FOUNDATION INVESTIGATION REPORT
FOR
PROPOSED STAR LAKE ROAD OVERPASS, NBL
STRUCTURE SITE NO. 44-392N
DISTRICT 52, HUNTSVILLE
W.P. 468-93-01

Submitted To:

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

Submitted By:

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

August 1999
TT98820B

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth &
Environmental Limited
104 Crockford Blvd.
Scarborough, Ontario
Canada M1R 3C6
Tel (416) 751-6565
Fax (416) 751-7592

August 31, 1999.
Ref. No.: TT98820B

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 STAR LAKE ROAD OVERPASS, NBL
STRUCTURE SITE NO. 44-392N
DISTRICT 52, HUNTSVILLE
W.P. 468-93-01

We take pleasure in enclosing six (6) 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,

Z.S. Ozden, P. Eng.,
Principal Engineer.

ZSO/dee

TABLE OF CONTENTS

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 the proposed realigned northbound lane of Highway 11 over the existing Star Lake Road. The site is located in the Village of Emsdale, about 0.3 km west of the intersection of Star Lake Road and present Highway 11, in the Township of Perry, Lot 14, Concession 11 in MTO District 52-Huntsville (see Key Plan, Drawing No. 1). The proposed bridge will be an approximately 21 m long, single 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 the approach fills.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located about 0.3 km west of the intersection of Star Lake Road and the present Highway 11, in the Village of Emsdale. The ground elevation in the general area of the proposed bridge site falls to the north and the east, ranging in Elevation from about 345 to 332 m. The surrounding area is wooded with residential properties about 100± m to the west and TransCanada PipeLine about 150± m further to the west.

Based on available geologic information, the site is in an area of ice-contact 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.

The bedrock generally consists of strongly foliated gneissic to migmatic rocks of the Central Gneiss Belt, which is part of the Grenville Province (a structural subdivision of the Canadian Shield).

3.0 INVESTIGATION PROCEDURE

The fieldwork for this project was performed during the periods of January 28 to 29, and February 18 to 25, 1999, and consisted of drilling and sampling seven boreholes (Borehole Nos. SL1 through 7) and performing four dynamic cone penetration tests. The plan locations of the boreholes, along with stratigraphic sections are shown on Drawing No. 2.

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 a soils 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 adjacent to four of the boreholes. 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 30 cm of penetration is recorded and this provides an indication of the relative changes in the soil density with depth.

Due to the presence of boulders above the bedrock surface, Boreholes SL2 and 4 were cored through boulders in the overburden utilizing NW size casing to the bedrock surface and the bedrock was subsequently cored using a NXL size core-barrel.

The borehole locations were established in the field by our engineering staff, in relation to the already staked out centre-line of Highway 11 (by Dearden and Stanton Limited). The borehole geodetic elevations and co-ordinates were later taken 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 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 in Figure Nos. 1 to 5.

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 SL1, 2 and 5 to monitor the groundwater level over a prolonged period of time without interference from surface water. The remaining boreholes were grouted on completion of the fieldwork, while the piezometer tubes were grouted on February 29, 1999.

4.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at seven borehole locations (Borehole Nos. SL1, 2, 3, 4, 5, 6, and 7), and were inferred at the locations of four dynamic cone penetration tests. The locations of the boreholes and 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 given on Drawing No. 2.

The ground surface at the proposed site falls to the north and east. The ground elevation at the proposed bridge location generally ranges from about 338 to 334 m.

In general, the boreholes have shown beneath a surficial topsoil the presence of cohesionless (i.e. granular) sand overburden to a depth of about 21 m. The overburden consists of generally fine or fine to medium sand with some (coarser) sand to sand & gravel zones. A bouldery sand & gravel layer was also encountered immediately overlying the bedrock. The Precambrian diorite bedrock was encountered at a depth of about 21 $\pm$ m (approximately Elevation 317 to 312 m). The groundwater table at the time of our investigation was encountered at depths of about 15 to 19 m below existing grade.

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 TOPSOIL

Topsoil was encountered at the majority of boreholes (except Boreholes SL3, 4 and 7), ranging in thickness from 0.05 to 0.2 m.

In our experience the thickness of topsoil frequently varies in between and beyond the borehole locations. In addition, at the time of our investigation the ground near the surface was frozen; therefore the soil conditions within the upper several decimeters could not be accurately determined and the descriptions given for this upper zone should be considered approximate only.

4.2 SILTY SAND

Below the surficial topsoil at Borehole SL5 and at the surface at Borehole SL7, a silty sand deposit was encountered to depths of 1.5 and 3.3 m (or Elevation 333.3 and 329.5 m), respectively. This cohesionless deposit contains occasional clayey silt seams (in Borehole SL7) and traces of gravel (in Borehole SL5). Measured 'N'-values within this deposit range from 15 to 58 blows/0.3 m, indicating a compact to very dense condition. Measured natural moisture contents range from 11 to 17%.

Results of the dynamic cone penetration tests range from 6 to 27 blows/0.3 m.

4.3 UPPER SAND TO GRAVEL & SAND

Underlying the surficial topsoil in Boreholes SL1 and SL2 (i.e. near the south abutment location) and below 1.4 and 3.3 m depths at Boreholes SL6 and SL7, a sand to sand & gravel deposit was contacted. This unit was found to be 3.6 to 5.6 m thick and extended to depths of between 3.8 m (Borehole SL2) and 8.9 m (Borehole SL7) below the ground surface or to Elevations 334.4 and 323.9 m, respectively. Eight grain size analyses were conducted on samples from this granular (cohesionless) deposit, resulting in the following grain size measurements.

Gravel:	17 - 55%
Sand:	42 - 81%
Silt and Clay:	0 - 7%

The grain size analyses results are presented in envelope form in Figure No. 1.

With the exception of two low values of 4 and 10 blows/0.3 m within 0.6 m of the ground surface, the measured 'N'-values within this deposit generally range from 27 to 76 blows/0.3 m, indicating a compact to very dense condition. The results of dynamic cone penetration tests in this deposit range from 19 to in excess of 100 blows/0.3 m, with lower values (3 to 5 blows/0.3 m) within the top 1 m $\pm$.

Measured natural moisture contents range from 2 to 9%.

4.4 SAND

Underlying the surficial soils described in the preceding sections, all boreholes contacted a major deposit of fine or fine to medium sand to depths of 1.4 (Borehole SL6) to 19.3 m (Borehole SL4) below existing grade or Elevation 339.5 m to 314.3 m. The grain size distribution of seventeen samples from this cohesionless (granular) deposit are presented in envelope form in Figure No. 2. These indicate 0-5% gravel, 84-99% sand and 1-16% soil fines (i.e. silt & clay) size particles.

Measured 'N'-values within the deposit range from 8 to 61 blows/0.3 m indicating loose to very dense conditions, but generally compact to dense. The results of dynamic cone penetration tests in this deposit range from 17 to in excess of 100 blows/0.3 m.

Measured natural moisture contents range from 1 to 10%.

4.5 GRAVELLY SAND

Interbedded within the fine sand deposit in Borehole SL2, is a gravelly sand layer extending from about 7.6 m (Elevation 330.6 m) to about 12.2 m (Elevation 326.0 m) below existing grade. A grain size distribution analysis was conducted on a sample from this granular deposit and the resulting curve is presented in Figure No. 3. The results indicate 34% gravel, 62% sand and 4% silt & clay size particles. Measured 'N'-values within this deposit range from 25 to 39 blows/0.3 m, indicating

a compact to dense condition. The measured natural moisture contents range from 1 to 2%.

4.6 LOWER SILTY SAND TO SANDY SILT

Near the south abutment location Boreholes SL1 and 2, contacted, underlying the fine to medium sand, a somewhat finer silty fine sand to fine sandy silt deposit at depths of 16.6 m (Elevation 321.1 m) and 16.2 m (Elevation 322.0 m), respectively. This basically cohesionless deposit was found to be 1.4 to 3.4 m thick and extended to depths of 18.0 m (Elevation 319.7 m) and 19.6 m (Elevation 318.6 m), respectively. Grain size distribution analyses were conducted on two samples and the range of particle sizes are presented in Figure No. 4. The analyses indicate the following particle distribution range.

Gravel:	0 %
Sand:	44 - 67%
Silt & Clay:	33 - 56%

The measured natural moisture contents range from 8 to 24%.

'N'-values recorded in this deposit range from 17 to 61 blows/0.3 m indicating a compact to very dense condition.

4.7 LOWER SAND & GRAVEL

Boreholes SL1 and SL2, drilled near the south abutment location, encountered, immediately above the bedrock, a sand & gravel deposit containing frequent cobbles and boulders. This bouldery deposit was contacted below depths of 18.0 m (Elevation 319.7 m) and 19.6 m (Elevation 318.6 m) at Boreholes SL1 and SL2, respectively and extended to the surface of the bedrock at depths of 21.3 m (Elevation 316.4 m) and 21.2 m (Elevation 317.0 m), respectively. The presence of the deposit was also inferred at the north abutment location at Borehole SL4, below a depth of 19.3 m or Elevation 314.3 m.

A grain size distribution analysis of a sample recovered from Borehole SL1 was carried out and, as shown in Figure No. 5, this indicated 42% gravel, 43% sand and 15% silt & clay size particles. It should however be pointed out that in Boreholes SL2 and SL4, coring had to be resorted in order to advance the boreholes through frequent cobbles and boulders.

Measured 'N'-values in this deposit range from 75 to in excess of 100 blows/0.3 m indicating a generally very dense condition although some of the measured values may be unreliable due to the presence of oversized materials.

Measured natural moisture contents range from 10 to 16%.

4.8 BEDROCK

Bedrock was encountered and cored in Boreholes SL1, 2 and 4 at depths of 21.3 m (Elevation 316.4 m), 21.2 m (Elevation 317.0 m) and 21.0 m (Elevation 312.6 m) below existing ground surface, respectively. These boreholes were advanced 3.1 to 4.8 m into the rock. The recovered core samples show that the Precambrian bedrock consists of a massive, moderately closely jointed, slightly metamorphosed diorite. In Boreholes SL1 and SL4 the percentage of core recovery was 97 to 100%, while in Borehole SL2 it was 45 to 100%. Rock quality designation (R.Q.D.) values of 80 to 100% were measured in Boreholes SL1 and SL4, with lower values in Borehole SL2 (0 to 83%). Based on these values together with a visual examination of the rock cores, the rock is considered to be of excellent quality in Boreholes SL1 and SL4, and generally of poor to good quality in Borehole SL2.

From the results of Boreholes SL1, 2 and 4, drilled for this investigation, and Boreholes SL12 and 14 for the proposed south-bound twin bridge about 30 m to the west, it can be surmized that the bedrock surface generally dips in a north easterly direction (i.e. from a high Elevation of 322.1 m at Borehole SL 14 to a low of 312.6 m at SL 4), more or less following the existing ground surface contours.

4.9 GROUNDWATER CONDITIONS

Groundwater levels in the open boreholes were observed during the drilling and at the completion of each borehole. To enable us to measure water levels at the site over a prolonged period of time without interference from surface water, standpipe piezometers were installed in Boreholes SL1, 2 and 5.

The recorded values, are shown on the individual Borehole Log Sheets. Based on the recorded values in the piezometers installed in Boreholes SL2 and 5 and moisture contents of samples in Boreholes SL1 and 4, the groundwater levels at the time of the investigation generally ranged from 15 to 19 $\pm$ m below the ground surface (Elevation 321 to 318 m). It should, however, 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.

AD/dee

LICENSED PROFESSIONAL ENGINEER
A. R. DREVININKAS
PROVINCE OF ONTARIO

Z.S. Ozden, P. Eng.

REGISTERED PROFESSIONAL ENGINEER
Z. S. OZDEN
PROVINCE OF ONTARIO

APPENDIX A

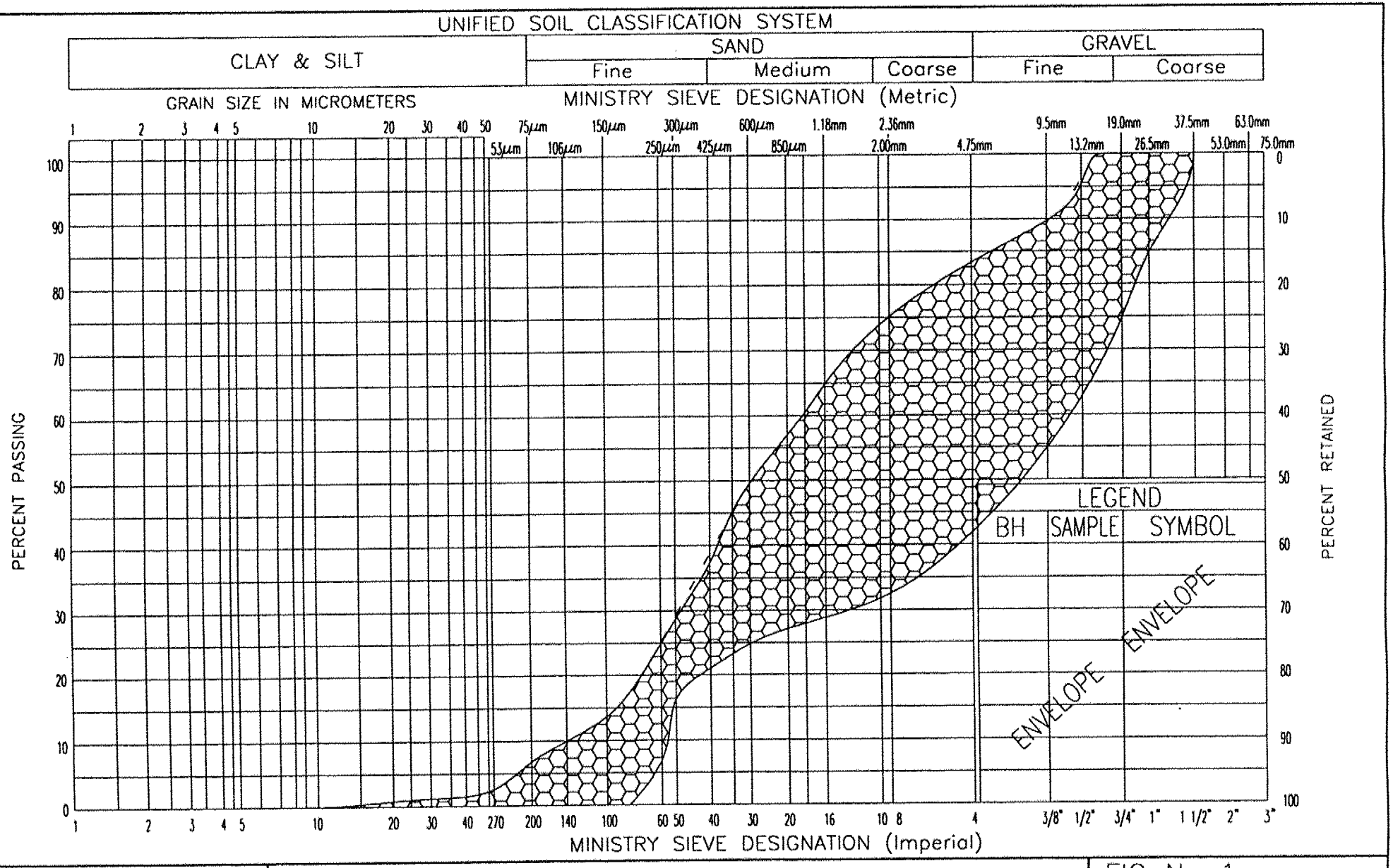
AGRA

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

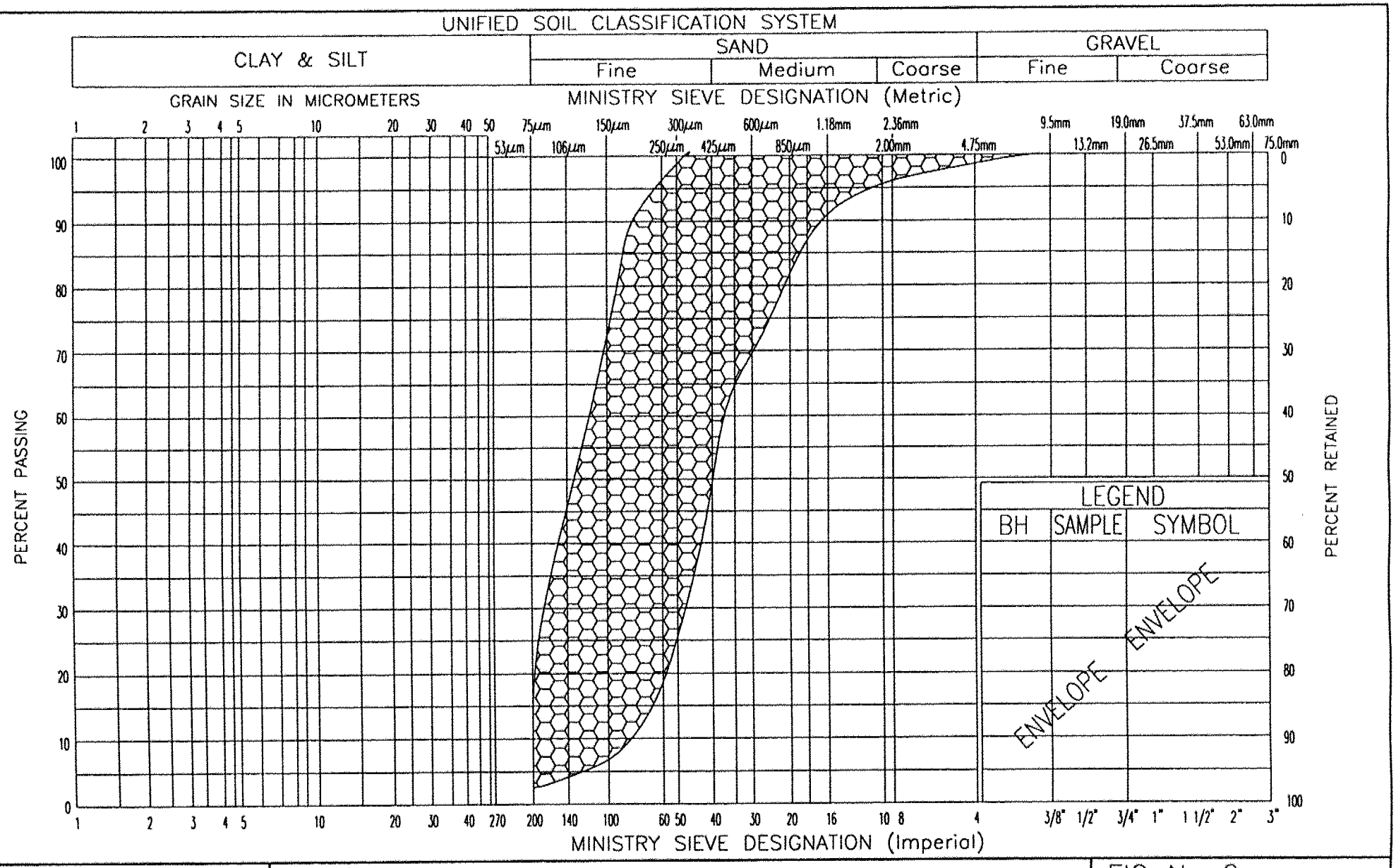


AGRA

GRAIN SIZE DISTRIBUTION
UPPER SAND TO SAND & GRAVEL

FIG No 1

W P 466-93-00

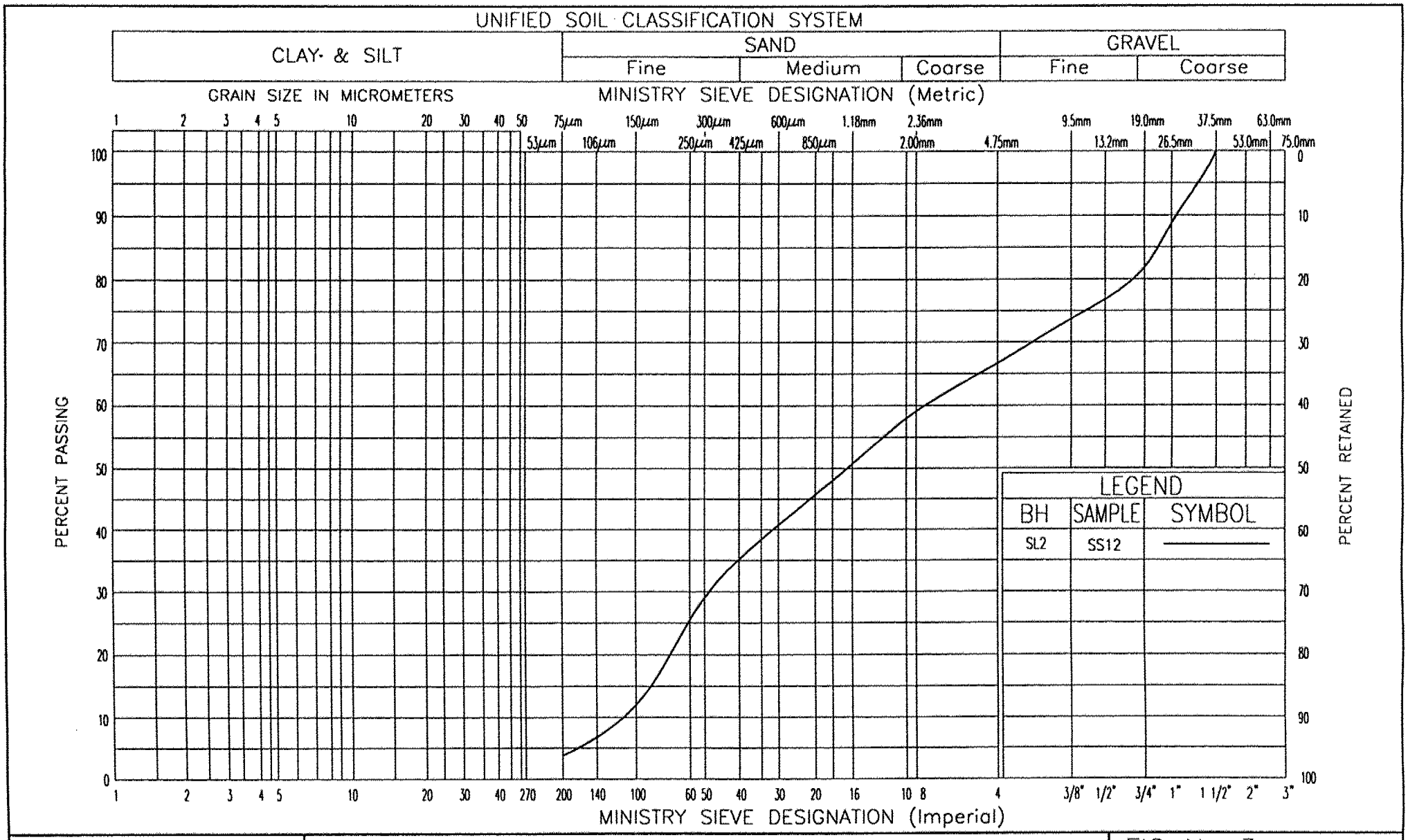


AGRA

GRAIN SIZE DISTRIBUTION
SAND

FIG No 2

W P 466-93-00

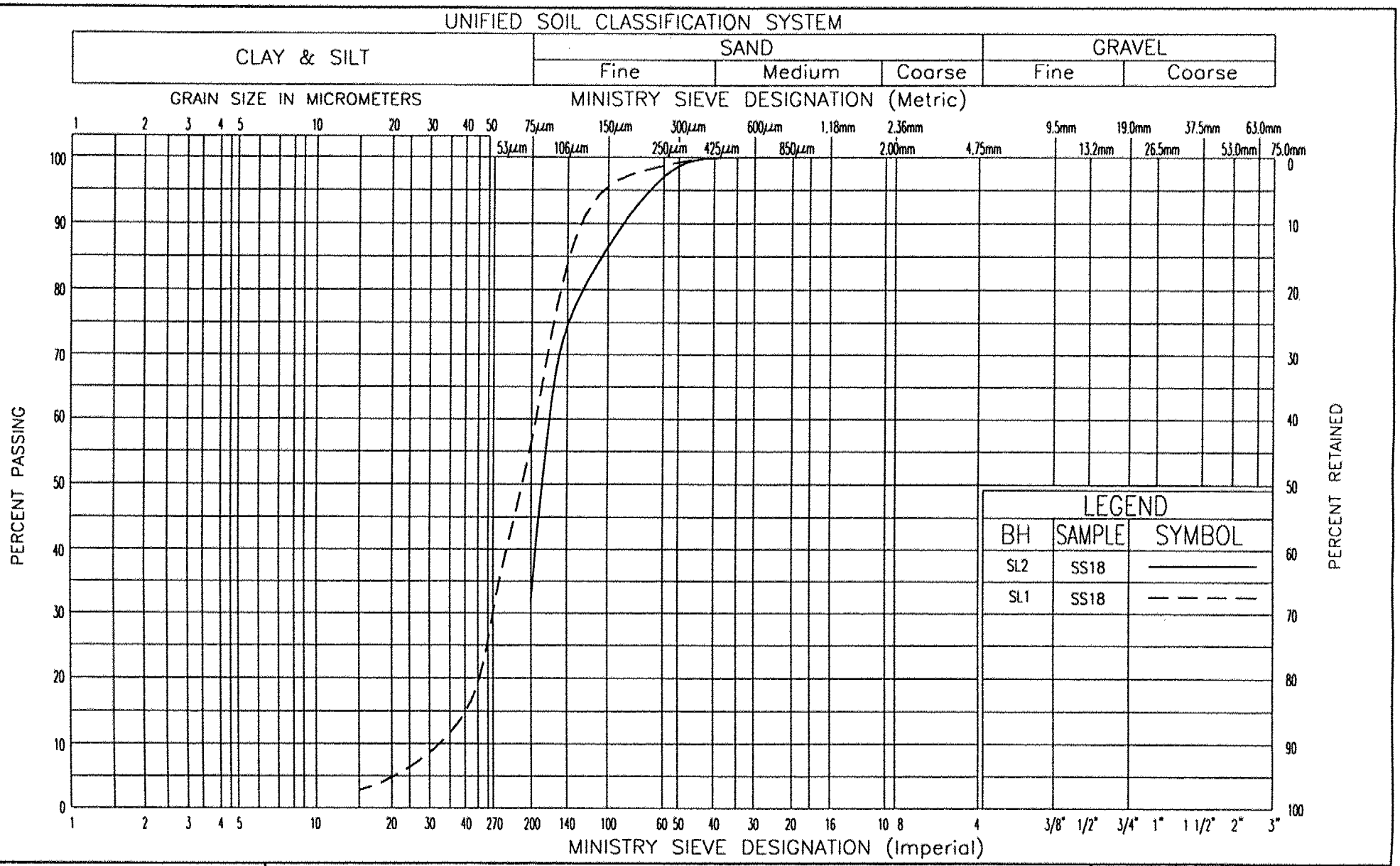


AGRA

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND

FIG No 3

W P 466-93-00

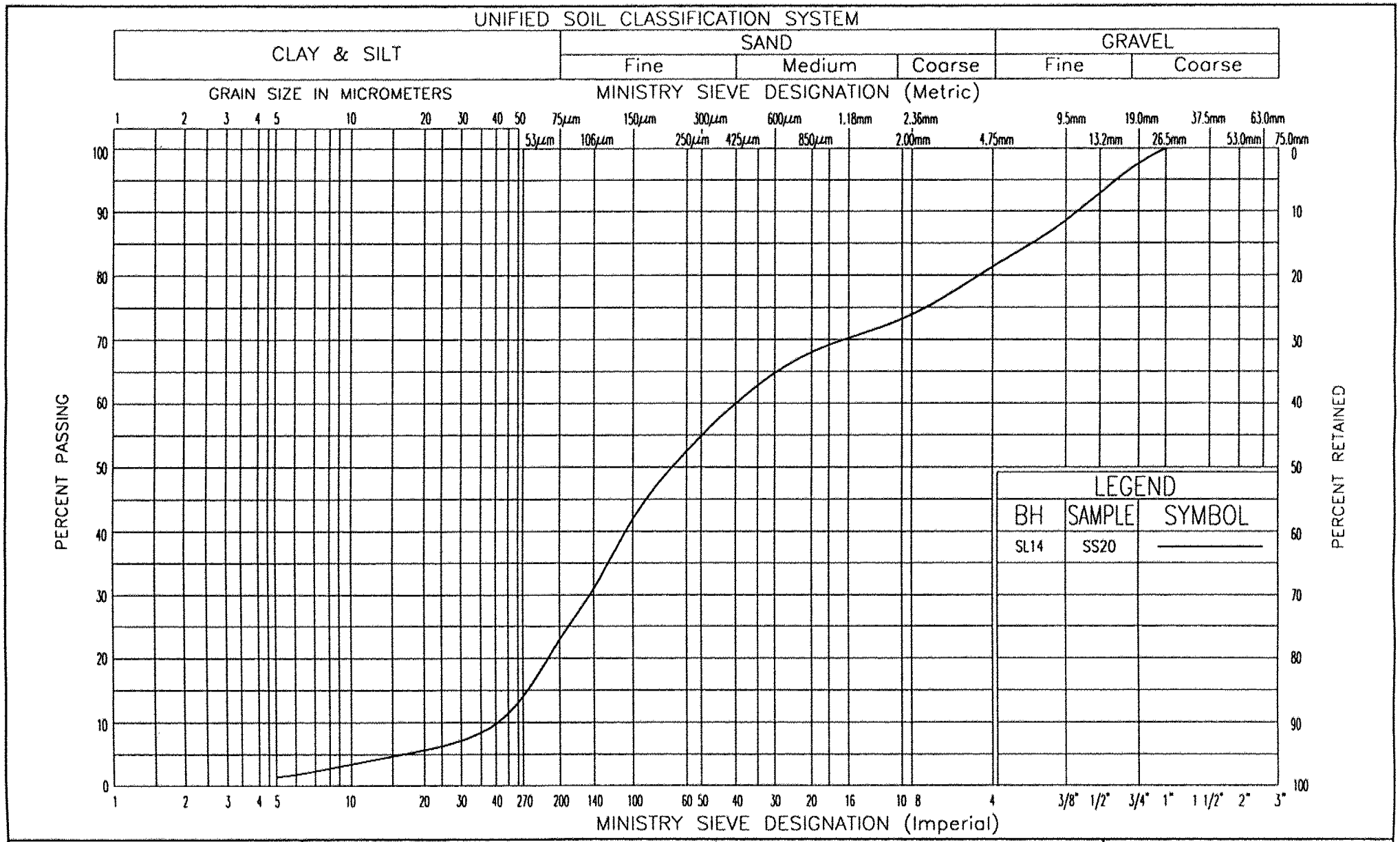


AGRA

GRAIN SIZE DISTRIBUTION
LOWER SILTY SAND to SANDY SILT

FIG No 4

W P 466-93-00



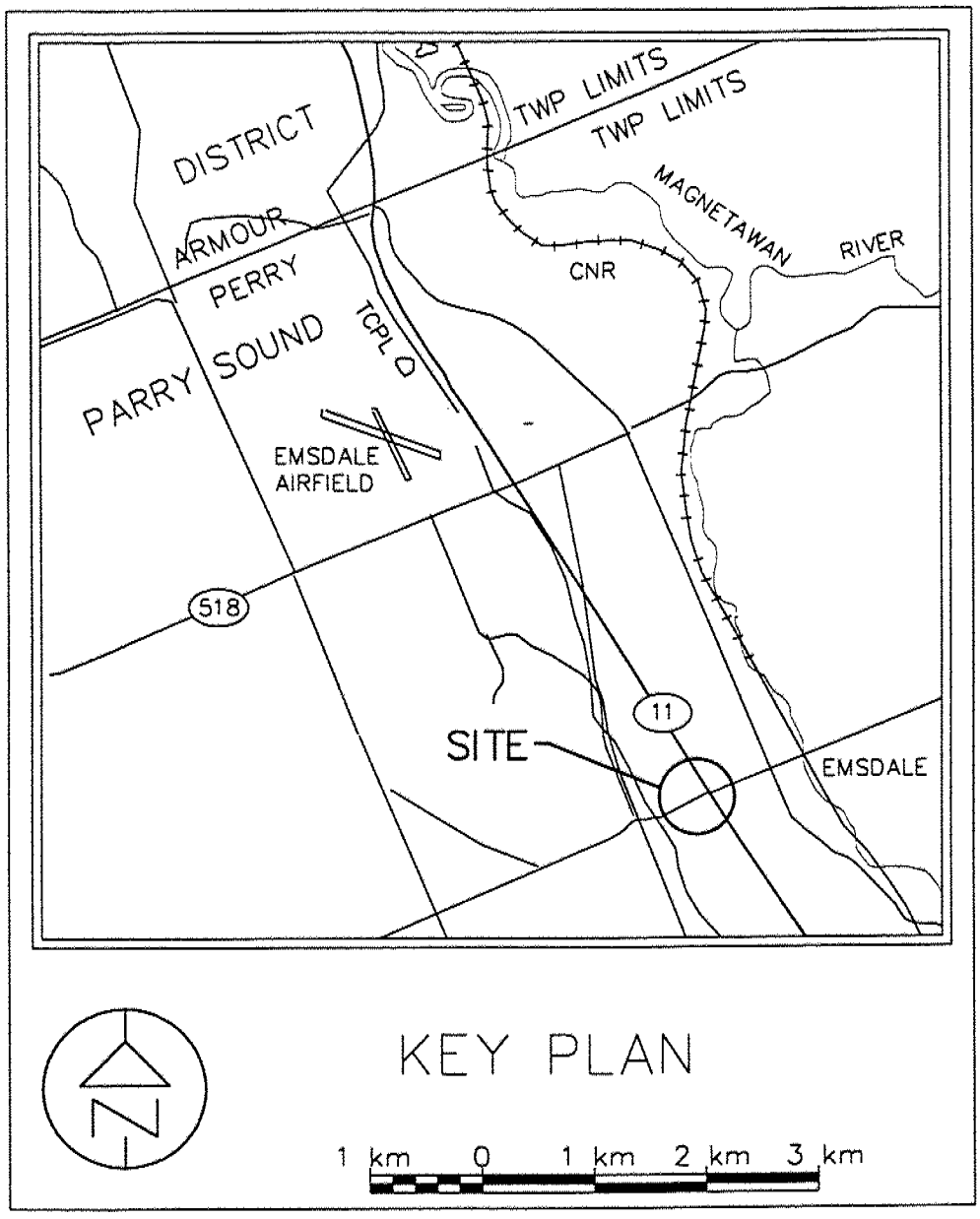
AGRA

GRAIN SIZE DISTRIBUTION
LOWER SAND & GRAVEL

FIG No 5

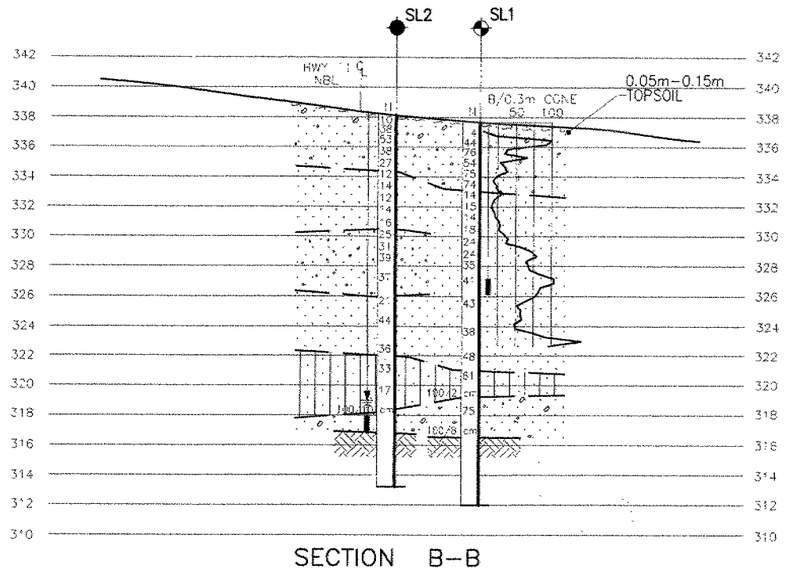
W P 466-93-00

ENCLOSURES

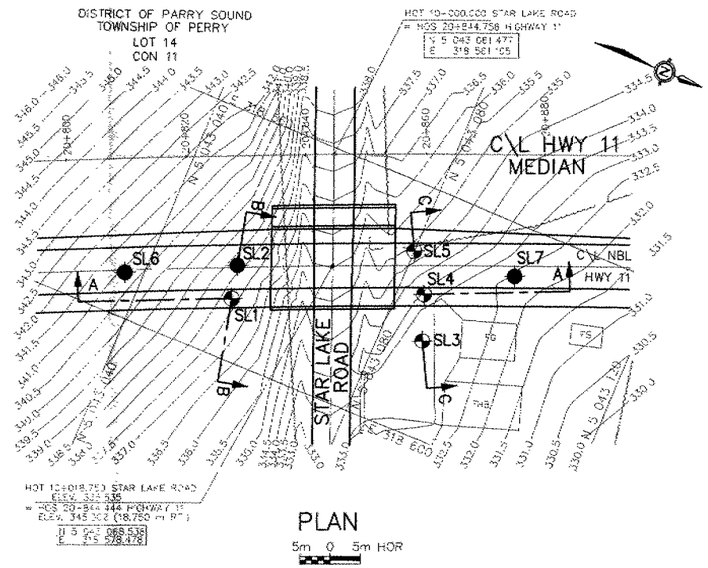


KEY PLAN

STAR LAKE ROAD OVERPASS (NBL) KEY PLAN	Dwg. No 1	AGRA

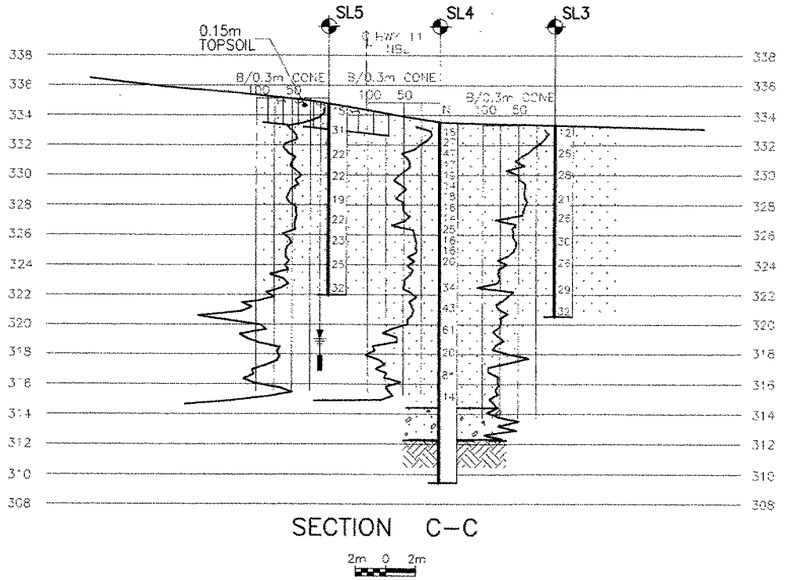


SECTION B–B



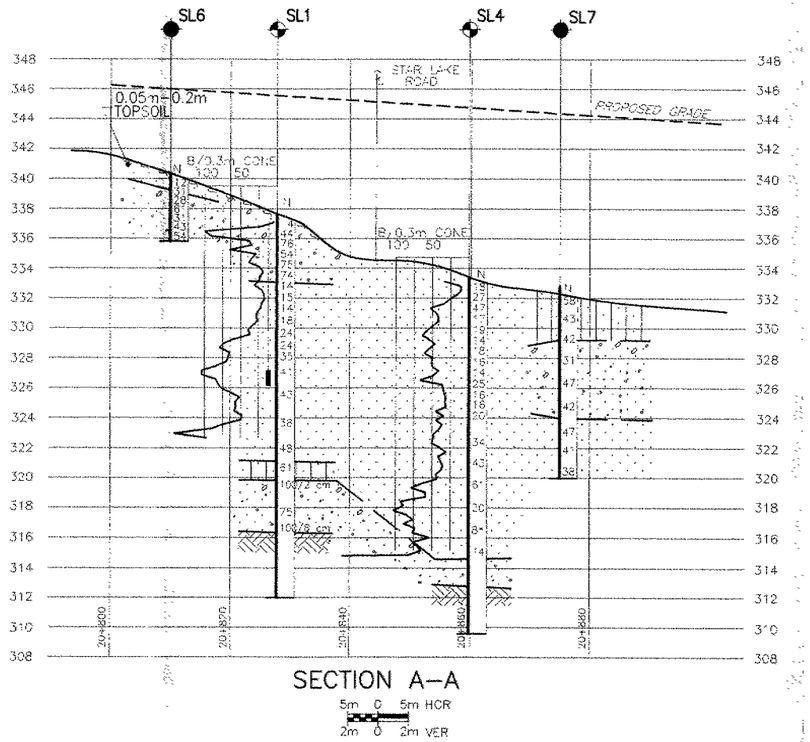
PLAN

5m 0 5m HOR



SECTION C–C

2m 0 2m



SECTION A–A

5m 0 5m HOR

2m 0 2m VER

SOIL STRATIGRAPHY LEGEND

- SAND to SAND & GRAVEL, Very Loose to Very Dense
- SAND, Compact to Dense
- GRAVELLY SAND, Compact to Dense
- SILTY SAND to SANDY SILT, Dense to Very Dense
- GRANODIORITE BEDROCK

METRIC

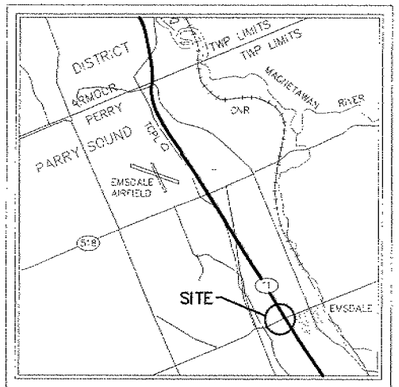
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN STATIONS IN KILOMETRES – METRES.

CONT. No.
W.P. No. 468-93-01

SHEET

STAR LAKE ROAD OVERPASS (NBL)
BORE HOLE LOCATIONS & SOIL STRATA

AGRA Earth & Environmental Ltd.



KEY PLAN

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
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
SL1	337.7	5 043 055	318 590
SL2	338.2	5 043 054	318 584
SL3	333.3	5 043 087	318 584
SL4	333.6	5 043 084	318 577
SL5	334.8	5 043 081	318 571
SL6	340.9	5 043 037	318 593
SL7	332.8	5 043 097	318 568

–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 90.2.01 of OPS Gen Conc

REV.	DATE	BY	DESCRIPTION

REF. Hwy 11 Bridge Site Plan
Dwg. By MTO; Jan. 1999

HWY No. 11				DST 52–HUNTSVILLE
SUBM'D ZO	CHECKED AD	DATE June, 1999		SITE 44–392H
DRAWN MA	CHECKED	APPROVED		DWG 2

RECORD OF BOREHOLE No SL1

1 OF 2

METRIC

W P. 468-93-01 LOCATION N 5043055 1 E 318590 0 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 28 January 1999 - 29 January 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
337.7							
0.0	0.05m TOPSOIL		1	SS	4		337
	very loose		2	SS	44		
	brown **SAND to SAND & GRAVEL** dense to very dense, dry		3	SS	76		336
			4	SS	54		335
			5	SS	75		
			6	SS	74		334
333.1							
4.6	brown **SAND** fine to medium dry		7	SS	14		333
			8	SS	15		
			9	SS	14		332
			10	SS	18		
			11	SS	24		331
	compact		12	SS	24		330
	dense		13	SS	35		
	cobbles						329
	trace gravel		14	SS	41		328
			15	SS	43		327
			16	SS	38		326
							325
							324
							323

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)

○ UNCONFINED + FIELD VANE

● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
Station 20 + 827 5.3 Rt NBL				
	55	42		(3)
	40	60		(0)
Solid Stem				
Hollow Stem				
	0	94		(6)
	0	87		(13)
	1	96		(3)

Continued Next Page

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No SL1

2 OF 2

METRIC

W.P. 468-93-01 LOCATION N 5043055.1 E 318590.0 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 28 January 1999 - 29 January 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			17	SS	48		322				
321.1 / 16.6											
	brown **SILTY SAND to SANDY SILT** very dense, wet		18	SS	61		321				0 44 56 0
319.7 / 18.0							320				
			19	SS	100/2		319				
	brown **SAND & GRAVEL** very dense wet						318				
			20	SS	75						42 43 (15)
316.4			21	SS	100/8		317				
21.3							316				RC22: REC=100% RQD=100%
	DIORITE BEDROCK massive, moderately closely jointed		22	RC			315				
			23	RC			314				RC23: REC=100% RQD=100%
			24	RC			313				RC24: REC=97% RQD=80%
312.0							312				
25.7	END OF BOREHOLE										

WL in Piezometer:

On completion: none

Feb 15/99: none

Dynamic Cone Penetration Test conducted 2.5m West of Borehole

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No SL2

1 OF 2

METRIC

W.P. 468-93-01 LOCATION N 5043053.8 E 318584.5 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 26 February 1999 - 27 February 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.2											
0.0	0.15m TOPSOIL		1	SS	10		338				Station 20 + 828 0.2 Lt NBL C/L
	loose		2	SS	38		337				
	brown **SAND to SAND & GRAVEL** compact to very dense damp		3	SS	53						51 43 (6)
			4	SS	38		336				
			5	SS	27		335				17 81 (2)
334.4											
3.8	brown **SAND** fine to medium compact dry		6	SS	12		334				
			7	SS	14						
			8	SS	12		333				0 92 (8)
			9	SS	14		332				
			10	SS	16						
330.6							331				
7.6	compact dense		11	SS	25						
	brown **GRAVELLY SAND** dry		12	SS	31		330				34 62 (4)
			13	SS	39		329				
			14	SS	37		328				
326.0							327				
12.2	compact dense		15	SS	21		326				0 98 2 0
	brown **SAND** fine to medium dry		16	SS	44		325				
							324				

Continued Next Page

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

RECORD OF BOREHOLE No SL2

2 OF 2

METRIC

W.P. 468-93-01 LOCATION N 5043053 8 E 318584 5 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 26 February 1999 - 27 February 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.0 / 16.2	brown **SILTY SAND to SANDY SILT** compact to dense damp		17	SS	36		323				
			18	SS	33		322				0 67 (33)
			19	SS	17		321				Refusal to further augering @ 20.7m on a boulder. Borehole advanced by rock coring using NW casing
318.6 / 19.6	brown **SAND & GRAVEL** with cobbles & boulders		20	SS	100/7D		320				
	boulder						319				RC21: REC=61% RQD=23%
	wet						318				
	boulder		21	RC			317				RC22: REC=58% RQD=21%
317.0 / 21.2	boulder										
	DIORITE BEDROCK massive, moderately closely jointed		22	RC			316				RC23: REC=81% RQD=44%
			23	RC							
			24	RC			315				RC24: REC=74% RQD=0%
			25	RC							
			26	RC			314				RC25: REC=45% RQD=13%
313.2 / 25.0			27	RC							
	END OF BOREHOLE										RC26: REC=100% RQD=83%
	WL IN PIEZOMETER: Feb 27/99: 19.3m										RC27: REC=75% RQD=75%

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No SL3

1 OF 2

METRIC

W.P. 468-93-01 LOCATION N 5043087.1 E 318584.5 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 21 February 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
333.3											
0.0	frozen		1	SS	12		333				Station 20 + 860 12.8 Rt NBL C/L
							332				0 96 (4)
			2	SS	26						
							331				
			3	SS	28		330				
							329				0 96 (4)
			4	SS	21						
	brown **SAND** fine to medium compact dry to damp						328				
			5	SS	26		327				
							326				2 88 (10)
			6	SS	30						
							325				
			7	SS	26		324				
							323				
			8	SS	29						
							322				
320.5	dense		9	SS	32		321				
12.8	WL on completion: none Dynamic Cone Penetration Test conducted 2.0m West of Borehole.										

Continued Next Page

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

RECORD OF BOREHOLE No SL3 2 OF 2 METRIC

W.P. 468-93-01 LOCATION N 5043087.1 E 318584.5 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 21 February 1999 CHECKED BY ZSO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
312.0 / 21.4	END OF DCPT @ 21.4m										

$+^{3}, \times^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No SL4 1 OF 2 METRIC

W.P. 468-93-01 LOCATION N 5043084.3 E 318577.1 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 18 February 1999 - 19 February 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
333.6											
0.0	frozen		1	SS	18		333				Station 20 + 859 4.9 Rt NBL C/L
	dense		2	SS	27		332				0 97 (3)
	some Gravel		3	SS	47		331				0 86 (14)
	brown **SAND** fine to medium compact dry		4	SS	17		330				0 84 (16)
			5	SS	19		329				
			6	SS	14		328				
			7	SS	18		327				
			8	SS	16		326				0 97 (3)
			9	SS	14		325				
			10	SS	25		324				
			11	SS	16		323				
			12	SS	16		322				5 94 1 0
			13	SS	20		321				
	dense		14	SS	34		320				
			15	SS	43		319				
	V.dense		16	SS	61						

Continued Next Page

+ 3, × 3. Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No SL4 2 OF 2 METRIC

W.P. 468-93-01 LOCATION N 5043084.3 E 318577.1 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 18 February 1999 - 19 February 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	wet		17	SS	20		318		○		
	compact						317		○		0 98 2 0
			18	SS	8*		316				* SS18: 'N'-value probably disturbed due to hydrostatic in equilibrium
			19	SS	14		315		○		
314.3											
19.3	**SAND & GRAVEL** with cobbles & boulders wet						314				Refusal to augering @19.3m. Refusal to Wash boring @19.8m. Rock coring with NW casing.
	boulder		20	RC							
	boulder						313				
	boulder										
312.6	boulder										
21.0	**DIORITE BEDROCK** massive, moderately closely jointed		21	RC			312				RC21: REC=100% RQD=100%
			22	RC			311				RC22: REC=100% RQD=93%
309.5							310				
24.1	END OF BOREHOLE										

WL on completion: Not stabilized due to water used for coring.

Dynamic Cone Penetration Test conducted 2.0m West of Borehole

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No SL5

1 OF 2

METRIC

W.P. 468-93-01 LOCATION N 5043080.8 E 318571.0 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 22 February 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
334.8									
0.0	0.15m TOPSOIL brown **SILTY SAND** trace gravel compact, damp		1	SS	15				Station 20 + 859 2.1 Lt NBL C/L
333.3									
1.5	dense brown **SAND** fine to medium compact dry to damp		2	SS	31				0 95 (5)
			3	SS	22				
			4	SS	22				0 87 (13)
			5	SS	19				
			6	SS	22				
			7	SS	23				
			8	SS	25				0 99 1 0
	dense		9	SS	32				
322.0									
12.8	END OF BOREHOLE Borehole extended to 17.8m by straight augering to install standpipe piezometer. WL IN PIEZOMETER Feb 23/99: 15.9m								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

ELEVATION SCALE: 334 333 332 331 330 329 328 327 326 325 324 323 322 321 320

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No SL5 2 OF 2 METRIC

W.P. 468-93-01 LOCATION N 5043080.8 E 318571.0 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 22 February 1999 CHECKED BY ZSO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
							319 318 317 316 315				
314.1									138 200/5		
20.7	END OF DCPT @ 20.7m Dynamic Cone Penetration Test conducted 2m West of Borehole										

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

RECORD OF BOREHOLE No SL6

1 OF 1 **METRIC**

W.P. 468-93-01 LOCATION N 5043037.3 E 318592.8 ORIGINATED BY AO

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 25 February 1999 CHECKED BY ZSO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
340.9											
0.0	0.2m TOPSOIL brown **SAND** fine to medium compact to dense damp		1	SS	12						Station 20 + 810 0.6 Rt NBL C/L
			2	SS	31		340				
339.5											
1.4	**SAND to SAND & GRAVEL** compact to very dense dry cobbles		3	SS	28		339				20 73 (7)
			4	SS	61						
			5	SS	31		338				50 46 (4)
			6	SS	43		337				
			7	SS	54		336				
335.9											
5.0	END OF BOREHOLE WL on completion: none										

+3, ×3, Numbers refer to Sensitivity O3% STRAIN AT FAILURE

RECORD OF BOREHOLE No SL7

1 OF 1 **METRIC**

W.P. 468-93-01 LOCATION N 5043097.2 E 318568.4 ORIGINATED BY AD

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem/Hollow Stem COMPILED BY CK

DATUM Geodetic DATE 23 February 1999 CHECKED BY ZSO

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
332.8 / 0.0	frozen		1	SS	58		332				Station 20 + 875 1.8 Rt NBL C/L
	brown **SILTY SAND** with occassional Clayey Silt seams dense, damp		2	SS	43		331				
							330				
329.5 / 3.3			3	SS	42						47 47 (6)
	brown **SAND to SAND & GRAVEL** dense damp to dry						329				
			4	SS	31		328				
							327				
			5	SS	47						44 51 5 0
							326				
			6	SS	42		325				
323.9 / 8.9	brown **SAND** fine to medium dense damp to dry		7	SS	47		324				
							323				
			8	SS	41		322				0 95 (5)
							321				
320.0 / 12.8	END OF BOREHOLE WL on completion: none		9	SS	38		320				

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