

**FOUNDATION INVESTIGATION REPORT  
FOR  
PROPOSED HIGHWAY 11  
HIGHWAY 518 (DEER LAKE ROAD) UNDERPASS  
STRUCTURE SITE NO. 44-393  
DISTRICT 52, HUNTSVILLE  
W.P. 471-93-01**

**Submitted To:**

**Delcan Corporation  
133 Wynford Drive  
North York, Ontario, M3C 1K1  
Canada**

**Submitted By:**

**AGRA  
104 Crockford Blvd.  
Scarborough, Ontario, M1R 3C6  
Canada**

**September 1999  
TT98820A**

September 30, 1999.

**Ref. No.: TT98820A**

Delcan Corporation  
133 Wynford Drive  
North York, Ontario, M3C 1K1  
Canada

**Attention: Mr. Khaled El-Dalati, P. Eng.**

Dear Sir:

**Re: FOUNDATION INVESTIGATION REPORT  
FOR  
PROPOSED HIGHWAY 11  
HIGHWAY 518 (DEER LAKE ROAD) UNDERPASS  
STRUCTURE SITE NO. 44-393  
DISTRICT 52, HUNTSVILLE  
W.P. 471-93-01**

We take pleasure in enclosing seven (7) copies of our Foundation Investigation Report carried out for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

  
George S.W. Chow, P. Eng.,  
Designated MTO Contact.

GSWC/dee

## TABLE OF CONTENTS

	PAGE
1.0 INTRODUCTION .....	1
2.0 SITE DESCRIPTION AND PHYSIOGRAPHY .....	1
3.0 INVESTIGATION PROCEDURES .....	2
4.0 SUBSURFACE CONDITIONS .....	3
4.1 IRREGULAR MIXTURE OF SAND, GRAVEL AND SILT (fill material) .....	3
4.2 SILTY FINE SAND TO SAND .....	4
4.3 SAND WITH CLAYEY SILT TO SILT INTERBEDS .....	4
4.4 SAND TO SAND & GRAVEL .....	5
4.5 SANDY SILT .....	6
4.6 GROUNDWATER CONDITIONS .....	6
5.0 CLOSURE .....	7

## APPENDIX A

### Limitations of Report

## FIGURES

GRAIN SIZE DISTRIBUTION CURVES  
PLASTICITY CHART

Figures 1 - 8  
Figure 9

## ENCLOSURES

KEY PLAN  
BOREHOLE LOCATIONS AND SOIL STRATA  
BOREHOLE LOG SHEETS

DWG. NO 1  
DWG. NO. 2

## 1.0 INTRODUCTION

AGRA, Consulting Geotechnical Engineers, was retained by Delcan Corporation to conduct a foundation investigation at the site of a proposed bridge that will carry Deer Lake Road and Highway 518 West over the realigned northbound and southbound lanes of proposed Highway 11 and associated interchange ramps. The site is located north of the Village of Emsdale, at the existing Deer Lake Road/Highway 518 West intersection with Highway 11, in the Township of Perry, Lot 14, Concession 12, MTO District 52 - Huntsville (see Key Plan, Drawing No. 1). The proposed bridge will be an approximately 69 m long, two span, 2-lane, structure.

The purpose of the investigation has been to obtain information about the subsurface conditions at the site of the proposed bridge and approach embankments by means of exploratory boreholes, and based on the findings, to provide recommendations for the foundation design of the proposed structure and approach fills.

## 2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located at the intersection of Highway 11 and Deer Lake Road/Highway 518 West, north of the Village of Emsdale south of Burk's Falls and north of Huntsville. The ground elevation in the general area of the proposed bridge site is generally level, ranging in Elevation from about 335 to 334 m. The ground rises west of the proposed bridge site, and drops to the east. The existing bridge alignment is located along existing Deer Lake Road and Highway 518 West. The surrounding area is heavily wooded with commercial buildings located along Highway 11.

Based on available geologic information, the site is in an area of glaciolacustrine sediments. Generally after the last glacial withdrawal, ice-contact sediments (sands and gravels) followed by glaciofluvial sediments (ranging from deltaic and nearshore sands and gravels to prodeltaic and lake bottom silts and clays) were deposited on top of the existing sandy glacial till or Precambrian bedrock. The area was then inundated by glacial Lake Algonquin depositing sands, silts and clays in low lying areas.

Published information shows that the bedrock can be expected to be composed of strongly foliated, gneissic to migmatic rocks which form part of the Central Gneiss Belt of the Grenville Province (a structural subdivision of the Canadian Shield).

### 3.0 INVESTIGATION PROCEDURES

The field work for this project was performed during the period of January 11 to 22, February 16 to 18 and March 5 to 6, 1999, and consisted of drilling and sampling ten boreholes and conducting seven dynamic cone penetration tests. The plan locations of the boreholes, along with stratigraphic sections, are shown on Drawing No. 2. The boreholes could not be drilled at the exact proposed abutment and pier locations, due to the presence of overhead cables and underground Bell Telephone cables, but were drilled as close as possible to the actual locations.

The boreholes were advanced using solid and hollow stem continuous flight augers with a track-mounted power auger drilling rig (CME 75) owned and operated by Canadian Soil Drilling Inc. and a track-mounted power auger drilling rig (BOA 6M) owned and operated by Groundworks Drilling Inc., under the full-time supervision of an engineer from AGRA.

Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer 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.

In addition, dynamic cone penetration tests were performed at seven borehole locations. This test consists of driving a 60° point, 50 mm diameter cone attached to the drill rod continuously, into the undisturbed ground with a driving energy of 475 J (63.5 kg hammer falling freely a distance of 76 cm) per blow. The number of blows for each 0.30 m of penetration is recorded and this provides an indication of the relative changes in the soil density with depth.

Due to difficult drilling conditions at Borehole DL1, the borehole was advanced below a 9 m depth by washboring methods, employing NW size casing.

The borehole locations were established in the field by our engineering staff, in relation to the already staked out centre-line of Highway 518/Deer Lake Road (by Dearden and Stanton Limited). The borehole geodetic elevations and co-ordinates were later taken and provided to us by surveyors from Dearden and Stanton Limited.

The soil samples were shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content and bulk unit weight determinations, Atterberg limits tests and grain-size analyses, was performed on selected representative soil samples. The results of the laboratory tests are presented on the appropriate Borehole Log Sheets and also on Figure Nos. 1 to 9.

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The boreholes were left open until the end of each work day to enable us to take additional water level readings. Standpipe piezometers were installed in Boreholes DL1, 2, 3, 5, 7, and 8, although the piezometer installed in Borehole DL1 did not function properly. All boreholes were backfilled on completion.

#### 4.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at ten borehole locations (Borehole Nos. DL1 to DL9 and DL5A), and were inferred at the locations of seven dynamic cone penetration tests. The locations of the boreholes and dynamic cone penetration tests are shown on the Plan and Profile Drawing No. 2 and are also indicated on the individual Borehole Log Sheets. Cross sections of inferred subsurface stratigraphy are also given on Drawing No. 2.

The ground surface at the proposed site is generally level. The ground elevation at the proposed bridge location generally ranges from about 335 to 334 m.

In general, the boreholes contacted, below a surficial granular pavement fill, granular soil deposits ranging from relatively finer materials (silty fine sand to sand) near the surface, becoming somewhat coarser with depth (i.e. sand to sand & gravel). In Boreholes DL2, 5 and 5A, drilled at the east abutment location, the sand has frequent clayey silt and silt interbeds below a depth of about 8.5 m or Elevation 326 m and extending to about 13 to 16 m. At the time of the investigation the groundwater table was recorded at depths of about 11 to 15 m below the existing grade or at Elevations generally ranging between about 323 and 319 m. A perched watertable was also contacted at depths of about 5 to 7 m below existing grade (approximately Elevations 329 to 327 m) overlying the clayey silt and silt interbeds in the sand at the proposed east abutment location.

Details of the subsurface conditions encountered in the boreholes are presented on the Borehole Log Sheets. The following paragraphs are only meant to complement and summarize these data.

#### 4.1 IRREGULAR MIXTURE OF SAND, GRAVEL AND SILT (fill material)

The boreholes encountered 0.6 to 2.3 m of pavement fill. The pavement structure generally consists of 0.15 m of hot mix underlain by about 0.15 m of granular base course which is in turn underlain by sub-base granular materials. The base course material generally consists of sandy gravel, whereas the sub-base material ranges in composition from sand and gravel to silty sand. Six grain size analyses were conducted on the sub-base granular material resulting in the following grain size measurements, which are presented in envelope form in Figure No. 1:

Gravel:	1 - 42%
Sand:	47 - 74%
Silt:	18 - 33%
Clay:	0 - 2%

.../...

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Measured 'N'-values within this fill range from 3 to 60 blows/0.3 m, but were generally in excess of 15 blows/0.3 m indicating that the majority of the fill has received compactive effort. Measured natural moisture contents range from 5 to 34%.

#### 4.2 SILTY FINE SAND TO SAND

Below the surficial pavement fill, Boreholes DL2, 3, 4, 5, 6, 7 and 8 encountered a granular deposit consisting of silty fine sand to sand. This deposit extends to depths ranging between 2.3 m or Elevation 332.7 m (Borehole DL7) and 12.0 m or Elevation 322.6 m (Borehole DL8). Grain size distribution analyses were conducted on thirteen samples from the material and the range of particle sizes are presented as a curve envelope in Figure No. 2. The analyses indicate:

Gravel:	0 - 17%
Sand:	51 - 95%
Silt and Clay:	5 - 49%

The deposit also contains some sandy silt to silt lenses. The grain size distribution of two samples from such lenses/seams is shown in Figure No. 3.

Measured 'N'-values in this deposit range from 10 to in excess of 50 blows/0.3 m indicating a compact to very dense condition, but generally compact to dense. Measured natural moisture contents range from 1 to 34%, but generally 3 to 19%.

In this deposit dynamic cone penetration tests yielded values ranging from 19 to in excess of 100 blows/0.3 m.

#### 4.3 SAND WITH CLAYEY SILT TO SILT INTERBEDS

At the east abutment location (Boreholes DL2, 5 and 5A), below the surficial silty sand to sand deposit (at depths ranging from 8.4 to 8.6 m below the ground surface or below about Elevation 326 m), a sand deposit was encountered that contains frequent clayey silt to silt zones (or interbeds). The deposit consists of cohesionless sand with interbedded cohesive clayey silt and silt. It extends to about 13 and 16 m (Elevation 321.8 and 318.4 m) in Boreholes DL2 and 5, respectively. Two grain size distribution analyses were conducted on samples from the cohesionless sand from Borehole DL5 and the range of particle sizes is presented in Figure No. 4. The analyses indicate:

Gravel:	0 - 30%
Sand:	62 - 96%
Silt and Clay:	4 - 8%

Measured natural moisture contents range from 3 to 9%.

The thickness of the cohesive interbeds generally range from about 50 to 400 mm.

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Five grain size distribution analyses were conducted on samples from the cohesive interbeds. The results are presented in Figure No. 5. The analyses indicate:

Gravel:	0 - 25%
Sand:	19 - 40%
Silt:	29 - 71%
Clay:	6 - 15%

Atterberg Limits were conducted on five cohesive samples, indicating the following results (presented in Figure No. 9):

	Average	Range
Plastic Limit (%)	15.9	13 - 19
Liquid Limit (%)	20.8	16 - 26
Plasticity Index (%)	4.9	3 - 9
Moisture Content (%)	18	9 - 29
Unit Weight (kN/m <sup>3</sup> )	-	20.1 - 21.4

The above results indicate that the interbedded layers generally consist of clayey silt to silt with minor zones of sandy silt and clay of low plasticity. The natural moisture content in the upper 1± m of the cohesive layers are generally higher than the material's measured liquid limit, whereas below this level the natural moisture content is below the liquid limit (in some cases below the plastic limit). Pocket penetrometer tests performed on the recovered split-spoon samples gave undrained shear strength values ranging from 120 to in excess of 220 kPa, indicating a very stiff to hard consistency.

The recorded 'N'-values in this deposit range from 15 to in excess of 50 blows/0.3 m. These results indicate a compact to very dense compactness condition (i.e. relative density) or very stiff to hard consistency.

The presence of occasional cobbles within the deposit was inferred while drilling and sampling.

#### 4.4 SAND TO SAND & GRAVEL

Underlying the pavement fill and/or sand or clayey silt deposits described in the preceding sections, an ice-contact sand to sand & gravel deposit was encountered at Boreholes DL1, 2, 3, 5, 7 and 9. In Boreholes DL1, 7 and 9 (located near the central pier area), this deposit was contacted at surficial depths (i.e. 2.3 to 2.5 m below the ground surface) while in the remaining borehole areas it was encountered below depths ranging from 11.2 to 16.2 m. In all cases the deposit extended to the remaining depth of the boreholes. This is a cohesionless (granular) deposit and contains lenses of silty sand and occasional cobbles and boulders. Nineteen grain size distribution analyses were conducted and the range of particle sizes is presented as a curve envelope in Figure No. 6. The analyses indicate:

.../...

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Gravel: 0 - 56%  
Sand: 26 - 88%  
Silt and Clay: 3 - 21%

Figure No. 7 shows the grain size distribution of two relatively finer layers in the deposit.

Measured 'N'-values in this deposit range from 17 to in excess of 50 blows/0.3 m indicating a compact to very dense condition. Measured natural moisture contents range from 3 to 19%.

Dynamic cone penetration results range from 24 to greater than 100 blows/0.3 m. In order to advance the boreholes at the central pier location (Borehole DL1), the borehole was cased and advanced using a tricone due to the presence of cobbles and boulders. Auger refusal on a boulder was encountered in Borehole DL9 at a depth of 9.8 m. In order to advance the borehole, a dynamic cone penetration test was conducted at the bottom of the borehole to a depth of 25.3 m where refusal was encountered.

These observations also show that the presence of cobbles and boulders can be expected in this deposit.

#### 4.5 SANDY SILT

In Borehole DL8 sandy silt was encountered at 12.0 m (Elevation 222.6 m). This deposit was penetrated for 0.3 m where the borehole was terminated. The grain size distribution of the deposit is presented in Figure No. 8.

Based on an 'N'-value of 50 blows/0.10 m the deposit is described as very dense.

#### 4.6 GROUNDWATER CONDITIONS

Groundwater levels in the open boreholes were observed during the drilling and at the completion of each borehole. The water levels in the open boreholes were checked prior to removing the augers or casing. To enable us to measure water levels for a prolonged period of time without interference from surface water, standpipe piezometers were installed in Boreholes DL1, 2, 3, 5, 7 and 8. The standpipe piezometer in Borehole DL1 did not function and is believed to have been plugged at depth as it retained drilling mud from the drilling process.

The recorded values, shown on the individual Borehole Log Sheets, indicate that the groundwater levels at the time of the investigation generally ranged from 11 to about 15 m below the ground surface (Elevations 323 to 319 m).

A perched watertable was encountered during drilling in Boreholes DL2 and 5, at a depth of about 5.0 to 7.0 m below existing grade, or at Elevations 329.4 to 327.6 m, respectively. This perched watertable lies within the surficial silty fine sand to sand deposit which overlies the sand with cohesive interbeds at the proposed east abutment location.

.../...

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It should, be pointed out that the groundwater at the site would fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to heavy rains.


## 5.0 CLOSURE

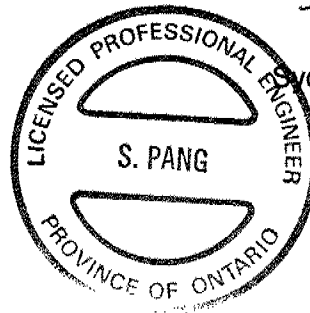
The Limitations of Report, as quoted in Appendix A, is an integral part of this report.

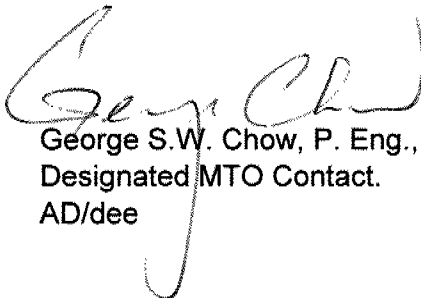
Sincerely,

  
Andrew Drevininkas, P. Eng.



  
Sydney Pang, P. Eng.



  
George S.W. Chow, P. Eng.,  
Designated MTO Contact.  
AD/dee



## APPENDIX A

**AGRA**  
**LIMITATIONS OF REPORT**

The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

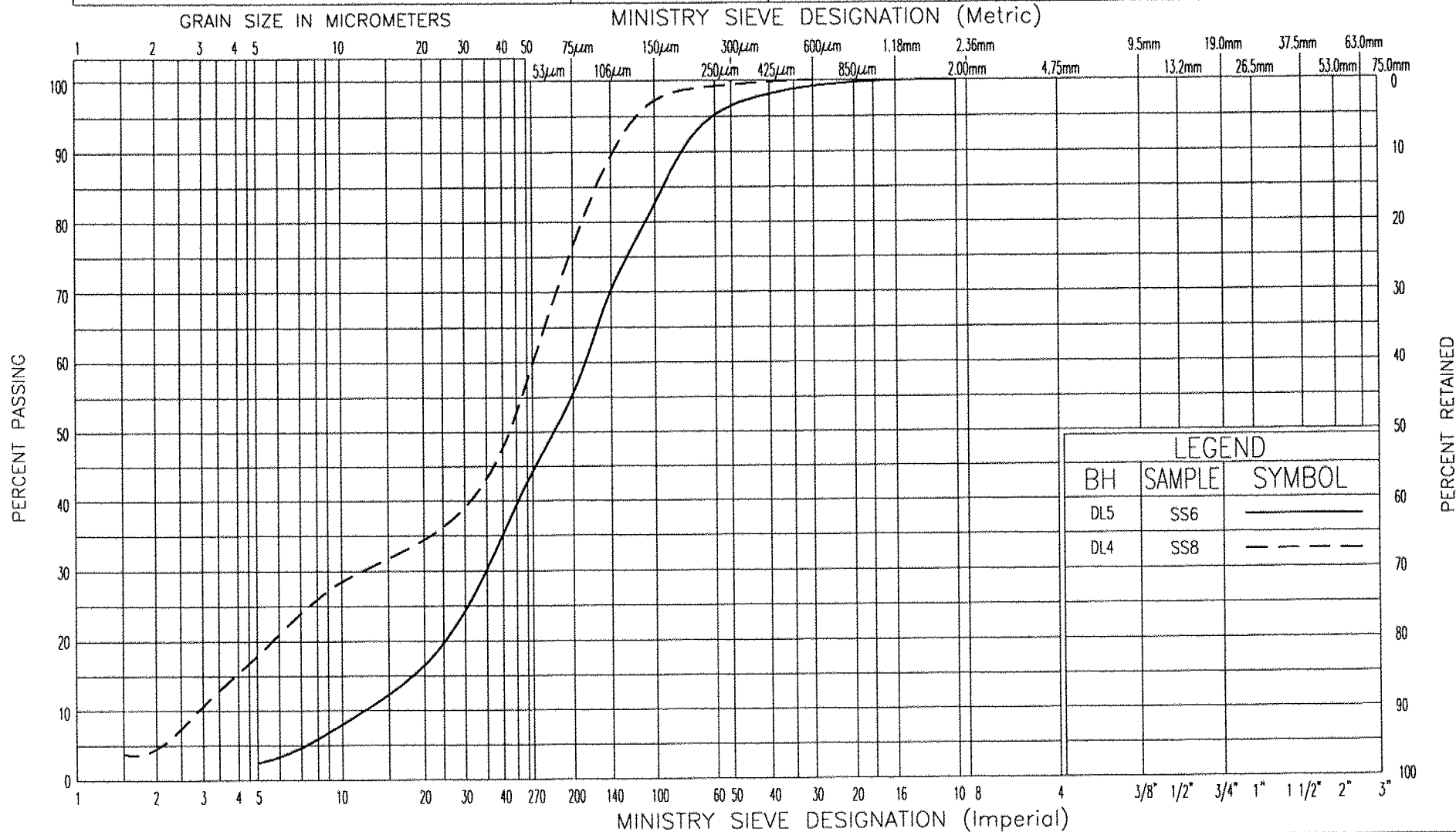
## FIGURES





# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION  
SANDY SILT

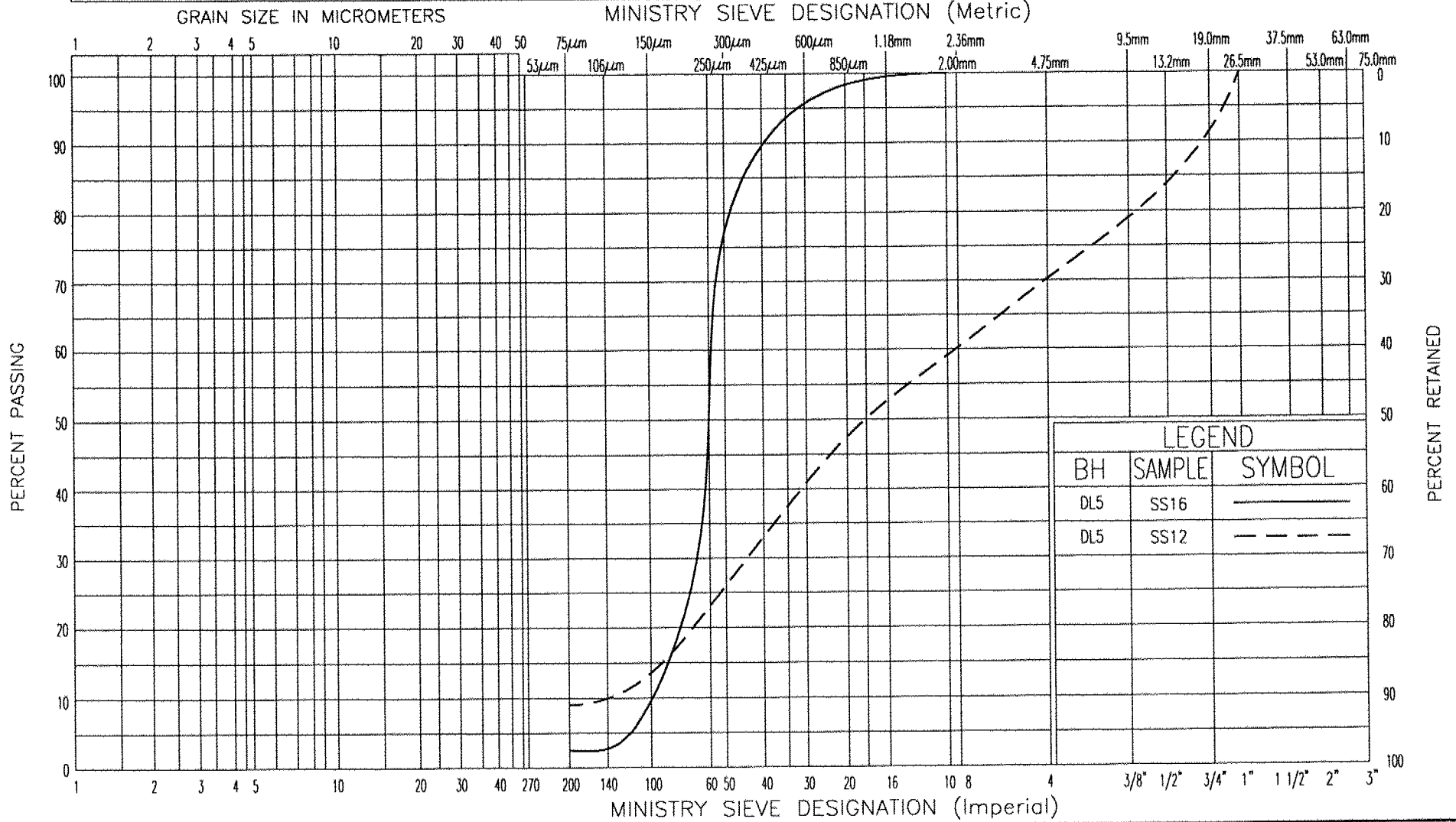
FIG No 3  
W P 471-93-01

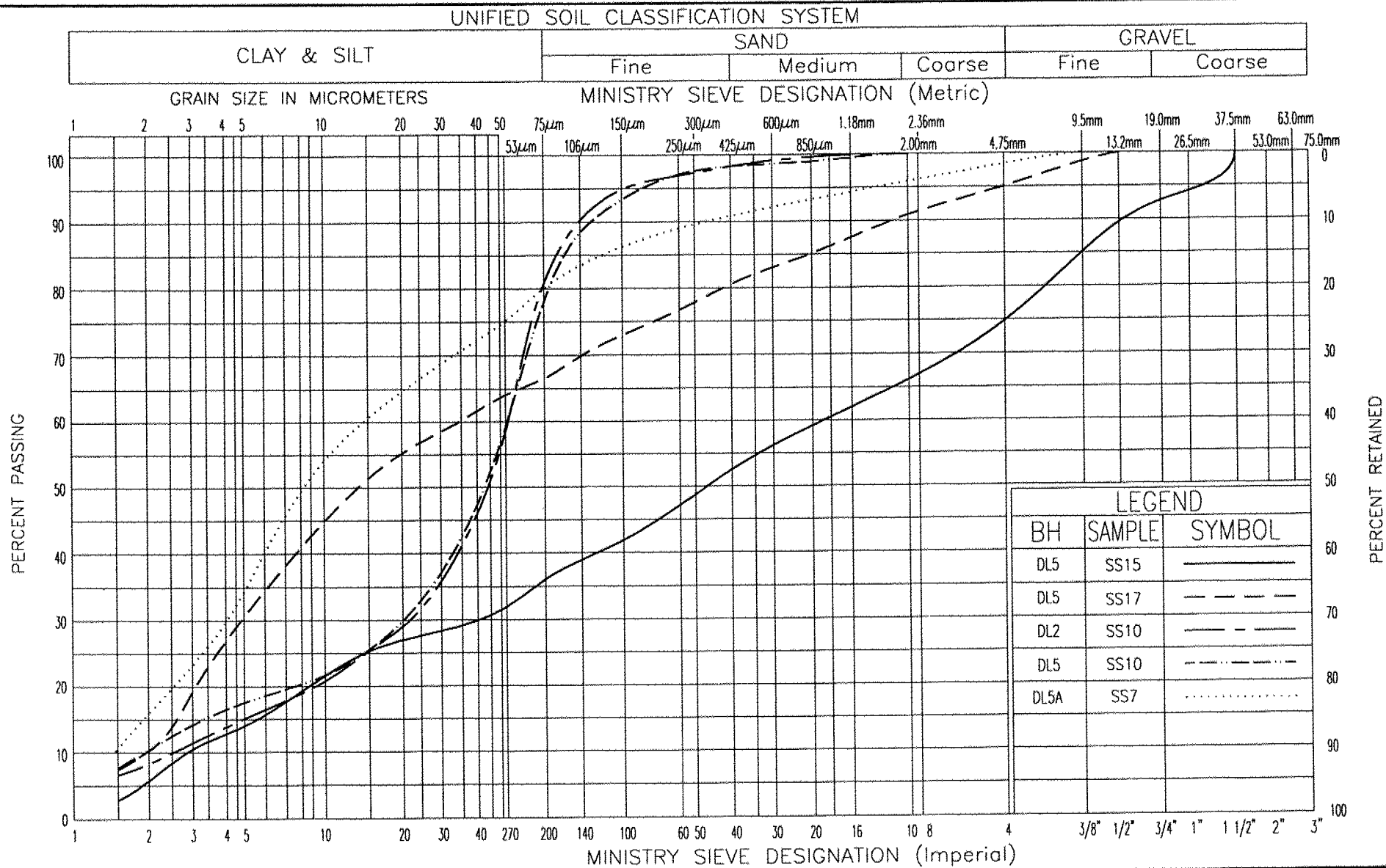




# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



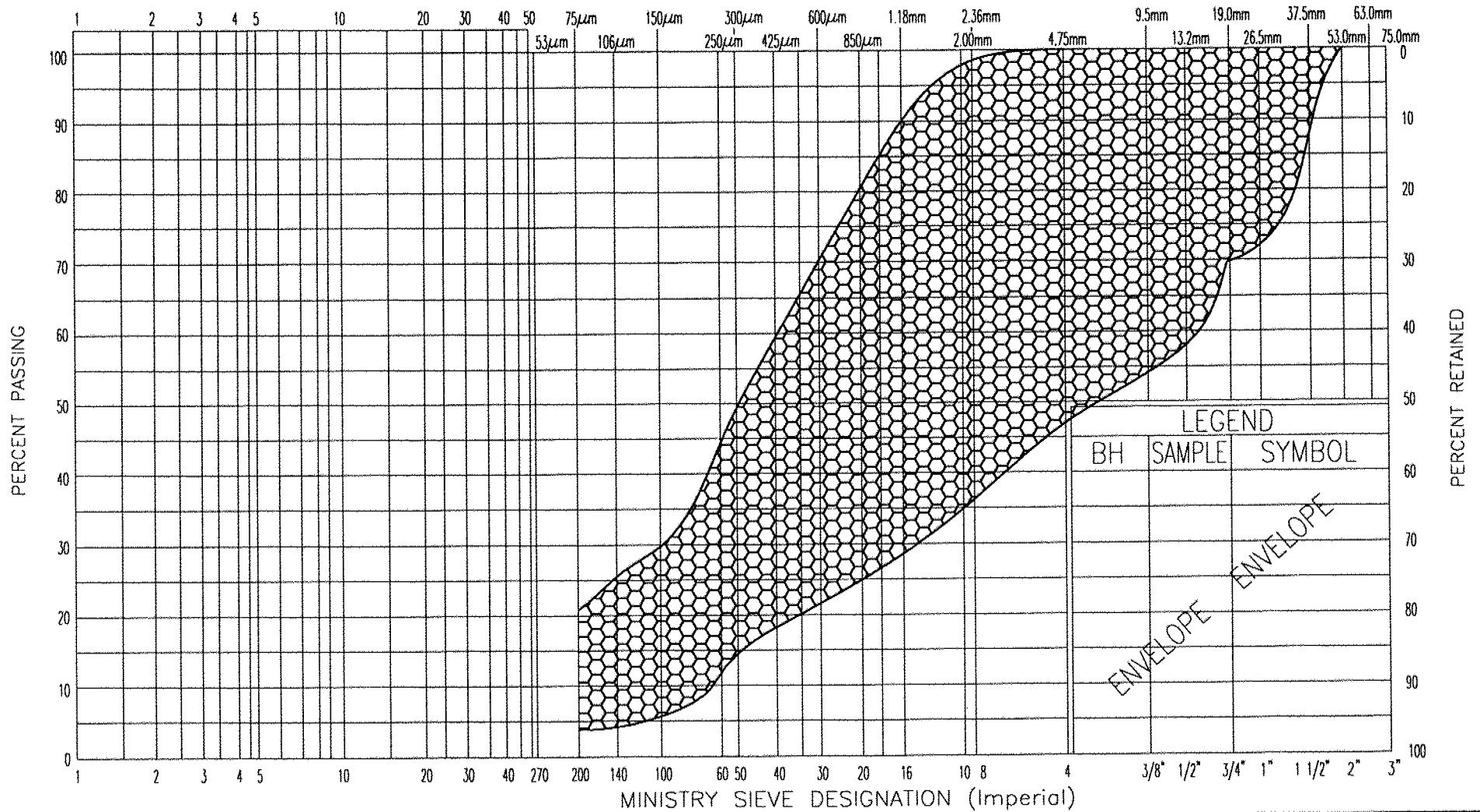


# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



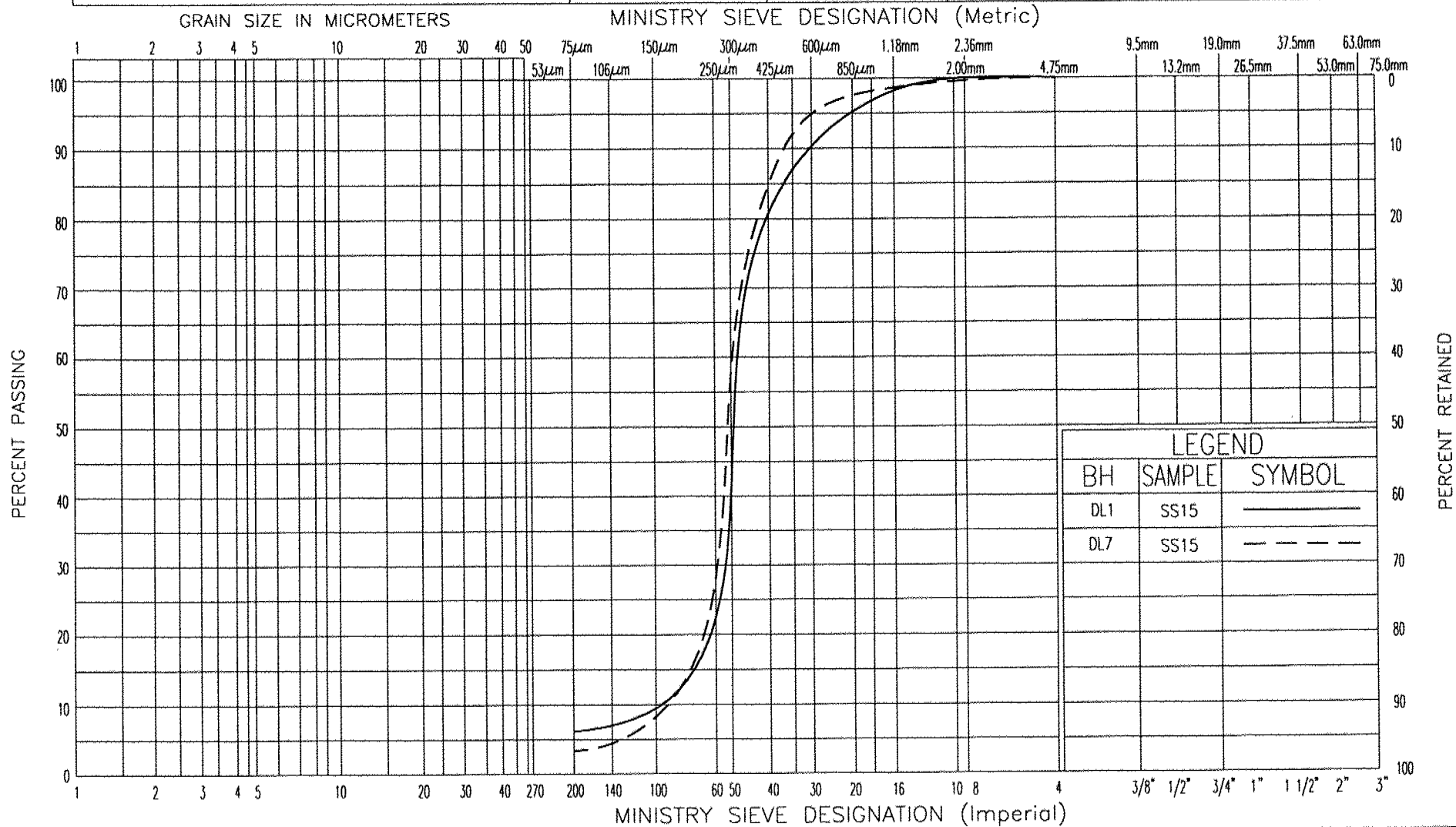
GRAIN SIZE DISTRIBUTION  
SAND TO SAND & GRAVEL

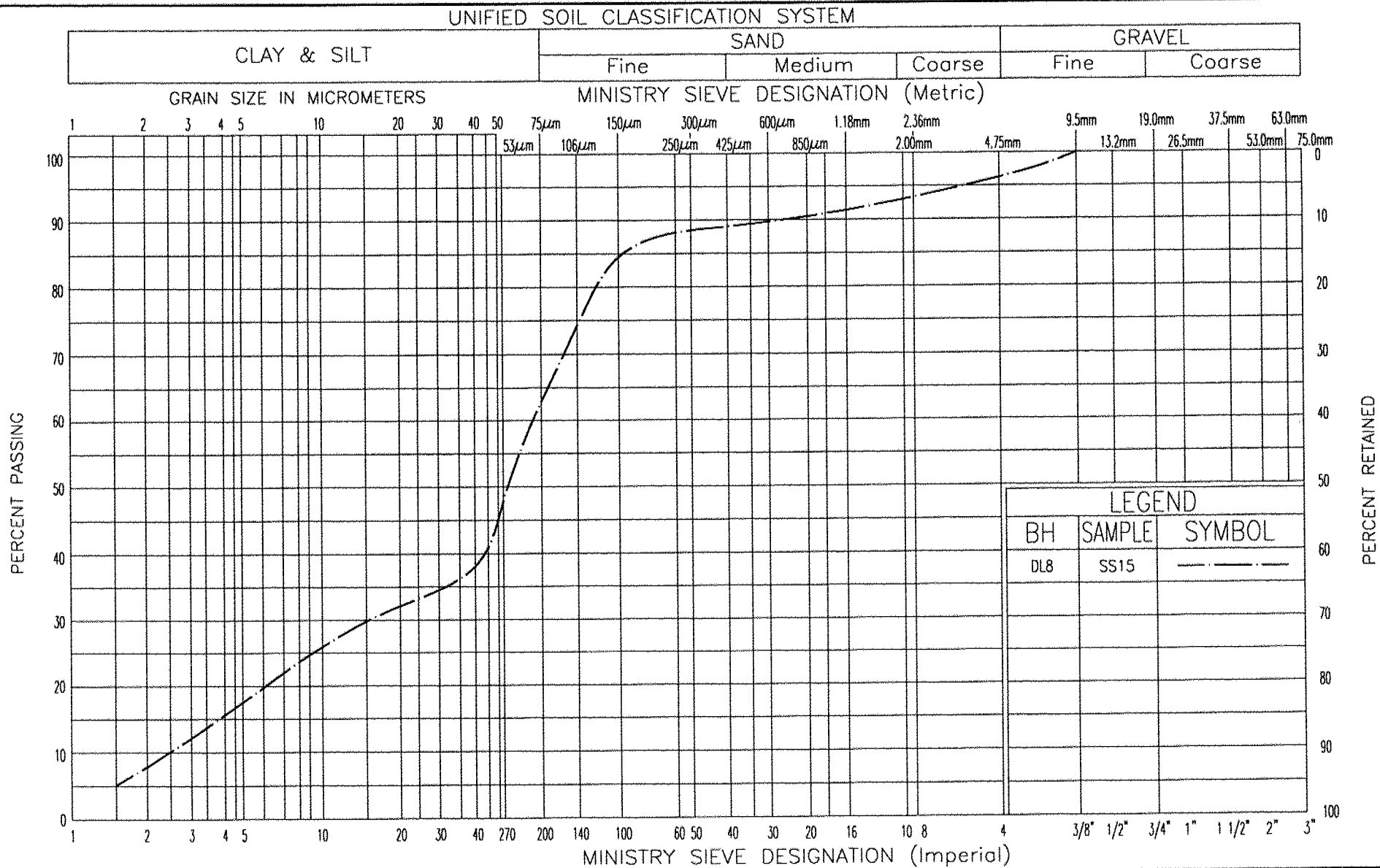
FIG No 6

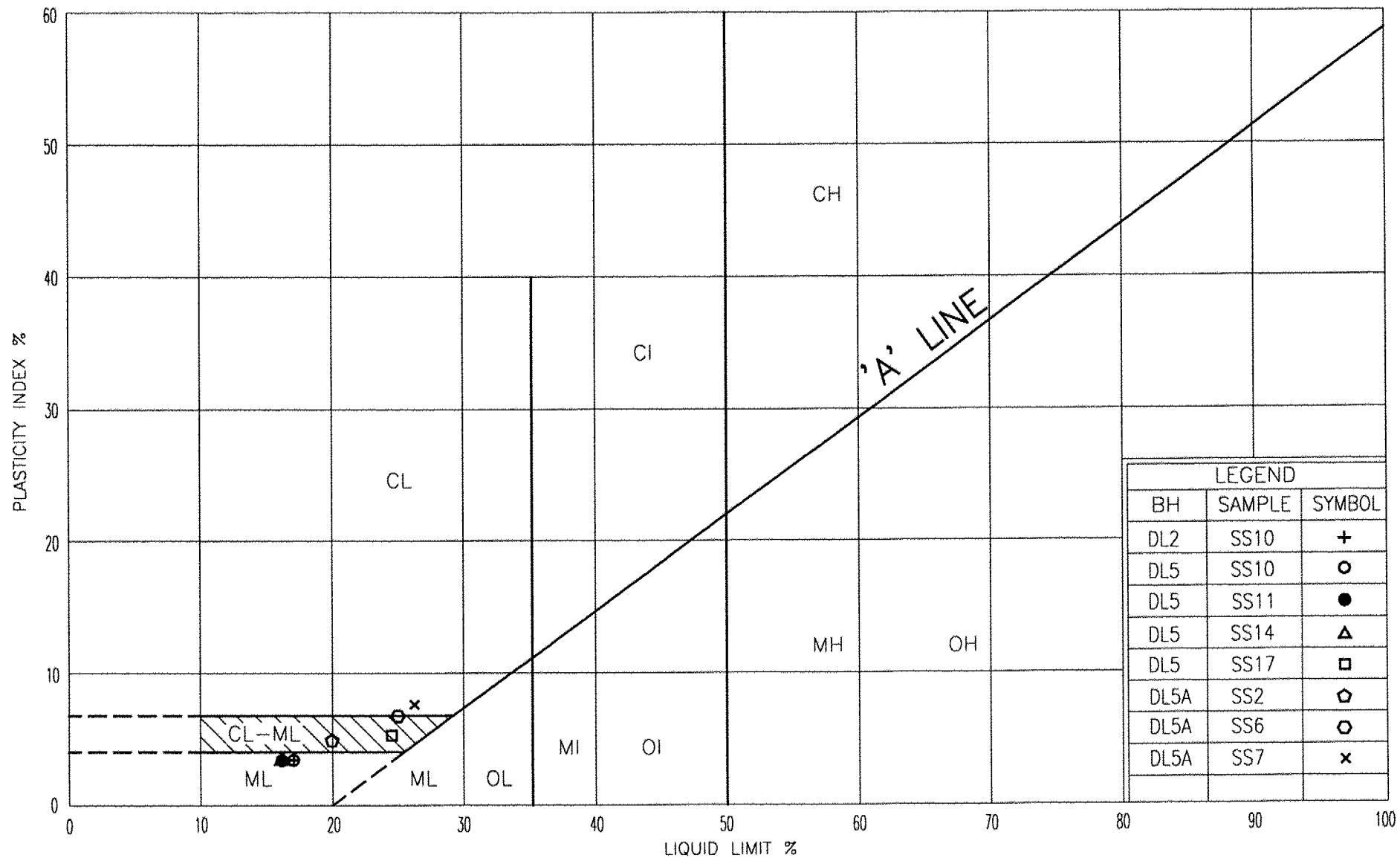
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# UNIFIED SOIL CLASSIFICATION SYSTEM

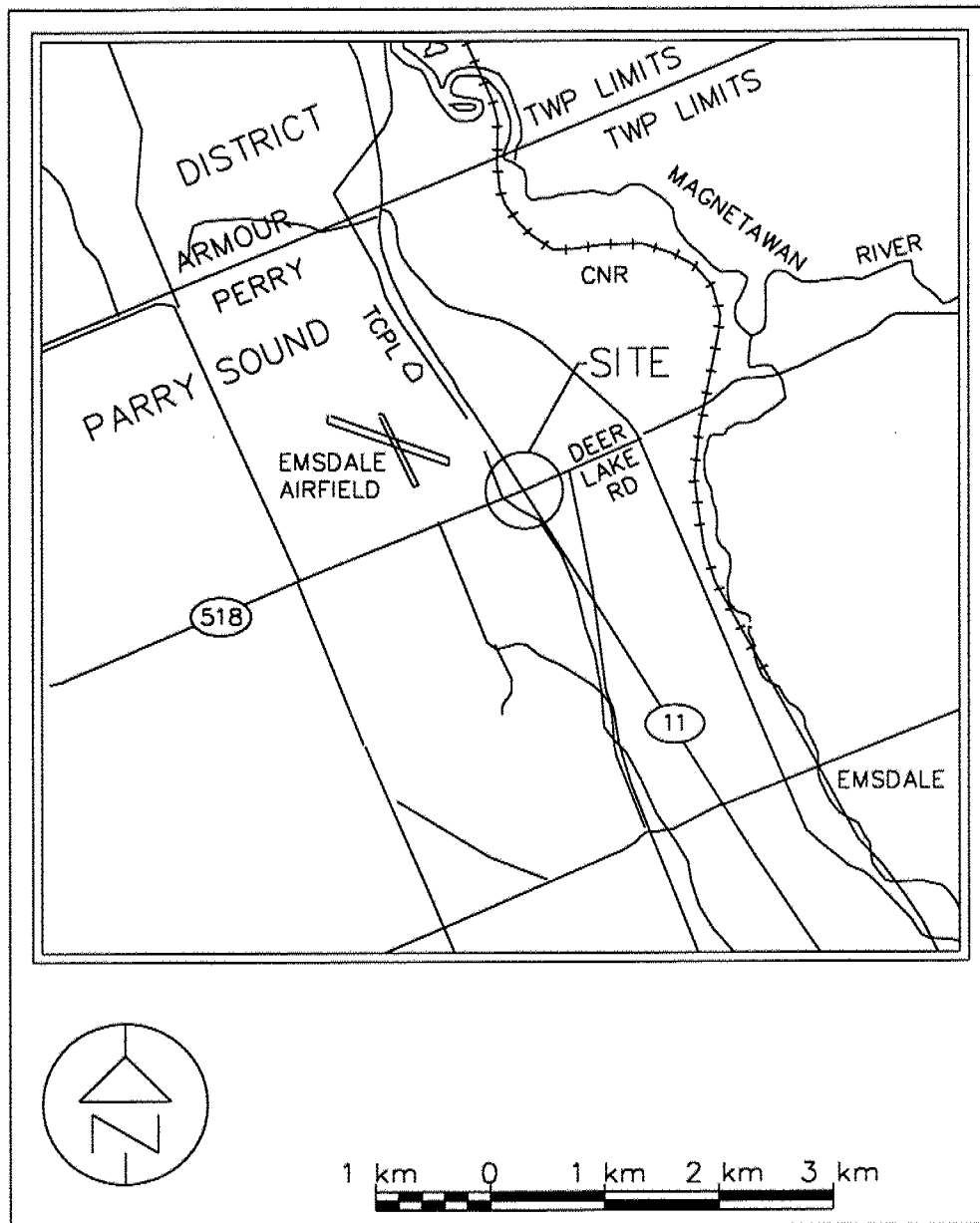
CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse







ENCLOSURES

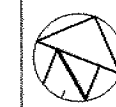


HWY 518 (DEER LAKE ROAD) UNDERPASS  
KEY PLAN

Dwg. No 1







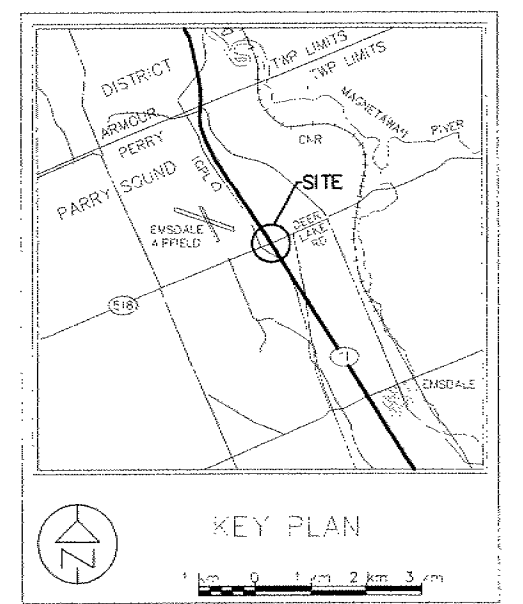
CONT. No.  
W.P. No. 471-93-01

HWY 518 (DEER LAKE ROAD) UNDERPASS

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

AGRA Earth & Environmental Ltd.



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- 'N' Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation Feb. 99
- WL in Piezometer Feb.15/99
- Piezometer

No	ELEVATION	CO-ORDINATES	EAST
DL1	335.0	5 044 915	317 752
DL2	334.5	5 044 932	317 776
DL3	334.5	5 044 897	317 710
DL4	334.4	5 044 889	317 690
DL5	334.6	5 044 927	317 780
DL5A	334.6	5 044 928	317 781
DL6	334.2	5 044 934	317 797
DL7	335.0	5 044 921	317 750
DL8	334.6	5 044 904	317 709
DL9	335.0	5 044 910	317 744

-NOTE-

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

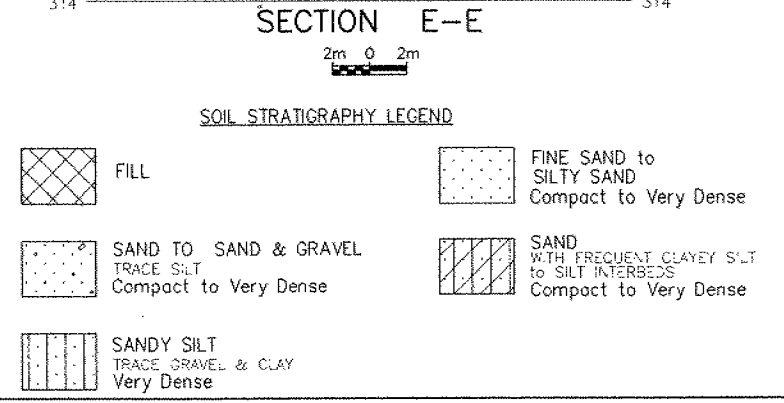
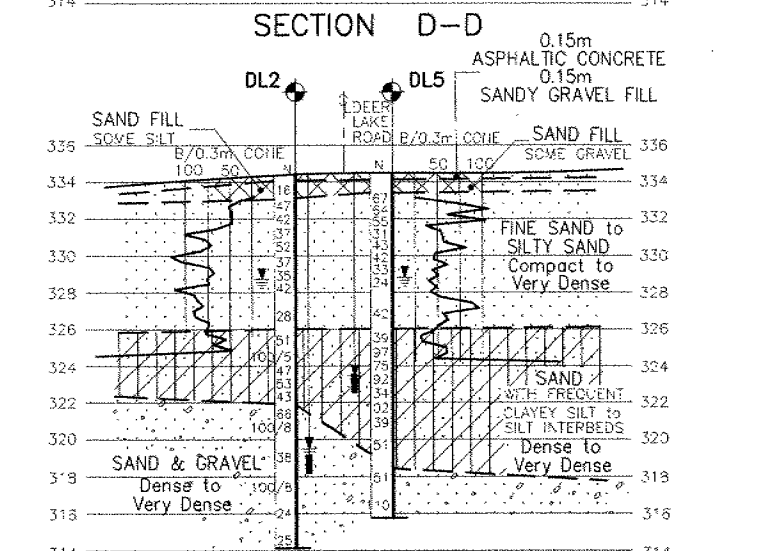
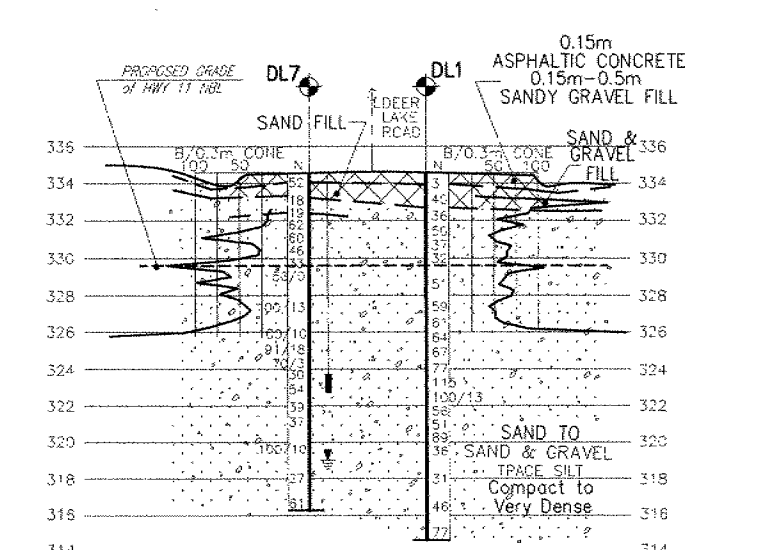
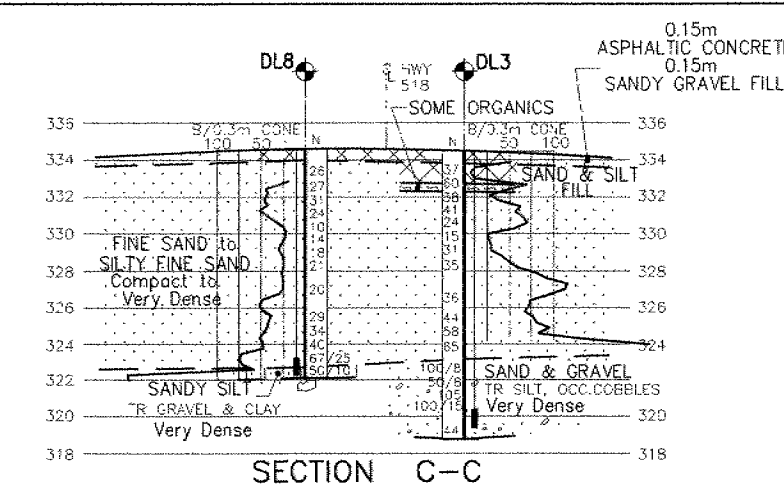
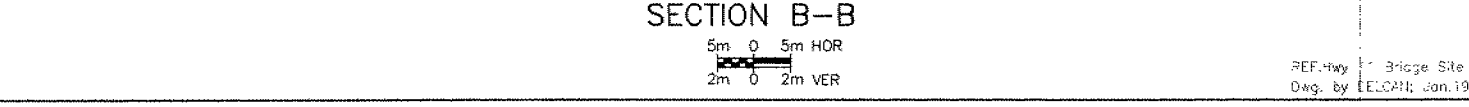
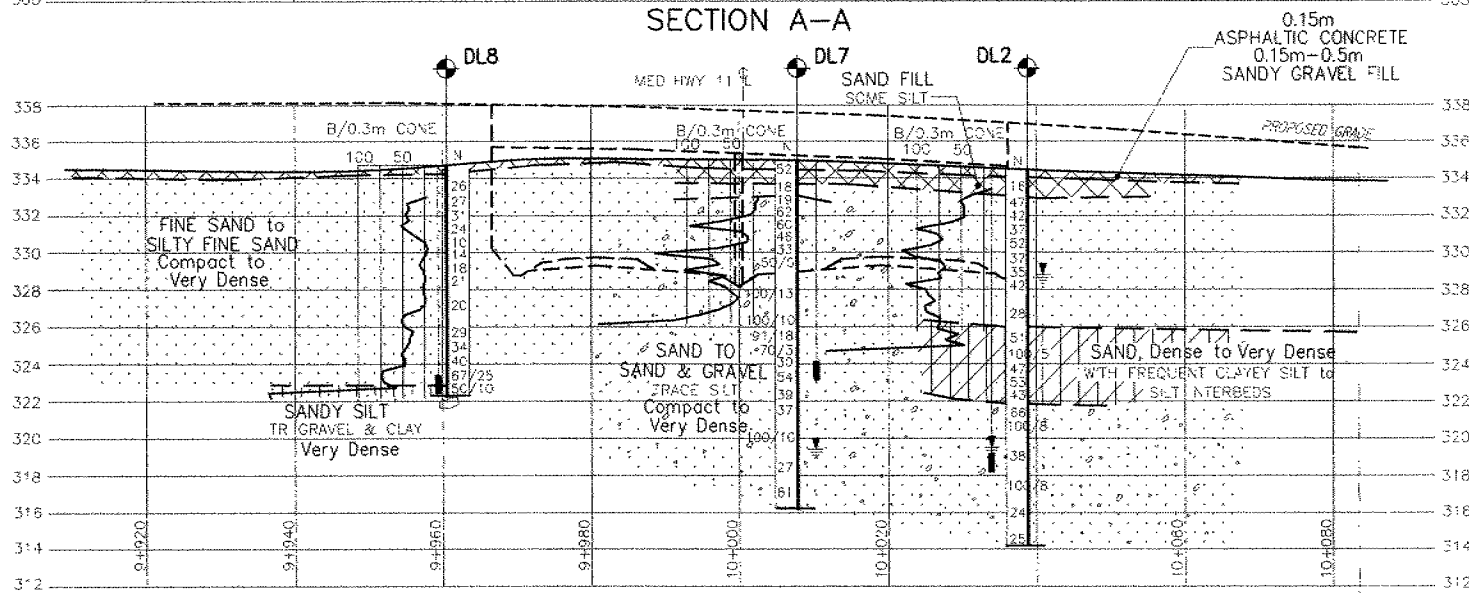
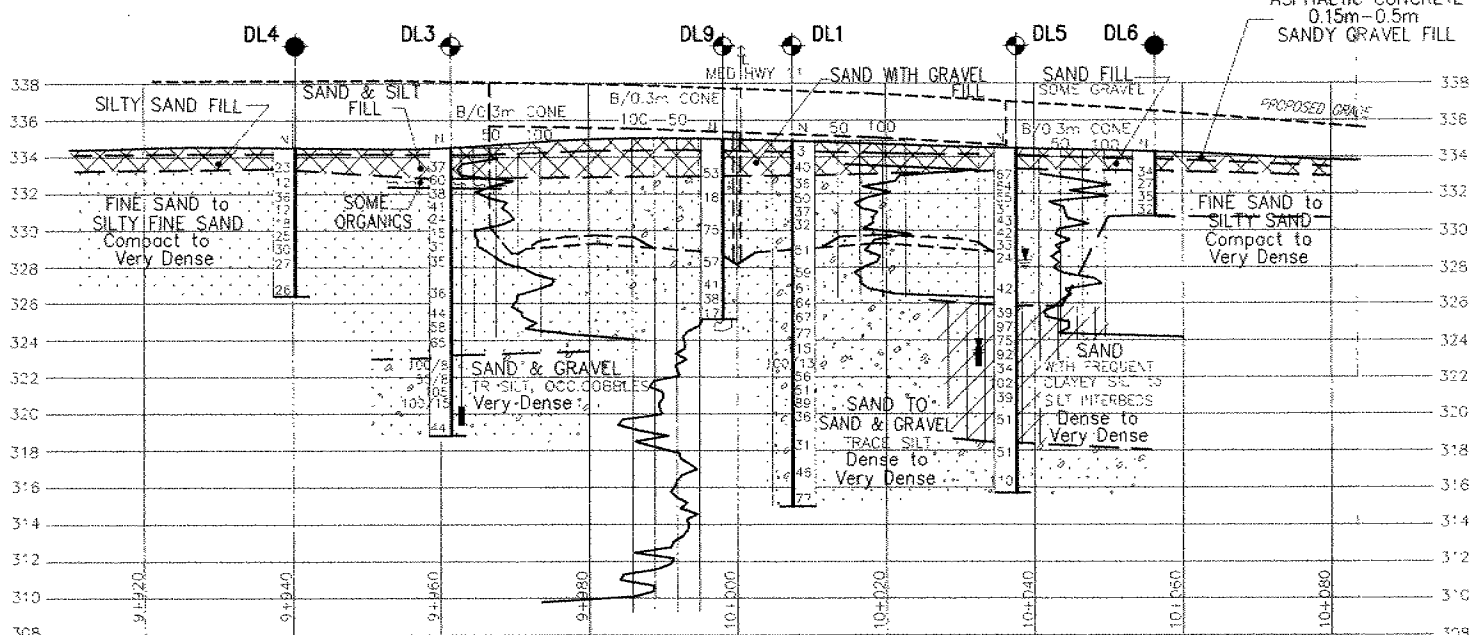
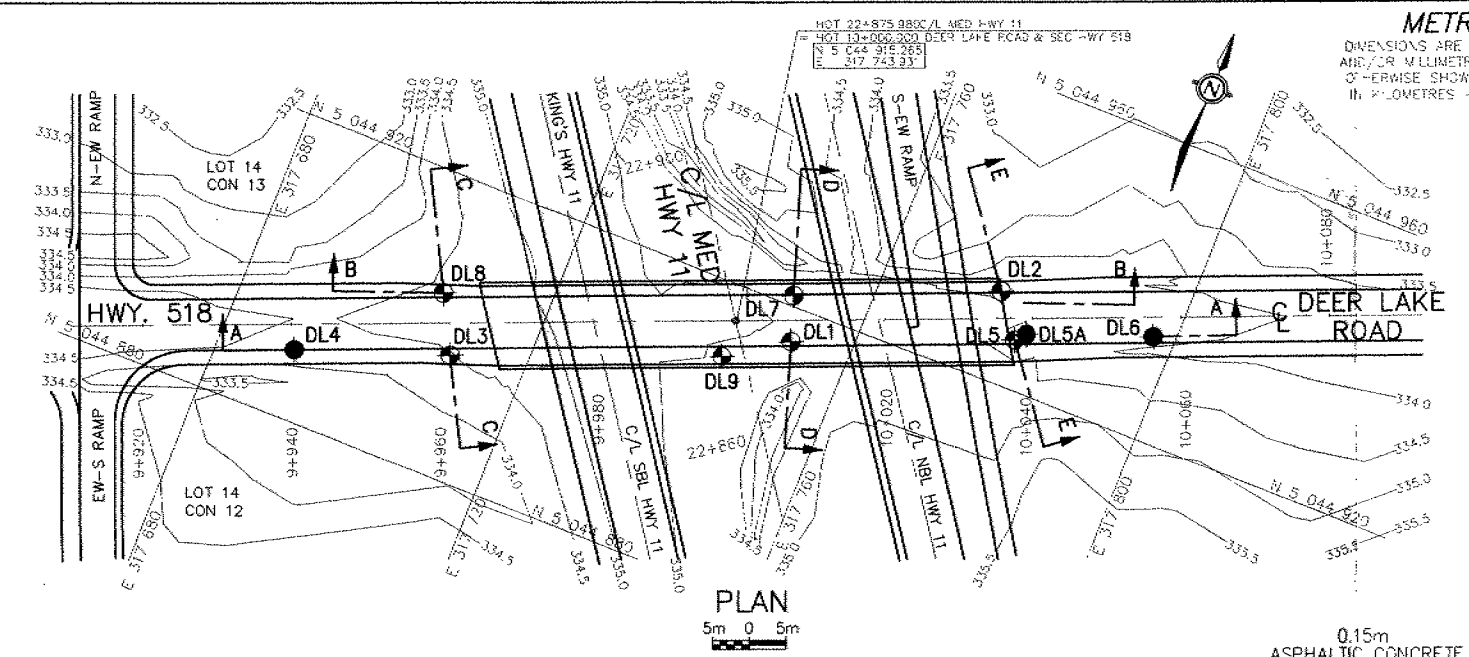
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 30.2C1 of CPS Gen.Cord.

REV.	DATE	BY	DESCRIPTION
------	------	----	-------------

HWY No. 11	CHECKED SP	DATE Sept. 30, 1999	SITE 44-393
SUBMITTED	CHECKED AD	DATE	DWG 2

METRIC

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

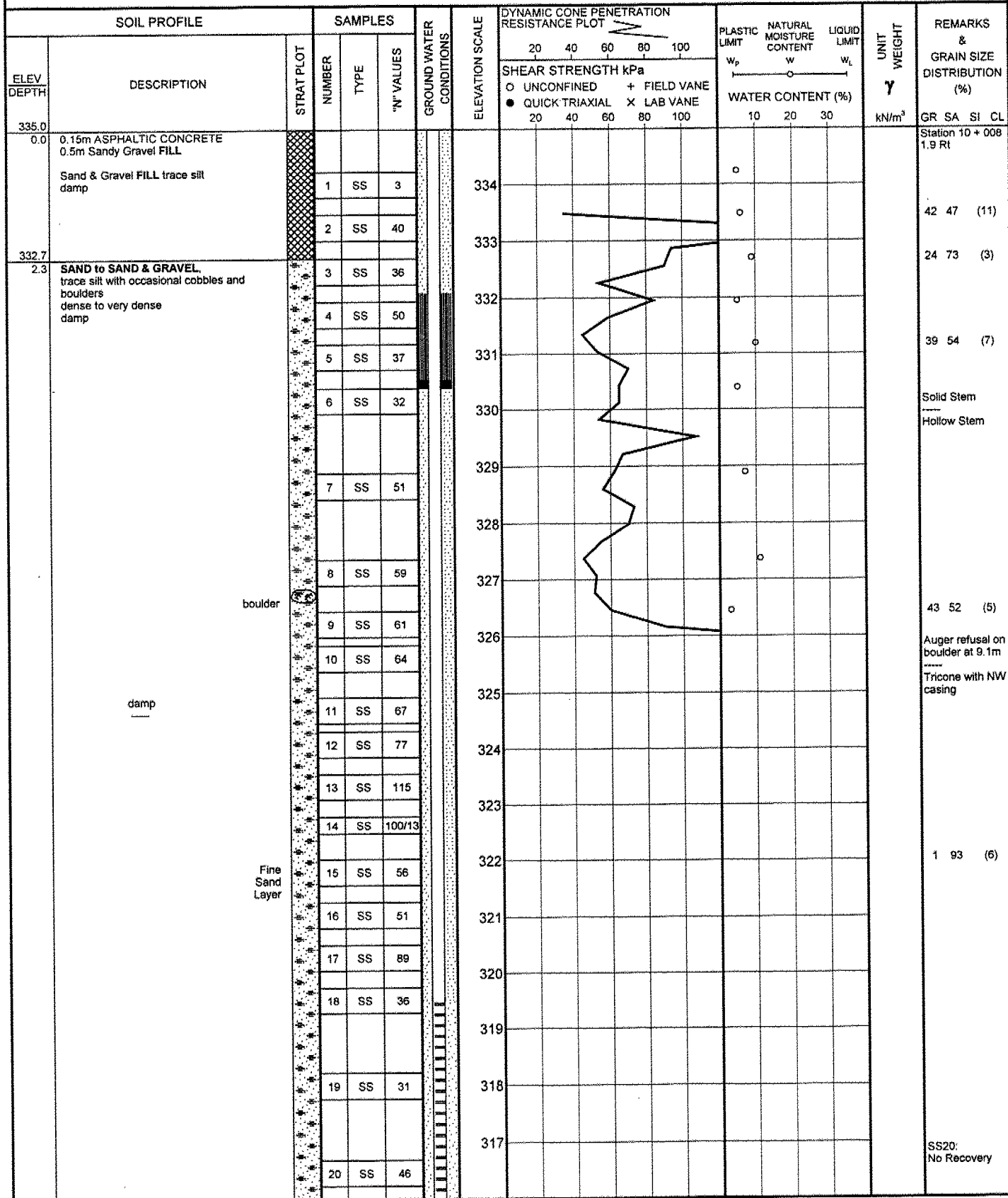


RECORD OF BOREHOLE No DL1

1 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044915.4 E 317752.0 ORIGINATED BY AD  
 DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK  
 DATUM Geodetic DATE 21 January 1999 CHECKED BY ZSO



Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

## RECORD OF BOREHOLE No DL1

2 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044915.4 E 317752.0 ORIGINATED BY AD  
 DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK  
 DATUM Geodetic DATE 21 January 1999 CHECKED BY ZSO

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			GR
314.7			21	SS	77		315											15 79 (6)
20.3	End of Borehole at 20.3 WL in Piezometer on completion: 7.1m (probably drilling mud) Feb. 15/99: 7.9m (probably drilling mud)																	

**METRIC**

W.P.	471-93-01	LOCATION	N 5044931.9 E 317776.1	ORIGINATED BY	AD
DIST	52	HWY	11	BOREHOLE TYPE	Solid Stem
DATUM	Geodetic	DATE	25 January 1999	COMPILED BY	CK
				CHECKED BY	ZSO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT $w_p$	NATURAL MOISTURE CONTENT $w$	LIQUID LIMIT $w_L$	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
								WATER CONTENT (%) 10 20 30					
334.5	0.15m Asphaltic Concrete 0.15m Sand & Gravel FILL												GR SA SI CL Station 10 + 036 4.5 Lt
333.2	Sand some silt FILL wet		1	SS	16								
1.4	brown SILTY FINE SAND to SAND dense		2	SS	47								
			3	SS	42								
			4	SS	37								
			5	SS	52								
			6	SS	37								
			7	SS	35								
			8	SS	42								
			9	SS	28								
325.9	brown		10	SS	51								
8.6	grey		11	SS	100/8								
	SAND with frequent very stiff to hard CLAYEY SILT TO SILT interbeds dense damp		12	SS	47								
			13	SS	53								
			14	SS	43								
321.8	brown SAND & GRAVEL dense to very dense		15	SS	66								
12.7			16	SS	100/8								
			17	SS	38								
			18	SS	100/8								
			19	SS	24								

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# RECORD OF BOREHOLE No DL2

2 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044931.9 E 317776.1 ORIGINATED BY AD  
DIST 52 HWY 11 BOREHOLE TYPE Solid Stem COMPILED BY CK  
DATUM Geodetic DATE 25 January 1999 CHECKED BY ZSO

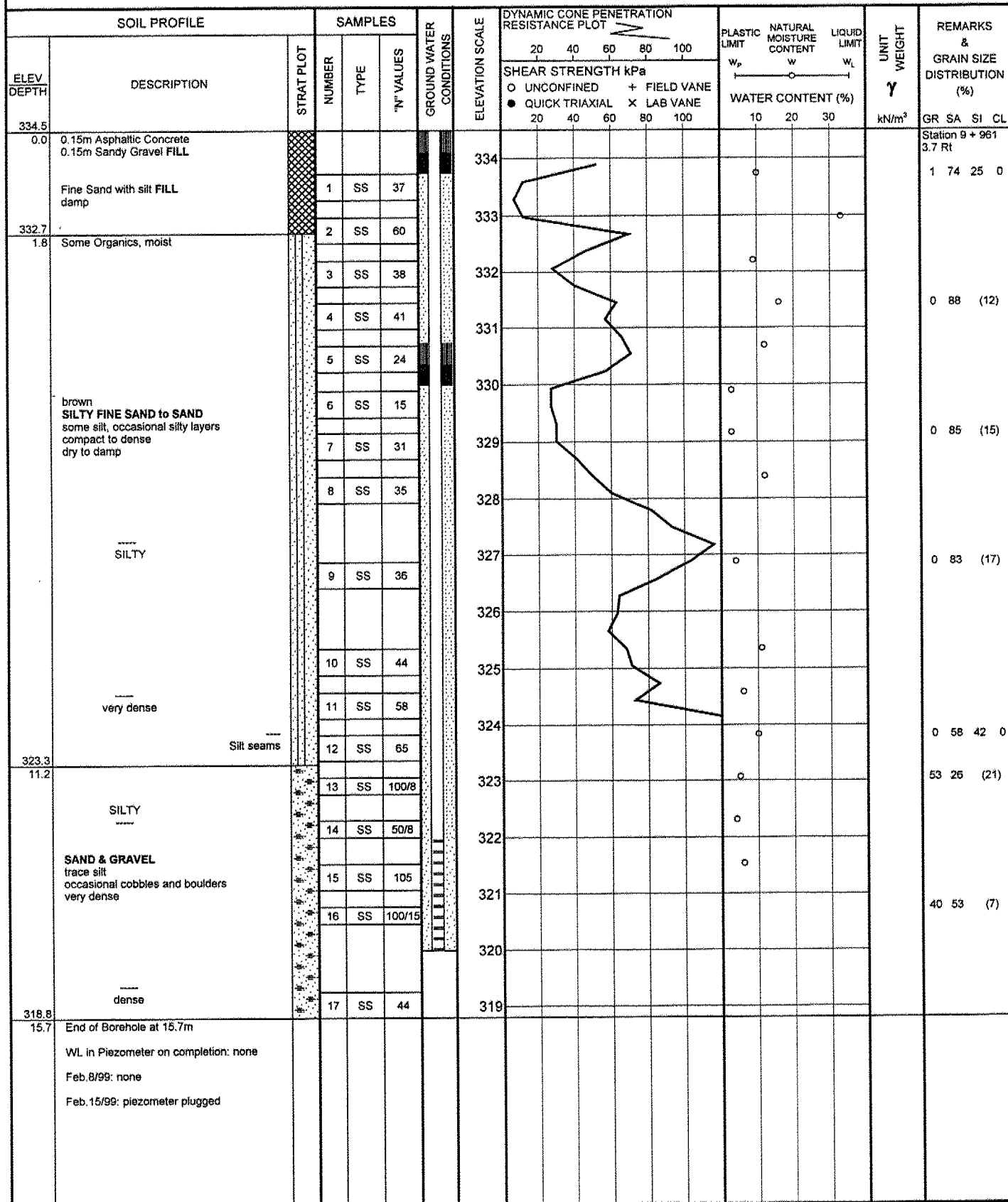
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	w	W <sub>L</sub>		
314.2							315										
20.3	End of Borehole at 20.3m WL in Piezometer Feb. 8/99: 15.0m Feb. 15/99: 15.5m		20	SS	25												30 57 (13)

RECORD OF BOREHOLE No DL3

1 OF 1

METRIC

W.P. 471-93-01 LOCATION N 5044896.6 E317709.9 ORIGINATED BY AD  
 DIST 52 HWY 11 BOREHOLE TYPE Solid Stem COMPILED BY CK  
 DATUM Geodetic DATE 26 January 1999 CHECKED BY ZSO



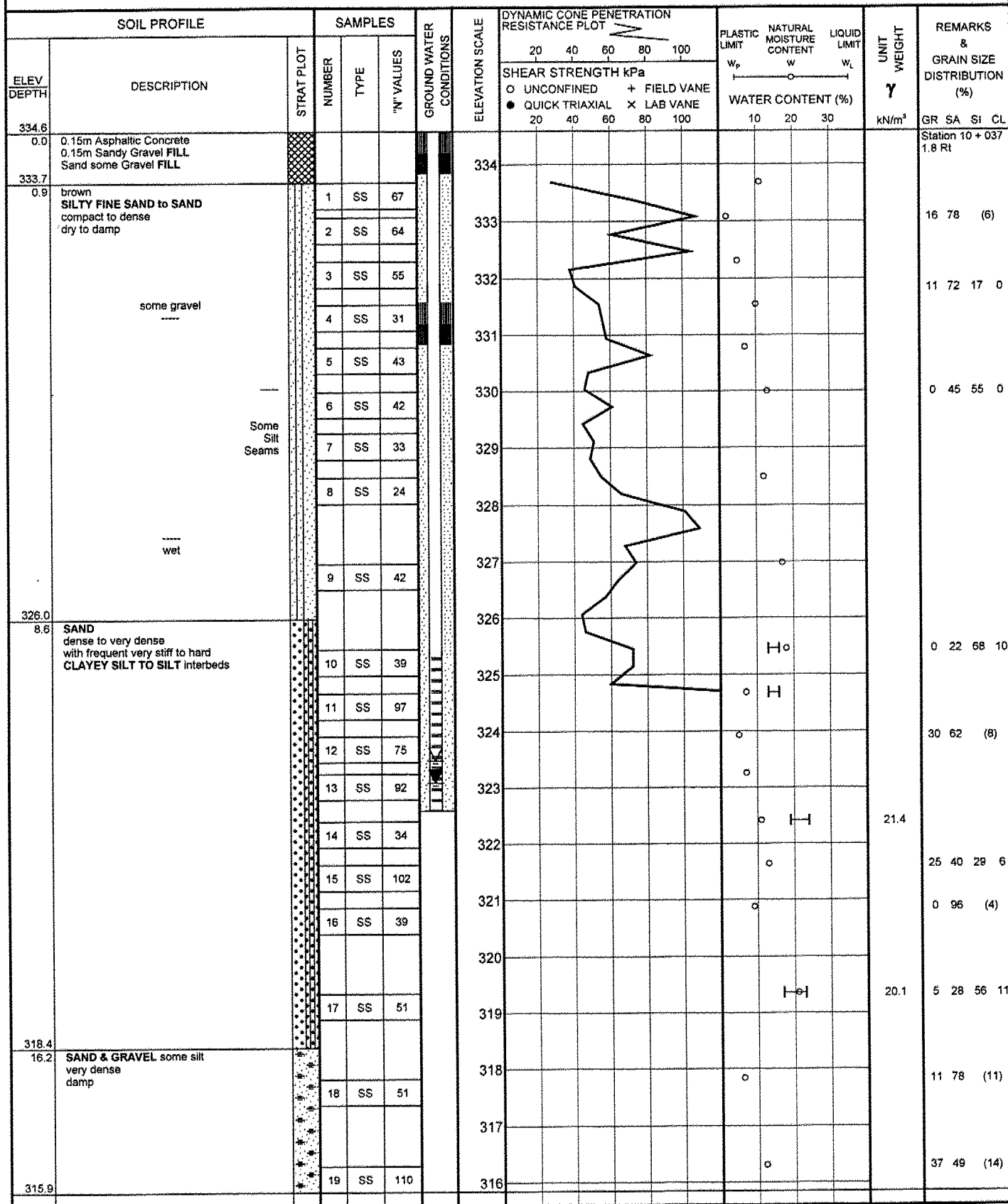
RECORD OF BOREHOLE No DL4										1 OF 1		METRIC			
W.P. 471-93-01		LOCATION N 5044889.5 E 317690.0				ORIGINATED BY AD									
DIST 52 HWY 11		BOREHOLE TYPE Solid Stem				COMPILED BY CK									
DATUM Geodetic		DATE 27 January 1999				CHECKED BY ZSO									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
334.4	0.0	0.15m Asphaltic Concrete 0.15m Sandy Gravel FILL					334								Station 9 + 940 2.9 Rt
333.4		Silty Sand FILL, moist	1	SS	23										1 66 33 0
1.0		brown SILTY FINE SAND to SAND with some Sandy Silt zones compact to dense damp	2	SS	12		333								
			3	SS	36		332								
			4	SS	12		331								0 80 20 0
			5	SS	18		330								
			6	SS	25		329								
			7	SS	30		328								0 22 70 8
			8	SS	27		327								
326.3			9	SS	26										
8.1		End of Borehole at 8.1m WL at completion: none													

RECORD OF BOREHOLE No DL5

1 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044926.7 E 317779.8 ORIGINATED BY AD  
 DIST 52 HWY 11 BOREHOLE TYPE Solid Stem COMPILED BY CK  
 DATUM Geodetic DATE 2 February 1989 CHECKED BY ZSO



Continued Next Page

+ 3, x 3. Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



RECORD OF BOREHOLE No DL5

2 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044926.7 E 317779.8 ORIGINATED BY AD  
 DIST 52 HWY 11 BOREHOLE TYPE Solid Stem COMPILED BY CK  
 DATUM Geodetic DATE 2 February 1999 CHECKED BY ZSO

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 $\gamma$ 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 (%)					
18.8	End of Borehole at 18.7m WL in piezometer on completion: 7.0m Feb. 8/99: 11.2m Feb. 15/99: 11.6m													

# RECORD OF BOREHOLE No DL5A

1 OF 1

METRIC

W.P. 471-93-01 LOCATION N 5044928 E 317781 ORIGINATED BY AD  
DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK  
DATUM Geodetic DATE 6 March 1999 CHECKED BY ZSO

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					
334.6 0.0														
	Auger to 8.4m													
326.2 8.4	SAND compact to very dense with frequent very stiff to hard CLAYEY SILT TO SILT interbeds damp		1	SS	22									
			2	SS	15									
			3	SS	25									
			4	SS	50/1*									
			5	SS	96									
			6	SS	50									
			7	SS	34									
			8	SS	40									
319.5 15.1	End of Borehole at 15.1m		9	SS	103*									

**RECORD OF BOREHOLE No DL6**

1 OF 1

**METRIC**

W.P. 471-93-01 LOCATION N 5044934.1 E 317797.1 ORIGINATED BY AD  
DIST 52 HWY 11 BOREHOLE TYPE Solid Stem COMPILED BY CK  
DATUM Geodetic DATE 25 January 1999 CHECKED BY ZSO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W <sub>p</sub>	W		
334.2	0.15m Asphaltic Concrete 0.15m Sandy Gravel FILL															
333.3	Sand FILL															
0.9	SILTY FINE SAND to SAND some gravel compact to dense dry to damp		1	SS	34											
			2	SS	27											
			3	SS	35											
			4	SS	32											
330.7	End of Borehole at 3.5m Water Level on completion: none															

# RECORD OF BOREHOLE No DL7

1 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044921.4 E317750.0 ORIGINATED BY AD  
DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK  
DATUM Geodetic DATE 2 February 1999 CHECKED BY ZSO

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						
								○ UNCONFINED      + FIELD VANE						
								● QUICK TRIAXIAL    x LAB VANE						
								20 40 60 80 100	20 40 60 80 100	10 20 30				
335.0														
0.0	0.15m Asphaltic Concrete 0.15m Sandy Gravel FILL													Station 10 + 008 4.4 Lt
	Sand FILL		1	SS	52		334							10 72 18 0
333.6														
1.4	brown SILTY FINE SAND to SAND compact, damp		2	SS	18		333							20 77 (3)
332.7														
2.3	Compact		3	SS	19		332							
			4	SS	62		331							
			5	SS	60		330							36 55 (9)
			6	SS	46		329							
			7	SS	33		328							
			8	SS	50/64		327							
			9	SS	100/13		326							
			10	SS	100/10		325							
			11	SS	91/18		324							
			12	SS	76/84		323							
			13	SS	30		322							
			14	SS	54		321							
			15	SS	39		320							
			16	SS	37		319							
			17	SS	100/10		318							
			18	SS	27		317							
			19	SS	61									
316.3														
18.7	End of Borehole at 18.7m.													

Continued Next Page

+ 3, x 3, Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

## RECORD OF BOREHOLE No DL7

2 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044921.4 E317750.0 ORIGINATED BY AD  
 DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK  
 DATUM Geodetic DATE 2 February 1999 CHECKED BY ZSO

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					
	WL in hollow stem augers on completion: 16m  WL in piezometer on completion: none  Feb. 8/99: none  Feb. 15/99: none						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60 80 100	10 20 30				

# RECORD OF BOREHOLE No DL8

1 OF 1

METRIC

W.P. 471-93-01 LOCATION N 5044904.2 E 317705.9 ORIGINATED BY AD  
DIST 52 HWY 11 BOREHOLE TYPE Solid Stem COMPILED BY CK  
DATUM Geodetic DATE 5 February 1999 CHECKED BY ZSO

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			SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
									20 40 60 80 100					
									20 40 60 80 100					
334.6	0.15m Asphaltic Concrete		1	AS										GR SA SI CL
0.0	0.15m Sandy Gravel FILL													Station 9 + 960
334.0	0.25m Silty Sand FILL													4.8 Lt
0.6			2	SS	26									12 55 31 2
	brown		3	SS	27									
	SILTY FINE SAND to SAND		4	SS	31									
	compact to dense		5	SS	24									0 51 47 2
	damp to dry		6	SS	10									
	V. Silty		7	SS	14									
			8	SS	18									0 95 (5)
			9	SS	21									
			10	SS	20									0 52 44 4
	frequent Silt seams		11	SS	29									
			12	SS	34									0 67 33 0
	moist		13	SS	40									
			14	SS	67/25									
322.6	brown, v. dense		15	SS	50/10									5 35 53 7
322.8	SANDY SILT, trace gravel & clay													
12.3	End of Borehole at 12.3m.													
	Auger Refusal on Probable Boulder													
	WL in piezometer on completion: none													
	Feb. 8/99: none													
	Feb. 15/99: none													

## RECORD OF BOREHOLE No DL9

1 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044910 E 317744 ORIGINATED BY AD  
 DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK  
 DATUM Geodetic DATE 5 March 1999 CHECKED BY ZSO

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			SHEAR STRENGTH kPa						
335.0	0.15m ASPHALTIC CONCRETE		1	AS										Station 9 + 996 4.0 Rt 25 51 24 0
0.0	Sand FILL with Gravel, Silt damp													
332.5	SAND to SAND & GRAVEL trace silt		2	SS	53									
2.5														
			3	SS	18									
	Compact dense to very dense													
			4	SS	75									
			5	SS	57									
		6	SS	41										
		7	SS	38										
		8	SS	17										
325.2	End of Borehole at 9.8m													
9.8	Auger Refusal on Boulder													
	WL on completion: none													

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

## RECORD OF BOREHOLE No DL9

2 OF 2

METRIC

W.P. 471-93-01 LOCATION N 5044910 E 317744 ORIGINATED BY AD  
 DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK  
 DATUM Geodetic DATE 5 March 1999 CHECKED BY ZSO

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 (%)					
							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
309.7						315							
						314							
						313							
						312							
						311							
25.3	End of DCPT at 25.3m					310							