general, below the silt to sandy silt deposit, the site is underlain by a major deposit of silty sand to sandy silt (glacial) till. This stratum was encountered in all the boreholes (except at Boreholes 3A and 4A) at depths ranging between 3.8 m (El. 193.7 m) in Borehole 6 to 15.0 m (El. 189.0 m) in Borehole 3, below ground surface. This deposit extended to borehole termination depths of between 12.3 m and 21.6 m (between El. 187.0 and 182.2 m) below ground surface.

The deposit is grey and generally consisted of a heterogenous mixture of silt, sand and gravel with trace clay. Being of glacial origin, the till can be expected to contain random cobbles and boulders due to its mode of deposition.

The results of grain-size distribution analyses carried out on five representative samples of this till deposit are given in Figure C-4 in Appendix C. These results show the following grain-size distribution:

Gravel:	5 – 24 %
Sand:	33 – 58 %
Silt:	26 – 33 %
Clay:	9 – 13 %

Standard Penetration tests conducted in this deposit generally yielded N-values of 13 blows to more than 100 blows for 0.3 m penetration. From these values the relative density of the material is described as compact to very dense, but generally very dense. In Boreholes 2 and 6, however, low N-values of 3 and 10 blows were recorded within the top 0.8 m of the deposit, indicating very loose to loose zones of the till in few areas at the interface with the overlying soils.

The natural moisture content of samples recovered from this deposit ranged from 5 to 21% and the unit weight ranged from 22.6 to 23.7 kN/m<sup>3</sup>.

#### 4.7 SAND AND GRAVEL

Near the north abutment, the organic silt in Borehole 6 was further underlain by a 0.4 m thick sand and gravel layer, overlying the silty sand to sandy silt till. In Boreholes 4 and 5, a 1.3 to 1.9 m thick sand and gravel to gravelly sand layer was also encountered interbedded within the glacial till at depths of about 12.1 m (El. 191.8 m) and 7.2 m (El. 189.8 m), respectively.

Standard Penetration test conducted in this stratum gave N-values of 12 and 26 blows/0.3 m indicating a compact condition. The low value of 12 may be due to disturbance

from possible hydrostatic uplift at the bottom of the hole. The measured natural moisture contents of representative samples from this deposit vary from about 6 to 10 %.

A representative sample of this material from Borehole 5 was subjected to a grain-size distribution analysis and the results are presented in Figure C-5 of Appendix C. The results show 39% gravel, 59% sand and 2% silt and clay size particles.

#### 4.8 GROUNDWATER CONDITIONS

Groundwater conditions in the open boreholes were observed while drilling and at the completion of each borehole. In addition, piezometers were installed in two of the deep boreholes (i.e. Boreholes 1 and 6 at Highway 401 level) and two of the shallow boreholes (i.e. Boreholes 3A and 4A at the embankment slope) to enable prolonged groundwater level measurements, without interference from surface water. The observations and recorded values are shown on the individual borehole log sheets.

Stabilized water level in the piezometer at Borehole 1 was measured at elevation of 195.4 m near the south pier or at a depth of 0.7 m below the ground surface at the Highway 401 level. No water was encountered in the piezometer in the shallow Borehole 3A, which was installed to a depth of 4.3 m. At the north pier area the stabilized water level was found at Elevation 196.0 m in Borehole 6, or about 1.5 m below existing grade. Along the north slope, the piezometer in Borehole 4A indicated water level at Elevation 198.4 m, or about 2.8 m below existing grade. The relatively higher water level at this location may represent a perched water level in the embankment fill.

Based on these values, the permanent groundwater table at the site can be expected at about Elevation 196.0 m. This groundwater level near the north abutment is expected to be controlled by the water level in the existing creek.

It should also be pointed out that the groundwater is subject to seasonal fluctuations and fluctuations in response to major weather events.

#### SHAHEEN & PEAKER LIMITED



Ramon Miranda, P.Eng.



Z.S. Ozden, P.Eng.



K. R. Peaker, Ph.D., P. Eng.





# DRAWINGS



FOR DETAILED SUBSURFACE CONDITIONS  
AND DYNAMIC CONE PENETRATION TESTS  
REFER TO RECORD OF BOREHOLE SHEETS.

**METRIC**

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

CONT No.

GWP 4322-04-00

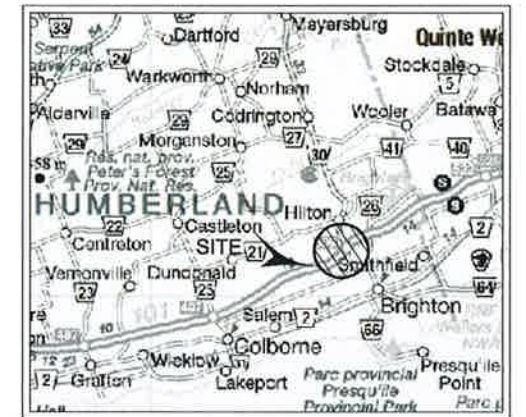
HWY 401 AT COUNTY ROAD 30

UNDERPASS

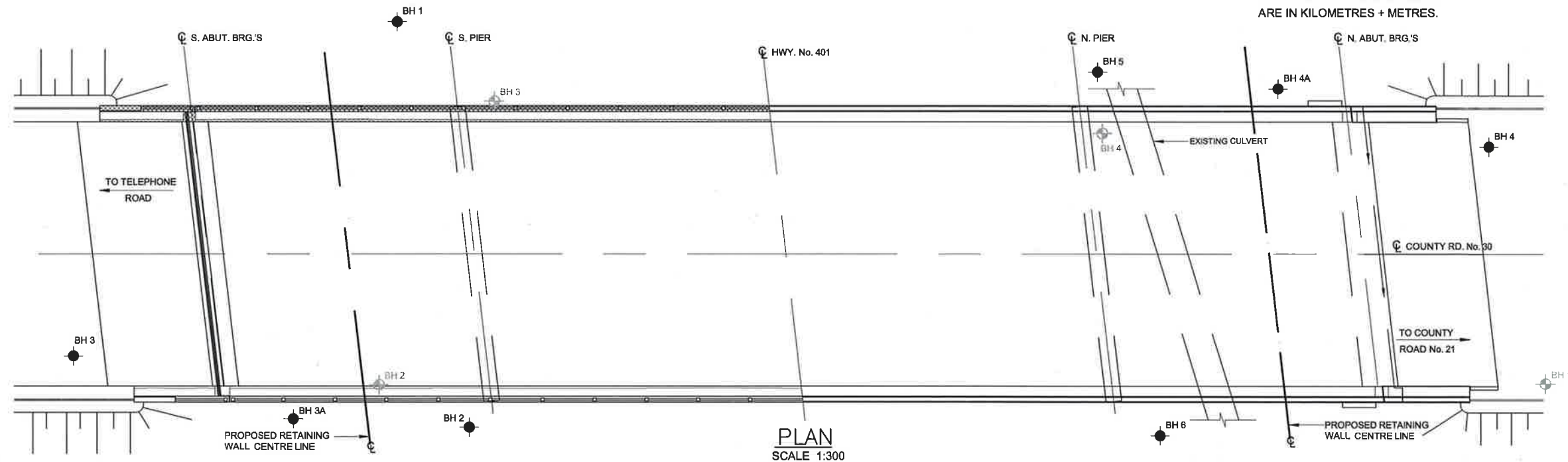
BORE HOLE LOCATIONS & SOIL STRATA



**SHAHEEN & PEAKER LIMITED**



KEY PLAN  
N.T.S



PLAN  
SCALE 1:300

**LEGEND**

- Bore Hole
- Bore Hole Done by MTO (1958)
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation Oct., 2004
- Water Level in Piezometer
- Piezometer

No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
BH 2	196.8	4 882 181.6	203 158.9
BH 3	204.0	4 882 158.3	203 164.6
BH 3A	200.9	4 882 171.8	203 162.7
BH 6	197.5	4 882 219.3	203 142.4

**NOTE**

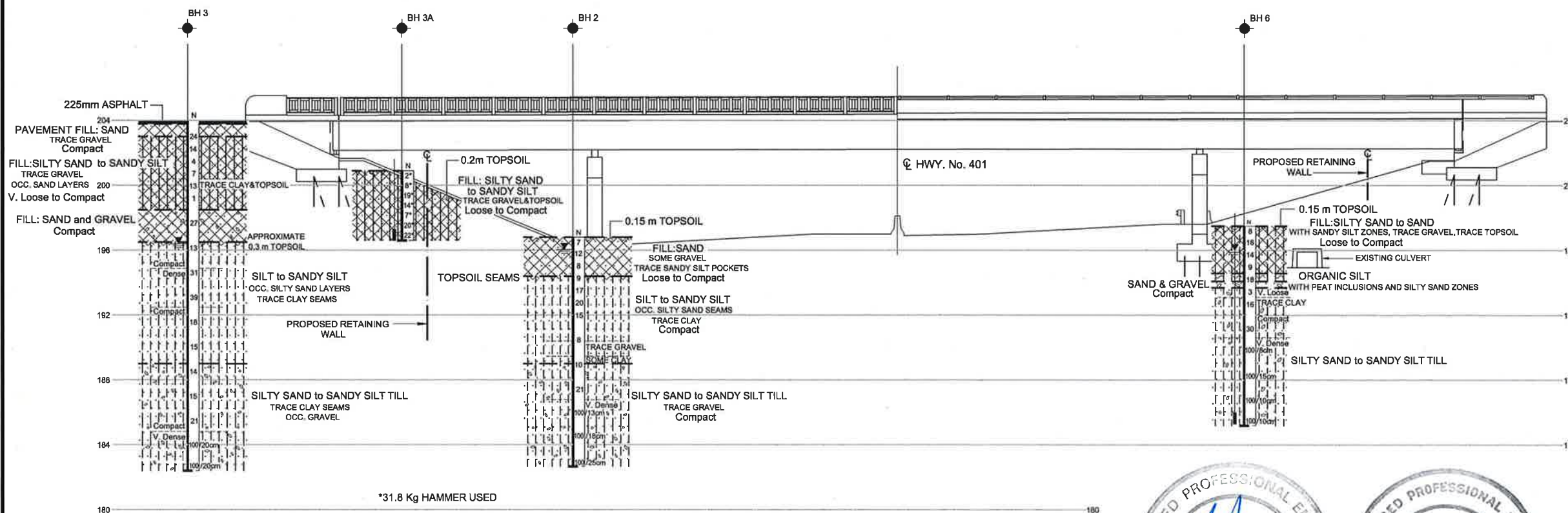
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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.

HWY No. 401			DIST 43
SUBM'D ZO	CHECKED RM	DATE Nov., 2004	SITE 21-296
DRAWN JZ	CHECKED YL	APPROVED	DWG 1



EAST ELEVATION  
SCALE 1:300







FOR DETAILED SUBSURFACE CONDITIONS  
AND DYNAMIC CONE PENETRATION TESTS  
REFER TO RECORD OF BOREHOLE SHEETS.

# METRIC

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

CONT No.

GWP 4322-04-00

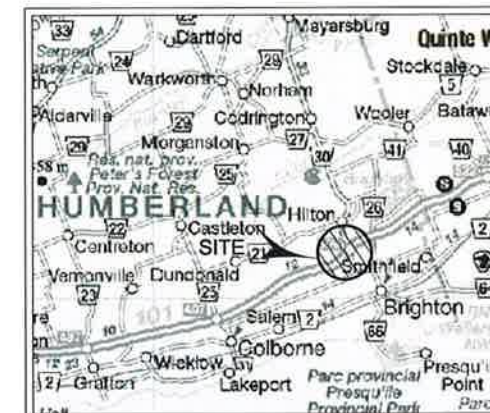
HWY 401 AT COUNTY ROAD 30

UNDERPASS

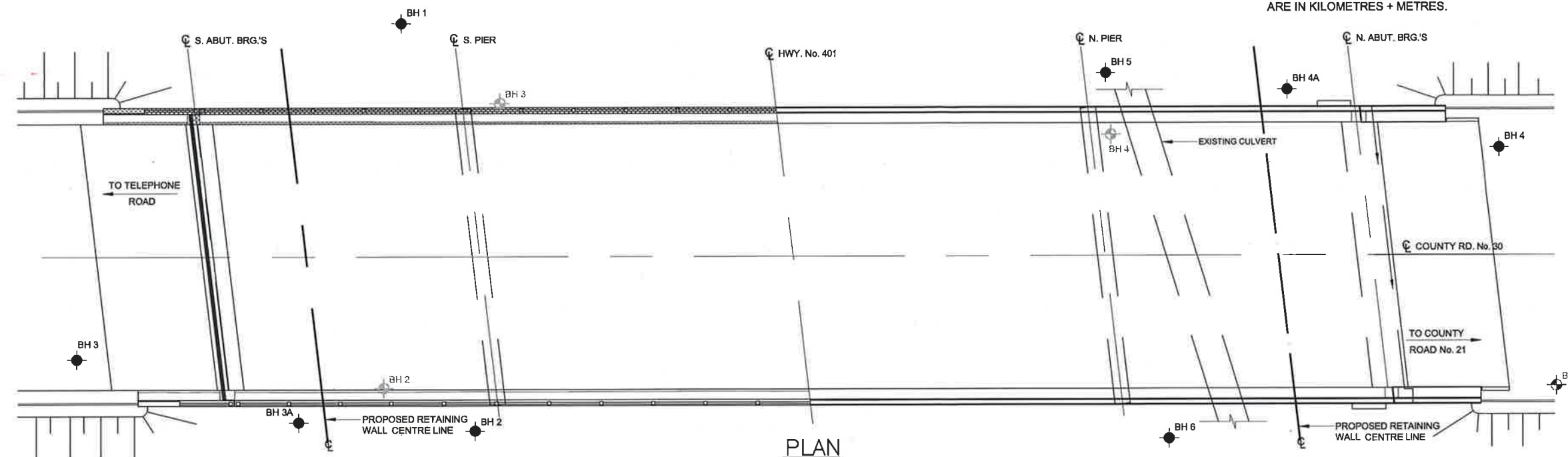
BORE HOLE LOCATIONS & SOIL STRATA



## SHAHEEN & PEAKER LIMITED



KEY PLAN  
N.T.S



PLAN  
SCALE 1:300

### LEGEND

- Bore Hole
- Bore Hole Done by MTO (1958)
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation Oct., 2004
- Water Level in Piezometer
- Piezometer

No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
BH 1	196.1	4 882 167.7	203 138.5
BH 4	203.9	4 882 230.2	203 118.6
BH 4A	201.2	4 882 217.2	203 120.6
BH 5	197.0	4 882 207.7	203 123.8

### NOTE

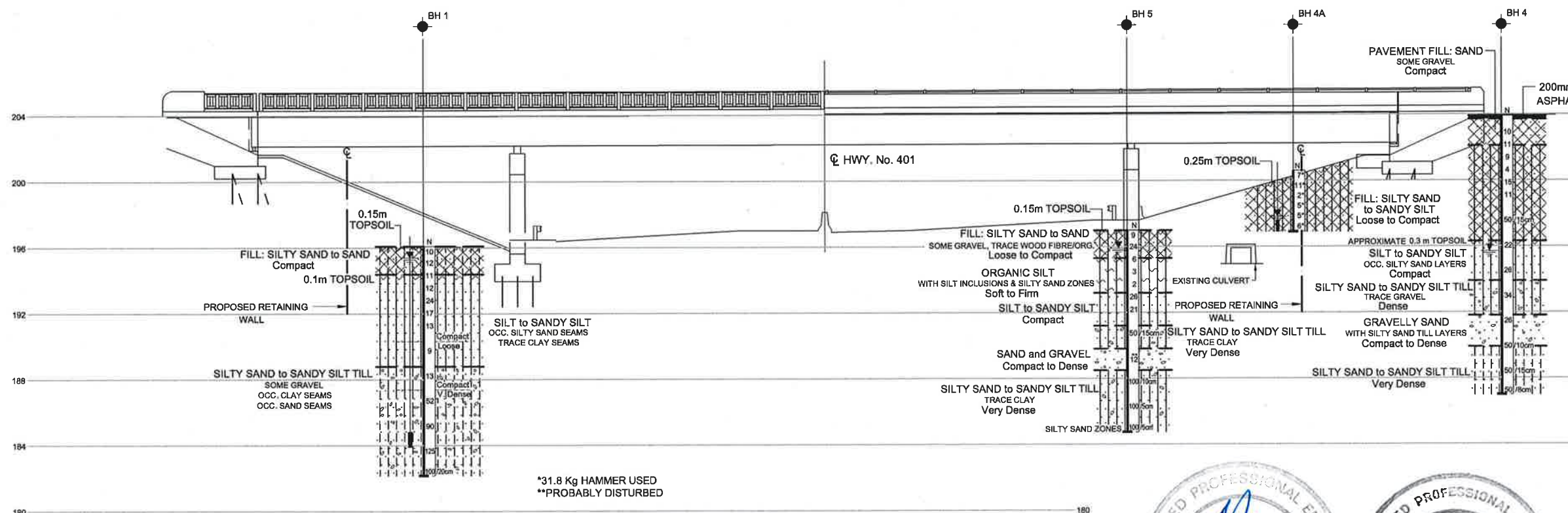
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REV.	DATE	BY	DESCRIPTION

Geocres No.

HWY No. 401			DIST 43
SUBM'D ZO	CHECKED RM	DATE Nov., 2004	SITE 21-296
DRAWN JZ	CHECKED YL	APPROVED	DWG 2



WEST ELEVATION  
SCALE 1:300

\*31.8 Kg HAMMER USED  
\*\*PROBABLY DISTURBED



## APPENDIX A

### Records of Boreholes (Shaheen & Peaker Limited)

SPT 1131

# RECORD OF BOREHOLE No 1

1 OF 2

METRIC

GWP 4322-04-00 LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 167.7; E 203 138.5 ORIGINATED BY Y.L.  
DIST 43 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/20/2004 CHECKED BY Z.O.

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 (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
196.1 0.0	Ground Surface												
	0.15 m TOPSOIL		1	SS	10								
	FILL: Silty Sand to Sand brown, compact		2	SS	12								3 93 (4)
194.4 1.7	0.1 m TOPSOIL		3	SS	11								
	SILT to SANDY SILT occasional silty sand seams trace clay seams grey to brown, wet dilatant		4	SS	12								
			5	SS	24								0 16 75 9
			6	SS	17								
			7	SS	13								
			8	SS	9								
188.8 7.3			9	SS	13								5 58 26 11
	SILTY SAND to SANDY SILT TILL some gravel occasional clay seams occasional sand seams grey, moist to wet		10	SS	52								
			11	SS	90								
			12	SS	126								
182.2 13.9	End of Borehole.		13	SS	100/20							23.7	
	*Water level @ 11.4 m (not stabilized) and hole open to full depth on completion.												

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
20  
15-10 5 10 (%) STRAIN AT FAILURE

SPT 1131

RECORD OF BOREHOLE No 1

2 OF 2

METRIC

GWP 4322-04-00 LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 167.7; E 203 138.5 ORIGINATED BY Y.L.  
 DIST 43 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/20/2004 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	WATER CONTENT (%)					
	Piezometer installed at 12.2 m. Water level on: Oct. 29, 2004 - 0.7 m (El. 195.4 m)													

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

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1131

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

GWP 4322-04-00

LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 181.6; E 203 158.9

ORIGINATED BY Y.L.

DIST 43 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 10/20/2004

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. PLT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
196.8 0.0	Ground Surface													
	0.15 m TOPSOIL		1	SS	7									
	FILL: Sand some gravel, trace sandy silt pockets brown, loose to compact, moist to wet		2	SS	12									
			3	SS	8									
194.4 2.4	Topsoil Seams		4	SS	9									
	SILT to SANDY SILT occasional silty sand seams, trace clay brown, compact, moist to wet distant		5	SS	17									
			6	SS	20									
	grey		7	SS	15									
			8	SS	8									
	trace gravel													
	some clay		9	SS	10									
189.0 7.8	SILTY SAND to SANDY SILT TILL trace gravel grey, compact		10	SS	21									
	wet moist													
			11	SS	100/13									
	very dense													
			12	SS	100/18									
	occasional clay seams													
182.6 14.1	End of Borehole.		13	SS	100/25									
	*Water level @ 0.76 m (not stabilized) and hole open to 1.5 m on completion.													

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

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1131

# RECORD OF BOREHOLE No 3

1 OF 2

METRIC

GWP 4322-04-00 LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 158.3; E 203 164.6 ORIGINATED BY Y.L.  
 DIST 43 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/21/2004 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	20 40 60 80 100	20 40 60 80 100		
204.0	Ground Surface						204					
0.0	225 mm ASPHALT		1	AS	-							
203.0	PAVEMENT FILL: Sand trace gravel brown, moist, compact		2	SS	24		203					
1.0			3	SS	14		202					
	FILL: Silty Sand to Sandy Silt trace gravel occasional sand layers brown, moist, loose to compact		4	SS	4		201					
			5	SS	7		200					
	trace clay & topsoil		6	SS	13		199					
	very loose		7	SS	1		198					
198.5							197					
5.5	FILL: Sand & Gravel brown, moist, compact		8	SS	27		196					
196.5							195					
7.5	approximate 0.3 m Topsoil		9	SS	13		194					
			10	SS	31		193					
	compact dense						192					
	SILT to SANDY SILT occasional silty sand layers trace clay seams brown, wet, dilatant		11	SS	39		191					
			12	SS	18		190					
	grey, compact		13	SS	15							
189.0												

Continued Next Page

+<sup>3</sup> × 3 : Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE



SPT 1131

RECORD OF BOREHOLE No 3

2 OF 2

METRIC

GWP 4322-04-00

LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 158.3; E 203 164.6

ORIGINATED BY Y.L.

DIST 43 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 10/21/2004

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. X LAB VANE	WATER CONTENT (%)						
189.0 15.0	SILTY SAND to SANDY SILT TILL trace clay seams occasional gravel grey, wet, distant		14	SS	14										
			15	SS	15										
			16	SS	21										
			17	SS	100/20										
			18	SS	100/20										
182.4 21.6	End of Borehole.														
	*Water level @ 7.6 m (not stabilized) and hole open to 6.2 m on completion.														

+<sup>3</sup>, X<sup>3</sup>; Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1131

# RECORD OF BOREHOLE No 3A

1 OF 1

METRIC

GWP 4322-04-00 LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 171.8; E 203 162.7 ORIGINATED BY J.Z.  
 DIST 43 HWY 401 BOREHOLE TYPE Hand Drilling COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/21/2004 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		
200.9	Ground Surface													
0.0	0.2 m TOPSOIL		1	SS	2**									
	FILL: Silty Sand to Sandy Silt trace gravel & topsoil brown, moist, loose to compact		2	SS	8**		200							
			3	SS	19**		199							
			4	SS	14**		198							
			5	SS	7**		197							
			6	SS	20**									
			7	SS	22**									
196.6														
4.3	End of Borehole. *Borehole dry (not stabilized) and hole open to full depth on completion. Piezometer installed at 4.3 m. Water level on: Oct. 29, 2004 - Dry **31.8 kg hammer used.													

# RECORD OF BOREHOLE No 4

1 OF 2

METRIC

GWP 4322-04-00 LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 230.2; E 203 118.6 ORIGINATED BY Y.L.  
 DIST 43 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/21/2004 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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
203.9 0.0	Ground Surface												
	200 mm ASPHALT		1	AS	-								
	PAVEMENT FILL: Sand some gravel brown, damp to moist, compact		2	SS	10		203						
202.1 1.8			3	SS	11		202						
	FILL: Silty Sand to Sandy Silt trace gravel brown, moist to wet, loose to compact		4	SS	9								
			5	SS	4		201						
			6	SS	15		200						
	trace clay & topsoil		7	SS	11		199						
			8	SS	50/15		198						
	some gravel						197						
196.3 7.6	approximate 0.3 m Topsoil		9	SS	22		196						
	SILT to SANDY SILT occasional silty sand layers brown, wet, compact, dilatant		10	SS	26		195						
193.9 10.0	SILTY SAND to SANDY SILT TILL trace gravel grey, moist, dense		11	SS	34		194						
191.8 12.1	GRAVELLY SAND with silty sand till layers grey, wet, compact to dense		12	SS	26		193					22.7	
189.9 14.0	SILTY SAND to SANDY SILT TILL grey, moist to wet, very dense		13	SS	50/10		192						
188.9							191						
							190						
							189						hard drilling below 14 m

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15 10 5  
 10 (%) STRAIN AT FAILURE

SPT 1131

# RECORD OF BOREHOLE No 4

2 OF 2

METRIC

GWP 4322-04-00 LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 230.2; E 203 118.6 ORIGINATED BY Y.L.  
 DIST 43 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/21/2004 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. X LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
188.9 15.0	<b>SILTY SAND to SANDY SILT TILL</b> grey, very dense  moist to wet moist		14	SS	50/15												
187.0 16.9	End of Borehole.		15	SS	50/8												
	*Wet cave @ 8.2 m (not stabilized) and hole open to full depth on completion.																

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

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1131

RECORD OF BOREHOLE No 4A

1 OF 1

METRIC

GWP 4322-04-00 LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 217.2; E 203 120.6 ORIGINATED BY J.Z.  
DIST 43 HWY 401 BOREHOLE TYPE Hand Drilling COMPILED BY J.Z.  
DATUM Geodetic DATE 10/21/2004 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								
							20	40	60	80	100					
201.2	Ground Surface															
0.0	0.25 m TOPSOIL		1	SS	7**											
	FILL: Silty Sand to Sandy Silt trace gravel & topsoil trace organic brown grey, moist, loose		2	SS	11**											
			3	SS	2**											
			4	SS	5**											
			5	SS	5**											
			6	SS	6**											
197.5	End of Borehole.															
3.7	<p>*Borehole dry (not stabilized) and hole open to full depth on completion.</p> <p>Piezometer installed at 3.7 m.</p> <p>Water level on: Oct. 29, 2004 - 2.8 m (El. 198.4 m)</p> <p>**31.8 kg hammer used.</p>															

SPT 1131

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

GWP 4322-04-00 LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 207.7; E 203 123.8 ORIGINATED BY Y.L.  
DIST 43 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/19/2004 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		
197.0 0.0	Ground Surface													
	0.15 m TOPSOIL		1	SS	9									
	FILL: Silty Sand to Sand some gravel, trace wood fibre/organics brown, loose to compact, moist		2	SS	24									
195.3 1.7			3	SS	6									
	ORGANIC SILT		4	SS	3									
	with silt inclusions and silty sand zones dark brown, soft to firm, moist		5	SS	2									
193.2 3.8			6	SS	26									
	SILT to SANDY SILT		7	SS	21									
	grey, compact, wet													
191.2 5.8			8	SS	50/15									
	SILTY SAND to SANDY SILT TILL													
	trace clay grey, very dense, damp													
189.8 7.2			9	SS	12**									
	SAND & GRAVEL													
	grey, compact to dense, wet													
188.5 8.5			10	SS	100/10									
	SILTY SAND to SANDY SILT TILL													
	trace clay grey, very dense, damp													
184.8 12.3			11	SS	100/5									
	silty sand zones													
	moist													
	End of Borehole.		12	SS	100/5									
	*Water level @ 1.1 m (not stabilized) and hole open to 1.2 m on completion.													

+ 3 x 3: Numbers refer to  
Sensitivity

20  
15-5  
10 (%) STRAIN AT FAILURE

SPT 1131

# RECORD OF BOREHOLE No 6

1 OF 1

METRIC

GWP 4322-04-00

LOCATION Hwy 401/County Road 30, ON; - Coords: N 4 882 219.3; E 203 142.4

ORIGINATED BY Y.L.

DIST 43 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 10/19/2004

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		
197.5	Ground Surface													
0.0	0.15 m TOPSOIL		1	SS	8		197							
	FILL: Silty Sand to Sand with sandy silt zones, trace gravel, trace topsoil brown, loose to compact, moist		2	SS	16									
			3	SS	14		196							
			4	SS	9		195							
194.6														
2.9	ORGANIC SILT		5	SS	18		194							
194.1	with peat inclusions and silty sand zones dark brown, moist													
3.4	SAND & GRAVEL													
193.7	grey, compact, wet		6	SS	3		193							
3.8														
	trace clay		7	SS	16		192							
	very loose													
	compact		8	SS	30		191							
	SILTY SAND to SANDY SILT TILL													
	grey, moist to wet		9	SS	100/8		190							
	very dense													
			10	SS	100/15		189							
			11	SS	100/10		188							
	damp													
			12	SS	100/10		187							
							186							
185.2														
12.3	End of Borehole.													
	*Water level at 10.8 m (not stabilized) and hole open to full depth on completion.													
	Piezometer installed at 12.2 m.													
	Water level on: Oct. 29, 2004 - 1.5 m (El. 196.0 m)													

+ 3, X 3: Numbers refer to  
Sensitivity

20  
15-5  
10 (%) STRAIN AT FAILURE

# APPENDIX B


## Records of Boreholes (MTO 1958)

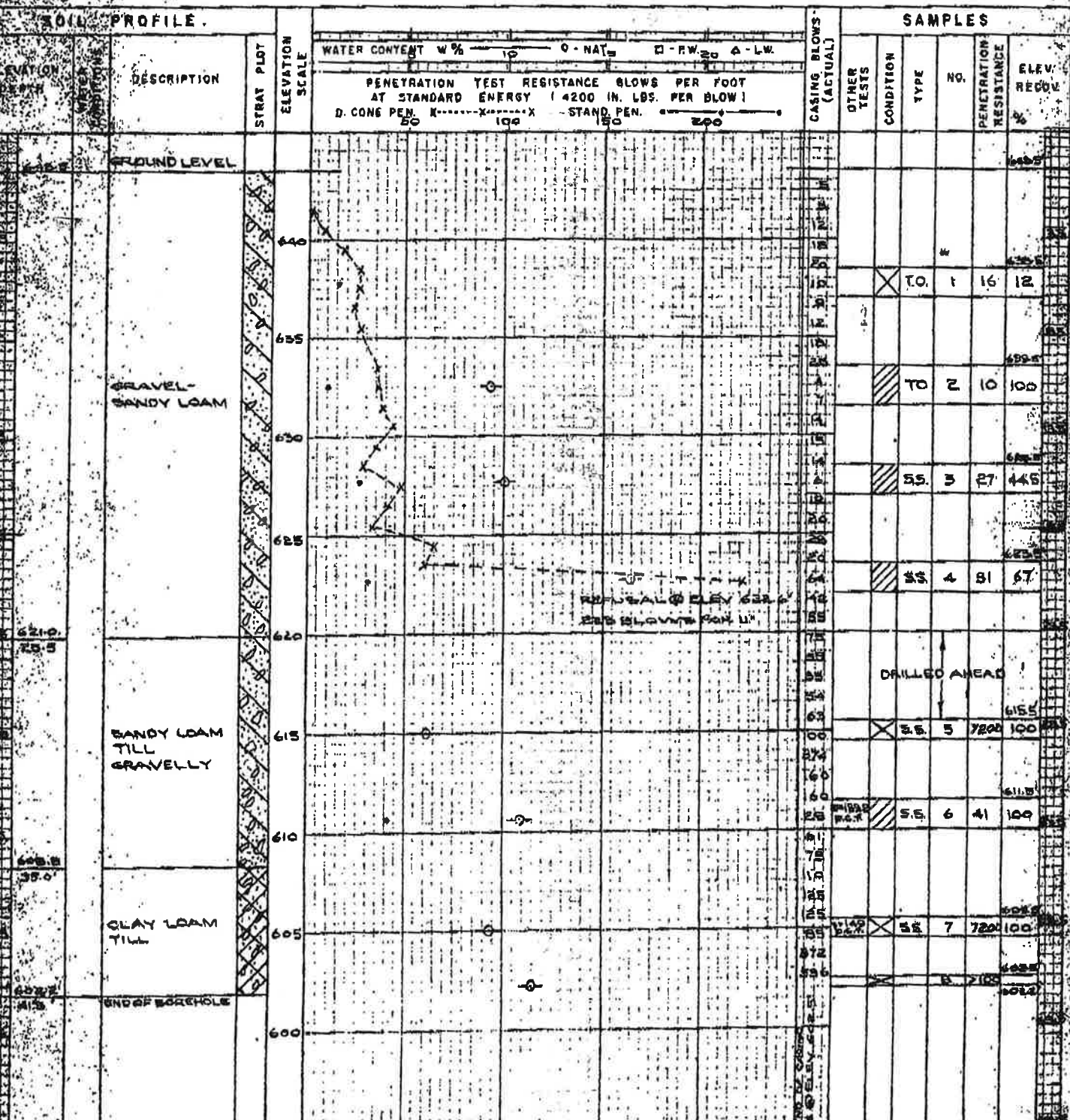


DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW  
**OFFICE REPORT ON SOIL EXPLORATION**

DRILL RIG 54-6 OPERATION BORE & PENETR JOB P-58-17 WP 58-58 BORING 1 STA. 134+05(27/4)  
CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT AUG. 1958  
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY AL CHECKED BY DATE BORING MAY 23 1958

**ABBREVIATIONS**  
INST. VANE SHEAR TEST Q - TRIAXIAL QUICK K - PERMIABILITY C.S. - CHUNK S.S. - SLEEVE SAMPLE  
MECHANICAL ANALYSIS S - TRIAXIAL SLOW C - CONSOLIDATION D.O. - DRIVE OPEN P.S. - PISTON SAMPLE  
UNCONFINED COMPRESSION WL - WATER LEVEL IN CASING CA - CASING D.F. - DRIVE FOOT VALVE WS - WASHED SAMPLE  
TRIAXIAL CONSOLIDATED QUICK WT - WATER TABLE IN SOIL U - UNIT WEIGHT T.O. - THIN WALLED OPEN R.C. - ROCK CORE

**SAMPLE CONDITION**  
 - DISTURBED  
- FAIR  
- GOOD  
- LOST



**MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW  
OFFICE REPORT ON SOIL EXPLORATION**

DRILL RIG 54-6 OPERATION BORE + PENETR JOB F-58-17 WP 59-52 BORING 2 STA. 131+85 (30' R)  
CASING EX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT AUG 1958  
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY AL CHECKED BY      DATE BORING MAY 28, 1958

## ABBREVIATIONS

V - INSITU VANE SHEAR TEST	Q - TRIAXIAL QUICK	K - PERMEABILITY
M - MECHANICAL ANALYSIS	S - TRIAXIAL SLOW	C - CONSOLIDATION
U - UNCONFINED COMPRESSION	WL - WATER LEVEL IN CASING	CA - CASING
Q - TRIAXIAL CONSOLIDATED QUICK	WT - WATER TABLE IN SOIL	γ - UNIT WEIGHT

## SAMPLE TYPES

C.S. - CHUNK	S.S. - SLEEVE SAMPLE
D.O. - DRIVE OPEN	P.S. - PISTON SAMPLE
D.F. - DRIVE FOOT VALVE	W.S. - WASHED SAMPLE
T.O. - THIN WALLED OPEN	R.C. - ROCK CORE

**SAMPLE CONDITION**



- DISTURBED
- FAIR
- GOOD
- LOST

### SOIL PROFILE

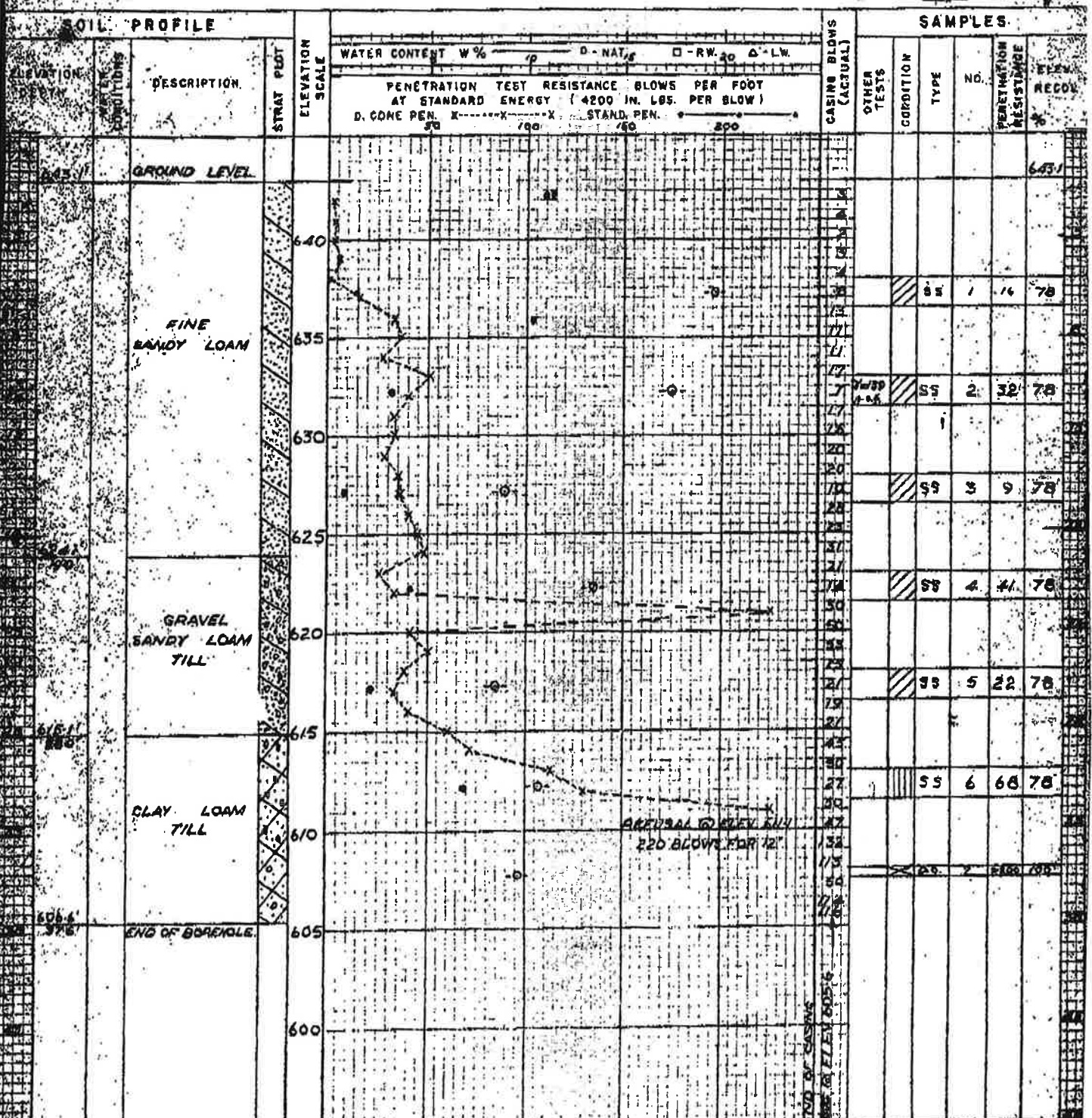
ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	WATER CONTENT W %				PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4800 IN. LBS. PER BLOW)				CASING BLOW (ACTUAL)	OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV.
					D. CONE PEN. X-----X-----X STAND. PEN. 50 100 150 200														
633.5 635		GROUND LEVEL																	635
635.5 100'		FINE SANDY LOAM		640									1						635
635.5 100'				635									1						635
635.5 100'		SILTY LOAM		630									1						635
635.5 100'				625									1						635
635.5 100'				620									1						635
635.5 100'		SANDY LOAM TILL GRAVELLY		615									1						635
635.5 100'				610									1						635
635.5 100'		END OF BOREHOLE		605									1						635
635.5 100'				600									1						635



DEPARTMENT OF HIGHWAYS, ONTARIO  
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW  
**OFFICE REPORT ON SOIL EXPLORATION**





DRILL NO. 54-6 OPERATION BORE & PENETN JOB F-58-17 NR 59-58 BORING 3 STA. 132+15(304.7)  
CASING BX (standard samplers to fill unless noted) DATUM GEODETIC DATE REPORT AUG 1958  
SAMPLER HAMMER WT. 250 LBS. DROP 20 INCHES COMPILED BY AL CHECKED BY --- DATE BORING JUNE 2, 1958

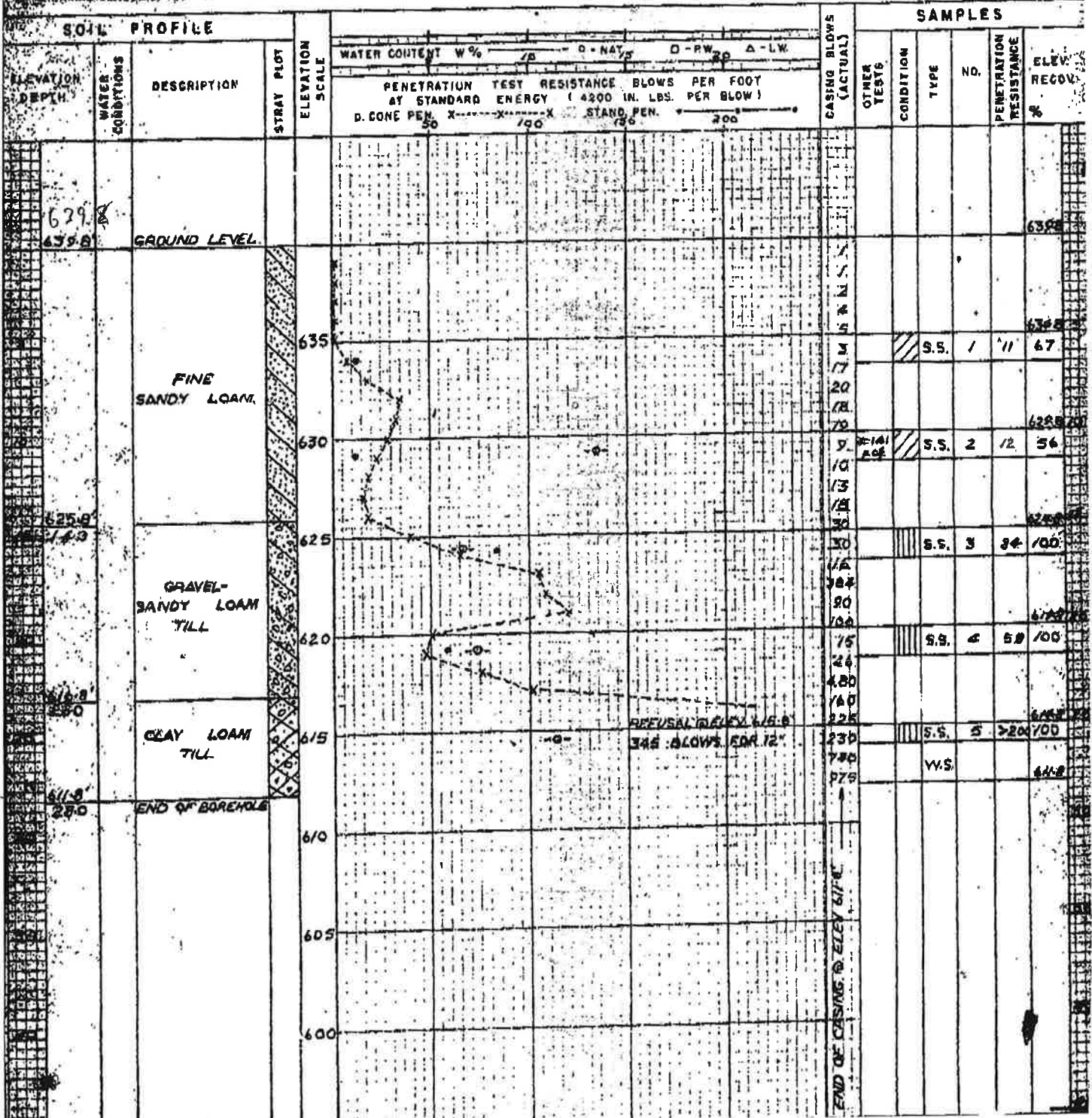
**ABBREVIATIONS**  
 IN-SITU VANE SHEAR TEST  
 MECHANICAL ANALYSIS  
 UNCONFINED COMPRESSION  
 TRIAXIAL CONSOLIDATED QUICK  
 Q - TRIAXIAL QUICK  
 S - TRIAXIAL SLOW  
 WL - WATER LEVEL IN CASING  
 WT - WATER TABLE IN SOIL  
 K - PERMIABILITY  
 C - CONSOLIDATION  
 CA - CASING  
 γ - UNIT WEIGHT  
 GS - CHUNK  
 DO - DRIVE OPEN  
 DF - DRIVE FOOT VALVE  
 TO - THIN WALLED OPEN  
**SAMPLE TYPES**  
 S.S. - SLEEVE SAMPLE  
 P.S. - PISTON SAMPLE  
 W.S. - WASHED SAMPLE  
 R.C. - ROCK CORE  
**SAMPLE CONDITION**  
 - DISTURBED  
 - FAIR  
 - GOOD  
 - LOST



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW  
**OFFICE REPORT ON SOIL EXPLORATION**

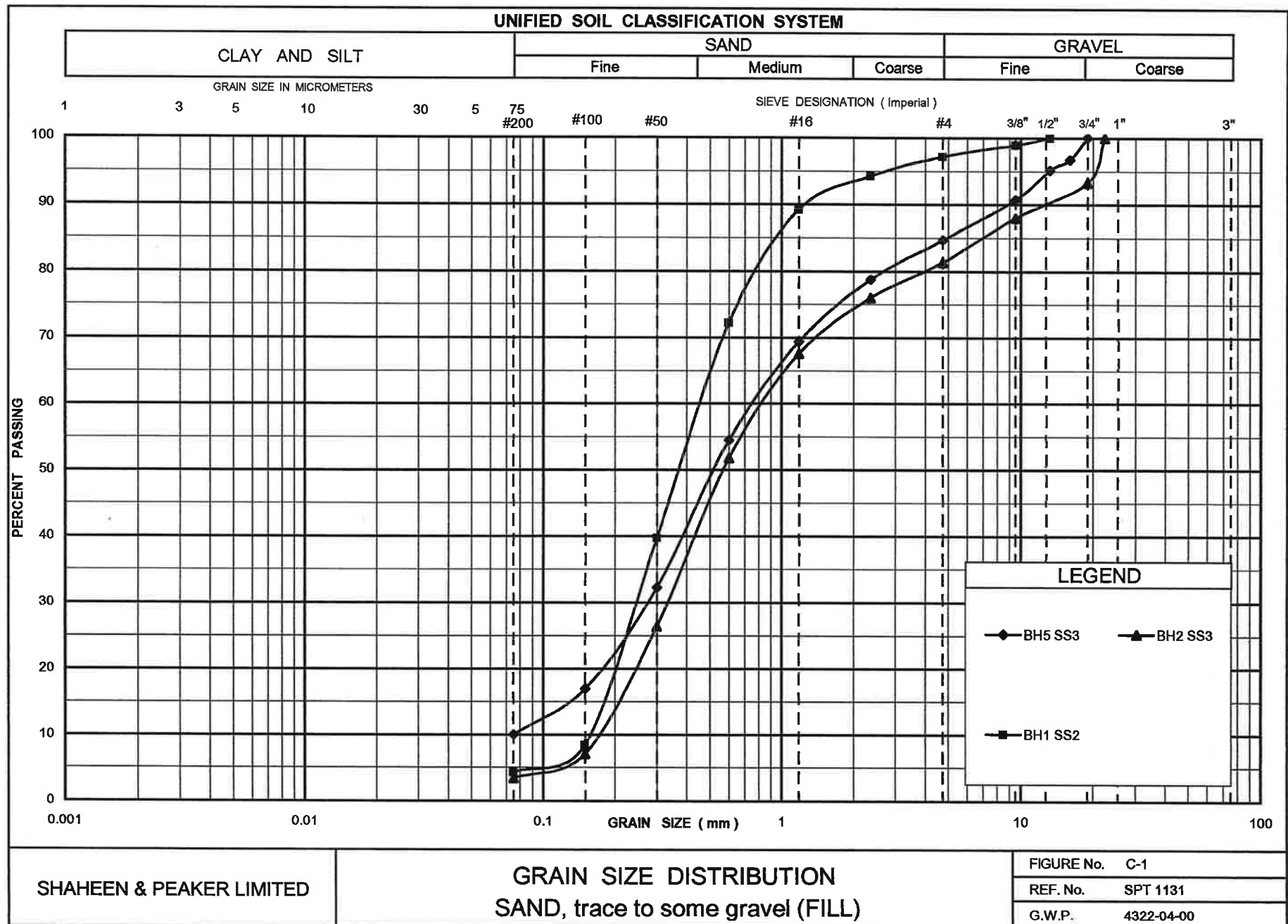
DRILL RIG S4-6 OPERATION BORE & PENETN JOB E-58-17 WP 62-58 BORING 4 STA. 33+35(25' LT)  
CASING 8 1/2 (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT AUG 1958  
SAMPLER HAMMER WT. 250 LBS. DROP 12 INCHES COMPILED BY AL CHECKED BY --- DATE BORING JUNE 4 1958

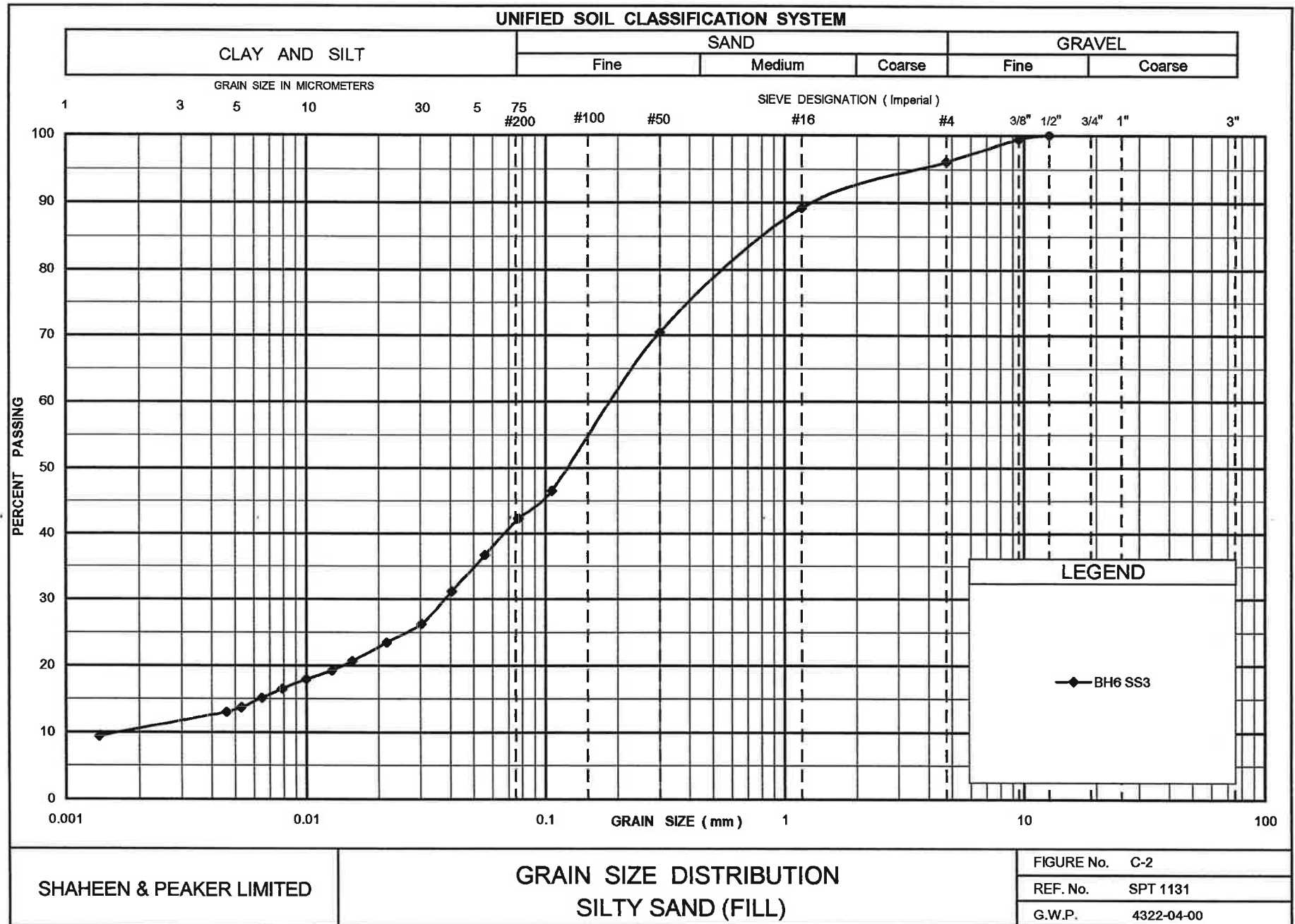
ABBREVIATIONS			SAMPLE TYPES		SAMPLE CONDITION	
JVS - VANE SHEAR TEST	Q - TRIAXIAL QUICK	H - PERMIABILITY	C.S. - CHUNK	S.S. - SLEEVE SAMPLE	 - DISTURBED	
M - MECHANICAL ANALYSIS	S - TRIAXIAL SLOW	C - CONSOLIDATION	DO - DRIVE OPEN	P.S. - PISTON SAMPLE	 - FAIR	
U - UNCONFINED COMPRESSION	WL - WATER LEVEL IN CASING	CA - CASING	DF - DRIVE FOOT VALVE	W.S. - WASHED SAMPLE	 - GOOD	
Q - TRIAXIAL CONSOLIDATED QUICK	WT - WATER TABLE IN SOIL	γ - UNIT WEIGHT	TO - THIN WALLED OPEN	R.C. - ROCK CORE	 - LOST	

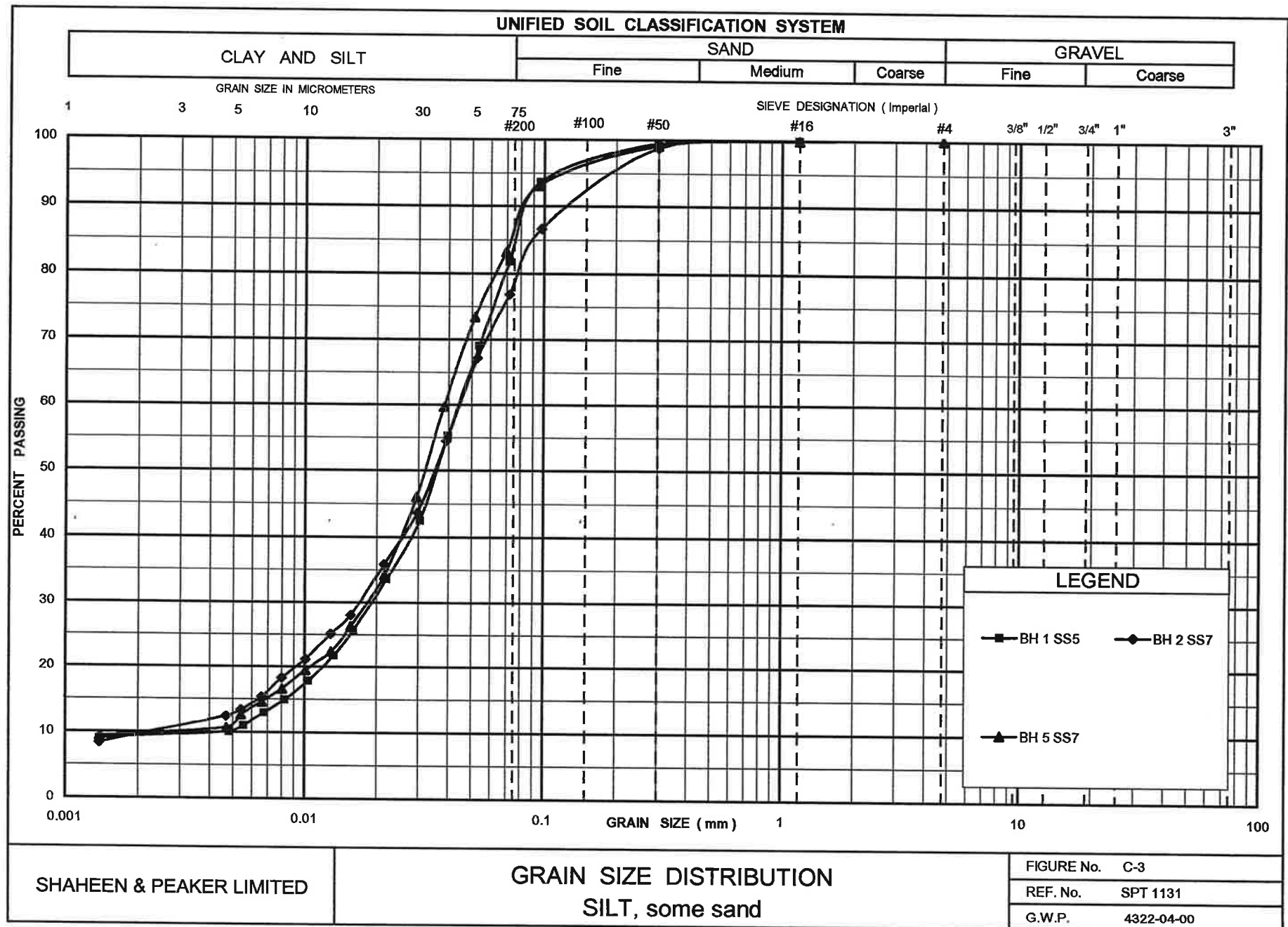


# APPENDIX C

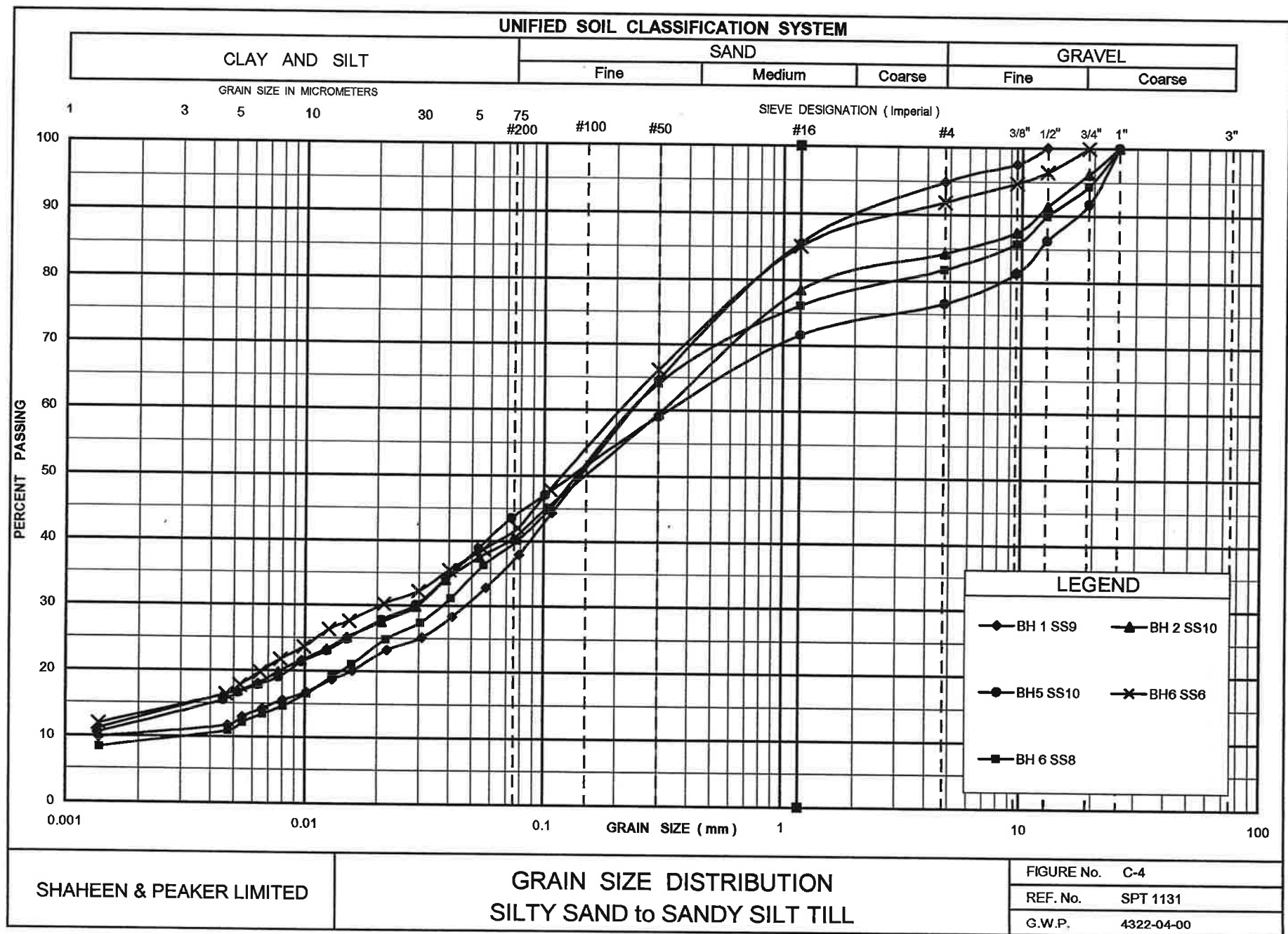
## Laboratory Test Results

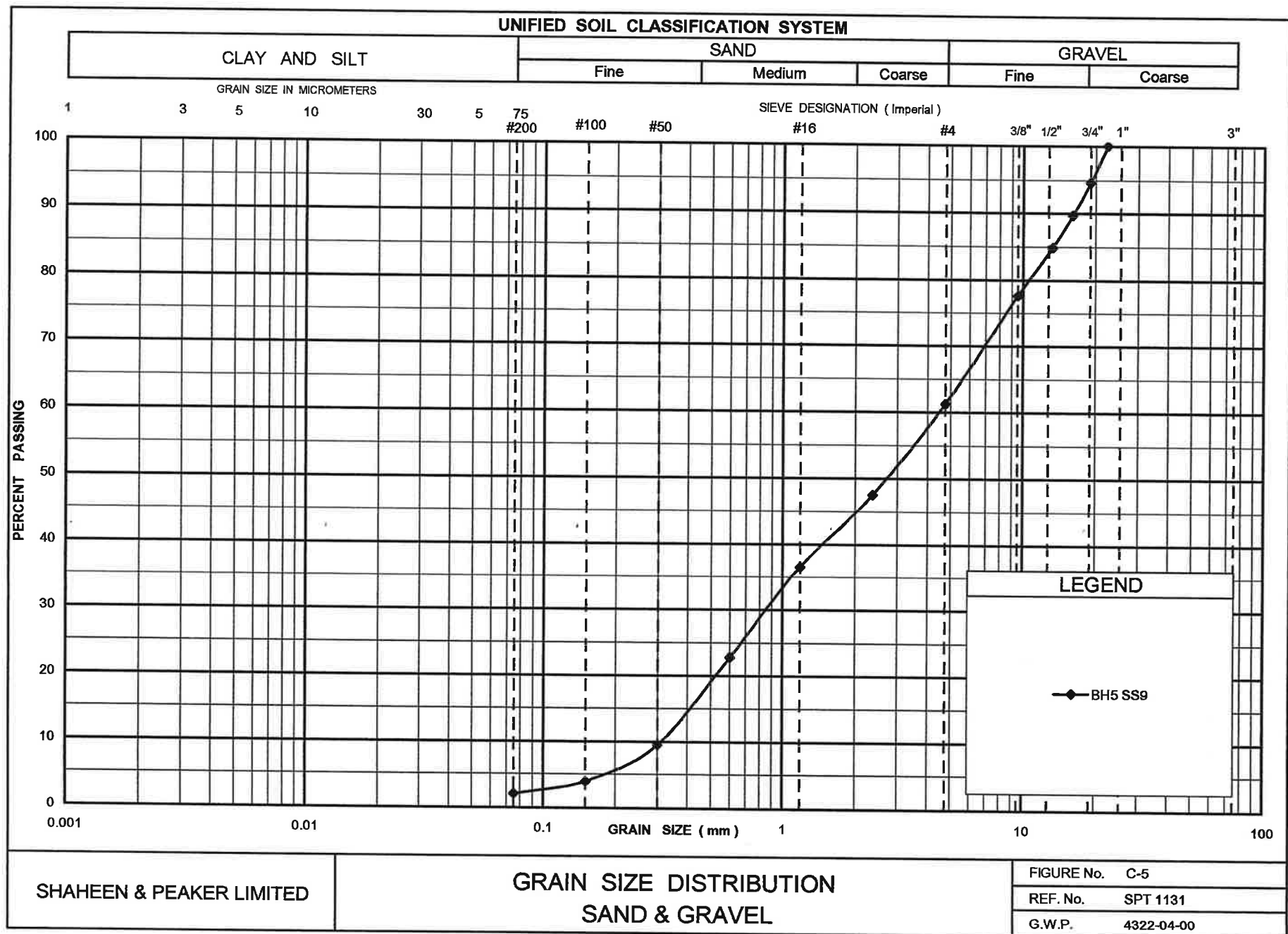












## APPENDIX D

### 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 – 60	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL 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

**JOINTING 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
$U_u$	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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	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

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	$e$	1%	VOID RATIO	$e_{min}$	1%	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	$n$	1%	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER						
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$w$	1%	WATER CONTENT	$D$	mm	GRAIN DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_p$	%	PLASTIC LIMIT	$h$	m	HYDRAULIC HEAD OR POTENTIAL
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	$q$	m <sup>2</sup> /s	RATE OF DISCHARGE
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_p$	%	PLASTICITY INDEX = $(w_L - w_p)$	$v$	m/s	DISCHARGE VELOCITY
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $(w - w_p) / I_p$	$l$	1	HYDRAULIC GRADIENT
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$I_c$	1	CONSISTENCY INDEX = $(w_L - w) / I_p$	$k$	m/s	HYDRAULIC CONDUCTIVITY
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL	$e_{max}$	1%	VOID RATIO IN LOOSEST STATE	$j$	kN/m <sup>3</sup>	SEEPAGE FORCE

**Appendix B**  
**Site Photograph**





Photo 1 West End of Butler Creek Culvert