

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 427 WIDENING
FROM FASKEN DRIVE TO STEELES AVENUE
CN HALTON SUBDIVISION OVERHEAD
TORONTO, ONTARIO
G.W.P. 202-95-00**

Geocres Number: 30M12-288

Report to

SNC-Lavalin

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the design and construction of the proposed widening of the existing mainline bridge structures at the Highway 427 overhead crossing at the CN Halton Subdivision in Toronto, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, provide a borehole location plan, borehole logs, stratigraphic profile and cross-sections and a written description of the subsurface conditions. A model of the subsurface conditions was developed to describe the geotechnical conditions influencing design and construction of the foundations and approach embankments for the structures.

Thurber carried out the investigation as a sub-consultant to SNC-Lavalin under the Ministry of Transportation Ontario (MTO) Agreement Number 2004-E-0071.

During the preparation of this report and in addition to the boreholes drilled for the proposed structure widening, reference has been made to available information on subsurface conditions from a previous investigation documented in the report below.

- MTO report titled “Foundation Investigation and Design Report, Hwy 427 C.N.R. Overhead (Halton Subdivision), W.P. 153-80-02, Site No. 37-1109, Central Region, Toronto”, GEOCREs No.30M12-235, 1981 (Reference 1).

2 SITE DESCRIPTION

The site is located approximately 300 m south of Albion Road and 1.6 km west of Highway 27 in Toronto, Ontario. The site is generally flat except for the embankment fills, and the vegetation is moderate consisting mainly of tall grass and shrubs.

Lands surrounding the site have been developed for commercial and industrial uses.

The existing structure consists of the northbound and southbound (NBL and SBL) bridges of Highway 427 over the existing CN tracks which run in an east-west orientation.

Photographs of the site are included in Appendix D and show the general layout of the adjacent lands.

The site is situated within the South Slope physiographic region. The geology generally comprises a till plain consisting of clayey silt to silty clay (Halton Till) overlying bedrock at relatively shallow depth. The bedrock consists of grey shale with hard siltstone and limestone interlayers of the Georgian Bay Formation.

3 SITE INVESTIGATION AND FIELD TESTING

The present site investigation was carried out from December 1 to 18, 2008. The field program consisted of drilling and sampling ten boreholes (numbered CNH-01 to CNH-10) at the site. Boreholes were drilled at locations of the structure abutments, piers and approaches parallel to the alignments of, and between, the existing Highway 427 bridges.

Boreholes CNH-02 to CNH-04 and CNH-06 to CNH-08 drilled for the proposed piers and abutments were terminated upon refusal in silty sand and silty clay till at depths ranging from 13.9 m to 23.2 m (Elevations 152.4 to 165.7 m). Boreholes CNH-09 and CNH-10 drilled at the south and north approaches, respectively, were terminated in silty clay fill and silty clay till at 6.7 m depth (Elevations 173.1 and 174.6 m).

Boreholes CNH-01 and CNH-05, drilled near the south abutment, were terminated upon refusal in bedrock at 25.0 m and 26.1 m depths (Elevations 155.3 and 154.1 m). Borehole CNH-01 was further advanced into shale bedrock by coring to a depth of 30.9 m (Elevation 149.4 m).

The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawing in Appendix E. The coordinates and elevations of the boreholes are given on these drawings and on the individual Record of Borehole Sheets in Appendix A. Records of boreholes (numbered 1 to 8) drilled during the previous investigation (1981) are enclosed in Appendix C.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations. A CN permit was obtained and flagging from CN Rail was used while drilling within the CN right of way.

Solid stem augers were used to advance the boreholes in the overburden and into the shale. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). NQ rock coring equipment was used to recover core samples of the bedrock in Borehole CNH-01. Core samples of the shale bedrock were carefully protected to prevent drying during transport to the laboratory

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, visually examined the recovered samples, and transported them to Thurber's laboratory for further examination and testing.

All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Three standpipe piezometers consisting of 19 mm PVC pipes with screens were installed in selected boreholes to permit monitoring of groundwater levels. Details of the piezometer installations and other borehole completion details are as shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit		Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
South Approach		CNH-09	None installed	Bentonite holeplug to surface.
South Abutment	Median	CNH-01	None installed	Borehole grouted with bentonite to surface.
	Median	CNH-05	25.0/155.2	Piezometer with 1.5 m slotted screen installed with sand filter to 21.3 m, bentonite holeplug from 21.3 m to 19.8 m, bentonite grout from 19.8 m to 2.4 m, then bentonite holeplug to ground surface.
South Pier	CNR grade	CNH-02	None installed	Bentonite grout to 2.1 m, then bentonite holeplug to surface.
	CNR grade	CNH-06	15.2/156.1	Piezometer with 1.5 m slotted screen installed with sand filter to 13.4 m, bentonite holeplug from 13.4 m to 12.5 m, bentonite grout from 12.5 m to 1.5 m, then bentonite holeplug to ground surface.
North Pier	CNR grade	CNH-03	12.7/158.9	Piezometer with 1.5 m slotted screen installed with sand filter to 7.6 m, bentonite holeplug from 7.6 m to 7.0 m, bentonite grout from 7.0m to 1.5 m, then bentonite holeplug to ground surface.
	CNR grade	CNH-07	None installed	Bentonite grout to 1.5 m, then holeplug to surface.
North Abutment	Median	CNH-04	None installed	Bentonite holeplug and auger cuttings to 0.075m, then asphalt to surface.
	Median	CNH-08	None installed	Bentonite holeplug and auger cuttings to 0.075m, then asphalt to surface.
North Approach		CNH-10	None installed	Bentonite holeplug and auger cuttings to 0.075m, then asphalt to surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and rock samples to geological logging. At least 25% of the recovered samples of soil were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. Moisture content determinations were carried out on all soil samples. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B. Laboratory testing results from the 1981 investigation (Reference 1) are also included in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Records of Borehole sheets in Appendix A. Details of the encountered soil and rock stratigraphy are presented in this appendix and on the Borehole Locations and Soil Strata Drawing in Appendix E. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general terms, the soil stratigraphy encountered at this site outside of the railway tracks comprises surficial topsoil or pavement structure overlying fill underlain by native silty clay till and silty sand. Weathered shale bedrock was contacted below the silty sand at the south abutment of the Highway 427 SBL. More detailed descriptions of the individual strata are presented below.

5.1.1 Topsoil

Topsoil was identified surficially in Boreholes CNH-01, CNH-05 and CNH-09. The topsoil thickness generally ranged from 50 mm to 75 mm. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.1.2 Pavement Structure

Pavement structure consisting of approximately 75 mm of asphalt overlying granular (gravelly sand to silt and sand fill) road base was encountered in Boreholes CNH-04, CNH-08 and CNH-10 drilled at the Highway 427 median shoulder. The road base granular fill was 1.0 m thick in Borehole CNH-08 and the fill is in a dense to very dense state with SPT 'N' values ranging from 47 to 60 blows per 0.3 m of penetration. The moisture content of the granular fill is in the order of 5% to 7%.

5.1.3 Sub-ballast

A 200-mm thick layer of rail sub-ballast was encountered surficially in Borehole CNH-03 drilled near the existing north pier of Highway 427 SBL.

5.1.4 Fill

Fill was contacted below the topsoil and the asphalt in boreholes drilled at the existing approaches and embankments (Boreholes CNH-01, CNH-04, CNH-05 and CNH-08 to CNH-10). It is understood that the fill was placed during construction of the existing bridges. The fill generally consists of layers of various types of soils:

- Brown silty clay with sand and trace gravel
- Brown silt and sand containing trace to some gravel and trace clay
- Brown gravelly sand

The thickness of the fill ranged from 6.7 m to 9.1 m at the south abutment and south approach and from 3.9 m to 4.5 m at the north abutment and north approach.

The depths to the base of the fill ranged from 4.0 m to 9.1 m (Elevations 171.1 to 177.3 m).

Borehole CNH-09 was terminated within the silty clay fill at 6.7 m depth (Elevation 173.1m).

Based on SPT 'N' values ranging from 8 to 30 blows per 0.3 m of penetration, the cohesive fill is described as stiff to hard in consistency. The cohesionless fill (silt and sand, and gravelly sand) is described as loose to very dense, based on SPT 'N' values of 7 to 60 blows per 0.3 m of penetration.

The natural moisture contents of the fill samples ranged from 8% to 21%.

Grain size distribution curves for fill samples tested are presented on the Record of Borehole sheets and on Figures B1 and B2 of Appendix B. Atterberg Limit test results are presented on Figure B10 of Appendix B.

The results of laboratory tests are summarized as follows:

Soil Particles	Silty Clay Fill (%)	Silty Sand Fill (%)
Gravel	3 to 8	0
Sand	24 to 31	45 to 55
Silt	34 to 41	39 to 51
Clay	25 to 34	4 to 6
Liquid Limit	36 to 38	-
Plasticity Index	20	-

The above results show that the silty clay fill is typically of medium plasticity with a group symbol of CI.

5.1.5 Silty Clay Till

Native brown to grey silty clay till with sand and trace gravel was contacted below the asphalt, topsoil, sub-ballast and fill at depths ranging from 8.5 m to 9.1 m at the south abutment, 4.0 m to 4.6 m at the north abutment and at 0.2 m at the north pier.

During the present investigation, silty clay till was also contacted superficially in two boreholes drilled at the south pier (Boreholes CNH-02 and CNH-06) and in one borehole drilled at the north pier (Borehole CNH-07). Silty clay till was also encountered superficially in the eight boreholes drilled during the previous investigation.

Thickness of the silty clay till ranged from 7.4 m to 13.8 m.

Layers of clayey silt were encountered within the silty clay till deposit.

A 1.6 m thick layer of silty clay till was also contacted at 9.1 m depth (Elevation 162.5 m) in Borehole CNH-03.

The depth to the base of the silty clay till ranged from 10.7 m to 21.3 m (Elevations 158.9 to 163.4 m).

Boreholes CNH-08 and CNH-10 were terminated within the silty clay till at 15.6 m and 6.7 m depth (Elevations 165.7 and 174.6 m).

Based on SPT 'N' values ranging from 8 to 92 blows for 0.3 m of penetration, the silty clay till is described as firm to hard in consistency. SPT 'N' values higher than 100 blows per 0.225 m of penetration were observed at or below Elevation 169.0 m in Boreholes CNH-04 and CNH-08, and near Elevations 166.0 to 163.0 m in Boreholes 6 and 7.

The natural moisture contents of the samples recovered from the silty clay till layer ranged from 8% to 30%.

Grain size distribution curves for the silty clay till samples tested are presented on the Record of Borehole sheets and on Figures B3 to B5 of Appendix B. Grain size distribution curves for clayey silt samples are presented on Figure B6 of Appendix B. Atterberg Limit test results are presented on Figures B11 to B13 of Appendix B.

Laboratory test results of previous investigation are presented in Appendix C.

The results of laboratory tests are summarized as follows:

Soil Particles	Silty Clay Till (%)	Clayey Silt (%)
Gravel	0 to 23	0
Sand	3 to 46	1 to 4
Silt	27 to 82	74 to 83
Clay	4 to 40	16 to 25

Liquid Limit	18 to 48	-
Plasticity Index	8 to 27	-

The above results show that the silty clay till is typically of low to medium plasticity with a group symbol of CL-CI.

Cobbles and boulders were noted in the silty clay till in Boreholes 3, 5, 6 and 7 drilled during the previous investigation. Glacial tills inherently contain cobbles and boulders which may occur for some high blow counts and resistance to augering.

5.1.6 Silty Sand

Native grey silty sand was contacted below the silty clay till in Boreholes CNH-01 to CNH-03 and CNH-05 to CNH-07, and 1 to 8, drilled for the present and previous investigations, respectively. The silty sand contains trace gravel, trace clay and occasional cobbles, boulders throughout the deposit and shale fragments.

The silty sand layer was fully penetrated in Borehole CNH-01 located at the south abutment, with a thickness of 5.2 m.

A layer of sand was encountered within the silty sand in Borehole CNH-01 near Elevation 157.0 m.

A layer of silt and sand was contacted below the silty clay till at 17.8 m depth in Borehole CNH-04. Borehole CNH-04 was terminated within the silt and sand layer at 23.2 m (Elevation 158.0 m).

Layers of sand and gravel and layers of cobbles and boulders were encountered within the silty sand layer in boreholes drilled during the previous investigation.

Boreholes were terminated within the silty sand layer at depths ranging from 13.9 m to 26.1 m (Elevations 147.7 to 158.0 m). Borehole 3, drilled at the south pier of the Highway 427 NBL, was terminated at 33.4 m depth (Elevation 138.1 m).

SPT 'N' values measured in the silty sand layer generally ranged from 100 to 128 blows per 0.3 m of penetration, indicating a very dense relative density. An SPT 'N' value of 20 blows per 0.3 m of penetration, indicating compact relative density, was measured in Borehole CNH-01 near Elevation 157.0. SPT 'N' values higher than 100 blows per 0.1 m of penetration were measured near borehole termination depths.

The natural moisture contents of the samples recovered from the silty sand layer ranged from 10% to 19%.

Grain size distribution curves for the silty sand samples tested are presented on the Record of Borehole sheets and on Figures B7 and B8 of Appendix B.

Laboratory test results of the previous investigation are presented in Appendix C.

The results of laboratory tests are summarized as follows:

Soil Particles	Sand (%)	Silt and Sand (%)	Silty Sand (%)
Gravel	4	5	0 to 25
Sand	80	37	28 to 85
Silt	-	42	11 to 64
Clay	-	16	1 to 15
Silt & Clay	16	-	-

Occasional cobbles and boulders are reported throughout the silty sand layer, and the lower part of this deposit (just above bedrock) may contain pieces and slabs of bedrock which may account for some high blow counts and resistance to augering.

5.1.7 Sandy Silt

Native grey sandy silt containing trace clay was contacted within the silty clay till in Boreholes CNH-03 and CNH-07 drilled for the present investigation. The thickness of the sandy silt was 1.5 m and 1.0 m in Boreholes CNH-03 and CNH-07, respectively.

The depths to the base of the sandy silt were 9.1 m and 6.9 m (Elevations 162.5 and 164.7 m).

Based on SPT 'N' values of 15 and 60 blows for 0.3 m of penetration, the sandy silt is described as compact to very dense.

The natural moisture contents of the samples recovered from the sandy silt layer were 20%.

Grain size distribution curves for two sandy silt samples tested are presented on the Record of Borehole sheets and on Figure B9 of Appendix B.

The results of laboratory tests are summarized as follows:

Soil Particles	Sandy Silt (%)
Gravel	0
Sand	29 to 46
Silt	50 to 68
Clay	3 to 4

5.1.8 Bedrock

Bedrock was contacted below the silty sand at 25.0 m depth (Elevation 155.3 m) in Borehole CNH-01. The shale encountered in the borehole is described as thinly bedded and contains frequent hard interbedded siltstone and limestone layers, typical of the Georgian Bay Formation. The shale bedrock is highly to moderately weathered within the upper 2 m below which the degree of weathering decreases with depth and the rock strength increases with depth. An SPT 'N' value obtained in the upper part of the shale bedrock was higher than 100 blows per 0.1 m penetration. A moisture content of 11% was measured.

Bedrock cores were collected using NQ sized coring equipment. Total core recovery (TCR) in the bedrock were 80% and 100% in the two core runs.

RQD values recorded in the core runs were 7%, indicating a very poor rock quality.

The shale bedrock typically contains layers of siltstone and limestone that can be significantly harder than the shale itself. The distribution, thickness and strength of these layers vary from location to location, and these layers typically exhibit less pronounced weathering than the shale.

5.1.9 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in three selected boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.1, along with the measurements in the boreholes upon completion of drilling.

Table 5.1 – Measured Groundwater Levels

Foundation Element	Borehole	Date	Water Level (m)		Comment	
			Depth (m)	Elevation (m)		
South Abutment	SBL	1	December 11, 1981	0.5	171.4	Perched water
	Median	CNH-05	January 21, 2009	14.5	165.7	In piezometer
			May 5, 2009	14.2	166.0	
June 8, 2009			14.2	166.0		
NBL	2	December 14, 1981	0.5	171.1	Perched water	
South Pier	SBL	4	December 21, 1981	1.4	170.0	Perched water
	CNR grade	CNH-02	December 9, 2008	8.2	162.9	In open borehole
	CNR grade	CNH-06	January 21, 2009	6.1	165.3	In piezometer
			May 5, 2009	4.9	166.5	
June 8, 2009			4.9	166.5		
NBL	3	December 17, 1981	0.9	170.6	Perched water	
North Pier	SBL	6	December 21, 1981	0.0	170.6	Perched water
	CNR grade	CNH-03	January 21, 2009	6.1	165.5	In piezometer
			May 5, 2009	5.6	166.0	
June 8, 2009			5.5	166.1		
CNR grade	CNH-07	December 12, 2008	0.5	171.1	In open borehole	
North Abutment	Median	CNH-04	December 15, 2008	11.6	169.7	In open borehole
	NBL	5	December 18, 1981	5.7	165.8	In open borehole

Groundwater levels measured in the piezometers ranged from Elevations 166.0 to 166.5 m. A higher perched water level was noted at elevations ranging from 170.0 to 171.4 m.

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall. Further, perched water may be encountered at higher levels in pockets or zones of more permeable sands and silts within the heterogeneous tills, or within the fill.

6 MISCELLANEOUS

Co-ordinates and ground surface elevations for boreholes of the present investigation were supplied to Thurber by SNC-Lavalin.

The drilling and sampling equipment was supplied and operated by DBW Drilling of Ajax, Ontario and Groundwork Drilling Inc. of Etobicoke, Ontario. The field work was supervised on a full time

basis by Mr. George Azzopardi and Mr. William Ball of Thurber Engineering Ltd. under the direction of Dr. Sydney Pang, P. Eng.

Laboratory testing was carried out at Thurber’s Laboratory in Oakville, Ontario.

Overall supervision of the field program was conducted by Dr. Sydney Pang, P. Eng. Interpretation of the data and preparation of the report were carried out by Dr. Sydney Pang, P. Eng, and Ms. R. Palomeque Reyna, P.Eng.

Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects, reviewed the report.

THURBER ENGINEERING LTD.

Rocio Palomeque Reyna, P.Eng.
Geotechnical Engineer



Sydney Pang, P.Eng.
Associate, Senior Project Engineer



P.K. Chatterji, P.Eng.
Review Principal



Appendix A

**Record of Borehole Sheets
(Present Investigation)**

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

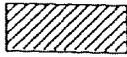
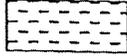
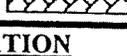
 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION		SYMBOLS		
Fresh (FR)	No visible signs of weathering.			
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.			CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.			SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.			SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.			COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.			Bedrock (general)
DISCONTINUITY SPACING		STRENGTH CLASSIFICATION		
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength	Field Estimation of Hardness*
			(MPa) (psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250 Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m			
Medium bedded	0.2 to 0.6m	Very Strong	100-250 15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m			
Very thinly bedded	20 to 60mm	Strong	50-100 7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm			
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0 3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0 750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0 150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0 35 to 150	Indented by thumbnail
TERMS				
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.			
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.			
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.			
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen			
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.			



RECORD OF BOREHOLE No CNH-01

1 OF 4

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 049.2 E 294 356.2 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.01 - 2008.12.03 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			T _N VALUES	SHEAR STRENGTH kPa			
						20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
						40 80 120 160 200	WATER CONTENT (%)				
180.3	TOPSOIL (50mm)										
180	Silty CLAY, with sand, trace gravel Stiff to Very Stiff Brown (FILL)		1	SS	16						
179											
178			2	SS	17						8 24 34 34
177			3	SS	27						
176			4	SS	30						
175			5	SS	15						
174			6	SS	24						7 31 37 25
173											
172											
171.1											
9.1	Silty CLAY, trace to some sand, trace gravel, occasional iron oxide Hard Brown (TILL)		7	SS	50						

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+³ . X³ Numbers refer to Sensitivity 20 15 10 5 (% STRAIN AT FAILURE)

RECORD OF BOREHOLE No CNH-01

2 OF 4

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 049.2 E 294 356.2 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.01 - 2008.12.03 CHECKED BY SKP

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 γ kN/m ³	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	40 80 120 160 200	20 40 60					
	Continued From Previous Page												
	Silty CLAY, trace to some sand, trace gravel, occasional iron oxide Hard Brown (TILL)					170							
	Occasional layers of clayey silt		8	SS	70							0 4 79 17	
						169							
			9	SS	63								
						168							
						167							
			10	SS	81								
						166							
						165							
	with sand		11	SS	41							6 35 43 16	
						164							
			12	SS	51								
						163							
						162							
			13	SS	50								
						161							
160.5													
19.8													

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Continued Next Page

+³. X³: Numbers refer to Sensitivity
 20
 15 5
 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CNH-01

3 OF 4

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 049.2 E 294 356.2 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.01 - 2008.12.03 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	T _N VALUES			20	40	60			80	100
	Continued From Previous Page		14	SS	100									
	Silty SAND, trace gravel, trace clay Very Dense Grey Wet Hard augering						160							
			15	SS	100/ 0.150		159							
157.7 22.6	Compact		16	SS	20		158							
156.5 23.8			17	SS	112		157							
155.3 25.0	SHALE, highly weathered, thinly bedded, frequent limestone and siltstone interbeds Grey		18	SS	100/ 0.100		156							
153.3 27.0	becoming moderately weathered		1	RUN			155							
			2	RUN			154							
							153							
							152							
							151							

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+³, X³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RUN 1#
TCR=80%,
SCR=7%,
RQD=7%

RUN 2#
TCR=100%,
SCR=7%,
RQD=7%

4 80 16
(SI+CL)

RECORD OF BOREHOLE No CNH-01

4 OF 4

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 049.2 E 294 356.2 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.01 - 2008.12.03 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			T _N VALUES	SHEAR STRENGTH kPa								
Continued From Previous Page						20	40	60	80	100	W _p	W	W _L			
149.4	SHALE, moderately weathered, thinly bedded, frequent limestone and siltstone interbeds Grey		3	RUN		150										RUN 3# TCR=100%, SCR=23%, RQD=7%
30.9	END OF BOREHOLE AT 30.9m. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.															

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+³, X³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CNH-02

1 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 073.9 E 294 349 3 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.08 - 2008.12.09 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa			
171.1	0.0					20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		GR SA SI CL
	Silty CLAY, with sand, trace gravel Stiff to Very Stiff Brown (TILL)		1	SS	13			o			
			2	SS	28			40-45			4 28 49 19
	Occasional layers of grey clayey silt		3	SS	22			c			0 1 83 16
	Grey		4	SS	25			o			
165.3	5.8		5	SS	48			40-45			3 26 37 34
	Hard		6	SS	56			o			
			7	SS	79			o			

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Continued Next Page

+³, X³: Numbers refer to Sensitivity
 20
 15 ⊕ 5
 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CNH-02

2 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 073.9 E 294 349.3 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.08 - 2008.12.09 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	T _N VALUES			20	40	60	80	100		
Continued From Previous Page														
160.5	Silty CLAY, with sand, trace gravel Hard Grey (TILL)						161							
10.7	Silty SAND, trace clay, trace gravel Very Dense Grey Wet		8	SS	105		160					o		
							159					o		
			9	SS	107		158							
							157					o		
			10	SS	112		156					o		
	occasional cobbles						155					o		
							154					o		
							153					o		
152.4	Layer of sand and gravel		13	SS	104/ .150							o		
18.7	END OF BOREHOLE AT 18.7m. BOREHOLE OPEN TO 18.7m AND WATER LEVEL AT 8.2m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO 2.1m, THEN SEALED WITH BENTONITE HOLEPLUG TO SURFACE.													

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+³. ×³: Numbers refer to Sensitivity $\frac{20}{15 \pm 5 / 10}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CNH-03

1 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 094.6 E 294 347.1 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.11 - 2008.12.11 CHECKED BY SKP

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 γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
171.6						20 40 60 80 100	0 UNCONFINED + FIELD VANE						
0.0	SUB-BALLAST (FILL)		1	SS	13		● QUICK TRIAXIAL × LAB VANE						
0.2	Silty CLAY, with sand, trace gravel Stiff Brown (TILL)												
171			2	SS	8								
168.9													
2.7	Very Stiff to Hard		3	SS	18							1 23 53 23	
168													
167	Occasional layers of grey clayey silt		4	SS	30							0 1 74 25	
166													
165	Grey		5	SS	37								
164.0													
7.6	Sandy SILT, trace clay Compact Grey Wet		6	SS	15							0 29 68 3	
163													
162.5													
9.1	Silty CLAY, trace to some sand, trace gravel Hard Grey (TILL)		7	SS	55								
162													

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

RECORD OF BOREHOLE No CNH-03

2 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 094.6 E 294 347.1 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.11 - 2008.12.11 CHECKED BY SKP

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	T _N VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)					
							40	80	120	160	200	20	40	60	kn/m ³	GR SA SI CL	
160.9	Continued From Previous Page Silty CLAY, trace to some sand, trace gravel Hard Grey (TILL)																
10.7	Silty SAND, trace to some gravel, occasional cobbles Very Dense Grey Wet		8	SS	116												
	Shale fragments, occasional inferred cobbles and boulders		9	SS	123												
157.7			10	SS	109/												
13.9	END OF BOREHOLE AT 13.9m. BOREHOLE OPEN TO 12.8m AND WATER LEVEL AT 0.3m UPON COMPLETION OF DRILLING. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.01.21 6.1 165.5 2009.05.05 5.6 166.0 2009.06.08 5.5 166.1				.150												

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RECORD OF BOREHOLE No CNH-04

1 OF 3

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 119.7 E 294 338.6 ORIGINATED BY WB
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.15 - 2008.12.15 CHECKED BY SKP

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
181.3	ASPHALT: (75mm)													
0.0 0.1	SILT and SAND, some gravel, trace clay Dense to Very Dense Brown Moist (FILL)		1	SS	60									
			2	SS	43									
			3	SS	31									
			4	SS	60									0 45 51 4
			5	SS	52									
177.3	Silty CLAY, with sand, trace gravel Very Stiff to Hard Brown (TILL)													
4.0			6	SS	23									
			7	SS	25									2 23 40 35
			8	SS	48									
			9	SS	44									

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



RECORD OF BOREHOLE No CNH-04

2 OF 3

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 119.7 E 294 338.5 ORIGINATED BY WB
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.15 - 2008.12.15 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W			LIQUID LIMIT W _L
Continued From Previous Page												
	Silty CLAY, with sand, trace gravel Hard Brown (TILL)	10	SS	30	▽							
		11	SS	100/ 275								
		12	SS	80								0 3 70 27
		13	SS	89								2 29 52 17
		14	SS	79								
163.4												
17.8	SILT and SAND, some clay, trace gravel Very Dense Grey Moist	15	SS	100/ 225								5 37 42 16
		16	SS	100/								

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+³. X³: Numbers refer to Sensitivity

20
15
10
5
0
5
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CNH-04

3 OF 3

METRIC

GW.P. 202-95-00 LOCATION N 4 845 119.7 E 294 338.5 ORIGINATED BY WB
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.15 - 2008.12.15 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	W P W W L	WATER CONTENT (%) 20 40 60				
	Continued From Previous Page												
	SILT and SAND, some clay, trace gravel Very Dense Grey Moist				.100								
			17	SS	100/								
					.100								
	Moist to Wet												
158.0			18	SS	100/								
23.2					.225								
	END OF BOREHOLE AT 23.2m AND WATER LEVEL AT 11.6m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.075m, THEN ASPHALT TO SURFACE.												

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

RECORD OF BOREHOLE No CNH-05

1 OF 3

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 053.1 E 294 358.8 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.04 - 2008.12.04 CHECKED BY SKP

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 γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)
180.2	TOPSOIL (75mm)													
0.0	Silty CLAY, with sand, trace gravel Stiff to Very Stiff Brown (FILL)	[Cross-hatched pattern]	1	SS	14									
0.1			2	SS	17									
			3	SS	20									6 30 36 28
			4	SS	18									
			5	SS	22									
			6	SS	27									
			7	SS	31									0 11 51 38
171.6	Silty CLAY, some sand, trace gravel Hard Brown to Grey (TILL)	[Diagonal hatched pattern]												
8.5														

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Continued Next Page

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

RECORD OF BOREHOLE No CNH-05

2 OF 3

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 053.1 E 294 358.8 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.04 - 2008.12.04 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kn/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			T _N VALUES	SHEAR STRENGTH kPa			
						20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
						40 80 120 160 200	WATER CONTENT (%)				
	Continued From Previous Page										
	Silty CLAY, some sand, trace gravel Hard Brown (TILL)		8	SS	41						
			9	SS	38						
			10	SS	60						
			11	SS	48						
			12	SS	54						3 27 47 23
	Hard augering		13	SS	80						

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+³ . x³ : Numbers refer to Sensitivity
 20
 15 5
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CNH-05

3 OF 3

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 053.1 E 294 358.8 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.04 - 2008.12.04 CHECKED BY SKP

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
													WATER CONTENT (%)		GR SA SI CL					
158.9	Continued From Previous Page Silty CLAY, some sand, trace gravel Hard Brown (TILL)		14	SS	92															
21.3	Silty SAND, trace clay, trace gravel Very Dense Grey Wet Hard augering		15	SS	121												5	64	23	8
155.8	Some gravel, some clay, occasional shale fragments, occasional cobbles and boulders Hard augering		16	SS	128															
24.4	Highly weathered shale		17	SS	115															
154.1	END OF BOREHOLE AT 26.1m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 26m AND WATER LEVEL AT 11.8m UPON COMPLETION OF DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.01.21 14.5 165.7 2009.05.05 14.2 166.0 2009.06.08 14.2 166.0		18	SS	105/	0.150														

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RECORD OF BOREHOLE No CNH-06

1 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 080.9 E 294 358.3 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.09 - 2008.12.10 CHECKED BY SKP

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40						60	80	100
171.4																	
0.0	Silty CLAY, with sand, trace gravel Stiff to Very Stiff Brown (TILL)		1	SS	11												3 23 34 40
	Occasional iron oxide staining		2	SS	28												
168.5																	
2.9	Hard trace sand		3	SS	50												0 3 68 29
	Grey		4	SS	48												
			5	SS	34												
	with sand		6	SS	48												2 31 47 20
			7	SS	69												

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+³. X³: Numbers refer to Sensitivity
 20
 15 10 5
 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CNH-06

2 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 080.9 E 294 358.3 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.09 - 2008.12.10 CHECKED BY SKP

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							WATER CONTENT (%)
160.7	Continued From Previous Page Silty CLAY, with sand, trace gravel Hard Grey (TILL)						20	40	60	80	100				
10.7	Silty SAND, some gravel, trace clay Very Dense Grey Wet		8	SS	101									11 55 25 9	
	Hard augering		9	SS	110										
			10	SS	122										
155.8			11	SS	101										
15.5	END OF BOREHOLE AT 15.5m. BOREHOLE OPEN TO 15.2m AND WATER LEVEL AT 5.8m UPON COMPLETION OF DRILLING. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2009.01.21 6.1 165.3 2009.05.05 4.9 166.5 2009.06.08 4.9 166.5														

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+³ × 3³ Numbers refer to Sensitivity $\frac{20}{15} \times \frac{5}{10}$ (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CNH-07

1 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 100.9 E 294 354.5 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.12 - 2008.12.12 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							W _P
171.6															
0.0	Silty CLAY, with sand, trace gravel Stiff Mottled Brown to Grey (TILL)		1	SS	10	▽									
				2	SS		9								
	Occasional iron oxide staining Very Stiff			3	SS		26								
167.1															
4.4	Hard Grey		4	SS	30										
165.6															
5.9	Layer of sandy silt Very Dense		5	SS	60								0 46 50 4		
164.7															
6.9			6	SS	79										
			7	SS	71										

ONTMT4S 9270.GPJ 6/29/09

Continued Next Page

+³, X³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CNH-07

2 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 100.9 E 294 354.5 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.12 - 2008.12.12 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT γ kN/m ³	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	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
	Continued From Previous Page													
160.9	Silty CLAY, with sand, trace gravel Hard Grey (TILL)													
10.7	Silty SAND, trace gravel Very Dense Grey Wet		8	SS	101									
	Hard augering occasional inferred cobbles		9	SS	115									
			10	SS	111									
156.0			11	SS	122									
15.5	END OF BOREHOLE AT 15.5m. BOREHOLE OPEN TO 14.6m AND WATER LEVEL AT 0.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO 1.5m, THEN SEALED WITH BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S 9270.GPJ 6/29/09

+³ . X³ : Numbers refer to Sensitivity $\frac{20}{15 \pm 5}$ (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CNH-08

1 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 128.7 E 294 354.8 ORIGINATED BY WB
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.18 - 2008.12.18 CHECKED BY SKP

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40						60	80	100	40	80	120	160	200	20	40	60
181.3	ASPHALT: (75mm)																								
0.0 0.1	Gravelly SAND Very Dense Brown Moist (FILL)		1	SS	53																				
180.3	SILT and SAND, trace clay Loose Brown Moist (FILL)																								
1.1			2	SS	7																				0 55 39 6
176.8	Silty CLAY, with sand, trace gravel Hard Brown (TILL)																								
4.6			3	SS	30																				0 22 45 33
	Occasional layers of silty sand		4	SS	42																				
			5	SS	30																				

ONTMT4S 9270.GPJ 6/29/09

Continued Next Page

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



RECORD OF BOREHOLE No CNH-08

2 OF 2

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 128.7 E 294 354.8 ORIGINATED BY WB
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.18 - 2008.12.18 CHECKED BY SKP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	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	W _p	W	W _L			
	Continued From Previous Page															
	Silty CLAY, with sand, trace gravel Hard Brown (TILL)		6	SS	35										1 21 38 40	
			7	SS	100/ 0.275											
			8	SS	100/ 0.225											
165.7	Hard augering		9	SS	100/ 0.250										4 32 43 21	
15.6	END OF BOREHOLE AT 15.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.075m THEN ASPHALT TO SURFACE.															

ONTMTAS 9270.GPJ 6/29/09

+³, X³: Numbers refer to Sensitivity
 20
 15 5
 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CNH-09

1 OF 1

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 035.8 E 294 359.8 ORIGINATED BY GA
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY AN
 DATUM Geodetic DATE 2008.12.05 - 2008.12.05 CHECKED BY SKP

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 Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
179.8	TOPSOIL (50mm)												
0.0	Silty CLAY, with sand, trace gravel Stiff to Very Stiff Brown (FILL)		1	SS	12								
			2	SS	16								
			3	SS	8								3 27 41 29
			4	SS	27								
			5	SS	26								
173.1													
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN AND DRY UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.												

ONTMT4S 9270.GPJ 6/29/09

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



RECORD OF BOREHOLE No CNH-10

1 OF 1

METRIC

G.W.P. 202-95-00 LOCATION N 4 845 130.8 E 294 336.8 ORIGINATED BY WB
 HWY 427 BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 2008.12.17 - 2008.12.17 CHECKED BY SKP

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						40	80	120	160	200	20
181.3 0.0 0.1	ASPHALT: (75mm)																						
	SILT and SAND, trace clay Dense to Compact Brown Moist (FILL)		1	SS	47																		
			2	SS	47																		
			3	SS	25																		
			4	SS	24																		
			5	SS	14																		
177.0 4.3	Silty CLAY, with sand, trace gravel Very Stiff Brown (TILL)		6	SS	16																		0 51 45 4
			7	SS	15																		0 25 48 27
174.6 6.7	END OF BOREHOLE AT 6.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.075m, THEN ASPHALT TO SURFACE.																						

ONTMT4S 9270.GPJ 6/29/09

+ 3, X 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

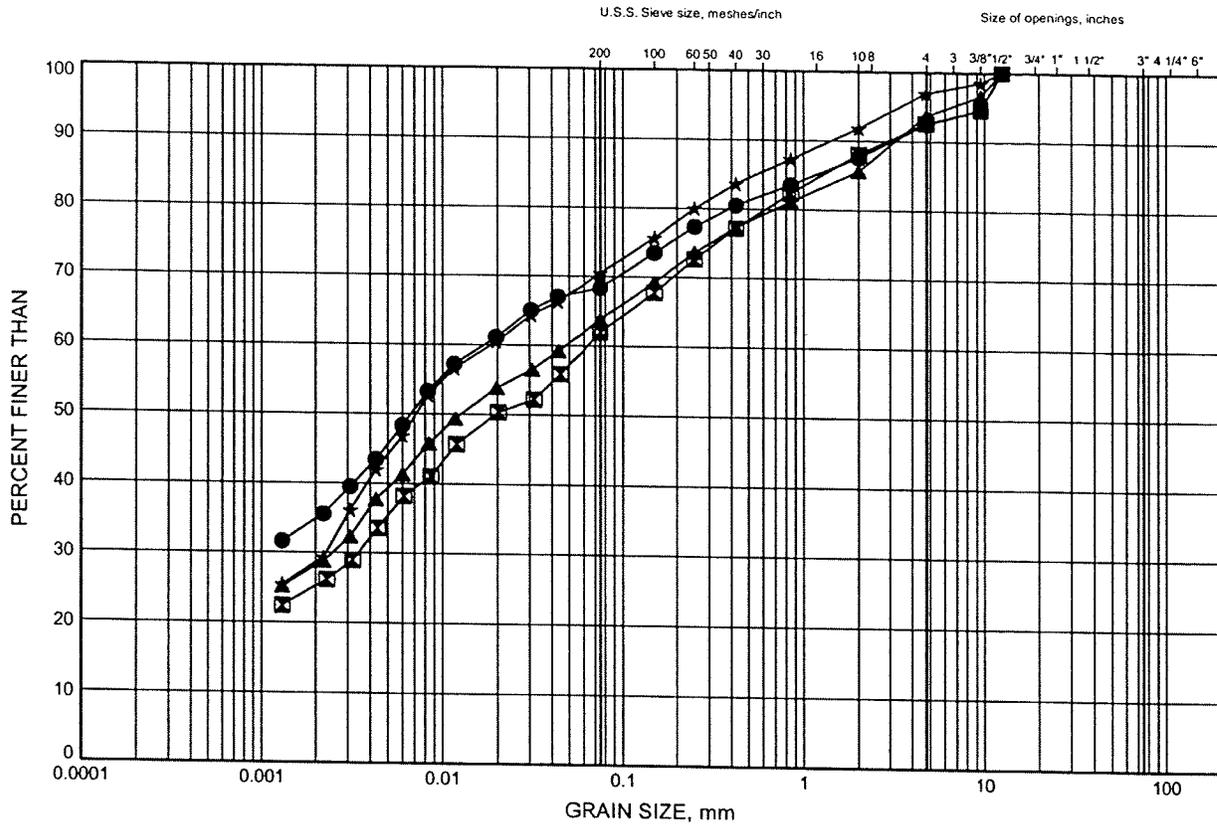
Appendix B

Laboratory Test Results

Hwy 427 Northbound and Southbound GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY CLAY FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-01	1.83	178.44
⊠	CNH-01	6.40	173.87
▲	CNH-05	3.35	176.81
★	CNH-09	3.35	176.45

GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 5/1/09

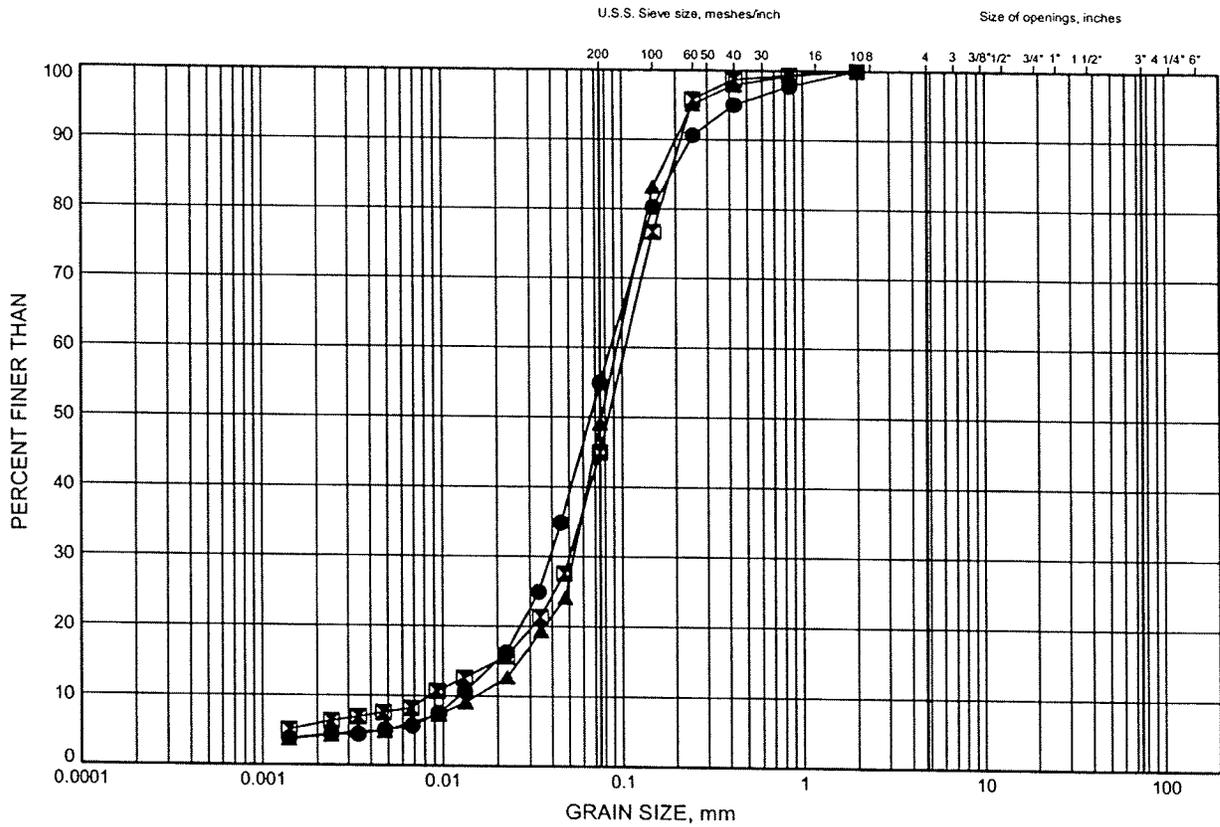
W.P.# .19-92-70.....
 Prepared By .AN.....
 Checked By .RPR.....



Hwy 427 Northbound and Southbound GRAIN SIZE DISTRIBUTION

FIGURE B2

SILT & SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-04	2.59	178.68
◻	CNH-08	3.35	177.97
▲	CNH-10	2.59	178.70

GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 7/8/09

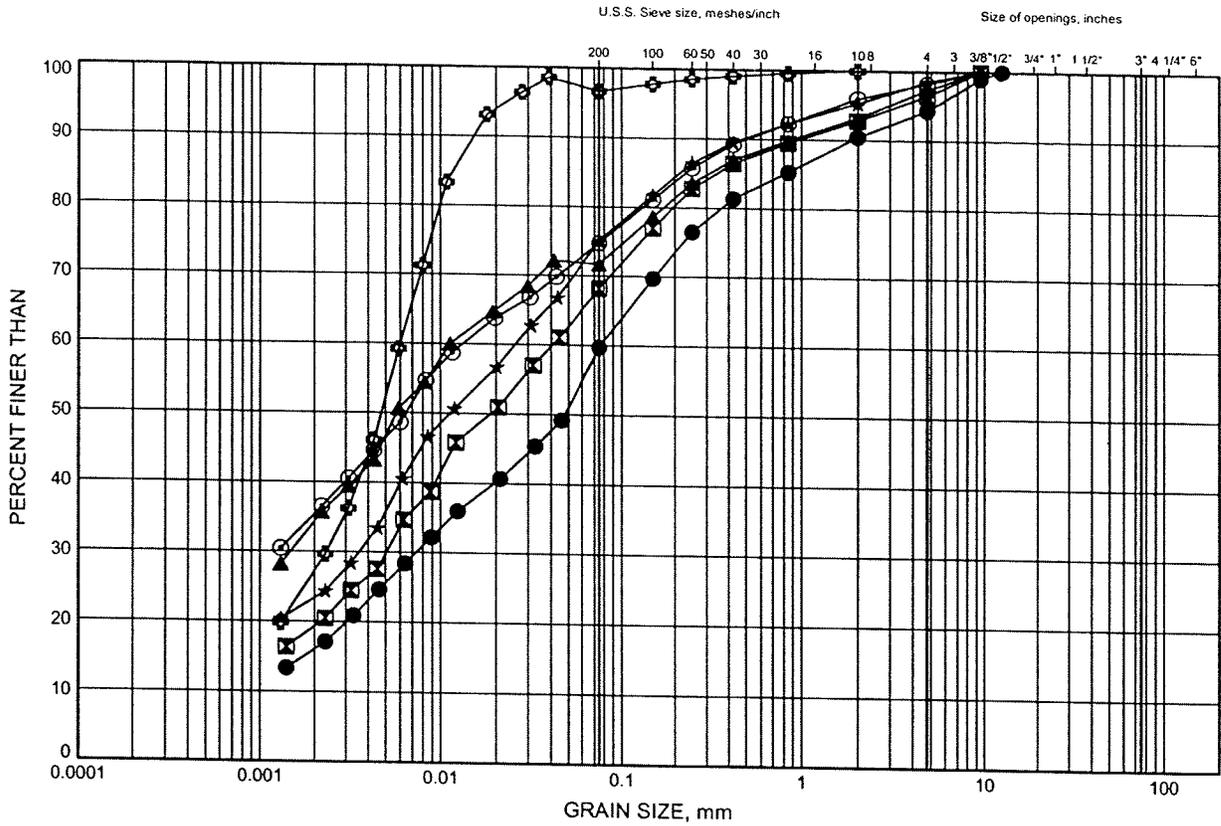
W.P.# 202-95-00
 Prepared By AN
 Checked By RPR



Hwy 427 Northbound and Southbound GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-01	15.54	164.73
⊠	CNH-02	1.83	169.30
▲	CNH-02	6.40	164.73
★	CNH-03	3.35	168.24
⊙	CNH-04	6.40	174.87
⊕	CNH-04	14.02	167.25

GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 5/1/09

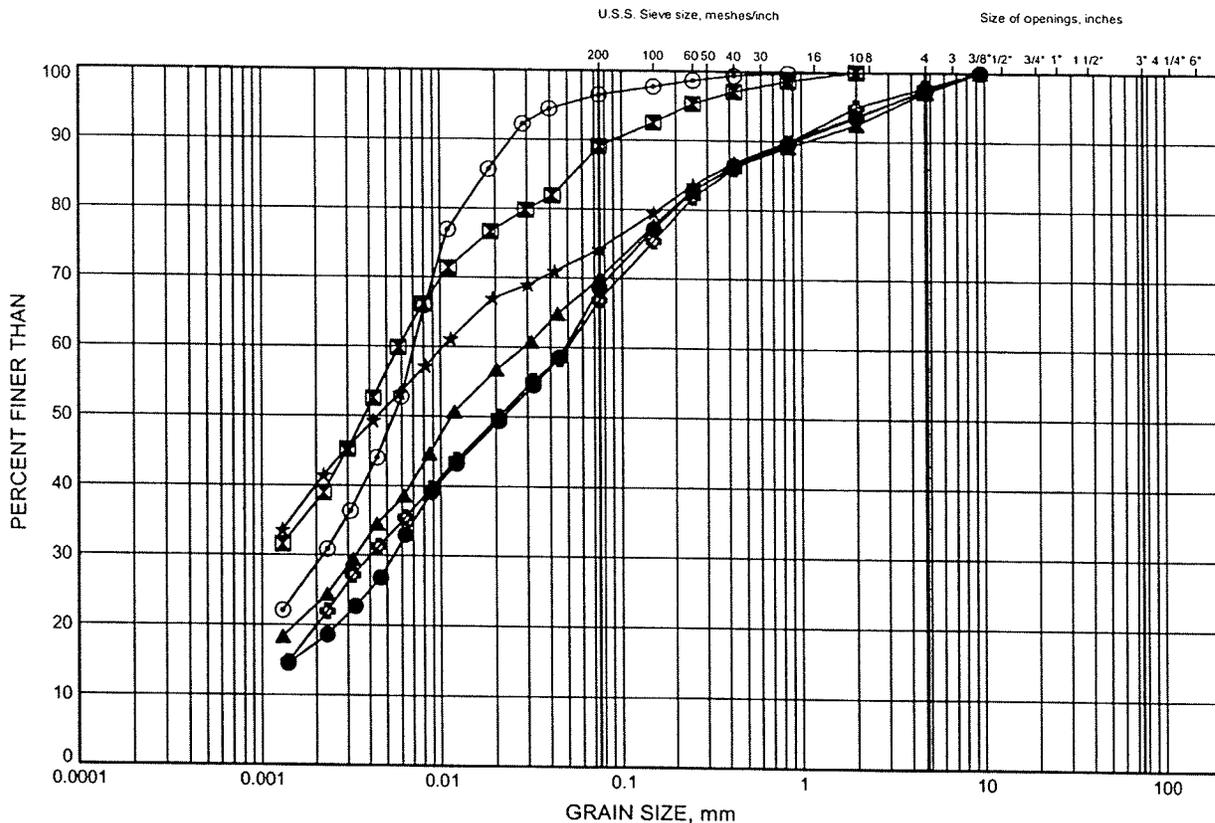
W.P.# 19-92-70
 Prepared By AN
 Checked By RPR



Hwy 427 Northbound and Southbound
GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY TILL



SILT and CLAY		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-04	15.54	165.73
⊠	CNH-05	9.45	170.72
▲	CNH-05	17.07	163.10
★	CNH-06	0.30	171.08
⊙	CNH-06	3.35	168.03
⊕	CNH-06	7.92	163.46

GRAIN SIZE DISTRIBUTION - THURBER 9270 GPJ 5/1/09

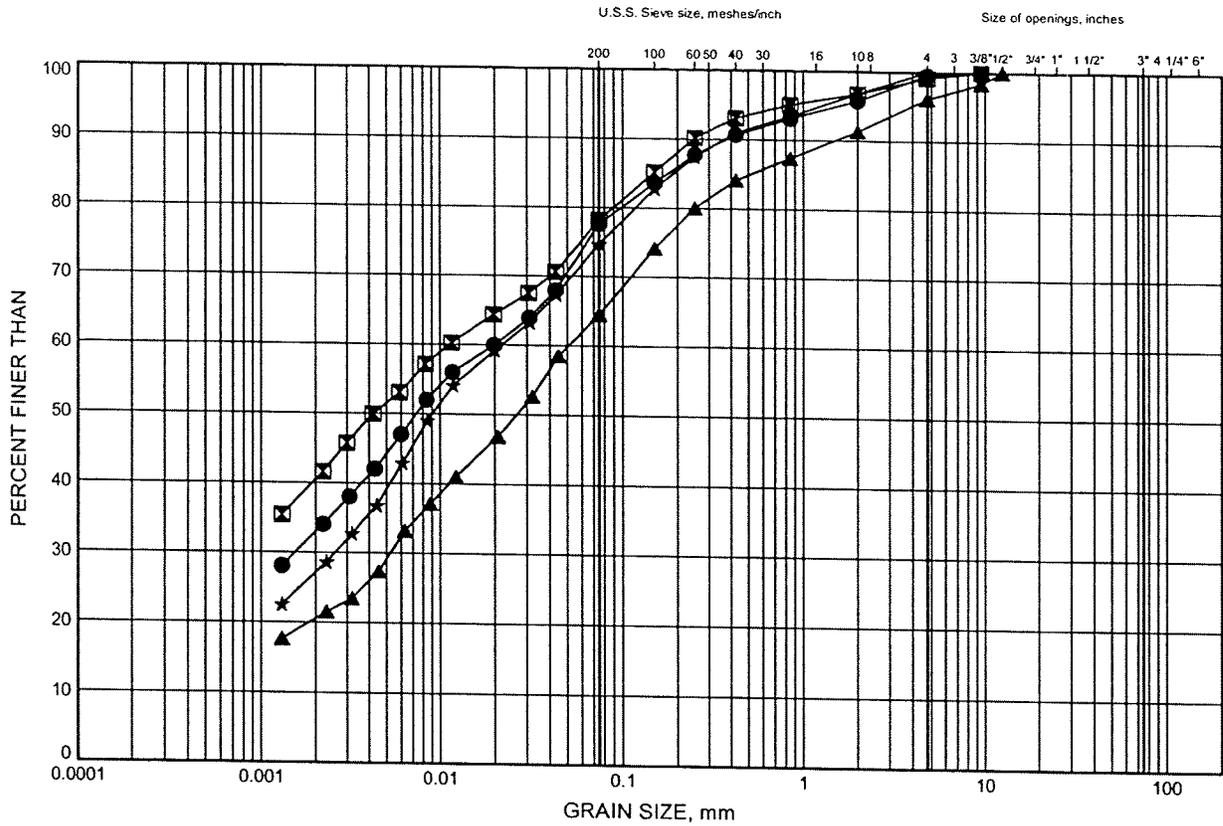
W.P.# ..19-92-70.....
Prepared By .AN.....
Checked By .RPR.....



Hwy 427 Northbound and Southbound GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY CLAY TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND		GRAVEL			

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-08	6.40	174.92
⊠	CNH-08	10.97	170.35
▲	CNH-08	15.44	165.88
★	CNH-10	4.88	176.42

GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 5/1/09

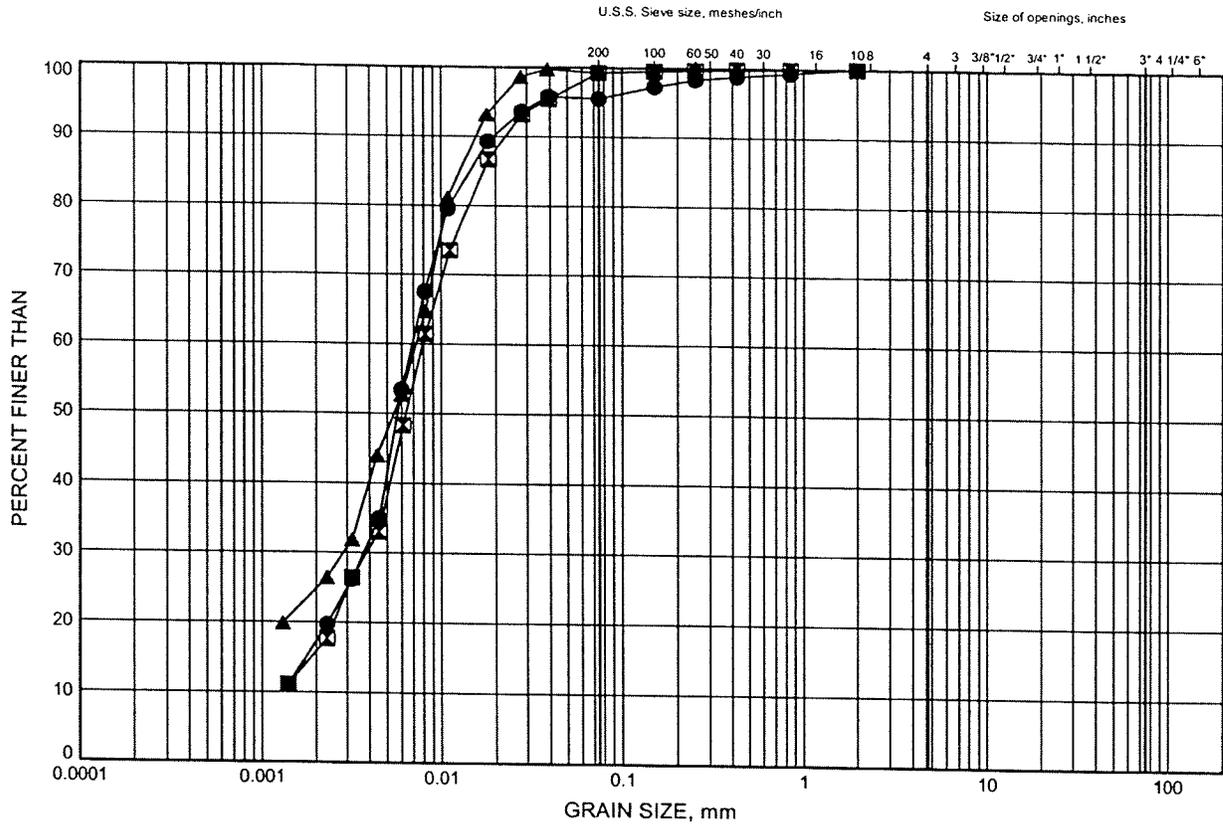
W.P.# 19-92-70
Prepared By AN
Checked By RPR



Hwy 427 Northbound and Southbound GRAIN SIZE DISTRIBUTION

FIGURE B6

CLAYEY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-01	10.97	169.30
⊠	CNH-02	3.35	167.78
▲	CNH-03	4.88	166.72

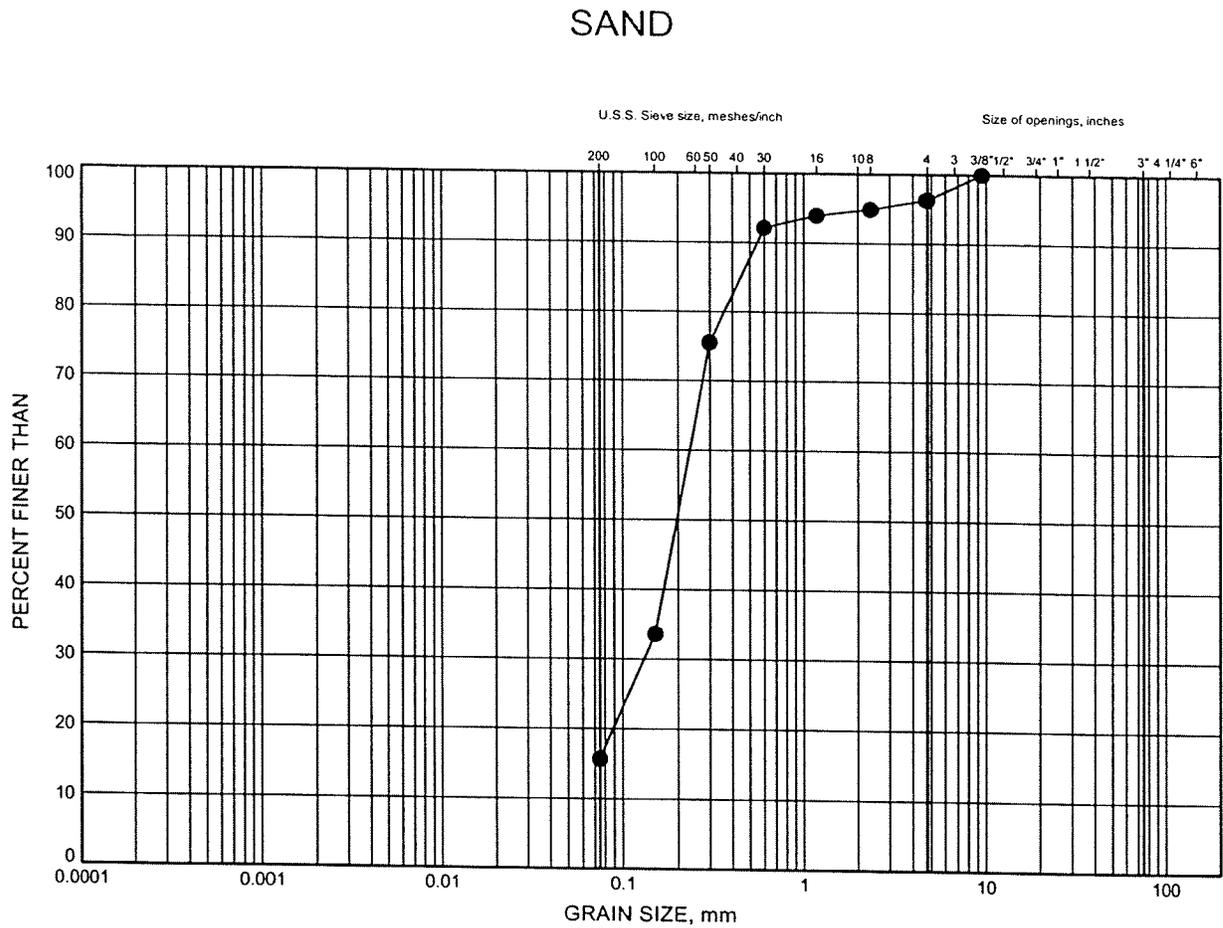
GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 5/1/09

W.P.# 19-92-70
 Prepared By AN
 Checked By RPR



Hwy 427 Northbound and Southbound
GRAIN SIZE DISTRIBUTION

FIGURE B7



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-01	23.16	157.11

GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 5/1/09

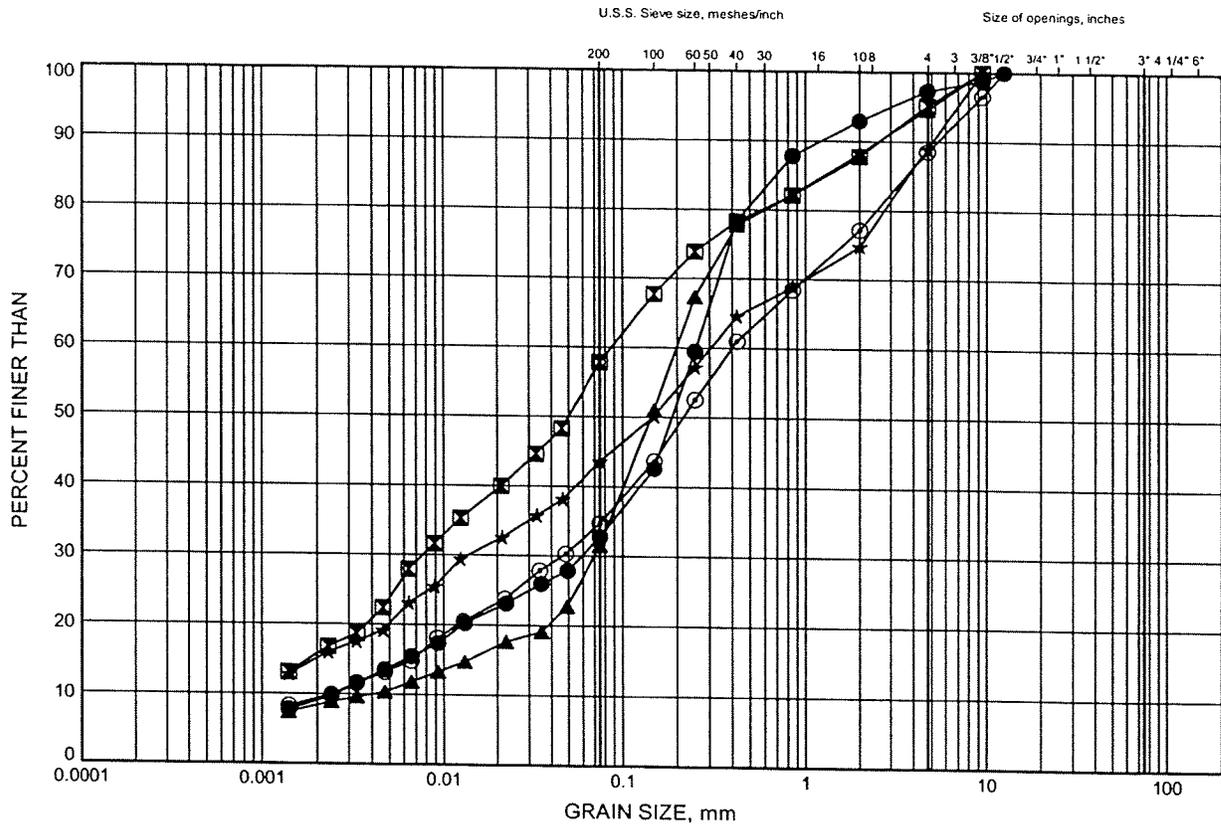
W.P.# .19-92-70.....
Prepared By .AN.....
Checked By .RPR.....



Hwy 427 Northbound and Southbound GRAIN SIZE DISTRIBUTION

FIGURE B8

SILTY SAND



SILT and CLAY		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-02	12.50	158.63
⊠	CNH-04	18.48	162.79
▲	CNH-05	21.64	158.52
★	CNH-05	24.69	155.48
⊙	CNH-06	10.97	160.41

GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 6/29/09

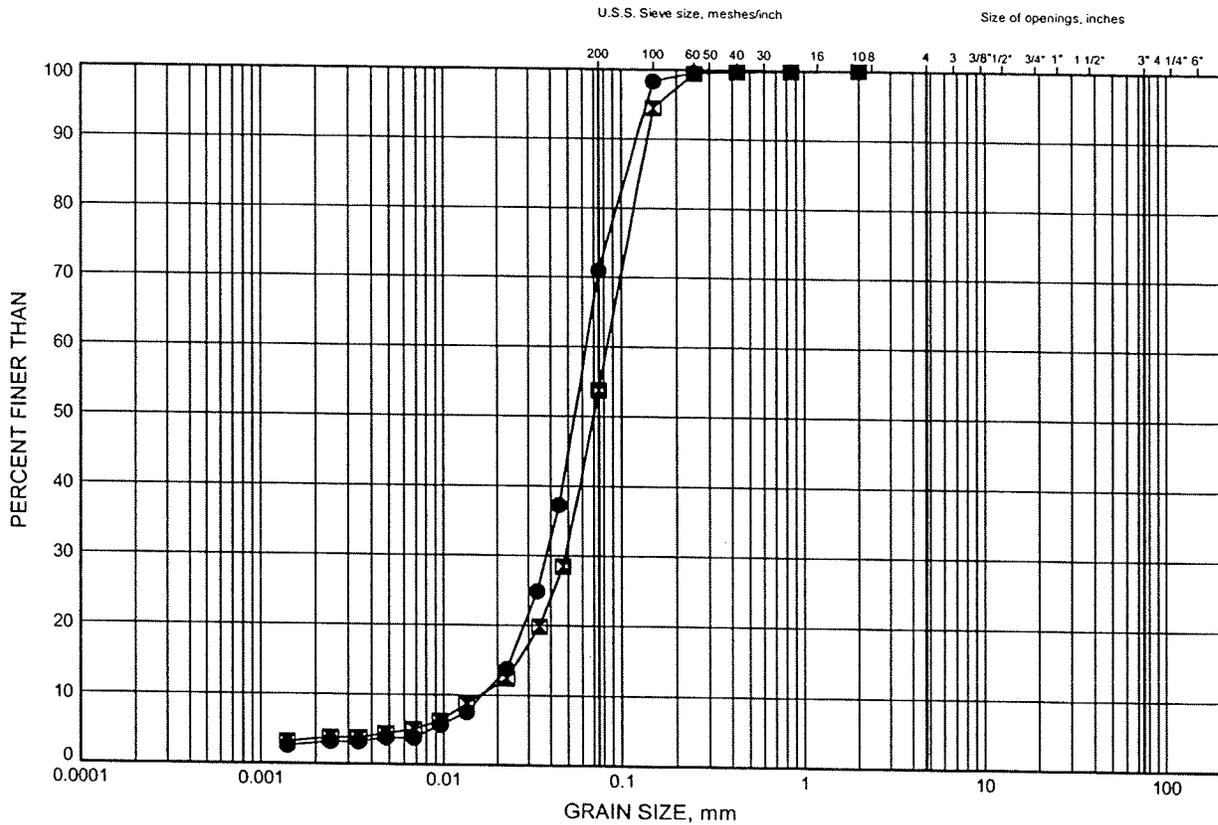
W.P.# .202-95-00.....
 Prepared By .MFA.....
 Checked By .RPR.....



Hwy 427 Northbound and Southbound GRAIN SIZE DISTRIBUTION

FIGURE B9

SANDY SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CNH-03	7.92	163.67
⊠	CNH-07	6.40	165.15

GRAIN SIZE DISTRIBUTION - THURBER 9270.GPJ 6/29/09

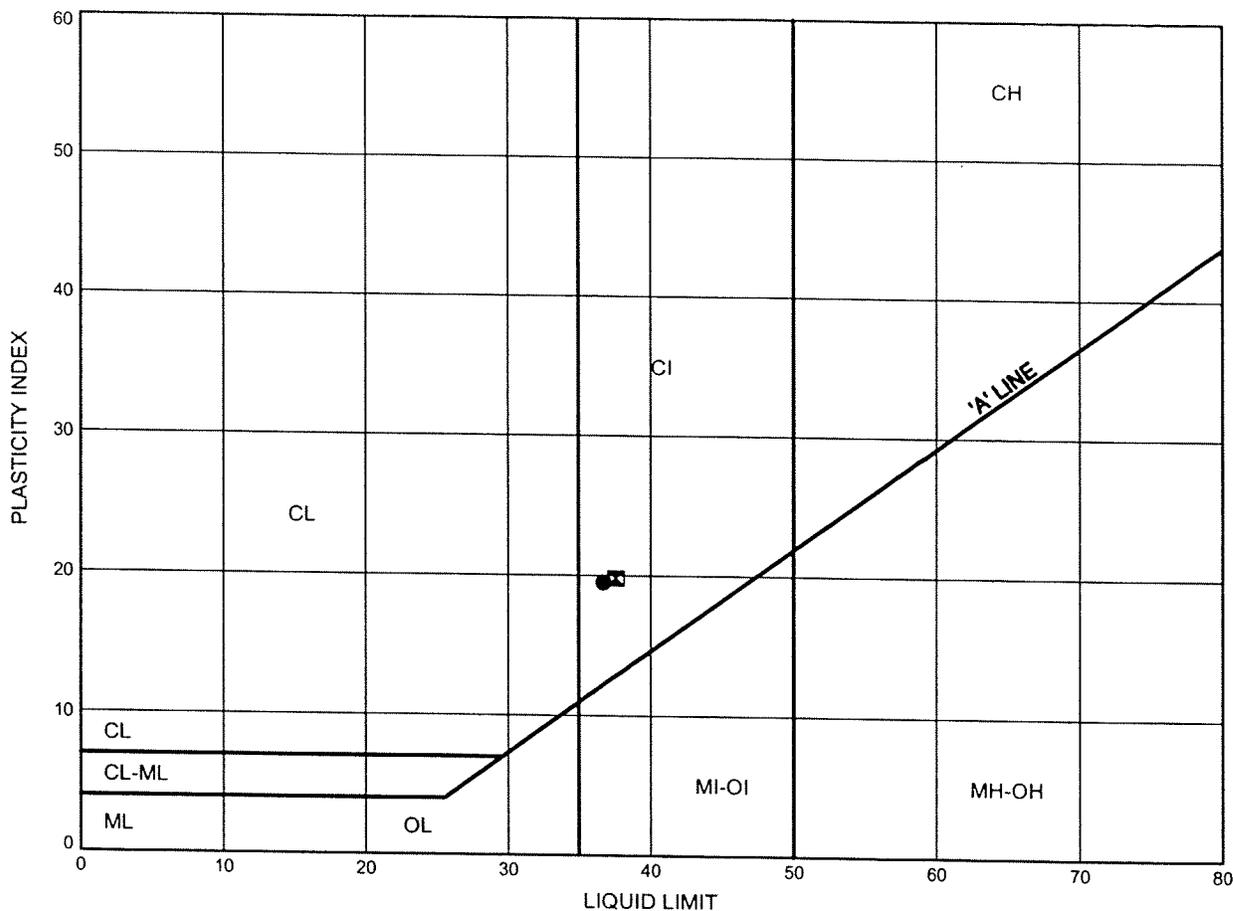
W.P.# . 202-95-00.....
 Prepared By . MFA.....
 Checked By . RPR.....



Hwy 427 Northbound and Southbound
ATTERBERG LIMITS TEST RESULTS

FIGURE B10

SILTY CLAY FILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CNH-01	6.40	173.87
⊠	CNH-09	3.35	176.45

THURBALT 9270.GPJ 5/1/09

Date May 2009
 Project 19-92-70

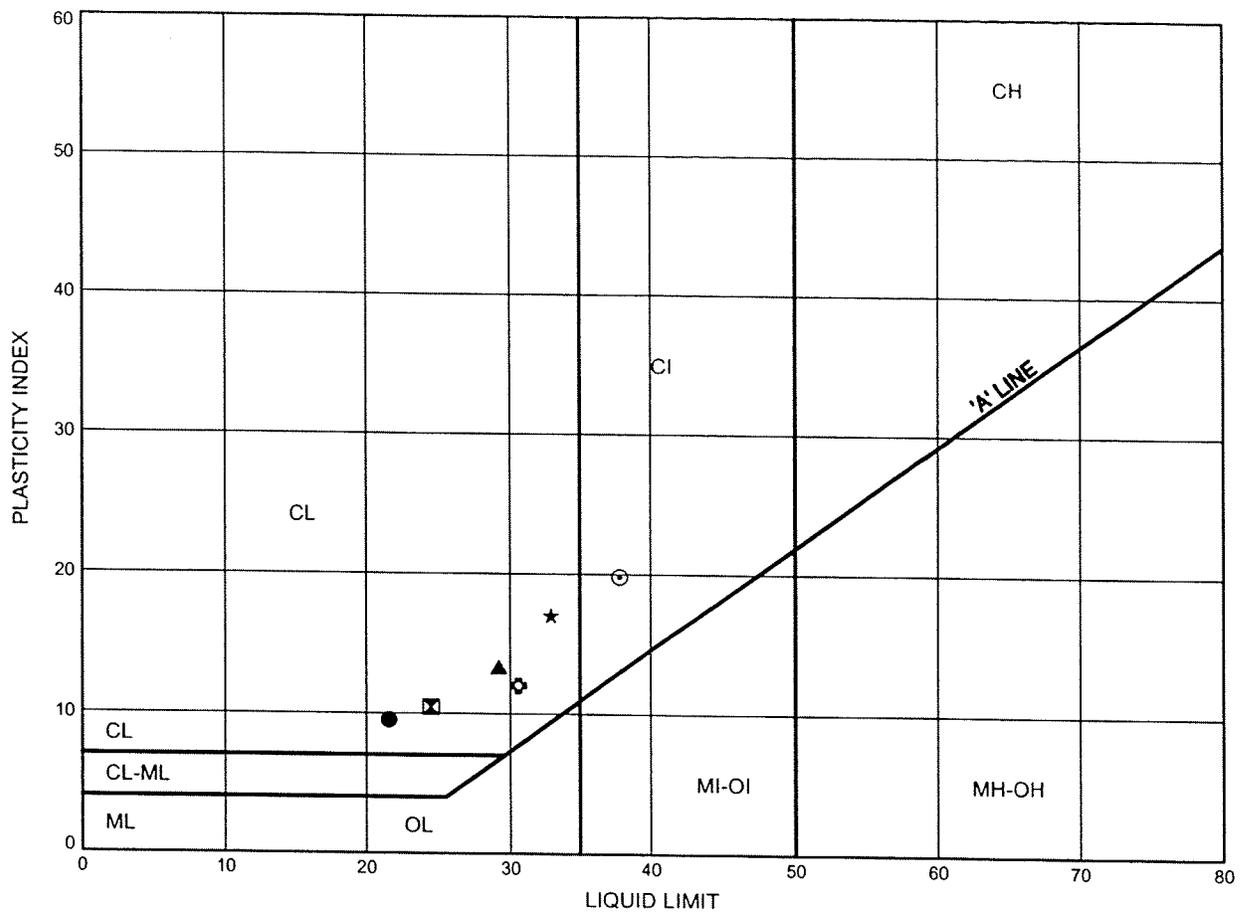


Prep'd AN
 Chkd. RPR

Hwy 427 Northbound and Southbound
ATTERBERG LIMITS TEST RESULTS

FIGURE B11

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CNH-01	15.54	164.73
⊠	CNH-02	1.83	169.30
▲	CNH-02	6.40	164.73
★	CNH-03	3.35	168.24
⊙	CNH-04	6.40	174.87
⊕	CNH-04	14.02	167.25

THURBALT 9270.GPJ 5/1/09

Date May 2009
 Project 19-92-70

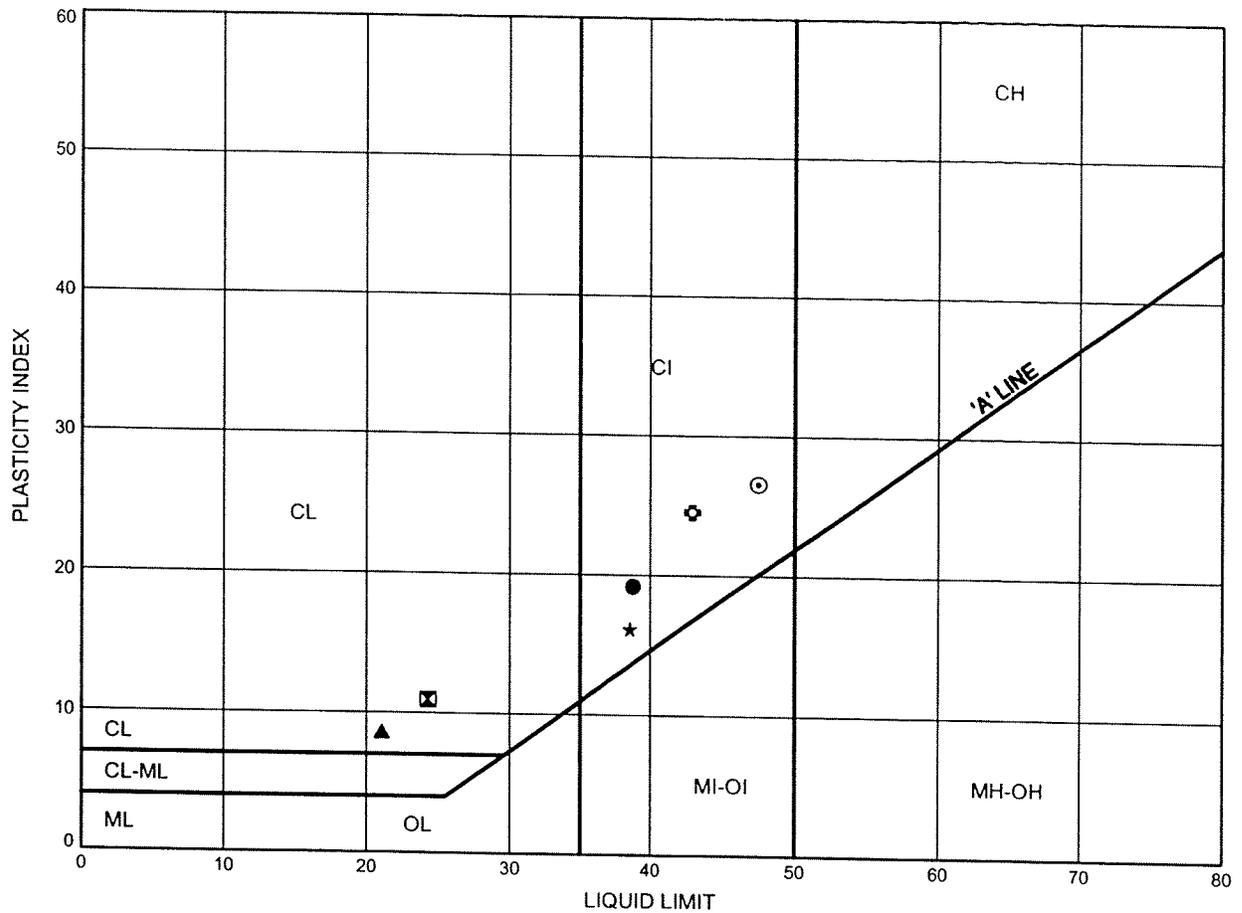


Prep'd AN
 Chkd. RPR

Hwy 427 Northbound and Southbound
ATTERBERG LIMITS TEST RESULTS

FIGURE B12

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CNH-05	9.45	170.72
⊠	CNH-05	17.07	163.10
▲	CNH-06	7.92	163.46
★	CNH-07	1.83	169.72
⊙	CNH-08	6.40	174.92
⊕	CNH-08	10.97	170.35

THURBALT_9270.GPJ 5/1/09

Date May 2009
 Project 19-92-70

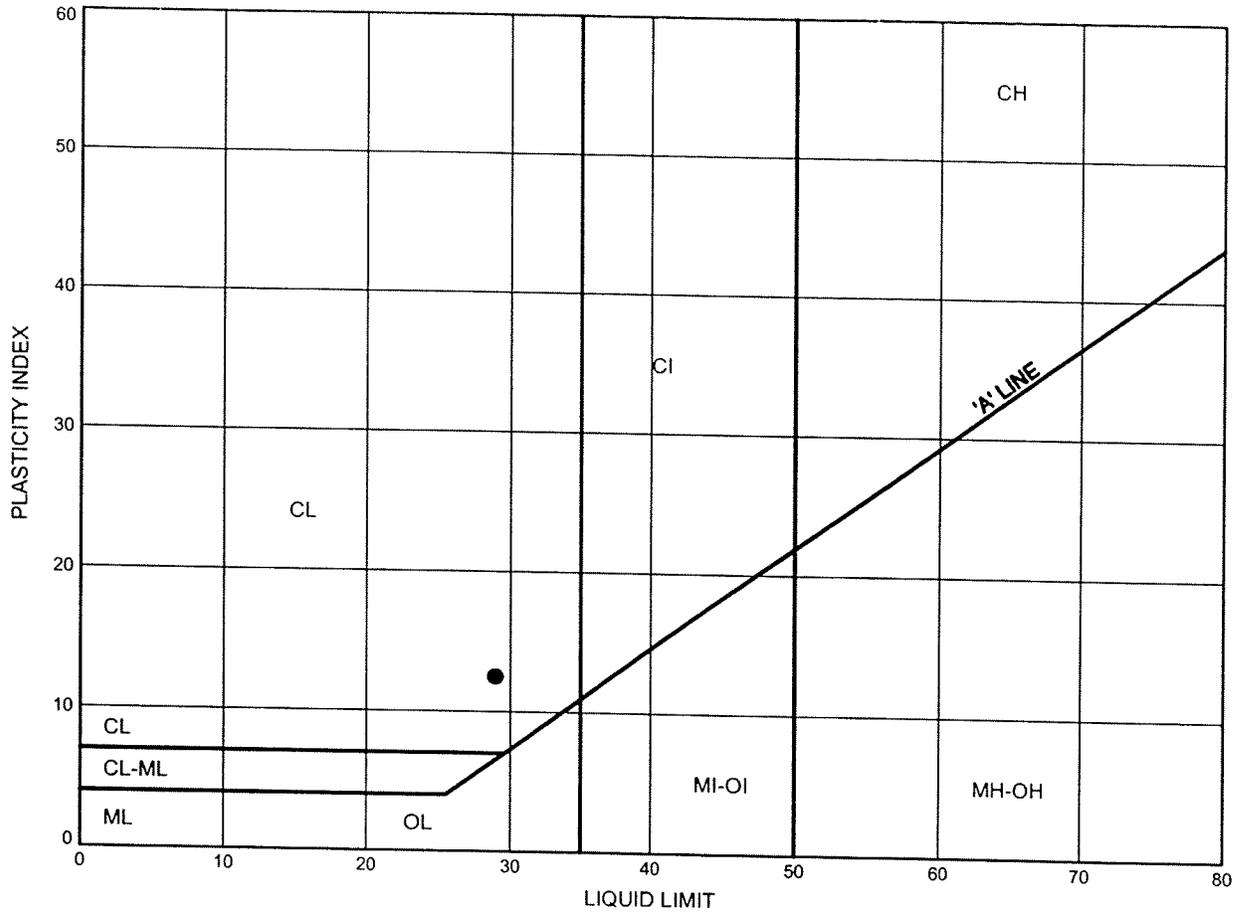


Prep'd AN
 Chkd. RPR

Hwy 427 Northbound and Southbound
ATTERBERG LIMITS TEST RESULTS

FIGURE B13

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	CNH-10	4.88	176.42

THURBALT 9270.GPJ 5/1/09

Date May 2009
 Project 19-92-70



Prep'd AN
 Chkd. RPR

Appendix C

**Record of Borehole Sheets
(Previous Investigation)**

RECORD OF BOREHOLE No 1

METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 821.2; E 294 328.3 ORIGINATED BY V.P.
 DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY V.P.
 DATUM Geodetic DATE 81-12-10 to 81-12-11 CHECKED BY CP

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE								
171.9	Ground Surface											
0.0	Mottled Brown Grey (Glacial Till) Silty Clay with Sand trace of Gravel Stiff to Hard		1	SS	9	170 168 166 164 162 160						2-20-45-33 3-20-57-20 0-28-42-30
			2	SS	13							
			3	SS	29							
			4	SS	27							
			5	SS	21							
			6	SS	15							
			7	SS	14							
			8	SS	16							
			9	SS	53							
			10	SS	37							
160.0												
11.9	Silty Sand Dense		11	SS	37	160						
158.0			12	SS	37							
158.0	Boulder		12	RC	-							
13.9	Break corebarrel in borehole											
45.4	Abandon hole End of Borehole											
	* Borehole caved at shallow depth. Perched water level at 0.5 metres.											

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

RECORD OF BOREHOLE No 2

METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 846.8; E 294 360.0 ORIGINATED BY V.P.
 DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY V.P.
 DATUM Geodetic DATE 81-12-11, 81-12-14, 81-12-15 CHECKED BY [Signature]

OFFICE REPORT ON SOIL EXPLORATION

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	N' VALUES			20	40	60	80	100		
171.6	Ground Surface													
U.0														
			11	SS	27		170							
			12	SS	32									
	Brown Grey (Glacial Till) Silty Clay with Sand trace of Gravel		13	SS	51									5-28-52-15
			14	SS	32		168							
			15	SS	47									
			16	SS	43		166							
			17	SS	33									12-15-41-32
	Very Stiff to Hard Silty Sand		18	SS	40		164							
			19	SS	78									
161.5							162							
10.1	Grey													
3.1	Silty Sand to Sand		10	SS	91		160							25-37-35-3
			11	SS	40									25-43-30-2
			12	SS	52									
			13	SS	94		158							1-72-16-11
			14	SS	55									
	Sand and Gravel with varying Amounts of Gravel		15	SS	106	18 CM	156							31-53-(16)
			16	SS	70	15 CM	154							2-65-32-1
	Occasional Cobbles and Boulders throughout						152							
			17	SS	100	15 CM								30-56-(14)
	Dense to Very Dense						150							
148.2	Refusal to Augering End of Borehole													
	* Note: Perched water table, B.E. caved at 3.5 metres.													

*3, *5: Numbers refer to Sensitivity
 20
 15 \diamond 5 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 3

METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 869.0; E 294 354.2 ORIGINATED BY V.P.
 DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Solid Stem Augers 24.4 m to 33.4 m COMPILED BY V.P.
 DATUM Canadian DATE R1-12-16, R1-12-17 and Cone Test CHECKED BY [Signature]

OFFICE REPORT ON SOIL EXPLORATION

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT Wp W Wl	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	'N' VALUES			20	40				
171.9	Ground Surface												
0.0	(Glacial Till)		1	SS	9		170						
			2	SS	26	*							
			3	SS	49								2-22-55-21
	Brown Grey Silty Clay with Sand trace of Gravel		4	SS	50		168						
			5	SS	38								
			6	SS	21		166						5-12-51-32
	occ. Cobbles and Boulders		7	SS	26								
			8	SS	30		164						
	Stiff to Hard		9	SS	44		162						
161.1													
10.4	boulder		10	SS	36		160						22-48-25-5
14.1	Grey		11	SS	105		158						
	Silty Sand to Sand Varying Amounts of Gravel		12	SS	58		156						2-71-25-2
	Occasional Cobbles and Boulders throughout						154						
	Alternating Seams and Layers of Silt, Sand and Gravel		13	SS	58 / 15 cm		152						44-42-(14)
	Dense to Very Dense		14	SS	105 / 13 cm		150						
							140						
138.1													
33.4	Refusal to Solid Augers, Possible Boulder or Bedrock End of Borehole												
10.4	* Perched Water Table at 0.9 m Borehole Caved at 3.5 m												
	Note: This borehole is a combination of two borings the first meeting refusal at 10.7 metres on a probable boulder.												

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

RECORD OF BOREHOLE No 4

METRIC

W P 153-80-02 LOCATION Co-ords N 4 844 838.7; E 294 313.7 ORIGINATED BY V.P.
 DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY V.P.
 DATUM Geodetic DATE 81-12-18 to 81-12-21 CHECKED BY [Signature]

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE			'N' VALUES	20	40	60					
171.4	Ground Surface														
0.0	(Glacial Till)		1	SS	42										
	Brown Grey		2	SS	60										1-17-67-15
	Silty Sand		3	SS	46										
	Silty Clay some Sand trace of Gravel		4	SS	75										
	Hard		5	SS	33										5-15-60-20
			6	SS	83										
			7	SS	45										
159.8	Cobbles		8	SS	20										15-53-30-2
11.6 38.1	Grey Compact Silty Sand to Gravel and Cobble layers Sand Varying Amounts of Gravel occasional Cobbles and Boulders throughout Very Dense		9	SS	84										
			10	SS	105/15										6-75-(19)
			11	SS	115/13										12-51-33-4
			12	SS	120/3										
148.5 22.9 25.1	End of borehole * Borehole caved at 9.3 metres. Perched Water Table														

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 5

METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 920.5; E 294 355.5 ORIGINATED BY V.P.
 DIST 6 HWY 427 BOREHOLE TYPE Solid Stem Auger/SW Casing and Cone Test COMPILED BY V.P.
 DATUM Geodetic DATE 81-12-16 to 81-12-17 CHECKED BY [Signature]

OFFICE REPORT ON SOIL EXPLORATION

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
177.5 0.0	Ground Surface (Glacial Till)														
	Silty Clay		1	SS	12										
			2	SS	15										
	Brown Grey		3	SS	17										1-18-66-15
			4	SS	18										
	with Sand trace of Gravel Stiff to Hard		5	SS	27										
			6	SS	15										
	Cobble		7	SS	20										6-26-46-22
	Gravel Cobbles & Boulders		8	SS	41										
162.6 9.1			9	SS	124										23-46-27-4
23.9	Grey Silty Sand to Sand		10	SS	77										
	Varying Amounts of Gravel		11	SS	53										0-85-11-4
	occasional Cobbles and Boulders throughout		12	SS	145										
			13	SS	148/23 cm										43-46-(11)
	Very Dense														
146.5 21.7	End of Borehole		14	SS	147/23 cm										0-28-64-8
21.2	* Note: W.L. after 24 hours Refusal to augering at 8.3 metres Move BH 1.2 m south Drive EW casing and run bi-cone 18.3 to 21.3 metres.														

* 3, x 5: Numbers refer to 20
Sensitivity 15 $\frac{1}{5}$ (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 864.4; E 294 316.3
 DIST 6 HWY 427 BOREHOLE TYPE Solid Stem Auger/Drive "B" Casing
 DATUM Geodetic DATE 81-12-21
 ORIGINATED BY V.P. COMPILED BY V.P. CHECKED BY [Signature]

OFFICE REPORT ON SOIL EXPLORATION

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80					
170.6	Ground Surface															
0.0	(Glacial Till)		1	SS	31											
			2	SS	44											4-26-52-16
	Brown Grey		3	SS	47											
			4	SS	35											2-4-82-12
	Silty Clay with Sand trace of Gravel		5	SS	40											
			6	SS	100/	8 cm										
	Hard		7	SS	36											
	Gravel & Cobbles		8	SS	40											
			9	SS	31											2-10-56-32
160.5			10	SS	36											
10.1	Grey		11	SS	74											24-47-25-4
33.1	Silty Sand to Sand		12	SS	149/	23 cm										3-56-35-6
	Varying Amounts of Gravel		13	SS	168/	23 cm										
	Occasional Cobbles and Boulders throughout		14	SS	145/	23 cm										
	Dense to Very Dense															
149.0																
21.6	End of Borehole															15-67-32-5
70.4	* Perched Water Level at Ground Surface. BH Caved at 6.9 m.															

3, x5: Numbers refer to Sensitivity
 20
 15 → 5 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 7

METRIC

W P 153-80-02 LOCATION Co-ords. N 4 844 880.0; E 294 310.4 ORIGINATED BY V.P.
 DIST 6 HWY 427 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY V.P.
 DATUM Geodetic DATE 81-12-22 CHECKED BY [Signature]

OFFICE REPORT ON SOIL EXPLORATION

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	'N' VALUES			20	40					
171.7	Ground Surface													
0.0	(Glacial Till)		1	SS	27	*	170							
	Brown Grey Silty Clay with Sand trace of Gravel occ. cobbles		2	SS	44		168							
			3	SS	30		166							
			4	SS	75		164							
	Very Stiff to Hard		5	SS	122/	22 cm	164							
161.6			6	SS	40		162							
10.1 33.1	Grey Silty Sand to Sand		7	SS	107		160							
	Varying Amounts of Gravel		8	SS	79		158							
	occasional Cobbles and Boulders throughout		9	SS	103		156							
	Very Dense		10	SS	102		154							
151.5			11	SS	157/	20 cm	152							
20.2 66.3	End of Borehole													
	* Note: W.L. not established at time of investigation.													

* J, x^S: Numbers refer to Sensitivity 20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8

METRIC

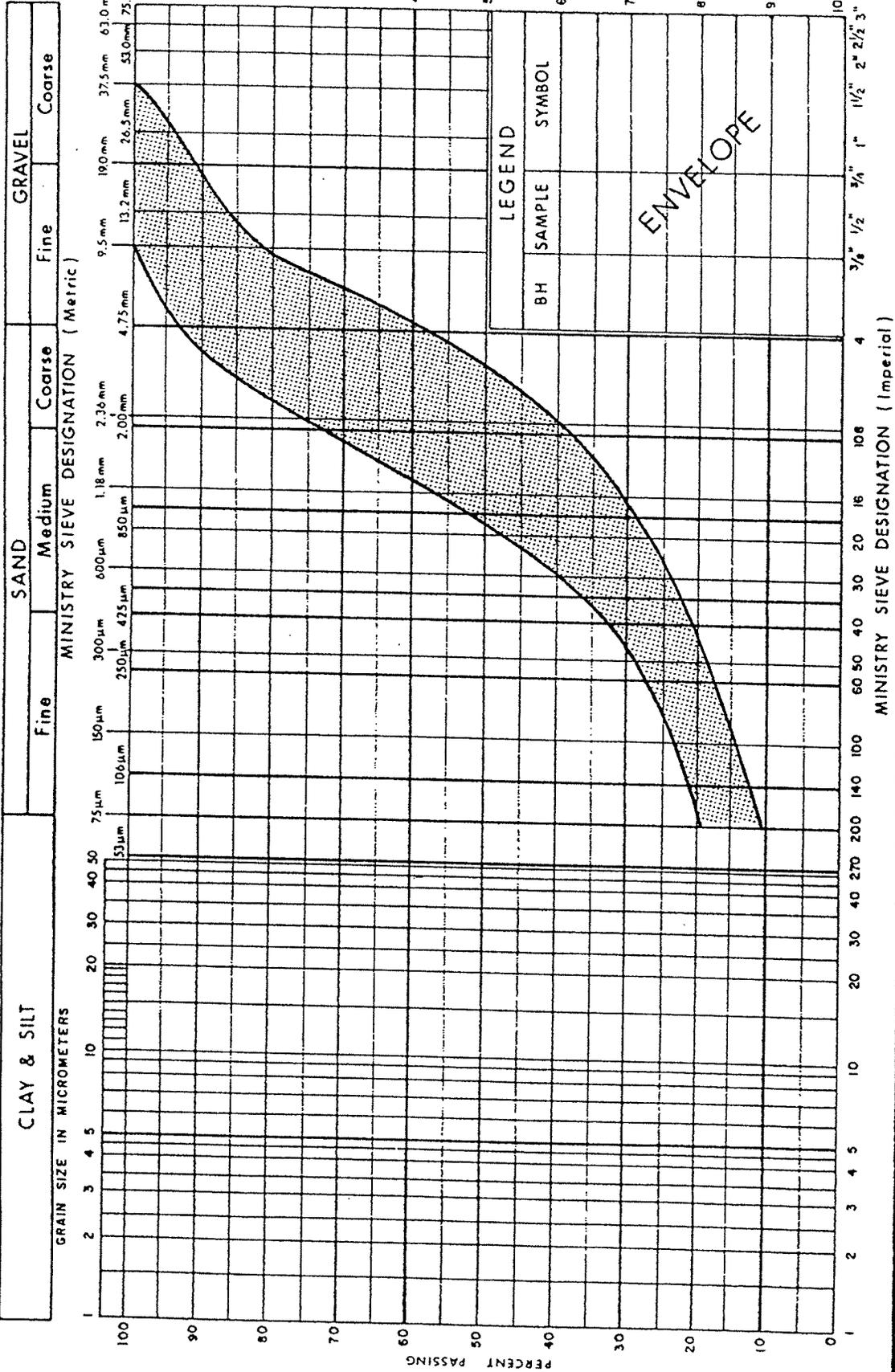
W P 153-80-02 LOCATION Co-ords. N 4 864 895.5; E 294 357.7 ORIGINATED BY V.P.
 DIST 6 HWY 427 BOREHOLE TYPE Solid Stem Auger/"8" Casing COMPILED BY V.P.
 DATUM Geodetic DATE 81-12-22 CHECKED BY [Signature]

OFFICE REPORT ON SOIL EXPLORATION

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
170.8	Ground Surface														GR SA SI CL
0.0	(Glacial Till)					*									
	Brown Grey		1	SS	31										
	Silty Clay with Sand trace of Gravel		2	SS	25										
			3	SS	23										
	Silty Sand		4	SS	27										
	Very Stiff to Hard		5	SS	100										
162.0															
8.8	Grey		6	SS	100										
28.9	Silty Sand to Sand		7	SS	118										
			8	SS	11										
	Varying Amounts of Gravel		9	SS	156										
	occasional Cobbles and Boulders Throughout		10	SS	111										
			11	SS	100	15 cm									
	Very Dense														
147.7															
23.1	End of Borehole		12	SS	100	8 cm									
25.8	* W.L. not established at time of investigation.														

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

UNIFIED SOIL CLASSIFICATION SYSTEM



CLAY & SILT		SAND			GRAVEL	
Fine		Medium	Coarse		Fine	Coarse
MINISTRY SIEVE DESIGNATION (Metric)						

Appendix D

Site Photographs



Photo 1. Looking at the existing north abutment, Highway 427 SBL



Photo 2. Looking at the south abutment and south pier, Highway 427 SBL

Hwy 427 Widening – CN Halton Subdivision

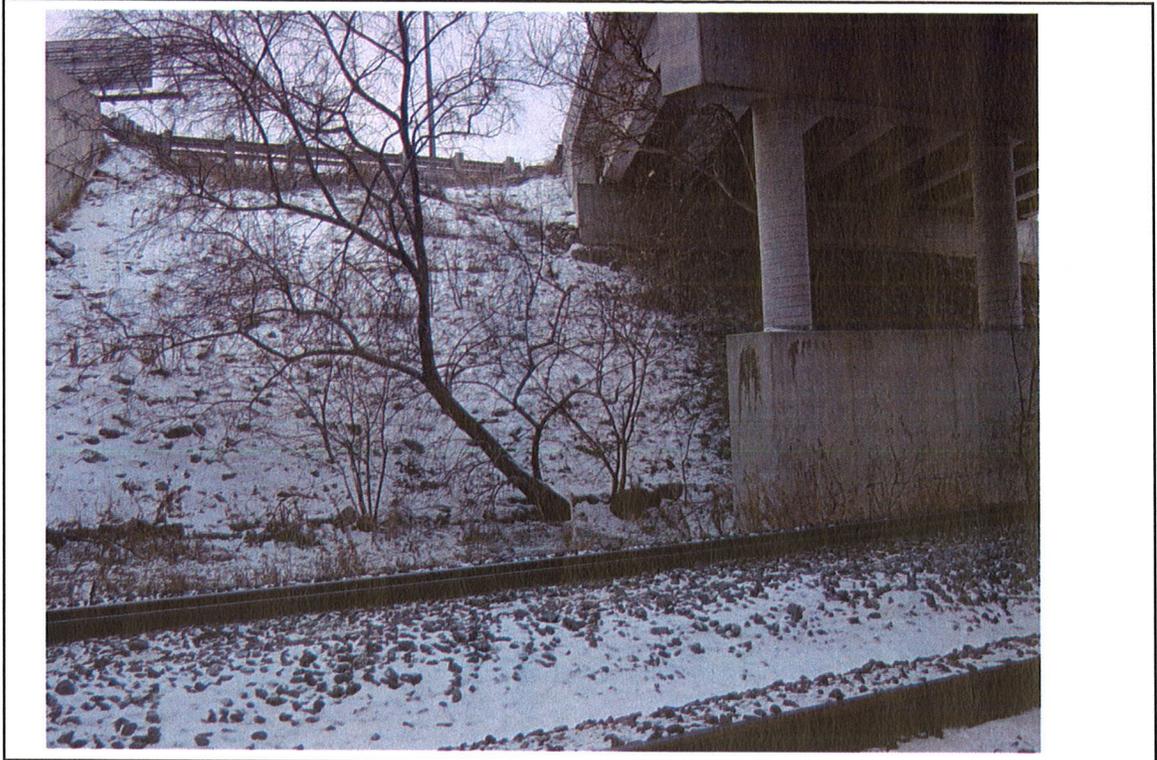


Photo 3. Looking at the existing south abutment and pier, Hwy 427 SBL (Boreholes CNH-02 and CNH-06)

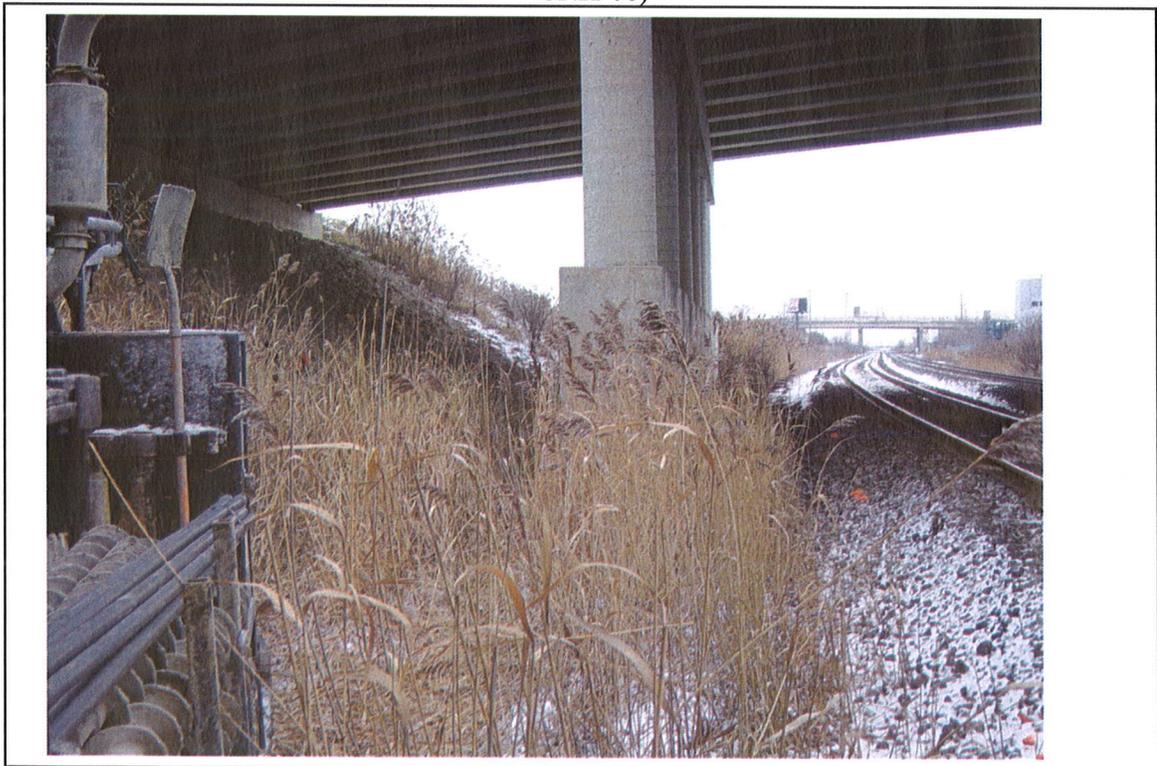


Photo 4. Looking at the existing north abutment and pier, Hwy 427 NBL (Boreholes CNH-03 and CNH-07)

Appendix E

Borehole Locations and Soil Strata Drawing

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

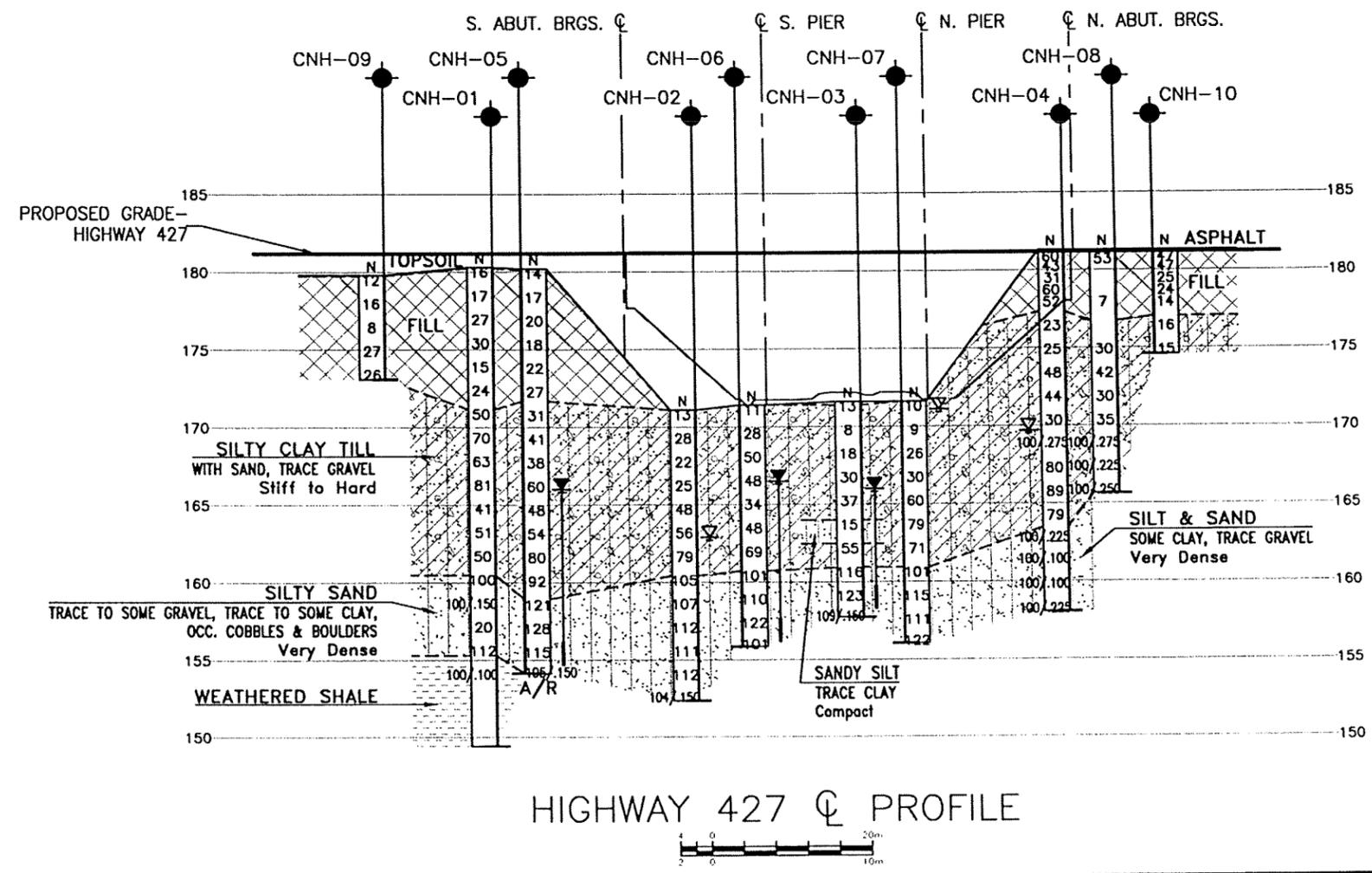
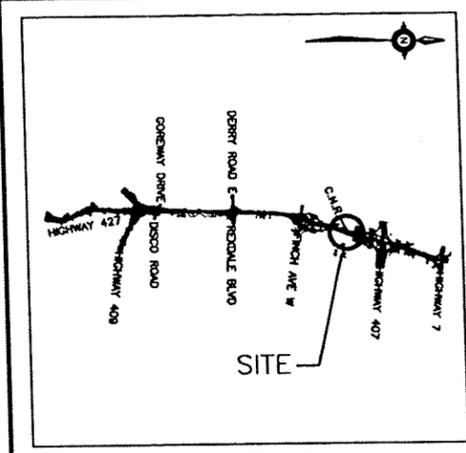
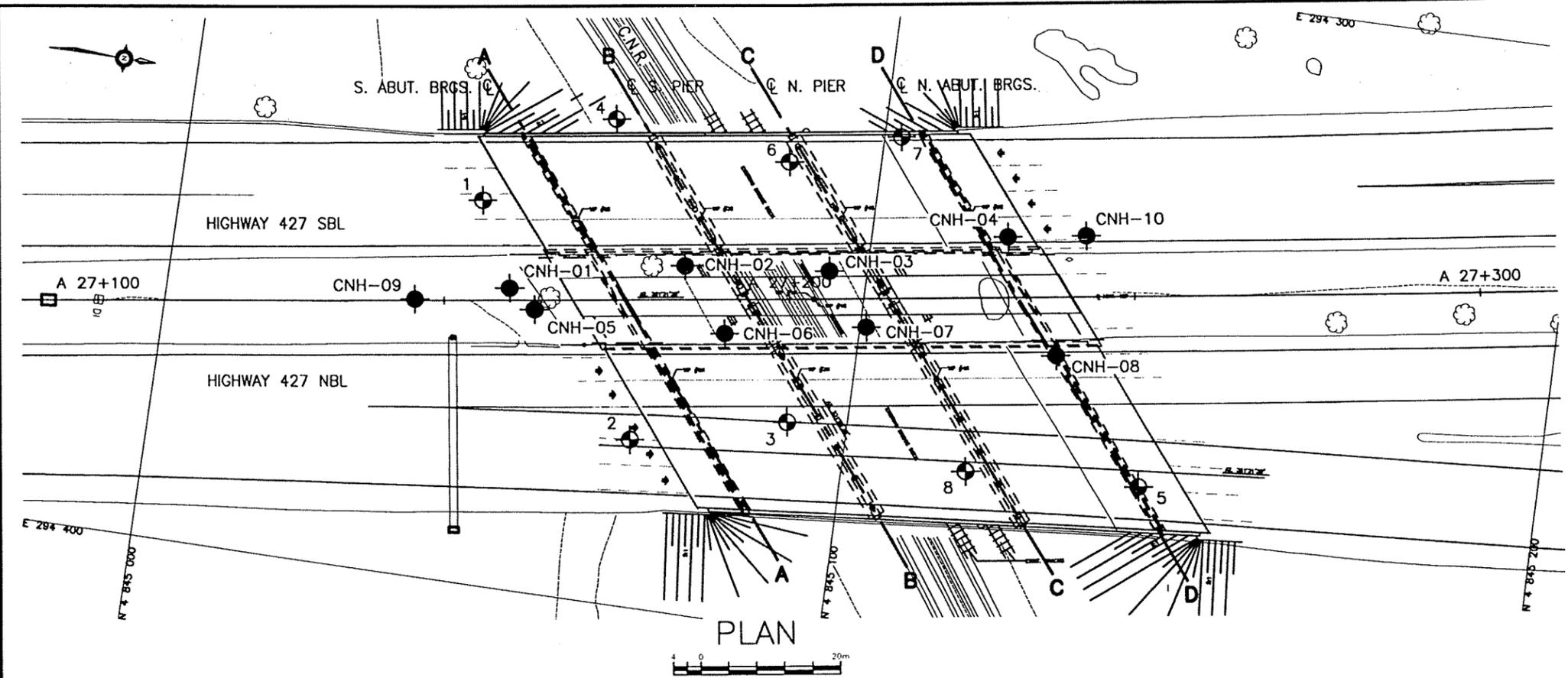
CONT No
GWP No 202-95-00

HIGHWAY 427
C.N.R. OVERHEAD
REHABILITATION & WIDENING
BOREHOLE LOCATIONS AND SOIL STRATA

SNC-LAVALIN

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

SHEET



LEGEND

- ◆ Borehole by Thurber (Present Investigation)
- ◇ Borehole by Others (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level in Open Borehole
- ↑ Head Artesian Water
- ⊕ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
CNH-01	180.3	4 845 049.2	294 356.2
CNH-02	171.1	4 845 073.9	294 349.3
CNH-03	171.6	4 845 094.6	294 347.1
CNH-04	181.3	4 845 119.7	294 338.5
CNH-05	180.2	4 845 053.1	294 358.8
CNH-06	171.4	4 845 080.9	294 358.3
CNH-07	171.6	4 845 100.9	294 354.5
CNH-08	181.3	4 845 128.7	294 354.8
CNH-09	179.8	4 845 035.8	294 359.8
CNH-10	181.3	4 845 130.8	294 336.8

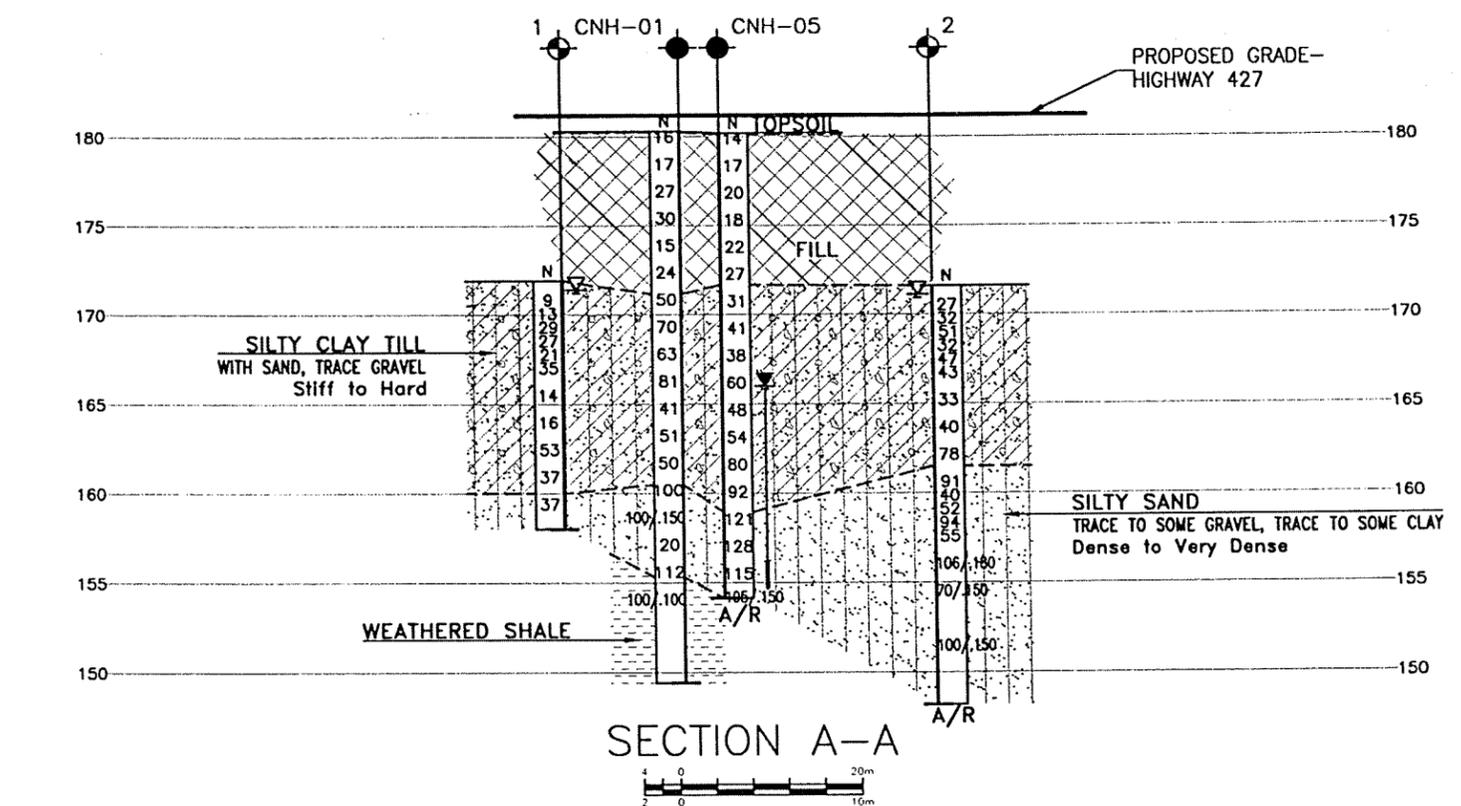
NOTES

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

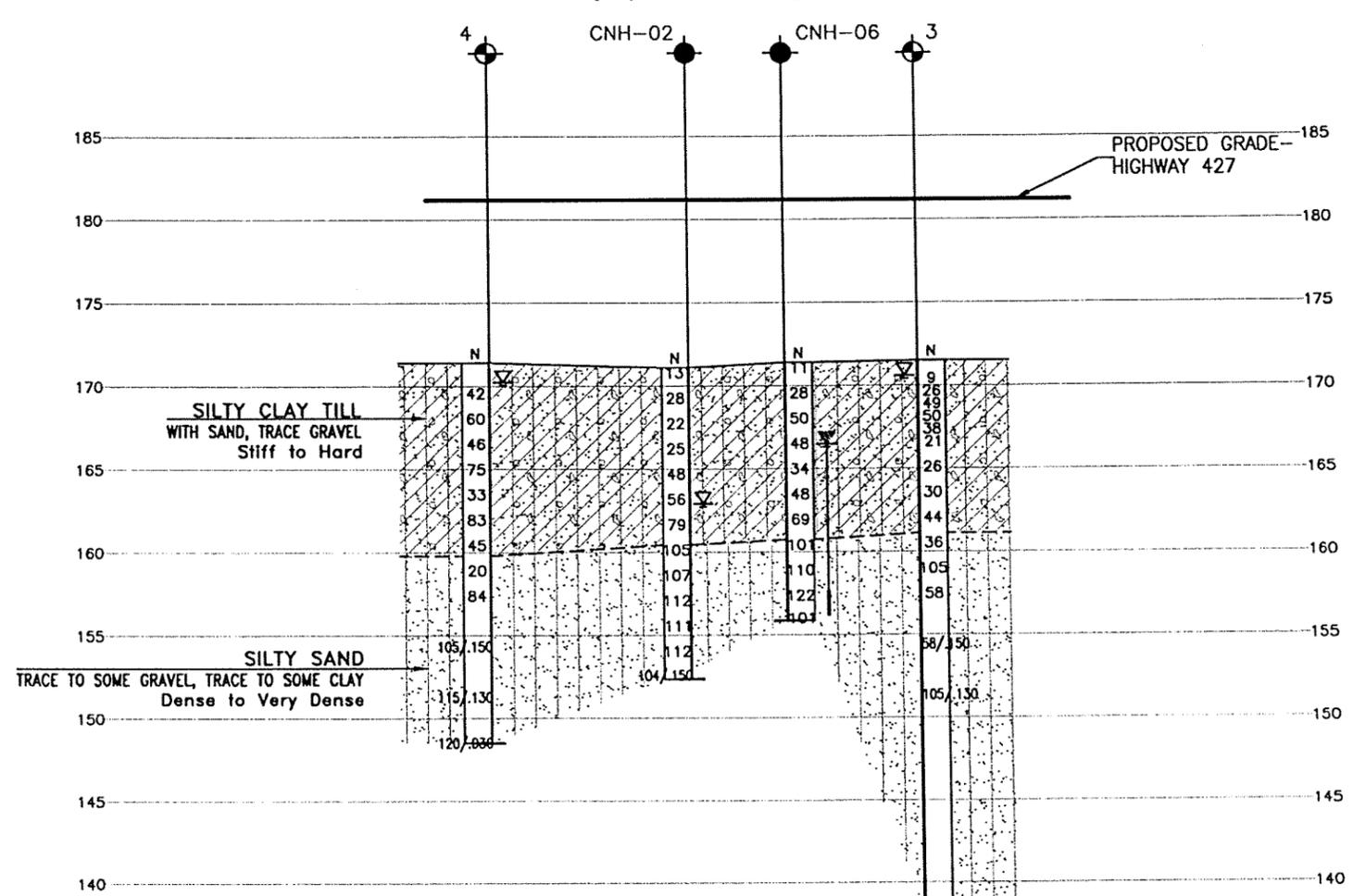
GEOCRES No. 30M12-288

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	SKP	CHK	PKC	CODE	LOAD	DATE	NOV. 2009
DRAWN	MFA	CHK	PKC	SITE	STRUCT	DWG	1



SECTION A-A
 0 10m 20m
 0 2

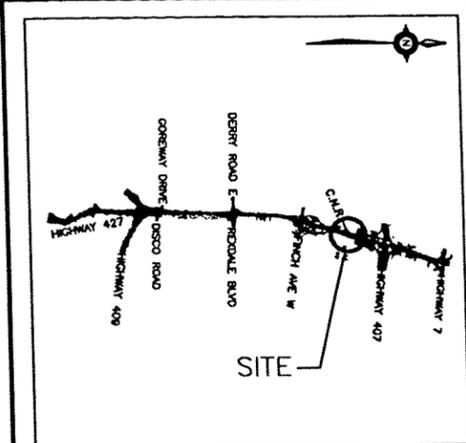


SECTION B-B
 0 10m 20m
 0 2

METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN

CONT No
 GWP No 202-95-00
 HIGHWAY 427
 C.N.R. OVERHEAD
 REHABILITATION & WIDENING
 BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

- ◆ Borehole by Thurber (Present Investigation)
- ◊ Borehole by Others (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- ▽ Water Level in Open Borehole
- ⊕ Head Artesian Water
- ⊖ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
CNH-01	180.3	4 845 049.2	294 356.2
CNH-02	171.1	4 845 073.9	294 349.3
CNH-03	171.6	4 845 094.6	294 347.1
CNH-04	181.3	4 845 119.7	294 338.5
CNH-05	180.2	4 845 053.1	294 358.8
CNH-06	171.4	4 845 080.9	294 358.3
CNH-07	171.6	4 845 100.9	294 354.5
CNH-08	181.3	4 845 128.7	294 354.8
CNH-09	179.8	4 845 035.8	294 359.8
CNH-10	181.3	4 845 130.8	294 336.8

- NOTES-**
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
 - This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCREs No. 30M12-288



REVISIONS	DATE	BY	DESCRIPTION

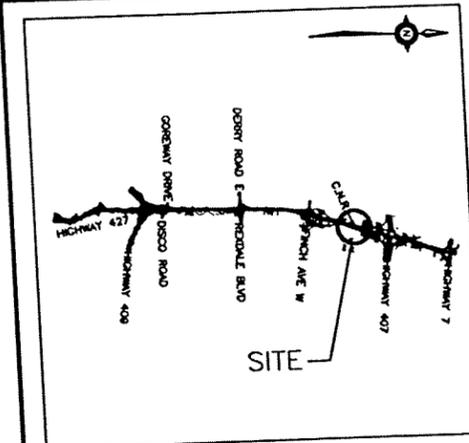
DESIGN	SKP	CHK	PKC	CODE	LOAD	DATE
DRAWN	MFA	CHK	PKC	SITE	STRUCT	NOV. 2009

METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN

CONT No
 GWP No 202-95-00

HIGHWAY 427
 C.N.R. OVERHEAD
 REHABILITATION & WIDENING
 BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

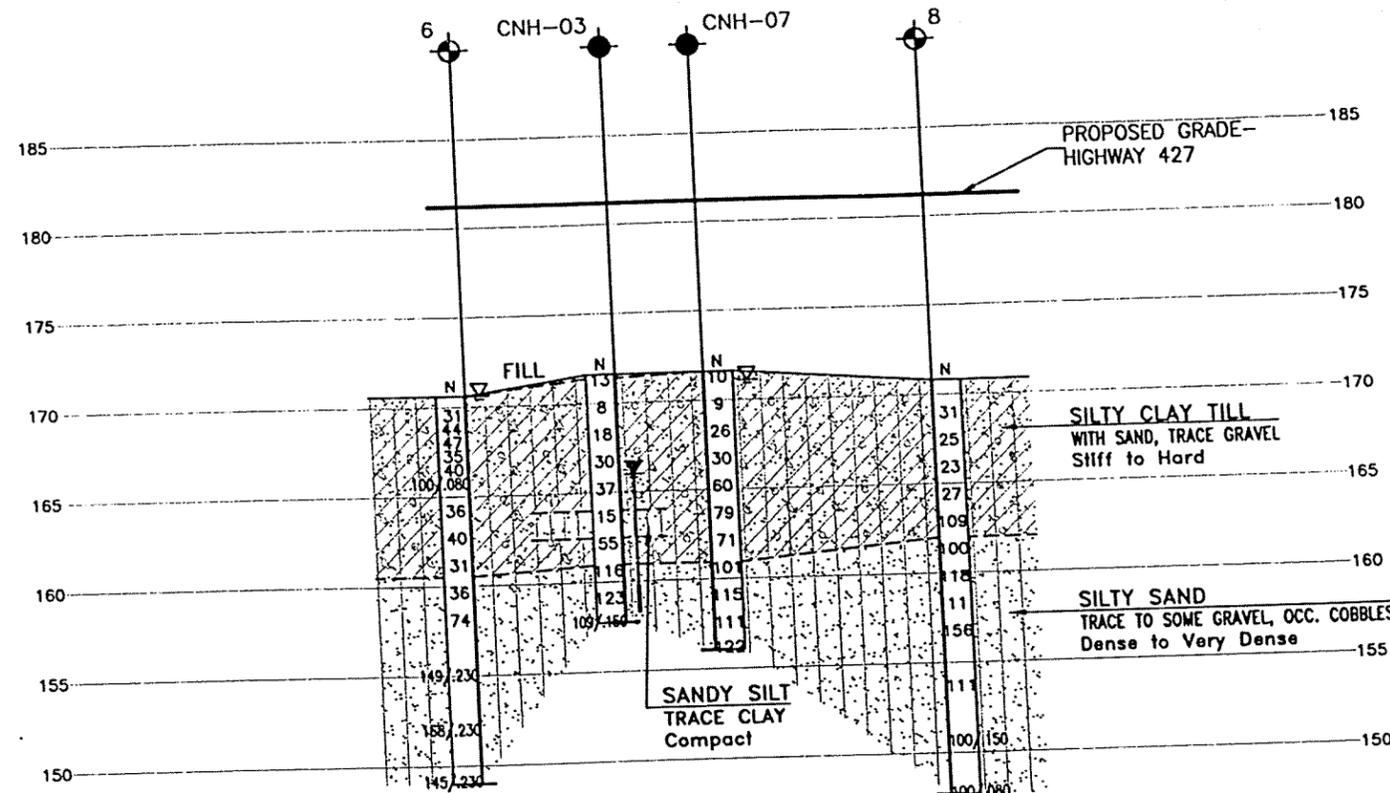
LEGEND

- ◆ Borehole by Thurber (Present Investigation)
- ◇ Borehole by Others (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- ☼ Water Level in Open Borehole
- ☼ Head Artesian Water
- ☼ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

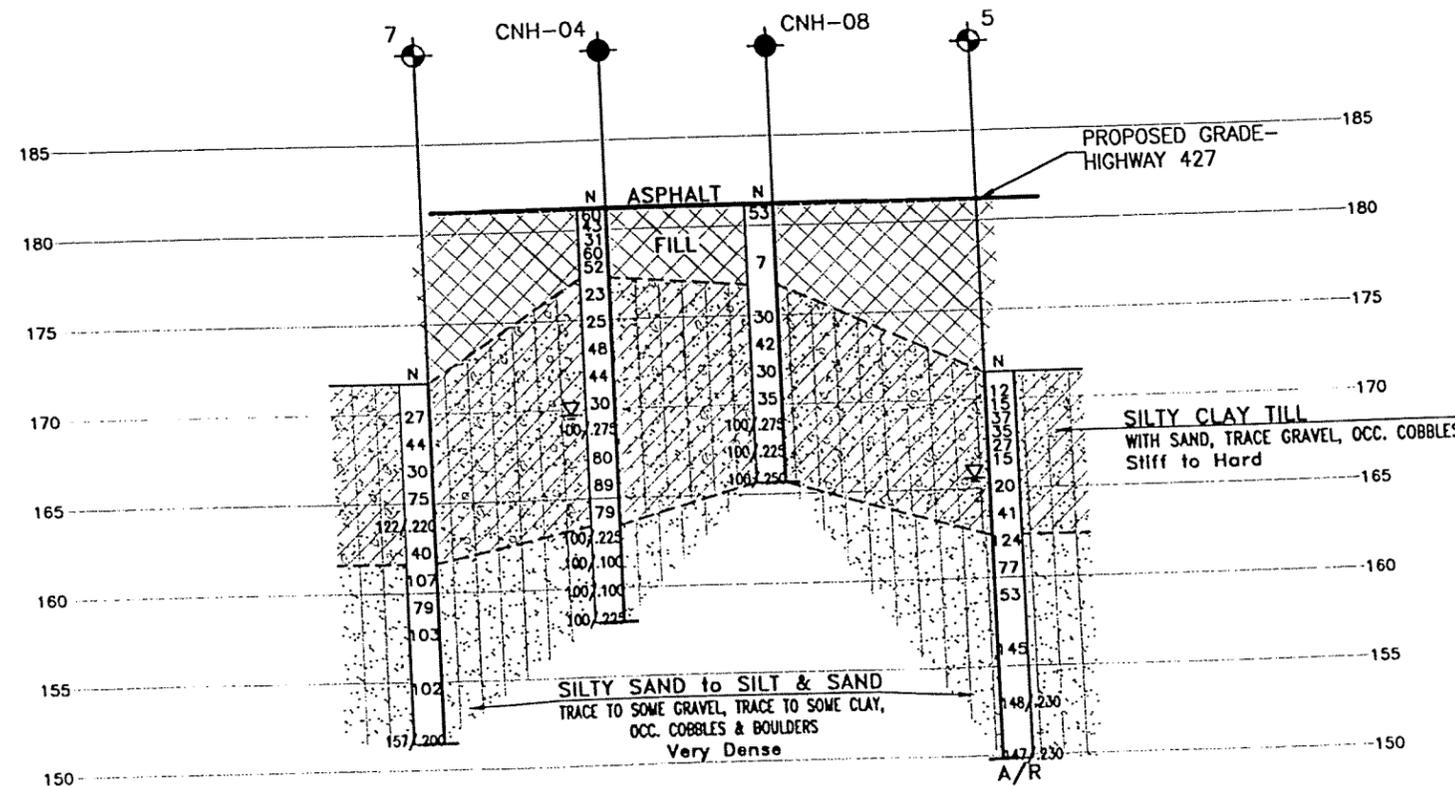
NO	ELEVATION	NORTHING	EASTING
CNH-01	180.3	4 845 049.2	294 356.2
CNH-02	171.1	4 845 073.9	294 349.3
CNH-03	171.6	4 845 094.6	294 347.1
CNH-04	181.3	4 845 119.7	294 338.5
CNH-05	180.2	4 845 053.1	294 358.8
CNH-06	171.4	4 845 080.9	294 358.3
CNH-07	171.6	4 845 100.9	294 354.5
CNH-08	181.3	4 845 128.7	294 354.8
CNH-09	179.8	4 845 035.8	294 359.8
CNH-10	181.3	4 845 130.8	294 336.8

- NOTES-**
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
 - This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

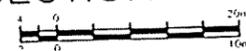
GEORES No. 30M12-288



SECTION C-C



SECTION D-D



DATE	BY	DESCRIPTION
DESIGN	SKP	CHK PKC CODE
DRAWN	MFA	CHK PKC SITE