

**REPORT ON
FOUNDATION INVESTIGATION
FOR RECONSTRUCTION OF
APPROACH EMBANKMENTS AND RAMPS
HIGHWAY 401 AND HIGHWAY 77 INTERCHANGE
TOWNSHIP OF TILBURY WEST, ESSEX COUNTY
G.W.P. 61-00-00
PURCHASE ORDER NO. 3005-A-000301
GEOCRES NO. 40J2-60**

Submitted

To

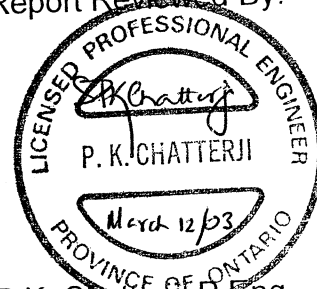
ERES Consultants

Direction of Fieldwork and
Engineering Analysis by :



Sydney Pang, P.Eng.
Project Engineer

Report Reviewed By:



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

Thurber Engineering Ltd.
Suite 103, 2010 Winston Park Drive
Oakville, Ontario
L6H 5R7
Tel. (905) 829-8666
Fax. (905) 829-1166
March 12, 2003
File: 19-2005-16

TABLE OF CONTENTS

SECTION	PAGE
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION.....	2
3.0 INVESTIGATION PROCEDURES.....	2
3.1 Field Investigation.....	2
3.2 Laboratory Testing.....	4
4.0 GENERAL SITE GEOLOGY AND SUBSURFACE STRATIGRAPHY.....	5
4.1 General Site Geology.....	5
4.2 Subsurface Stratigraphy.....	5
4.2.1 Pavement and Topsoil.....	5
4.2.2 Fill.....	6
4.2.3 Silty Clay Till.....	6
4.2.4 Groundwater Conditions.....	8

DRAWINGS

19-2005-16-1 Borehole Locations and Soil Strata Plan

APPENDICES

- Appendix A Records of Boreholes
- Appendix B Laboratory Test Results
Figures B1 to B6 Plasticity Charts
- Appendix C Laboratory Test Results
Figures C1 to C3 Grain Size Distribution Curves
- Appendix D Oedometer Tests

**REPORT ON
FOUNDATION INVESTIGATION
FOR RECONSTRUCTION OF
APPROACH EMBANKMENTS AND RAMPS
HIGHWAY 401 AND HIGHWAY 77 INTERCHANGE
TOWNSHIP OF TILBURY WEST, ESSEX COUNTY
G.W.P. 61-00-00
PURCHASE ORDER NO. 3005-A-000301
GEOCRES NO. 40J2-60**

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the detailed design and reconstruction of approaches, and construction of new ramps at the Highway 401 interchange with Highway 77 in Essex County, Ontario. This work is part of the project involving reconstruction and widening of 10.6 km of Highway 401 from 1.2 km west of Highway 77 to 1.0 km east of Essex County Road 42.

The purpose of this investigation was to determine the subsurface conditions at the existing bridge approaches and areas within the footprints of the proposed fill and, based on this and other available data, to provide foundation recommendations for the design of the new embankments.

Prior to this investigation, relevant foundation engineering references available from the GEOCRES system have been consulted. Particular reference is made to the following document in the preparation of this report.

- Peto MacCallum Ltd. titled "Foundation Investigation and Design Report for Highway 77 Underpass, G.W.P. 60-00-00, Site 6-104, Highway 401, Comber, Ontario", PML Ref. 01TF072E, September 2002, GEOCRES No. 40J2-46 (Reference 1).

2.0 SITE DESCRIPTION

The site is located at the Highway 401 underpass at Highway 77 within the jurisdiction of the Town of Lakeshore, Township of Tilbury West, Essex County, some 50 km east of Windsor, Ontario. This site is situated within the MTO District 31 and its location is shown on Drawing 19-2005-16-1.

Highway 401 runs in an east-west direction at the bridge location. The existing bridge is a single span, rigid frame reinforced concrete structure. The existing north and south approach fills are up to 7 m high near the bridge abutments. The fill side slopes have an inclination of approximately 2 H : 1 V.

Ramps currently exist at the northwest and southeast quadrants. Visual observations of the existing slopes did not reveal evidence of active surficial sloughing.

The general vicinity of the interchange is lightly vegetated with grass and occasional shrubs and trees. The field at the northeast quadrant of the interchange is currently being used for agricultural purposes. The original terrain is relatively flat-lying with the existing bridge and approaches being the prominent features on site. Highway 77 intersects North Middle Road (West and East) immediately to the south of the south approach.

3.0 INVESTIGATION PROCEDURES

3.1 Field Investigation

The plans and profiles for the proposed works were provided to us on preliminary drawings by ERES.

The borehole investigation program for this project was carried out during the period of November 26 to December 5, 2002, inclusive, when 15 sampled boreholes, numbered 02-1 to 02-15, were drilled and sampled at selected locations. The sampled depths of these boreholes ranged between 6.7 m and 18.9 m.

The approximate locations of all boreholes are shown on Drawing 19-2005-16-1. The investigation was carried out using track and truck mounted drill rigs supplied and operated by specialist drilling contractors.

In the boreholes, a majority of soil samples were obtained with a 50 mm outside diameter split spoon sampler driven in accordance with the Standard Penetration Test (SPT). Undisturbed samples of the firm portions of the cohesive soils were recovered using 2-7/8 in. (70 mm) inside diameter thin-walled Shelby tubes. Field vane shear tests, using an MTO 'N' size vane, were carried out at periodic depth intervals within the cohesive deposits. A 'B' vane was used where the 'N' vane could not be pushed and/or sheared in the soil. Pocket penetrometer readings were obtained from selected cohesive samples for qualitative strength correlation purposes. A dynamic cone penetration test was carried out from the bottom of each of the Boreholes 02-2 and 02-11 until a high resistance (>100 blows per 0.3 m penetration) was encountered. Groundwater conditions in the open boreholes were observed throughout the drilling operations. One standpipe piezometer was installed in each of the Boreholes 02-11 and 02-14 to permit longer term groundwater level monitoring.

The field work was supervised on a full-time basis by one of our field technicians who located the boreholes in the field, cleared borehole locations of underground utilities, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in

appropriately labelled containers and transported back to Thurber's laboratory in Oakville for further examination and testing. Particular attention was paid to the handling, packaging, insulation and transportation of Shelby tube samples to avoid undue disturbance and potential freezing at all times.

Upon completion of drilling, the boreholes on the bridge approaches were grouted with cement and bentonite, and capped with cold patch asphalt. All remaining boreholes were backfilled with drill cuttings. Once the last set of piezometer readings was taken, the piezometers were decommissioned with cement and bentonite.

All as-drilled borehole locations were established in the field by Thurber's drilling supervisor in relation to surface features on site. The ground surface elevations and plan co-ordinates (northings and eastings) at the borehole locations have been estimated based on plans and profiles provided by MTO and ERES.

Results of the field sampling and testing are presented on Drawing 19-2005-19-1 and on the Records of Boreholes in Appendix A.

3.2 Laboratory Testing

Geotechnical laboratory testing consisted of natural moisture content, visual classification and description of all soil samples in accordance with the current MTO standards. Grain size distribution analysis and Atterberg Limits tests were conducted on selected samples. The level of testing carried out at this site exceeds the minimum requirement of 25% of all recovered soil samples as stipulated in the Terms of Reference. Two undisturbed specimens of the silty clay till prepared from Shelby tube samples, were subjected to laboratory oedometer testing to determine their consolidation characteristics. Complete results of these tests are included in Appendix D.

4.0 GENERAL SITE GEOLOGY AND SUBSURFACE STRATIGRAPHY

4.1 General Site Geology

Based on published geological information, the general area of the project is located within the physiographic sub-region named Essex Clay Plain of the St. Clair Clay Plains. This is a till plain with lacustrine clay deposits which settled in the depressions while the knolls were lowered by wave action of past glacial lakes. The till deposits consist mainly of a silty clay to clayey silt matrix. Below the extensive till deposits lies bedrock of the Dundee Formation (Chapman and Putnam, "The Physiography of Southern Ontario", Third Edition, Ontario Geological Survey, 1984). The bedrock reportedly consists of limestone, dolostone and shale.

4.2 Subsurface Stratigraphy

This section contains generalized summary of the subsurface conditions at this site. The detailed subsurface soil and groundwater conditions encountered in the boreholes are presented on the Records of Borehole sheets in Appendix A.

In general, the subsurface conditions encountered in the boreholes at the existing bridge approaches consist of a pavement structure overlying approach fill which is largely composed of silty clay till materials. The native soils below the original ground surface consist predominantly of a deposit of silty clay till underlying topsoil. Groundwater levels at 2.5 m and 6.3 m depths were measured in the piezometers installed in two selected boreholes.

4.2.1 Pavement and Topsoil

At the bridge approaches, Boreholes 02-3 and 02-4 encountered a pavement structure consisting of 75 mm of asphalt. At the existing road shoulders, Boreholes 02-8 and 02-15 encountered 75 mm and 50 mm of asphalt, respectively. The asphalt in Borehole 02-15 was underlain by 0.4 m of sand fill.

Topsoil was encountered in Boreholes 02-5 to 02-7 and 02-11 to 02-14. At the borehole locations, topsoil thickness varied between 25 mm and 150 mm.

4.2.2 Fill

Fill was encountered in most boreholes at this site, except Boreholes 02-6 to 02-8 and 02-11 to 02-14.

In Boreholes 02-3 and 02-4, the approach fill was largely cohesive in nature. It consisted of a silty clay matrix with trace of sand and gravel (till-like material). It extended from just below the pavement structure to between 6 m and 7 m depths. The measured SPT 'N' values within the fill varied from 8 blows to 29 blows per 0.3 m penetration indicating a typically stiff to very stiff consistency. Moisture contents ranging between about 18 % and 20 % were measured on samples of the fill. Figure B1 shows Atterberg limits test results of selected silty clay fill samples plotted on a plasticity chart, which indicates that the fill has a low plasticity. Figure C1 shows grain size distribution curves of selected silty clay fill samples, which indicate clay content of 35% to 48%.

The granular fill (pavement granular and road base materials) encountered in Boreholes 02-1, 02-2, 02-3, 02-4, 02-9, 02-10 and 02-15 consisted of sand and gravel with depths ranging between 75 mm and 725 mm. This fill was in a typically compact state as indicated by SPT 'N' values of between about 15 blows and 30 blows per 0.3 m penetration, where measured. Measured moisture contents were typically less than 5 %.

4.2.3 Silty Clay Till

A deposit of silty clay till was encountered below the fill and/or topsoil in all boreholes drilled during this investigation. This deposit was not fully penetrated in any of these boreholes. Full penetration of this till was achieved in Boreholes

104-3 and 104-4 put down by others (see Reference 1 and Drawing 19-2005-16-1). Where it was fully penetrated, the till was found extending to about 35 m below original ground surface where bedrock was encountered.

The upper zone of the silty clay till is dessicated and is brown to mottled brown and grey in colour. The thickness of this stiff crust varies between boreholes, but is generally greater than 6 m. Correlations with SPT 'N' values varying from 15 blows to greater than 30 blows, and with pocket penetrometer test results, indicated that the crust has a typically very stiff to hard consistency. No successful field vane test was carried out within this crust due to its stiffness.

Atterberg limits tests carried out on representative samples of this crust yielded liquid limits ranging typically from 35% to 40%, and corresponding plasticity indices ranging from 15% to 22%. Figures B2 and B3 shows Atterberg limits test results of selected samples of this crust. These results show that the crust has a medium plasticity (group symbol of CI). Occasional samples, such as the one at 1.8 m depth in Borehole 02-9, exhibited high plasticity (group symbol of CH) (see Figure B3). Figure C2 shows typical grain size distribution curves of selected samples of the crust. Measured moisture contents of samples of the crust ranged between 18% and 22%, with a majority of values at 20%.

Below the crust is the main body of the grey silty clay till. Where measured, field vane shear strengths were typically between 140 kPa and 40 kPa. These results in conjunction with SPT 'N' values and pocket penetrometer results indicated a stiff to firm consistency below the crust.

Atterberg limits tests carried out on representative samples of the grey till yielded liquid limits also ranging from 35% to 40%, and corresponding plasticity indices ranging from 15% to 22%, indicating a medium plasticity throughout (group symbol CI). Figures B4 to B6 show Atterberg limits test results of samples of the

grey portion of the till. Figures C3 shows typical grain size distribution curves of selected samples. Measured moisture contents of samples of the till deposit ranged between 18% and 22%, with a majority of the values at 20%.

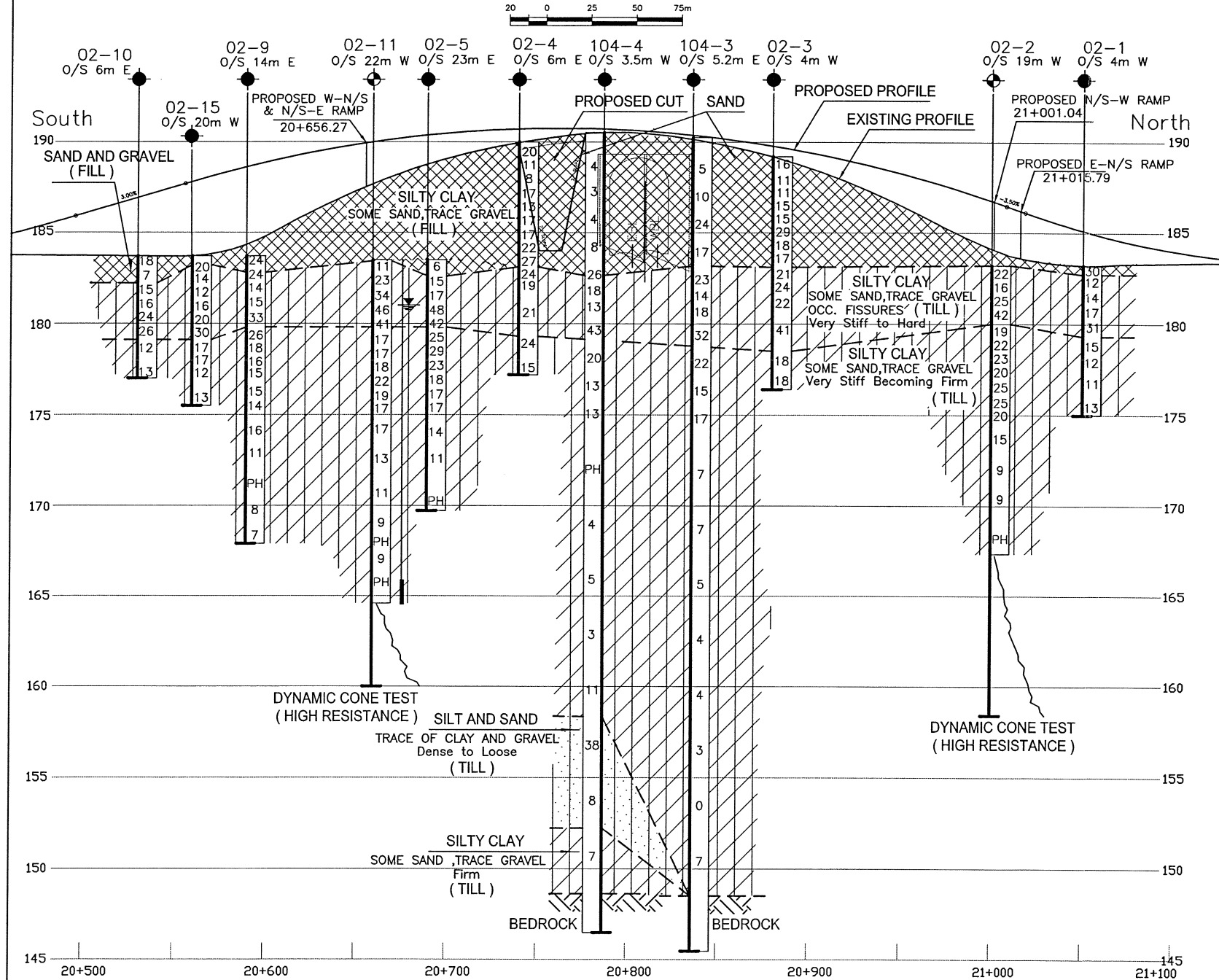
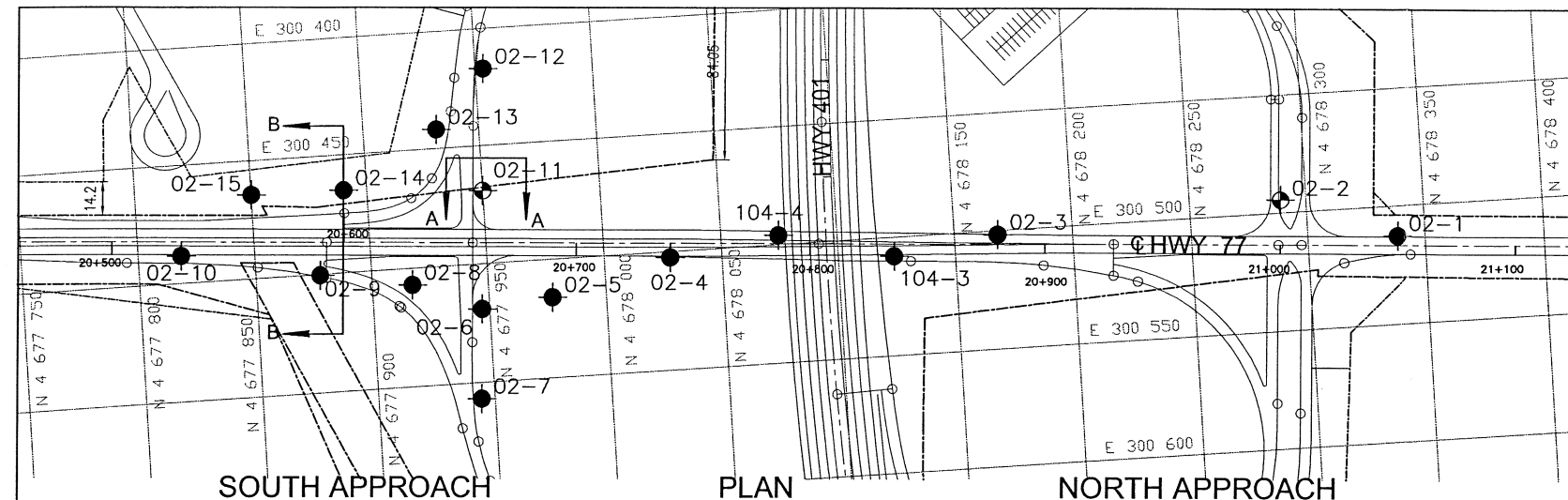
Two oedometer tests were carried out on selected specimens prepared from Shelby tube samples of the grey silty clay till obtained at 12.5 m depth in Borehole 02-9 and 18.5 m depth in Borehole 02-11. The preconsolidation pressure of these samples is estimated to be 230 kPa in Borehole 02-9 and 240 kPa in Borehole 02-11. The compression index for primary consolidation is estimated to be 0.21 and 0.23. Detailed results of these oedometer tests are included in Appendix D.

In Borehole 104-4 from Reference 1, a 6 m thick layer of dense to loose silt and sand till was found within the silty clay till at approximately 24 m and 30 m depths below the original ground surface.

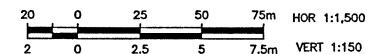
4.2.4 Groundwater Conditions

During drilling, no free water was observed in any of the open boreholes. One piezometer was installed at the bottom of each of Borehole 02-11 and Borehole 02-14. Piezometric levels of 2.5 m depth (Elevation 181.0 m) and 6.3 m depth (Elevation 177.4 m) were measured in Boreholes 02-11 and 02-14, respectively, on January 9, 2003. Based on information from Reference 1, the piezometric level established in Borehole 02-11 represents the stabilized groundwater level at this site.

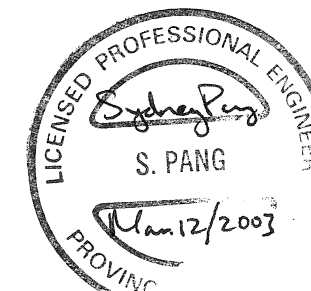
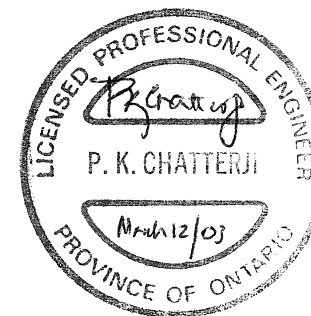
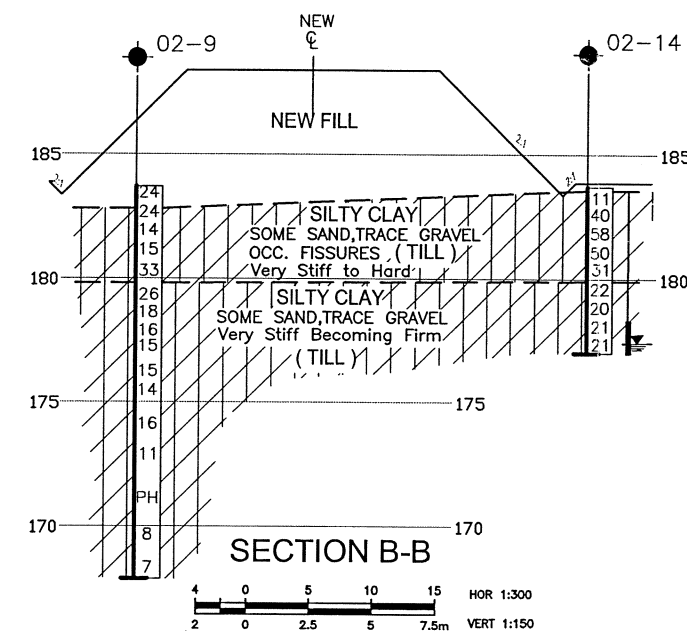
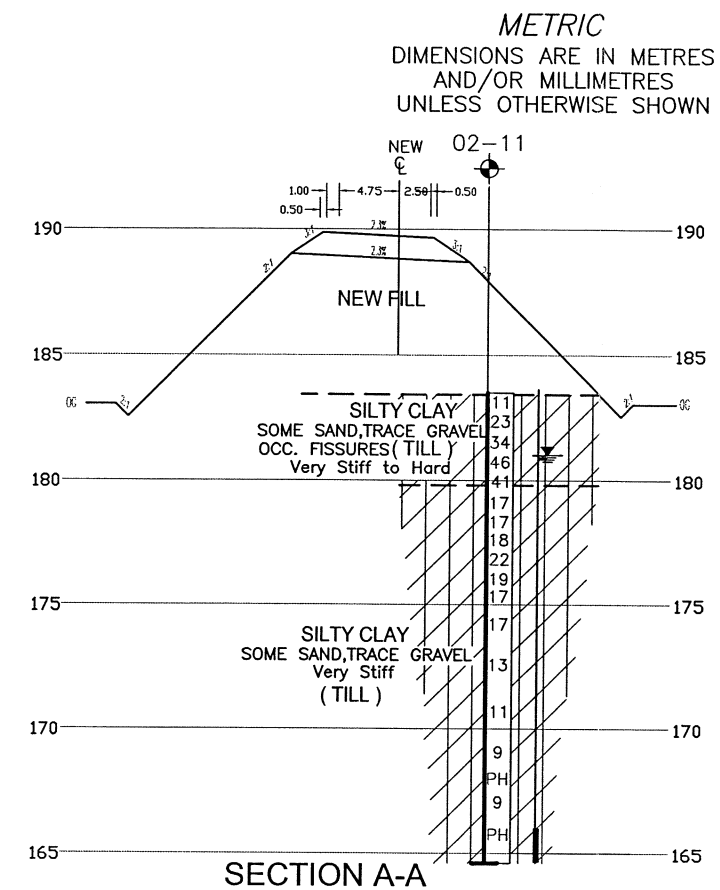
It should be noted that groundwater levels are subject to seasonal fluctuations and may also be influenced by the water level in the creek.



PROFILE ϕ OF HWY 77



NOTE:
All Boreholes Dry on Completion of Drilling.



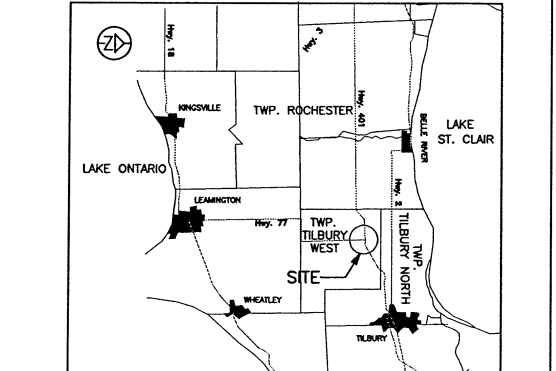
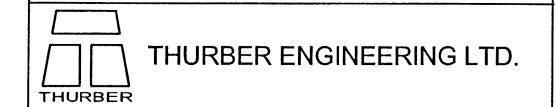
DIST NO. 31, HWY. 401
GWP NO. 61-00-00



HIGHWAY 77 INTERCHANGE

SHEET

BORE HOLE LOCATION & SOIL STRATA



KEY PLAN



LEGEND

	Bore Hole
	Dynamic Cone penetration Test (cone)
	Bore Hole & Cone
N	Blow / 0.3m (std pen Test, 475 J / blow)
CONE	Blows / 0.3m (60' Cone , 475J/blow)
PH	Pressure, Hydraulic
	WL on January 9, 2003
	Head Artesian Water

NO	ELEVATION	NORTHING	EASTING
02-1	183.2	4678338	300513
02-2	183.2	4678289	300494
02-3	189.2	4678168	300501
02-4	190.0	4678028	300502
02-5	183.5	4677977	300516
02-6	183.5	4677946	300519
02-7	183.5	4677944	300556
02-8	183.7	4677917	300507
02-9	183.7	4677877	300500
02-10	183.7	4677818	300488
02-11	183.5	4677950	300469
02-12	183.5	4677953	300417
02-13	183.7	4677931	300441
02-14	183.7	4677890	300465
02-15	183.7	4677850	300464

NOTE

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

REVISIONS	DATE	BY	DESCRIPTION
MAR.2003	SP	FINAL	
DEC.2002	SP	ISSUED AS DRAFT FOR REVIEW	
DESIGN	SP	CHK PKC	CHBDC 2000
DRAWN	SS	CHK SP	SITE
			LOAD
			STRUCT
			DWG. 19-2005-16-1

APPENDIX A
Records of Boreholes

19-2005-16

March, 2003

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			

SYMBOLS AND TERMS USED ON TEST HOLE LOGS

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	Less than 10	Less than 2
Soft	10 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 TEST HOLE LOGS

SYMBOLS FOR	 Shelby Tube	A - Casing
SAMPLE TYPE	 SPT	 Grab/Auger sample
	 No Recovery	 Core

- MC – Moisture Content (% by Weight) as determined by sample

 Water Level

C_{vane}	Shear Strength Determination by Field Insitu Vane
C_{pen}	Shear Strength Determination by Pocket Penetrometer
C_{lab}	Shear Strength Determination using a Laboratory Vane Apparatus
C_U	Undrained Shear Strength determined by Unconfined Compression Test

- (1) SPT Standard Penetration Test – refers to the number of blows from a 63.5kg hammer falling through 0.76m to advance a 60 degree truncated cone 0.3m.

RECORD OF BOREHOLE No 02-1

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 678 338 E 300 513 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 28.11.02 - 28.11.02 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			20	40	60	80	100		
183.2														
0.0	CRUSHER RUN LIMESTONE,													
182.7	Compact			SS	30		183							
0.5	Brown													
	(FILL)													
	Silty CLAY , trace to some sand,			SS	12		182							
	trace gravel, occasional iron oxide													
	staining, occasional grey silt fissures			SS	14									
	Stiff to Very Stiff						181							
	Brown - Grey													
	(TILL)(Cl)			SS	17									
	Becoming Hard						180							1 15 37 48
				SS	31									
179.3														
3.9	Silty CLAY , some sand to sandy,			SS	15		179							
	trace gravel													
	Very Stiff to Stiff													
	Grey			SS	12		178							1 12 39 48
	(TILL)(Cl)													
							177							
				SS	11									
							176							
175.0				SS	13									
8.2	END OF BOREHOLE AT 8.23m.						175							
	BOREHOLE DRY ON													
	COMPLETION													
	BOREHOLE OPEN TO 8.23m.													
	BOREHOLE BACKFILLED WITH													
	DRILL CUTTINGS.													

METRIC

± 3, × 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 02-2

2 OF 2

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 678 289 E 300 494 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 04.12.02 - 04.12.02 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	20
167.4				TW	PH		168											
15.9	END OF SOIL SAMPLING AT 15.85m. BOREHOLE DRY ON COMPLETION DYNAMIC CONE TESTING STARTED AT 15.85m.																	
157.6																		
25.6	END OF DYNAMIC CONE TESTING																	

RECORD OF BOREHOLE No 02-3

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 678 168 E 300 501 ORIGINATED BY GA
DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
DATUM Geodetic DATE 27.11.02 - 27.11.02 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			20	40	60	80	100		
189.2	ASPHALT (75mm)													
188.6	SAND, trace gravel, trace silt			SS	16									
188.4	Compact													
0.8	Brown			SS	11									
	Dry													
	(FILL)													
	Silty CLAY, sandy, trace gravel, occasional iron oxide staining			SS	11									
	Stiff to Very Stiff													
	Brown			SS	15									
	(CL-TILL)(FILL)													
				SS	15									
				SS	29									
				SS	18									
				SS	17									
183.1														
6.1	Silty CLAY, some sand to sandy, occasional rootlets, occasional wood fibers			SS	21									
	Very Stiff to Hard													
	Brown-Grey			SS	24									
	(TILL)(CI)													
				SS	22									
				SS	41									
178.5														
10.7	Silty CLAY, trace to some sand, trace gravel			SS	18									
	Very Stiff													
	Grey													
	(TILL)(CI)													
				SS	18									
176.4														
12.8	END OF BOREHOLE AT 12.80m BOREHOLE OPEN TO 12.81m. BOREHOLE DRY ON COMPLETION. BOREHOLE GROUTED WITH CEMENT/BENTONITE FROM BOTTOM TO 0.15m.													

+ 3 . x 3 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-4

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 678 028 E 300 502 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 27.11.02 - 27.11.02 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				
								20 40 60 80 100				
								20 40 60 80 100				
						<div><div>○ UNCONFINED</div><div>● QUICK TRIAXIAL</div></div>	<div><div>+ FIELD VANE</div><div>× LAB VANE</div></div>		<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div></div> <div><div>W_P</div><div>W</div><div>W_L</div></div>			
190.0							190					
189.9	ASPHALT (75mm)											
0.1	SAND, trace to some gravel			SS	20							
189.5	Compact			SS	11							
0.5	Brown											
	Dry											
	(FILL)											
	Silty CLAY, sandy, trace gravel, occasional silt fissures, occasional rootlets and wood fibers, occasional iron oxide staining			SS	8							
	Stiff to Very Stiff			SS	17							
	Brown - Grey											
	(CL-TILL)(FILL)			SS	13							
				SS	17							
				SS	22							
				SS	27							
183.1												
6.9	Silty CLAY, trace to some sand, trace gravel, occasional iron oxide staining			SS	24							
	Very Stiff											
	Brown			SS	19							
	(TILL)(CI)											
				SS	21							
179.3												
10.7	Silty CLAY, some sand, trace gravel			SS	24							
	Very Stiff											
	Grey											
	(TILL)(CI)											
				SS	15							
177.2												
12.8	END OF BOREHOLE AT 12.80m. BOREHOLE DRY ON COMPLETION BOREHOLE OPEN TO 12.81m. BOREHOLE GROUTED WITH CEMENT/BENTONITE FROM BOTTOM TO 0 15m											

RECORD OF BOREHOLE No 02-5

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 977 E 300 516 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 05.12.02 - 05.12.02 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 (%)
								○ UNCONFINED 20 40 60 80 100	+ FIELD VANE 20 40 60 80 100	× LAB VANE 20 40 60 80 100						
183.5 183.6 0.1	TOPSOIL (50mm) Silty CLAY , sandy, trace gravel, trace rootlets, trace black organics, trace iron oxide staining			SS	6											
182.4	trace iron oxide staining			SS	15											
1.1	Firm to Very Stiff Brown-Grey (FILL)(CL)			SS	17											
	Silty CLAY , trace to some sand, trace gravel, trace iron oxide staining, occasional grey silt fissures			SS	48											
	Very Stiff to Hard Brown-Grey (TILL)(CL-CI)			SS	42											
179.7																
3.8	Silty CLAY , some sand, trace gravel Very Stiff to Hard Grey (TILL)(CI)				SS	25										
					SS	29										
					SS	23										
					SS	18										
				SS	17											
				SS	17											
				SS	14											
				SS	11											
170.7				TW	PH											
12.8	END OF BOREHOLE AT 12.80m. BOREHOLE OPEN TO 12.80m. BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.															

RECORD OF BOREHOLE No 02-6

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 946 E 300 519 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 05.12.02 - 05.12.02 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			20	40	60	80	100		
183.5	TOPSOIL (50mm)													
183.0	Silty CLAY , some sand, trace gravel, trace rootlets, occasional black organics, occasional iron oxide staining, occasional grey silt fissures			SS	11		183							
0.1				SS	19		182							
	Stiff to Hard Dark Brown to Brown (TILL)(CI)			SS	25		181							
180.5				SS	60		180							
3.1	Silty CLAY , some sand, trace gravel Hard to Very Stiff Grey (TILL)(CI)			SS	31		179							
				SS	31		178							
				SS	22		177							
				SS	20									
				SS	24									
176.8	END OF BOREHOLE AT 6.71m. BOREHOLE OPEN TO 6.71m. BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.													
6.7														

RECORD OF BOREHOLE No 02-7

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 944 E 300 556 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 05.12.02 - 05.12.02 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					
183.5																	
183.4																	
0.1	TOPSOIL (100mm)																
	Silty CLAY , some sand, trace gravel, occasional rootlets, occasional iron oxide staining, occasional grey silt fissures Firm to Hard Grey-Brown (TILL)(CI)			SS	7		183										
				SS	15		182										
				SS	25		181										
				SS	42		180										
				SS	37		179										
179.7				SS	29		178										
3.8	Silty CLAY , some sand, trace gravel Very Stiff Grey (TILL)(CI)			SS	24		177										
				SS	21												
				SS	18												
176.8																	
6.7	END OF BOREHOLE AT 6.71m. BOREHOLE OPEN TO 6.71m. BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.																

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

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-8

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 917 E 300 507 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 27.11.02 - 27.11.02 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			20	40	60	80	100		
183.7														
182.6	ASPHALT (75mm)													
0.1	Silty CLAY, some sand, trace gravel, occasional rootlets, occasional iron oxide staining Stiff to Very Stiff Brown-Grey (TILL)(CI)		SS		8		183							
			SS		12		182							
			SS		15		181							
			SS		29		180							
			SS		22		179							
179.7	Silty CLAY, some sand, trace gravel Stiff Grey (TILL)(CL)		SS		12		178							
4.0			SS		13		177							
			SS		11									
177.0	END OF BOREHOLE AT 6.71m. BOREHOLE OPEN TO 6.71m. BOREHOLE DRY ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.													
6.7														

METRIC

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-9

2 OF 2

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 877 E 300 500 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 28.11.02 - 28.11.02 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			20	40	60	80	100					
167.9				SS	7		168										
15.8	END OF BOREHOLE AT 15.84m. BOREHOLE OPEN TO 15.84m. BOREHOLE DRY ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.																

$\times 3$: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-11

1 OF 2

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 950 E 300 469 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 04.12.02 - 04.12.02 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
183.5 183.9 0.0	TOPSOIL (25mm) Silty CLAY , some sand, trace gravel, occasional iron oxide staining, occasional grey silt fissures, trace rootlets Stiff to Hard Brown-Grey (TILL)(CL-CI)						183							
			SS		11									
			SS		23									
			SS		34									
			SS		46									
			SS		41									
179.7 3.8	Silty CLAY , some sand, trace gravel Very Stiff Grey (TILL)(CI)		SS		17		179							1 12 37 50
			SS		17									
			SS		18		178							
			SS		22		177							
			SS		19		176							1 15 36 48
			SS		17									
							175							
			SS		17		174							
							173							
	Becoming Stiff		SS		13									
							172							
			SS		11		171							
							170							
			SS		9		169							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-11

2 OF 2

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 950 E 300 469 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 04.12.02 - 04.12.02 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								
164.6	Oedometer Test			TW	PH		168					19.8	
18.9	END OF BOREHOLE AT 18.89m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. Dynamic Cone Penetration Test started at 18.89m.			SS	9		167						
							166						
				TW	PH		165						
159.1	END OF DYNAMIC CONE PENETRATION TEST AT 24.38m.						164						
24.4	WATER LEVEL READINGS: DATE DEPTH ELEVATION (m) (m) 05/12/02 Dry 09/01/03 2.5 181.0						163						
							162						
							161						
							160						

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-12

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 953 E 300 417 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 04.12.02 - 04.12.02 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			20	40	60	80	100		
183.5 182.9 0.0	TOPSOIL (25mm) Silty CLAY , some sand, trace gravel, occasional iron oxide staining, trace rootlets, mottled Stiff to Hard Brown-Grey (TILL)(CI)													
			SS		10		183							
			SS		30		182							
			SS		42									
			SS		48		181							
			SS		44		180							
			SS		29									
178.9							179							
4.6	Silty CLAY , some sand, trace gravel Very Stiff Grey (TILL)(CI)		SS		20									
			SS		18		178							
			SS		22									
176.8							177							
6.7	END OF BOREHOLE AT 6.71M. BOREHOLE OPEN TO 6.71m. BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.													

RECORD OF BOREHOLE No 02-13

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 931 E 300 441 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 04.12.02 - 04.12.02 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			20	40	60	80	100		
183.7														
183.7	TOPSOIL (50mm)													
0.1	Silty CLAY, some sand, trace gravel, trace rootlets, trace iron oxide staining Very Stiff to Hard Brown-Grey (TILL)(CI)			SS	13		183							
				SS	26									
				SS	30		182							
				SS	38		181							
				SS	32									
179.9				SS	25		180							
3.8	Silty CLAY, some sand, trace gravel Very Stiff Grey (TILL)(CI)			SS	20		179							
				SS	19		178							
				SS	20									
177.0							177							
6.7	END OF BOREHOLE AT 6.71m. BOREHOLE OPEN TO 6.71m. BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.													

RECORD OF BOREHOLE No 02-14

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 890 E 300 465 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 04.12.02 - 04.12.02 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 (%)
								20 40 60 80 100										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
183.7 186.6	TOPSOIL (150mm)																	
0.2	Silty CLAY, some sand, trace gravel, occasional iron oxide staining, trace rootlets Stiff to Hard Brown-Grey (TILL)(CI)		SS	11			183						○					
			SS	40									○					
			SS	58			182						○					
			SS	50			181						○					
			SS	31			180						○					
179.9																		
3.8	Silty CLAY, some sand, trace gravel Very Stiff Grey (TILL)(CI)		SS	22			179						○					
			SS	20									○					
			SS	21			178						○					
177.0			SS	21									○					
6.7	END OF BOREHOLE AT 6.71m. BOREHOLE OPEN TO 6.71m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH ELEVATION (m) (m) 05/12/02 Dry 09/01/03 6.3 177.4						177											

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-15

1 OF 1

METRIC

W.P. G.W.P. 61-00-00 LOCATION N 4 677 850 E 300 464 ORIGINATED BY GA
 DIST 31 HWY 401 BOREHOLE TYPE 210mm HOLLOW STEM AUGERS COMPILED BY WM
 DATUM Geodetic DATE 26.11.02 - 26.11.02 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			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
183.7	ASPHALT (50mm)												
183.6	SAND, trace gravel, trace silt			SS	20								
0.1	Compact			SS	14								
183.2	Brown			SS	12								
0.5	Dry (FILL)			SS	16								
	Silty CLAY, some sand, trace gravel, occasional iron oxide staining			SS	27								
	Stiff to Very Stiff			SS	30								
	Brown - Grey (TILL)(CI)			SS	17								
179.1	Silty CLAY, some sand, trace gravel			SS	17								
4.6	Very Stiff to Stiff			SS	17								
	Grey (TILL)(CI)			SS	12								
				SS	13								
175.5	END OF BOREHOLE AT 8.23m. BOREHOLE OPEN TO 8.23M. BOREHOLE DRY ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.												
8.2													

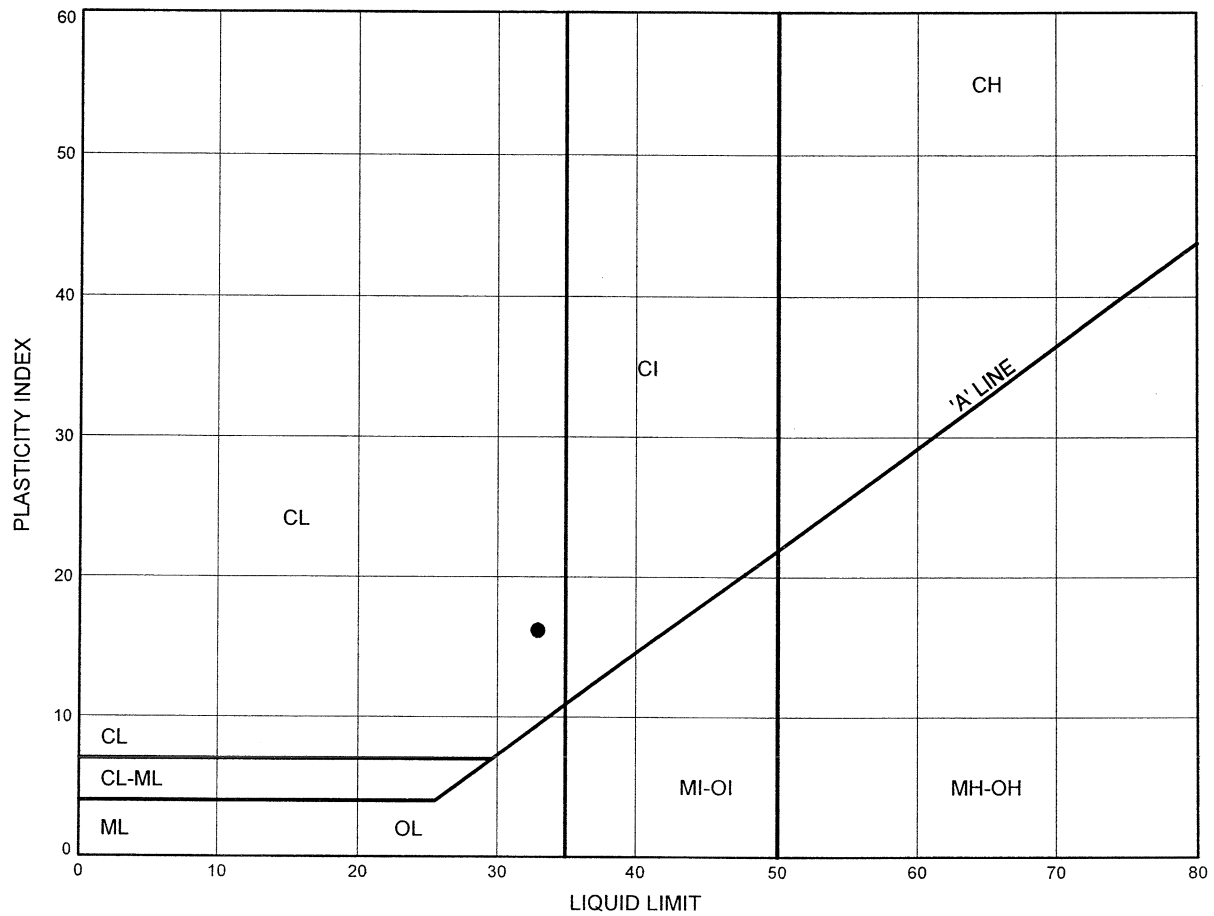
APPENDIX B
Laboratory Test Results
Plasticity Charts

19-2005-16

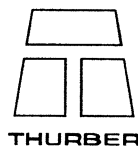
March, 2003

ATTERBERG LIMITS TEST RESULTS SILTY CLAY (FILL)

FIGURE B1



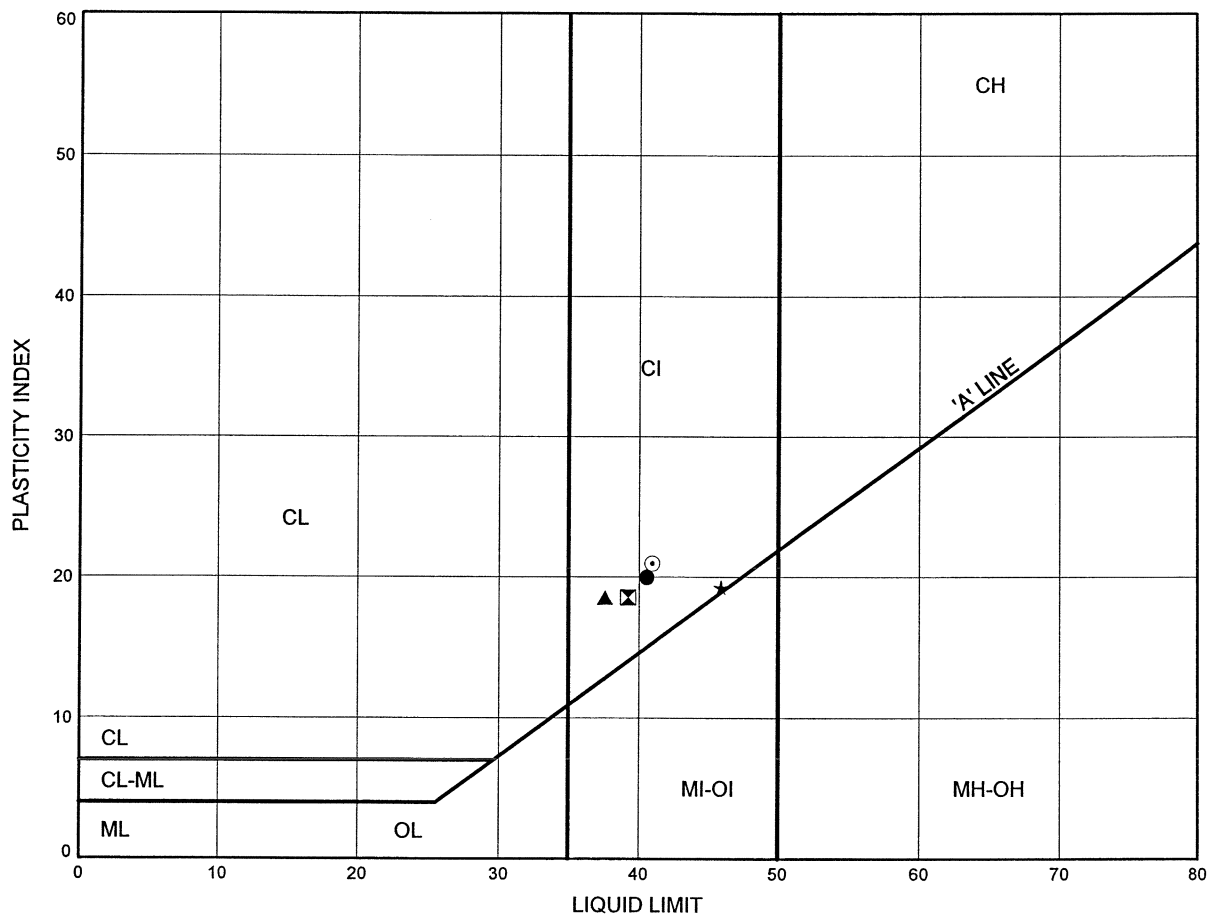
SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-3	1.83	187.37

Date March 2003Project G.W.P. 61-00-00Prep'd WMChkd. SKP

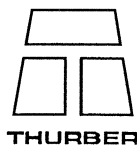
ATTERBERG LIMITS TEST RESULTS

SILTY CLAY (FILL) (CRUST)

FIGURE B2



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-1	1.83	181.37
⊠	02-1	3.35	179.85
▲	02-2	1.83	181.37
★	02-3	9.45	179.75
⊙	02-4	7.92	182.08

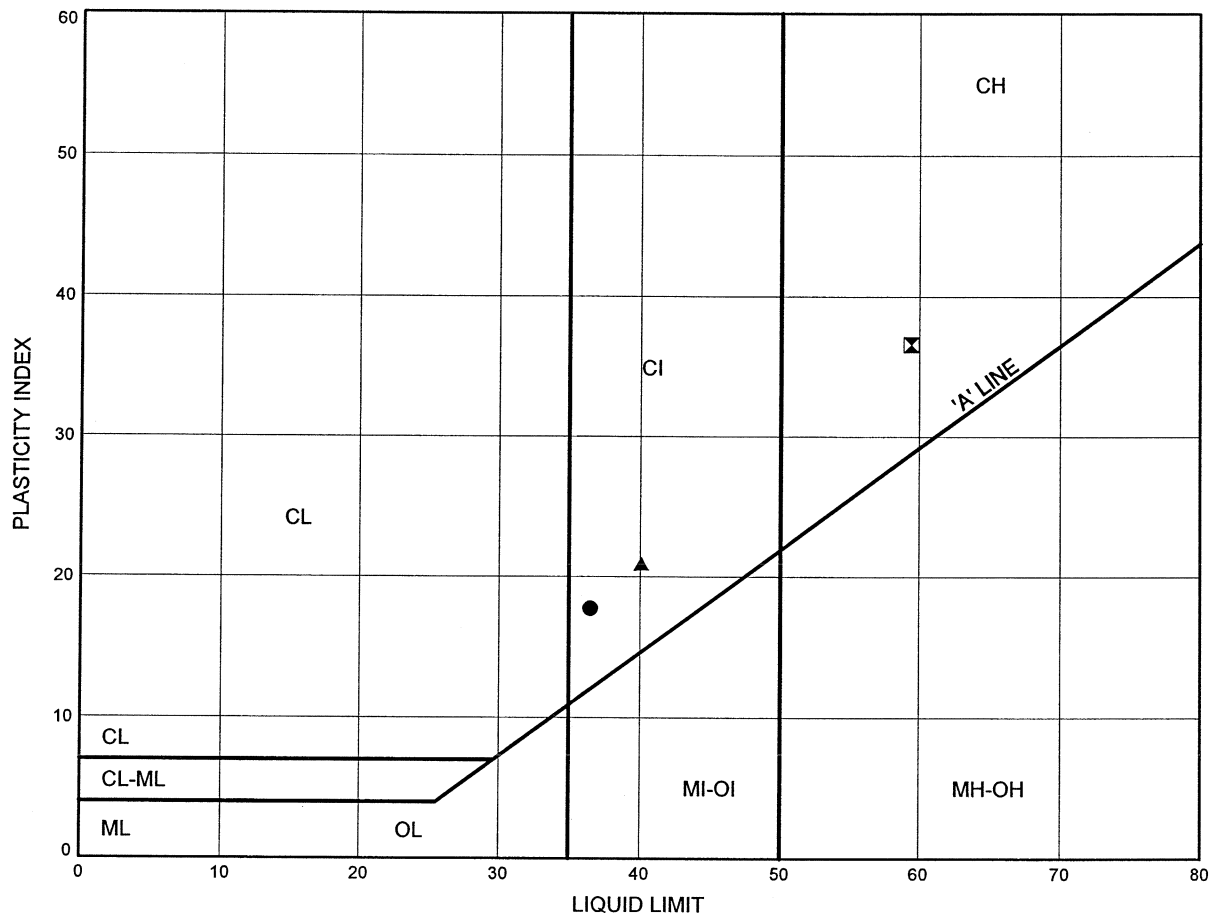
Date March 2003Project G.W.P. 61-00-00Prep'd WMChkd. SKP

Hwy 401 Culverts and Embankments

ATTERBERG LIMITS TEST RESULTS

SILTY CLAY (TILL) (CRUST)

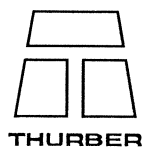
FIGURE B3



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-11	1.83	181.67
⊠	02-9	1.83	181.87
▲	02-9	3.35	180.35

Date March 2003

Project G.W.P. 61-00-00



Prep'd WM

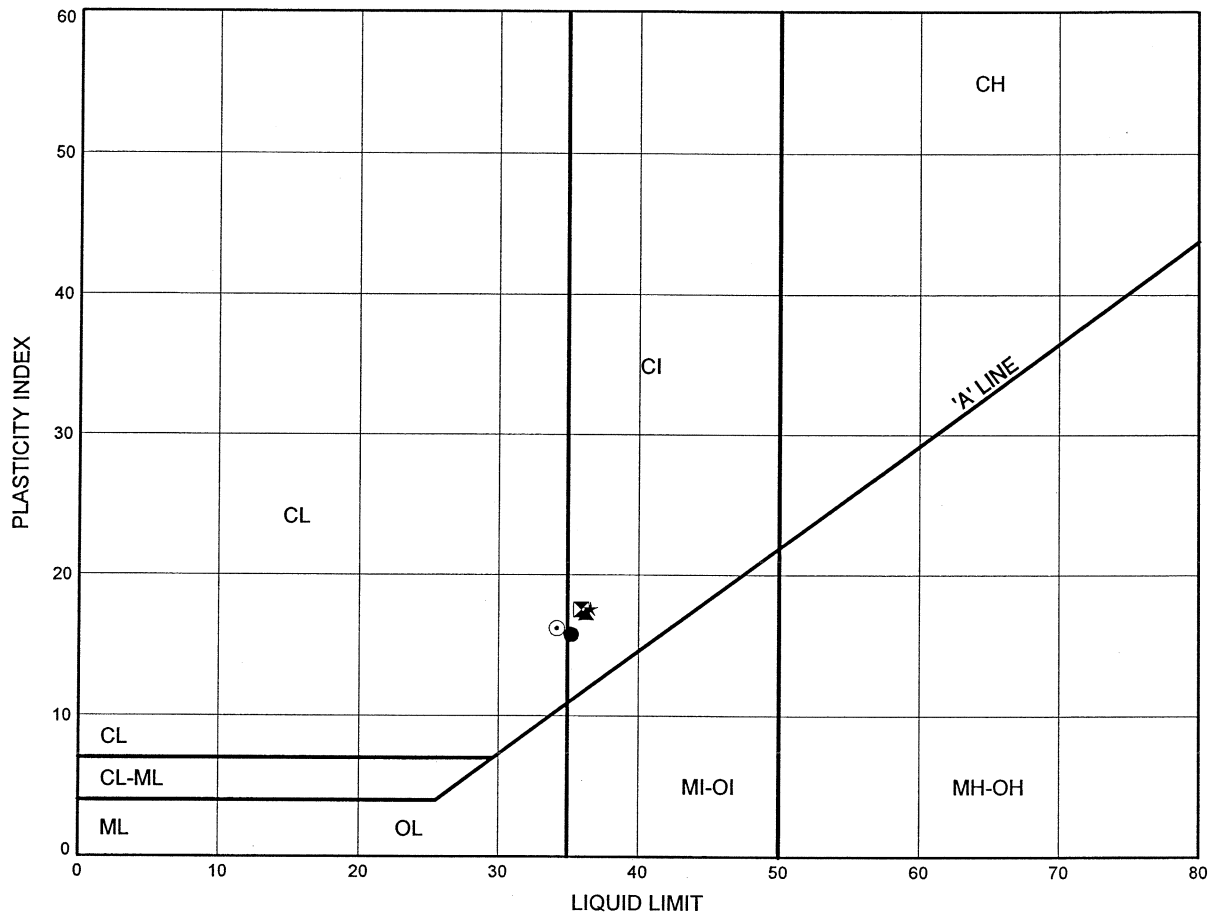
Chkd. SKP

Hwy 401 Culverts and Embankments

ATTERBERG LIMITS TEST RESULTS

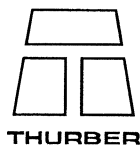
SILTY CLAY (TILL)

FIGURE B4



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-1	4.88	178.32
⊠	02-2	4.11	179.09
▲	02-2	9.45	173.75
★	02-2	10.97	172.23
⊙	02-2	12.50	170.70

Date March 2003
 Project G.W.P. 61-00-00



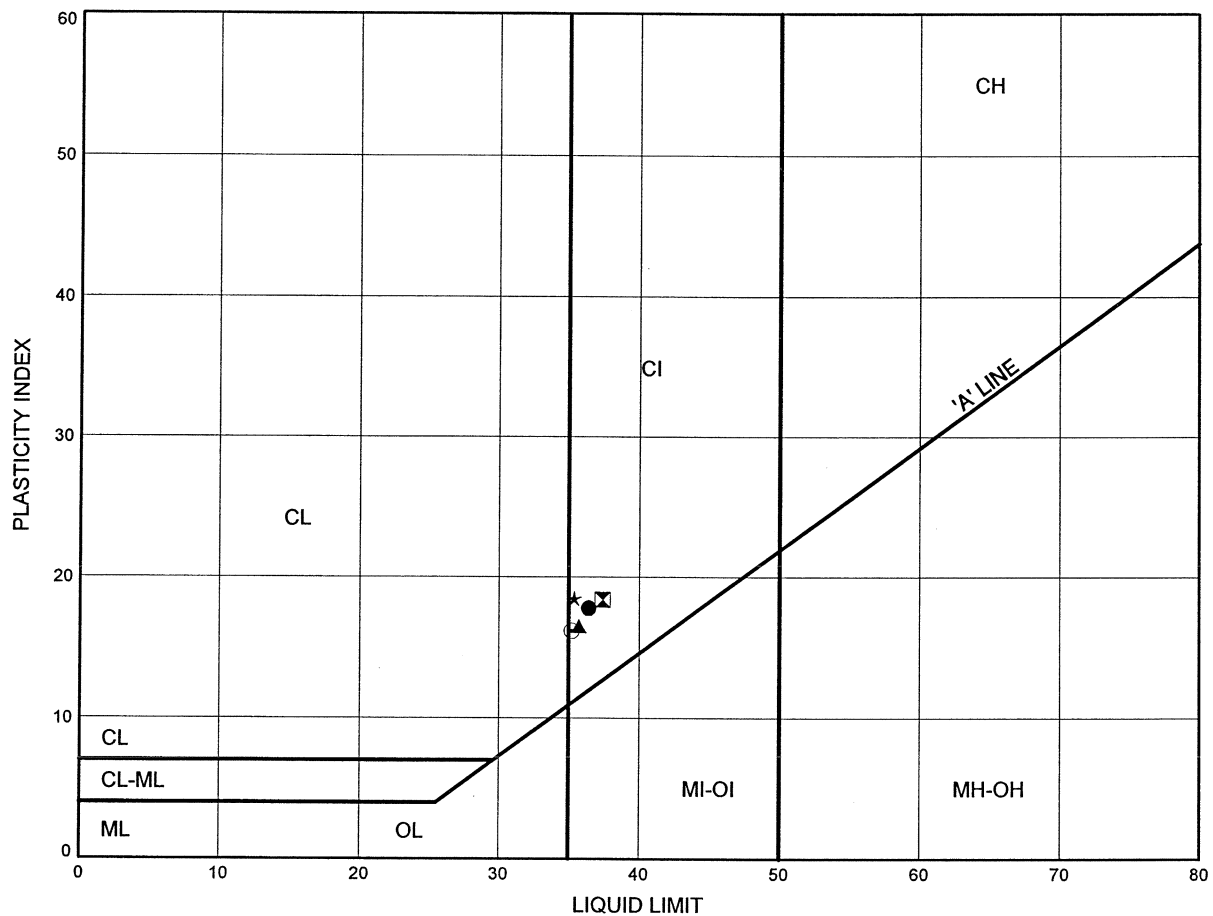
Prep'd WM
 Chkd. SKP

Hwy 401 Culverts and Embankments

ATTERBERG LIMITS TEST RESULTS

SILTY CLAY (TILL)

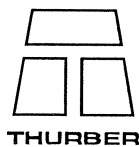
FIGURE B5



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-11	4.88	178.62
⊠	02-4	12.50	177.50
▲	02-9	5.03	178.67
★	02-9	9.45	174.25
⊙	02-9	15.54	168.16

Date March 2003

Project G.W.P. 61-00-00



Prep'd WM

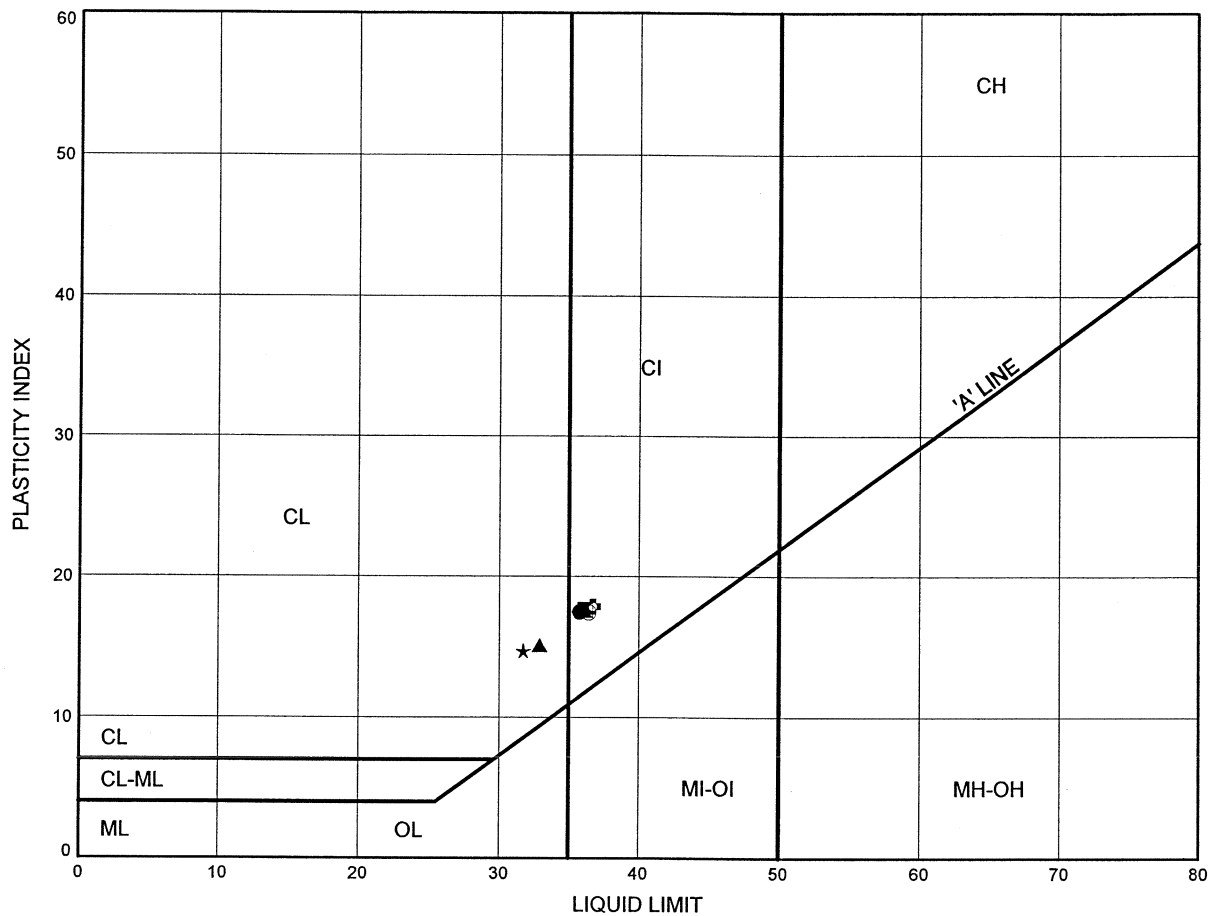
Chkd. SKP

Hwy 401 Culverts and Embankments

ATTERBERG LIMITS TEST RESULTS

SILTY CLAY (TILL)

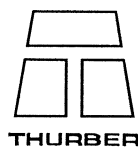
FIGURE B6



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-11	7.92	175.58
⊠	02-11	9.45	174.05
▲	02-11	10.97	172.53
★	02-11	12.50	171.00
⊙	02-11	14.02	169.48
⊕	02-11	17.07	166.43

Date March 2003

Project G.W.P. 61-00-00



Prep'd WM

Chkd. SKP

APPENDIX C

Laboratory Test Results

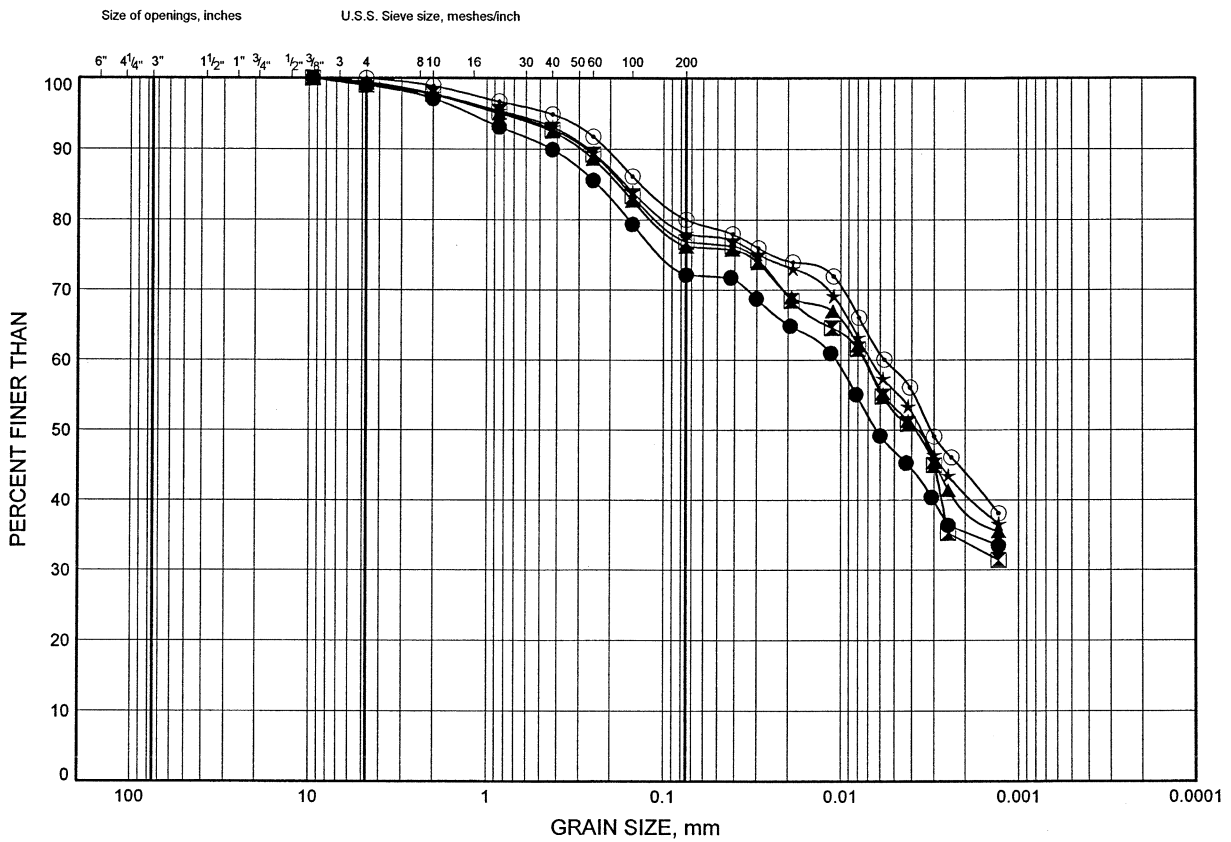
Grain Size Distribution Curves

Hwy 401 Culverts and Embankments

GRAIN SIZE DISTRIBUTION

SILTY CLAY (FILL)

FIGURE C1

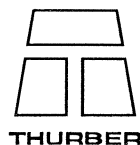


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-3	1.06	188.14
☒	02-3	4.11	185.09
▲	02-4	1.06	188.94
★	02-4	3.35	186.65
⊙	02-4	5.64	184.36

Date March 2003

Project G.W.P. 61-00-00



Prep'd WM

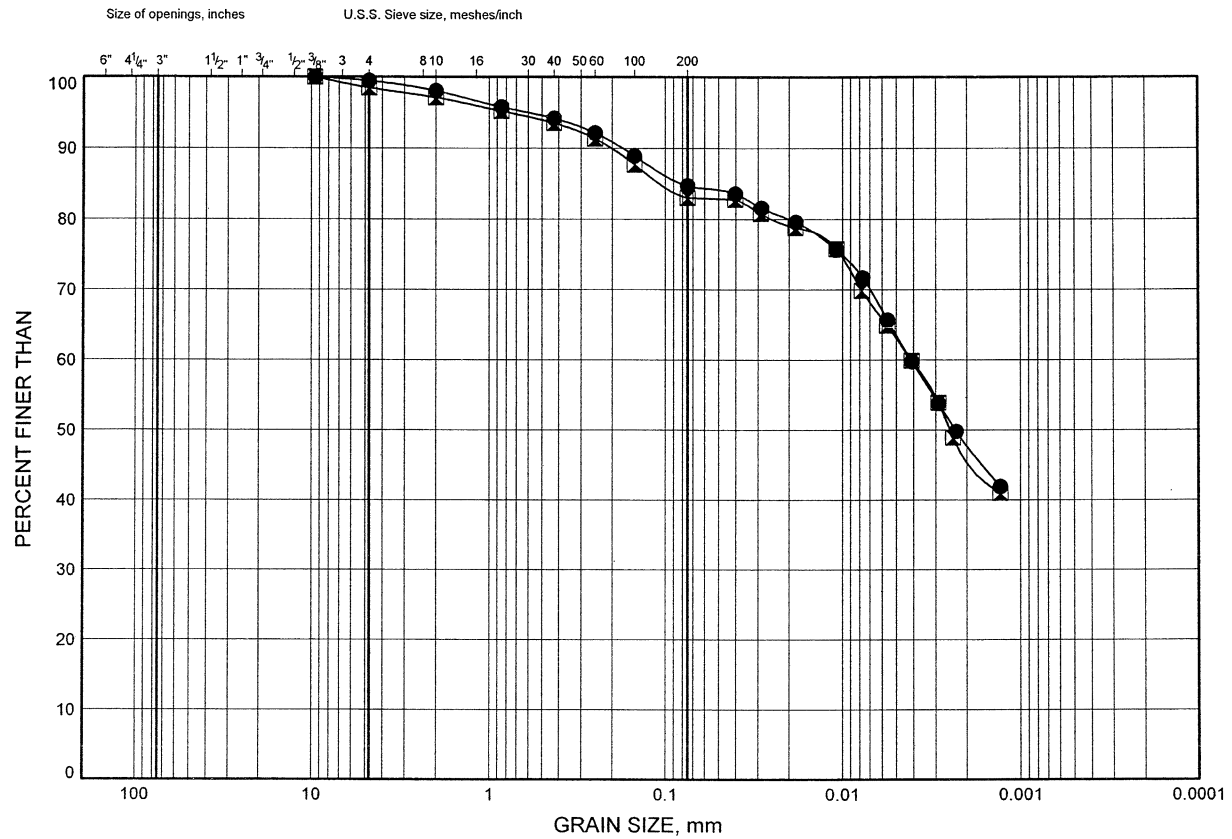
Chkd. SKP

Hwy 401 Culverts and Embankments

GRAIN SIZE DISTRIBUTION

SILTY CLAY (TILL) (CRUST)

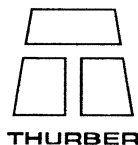
FIGURE C2



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-1	2.59	180.61
⊠	02-9	2.59	181.11

Date March 2003
Project G.W.P. 61-00-00



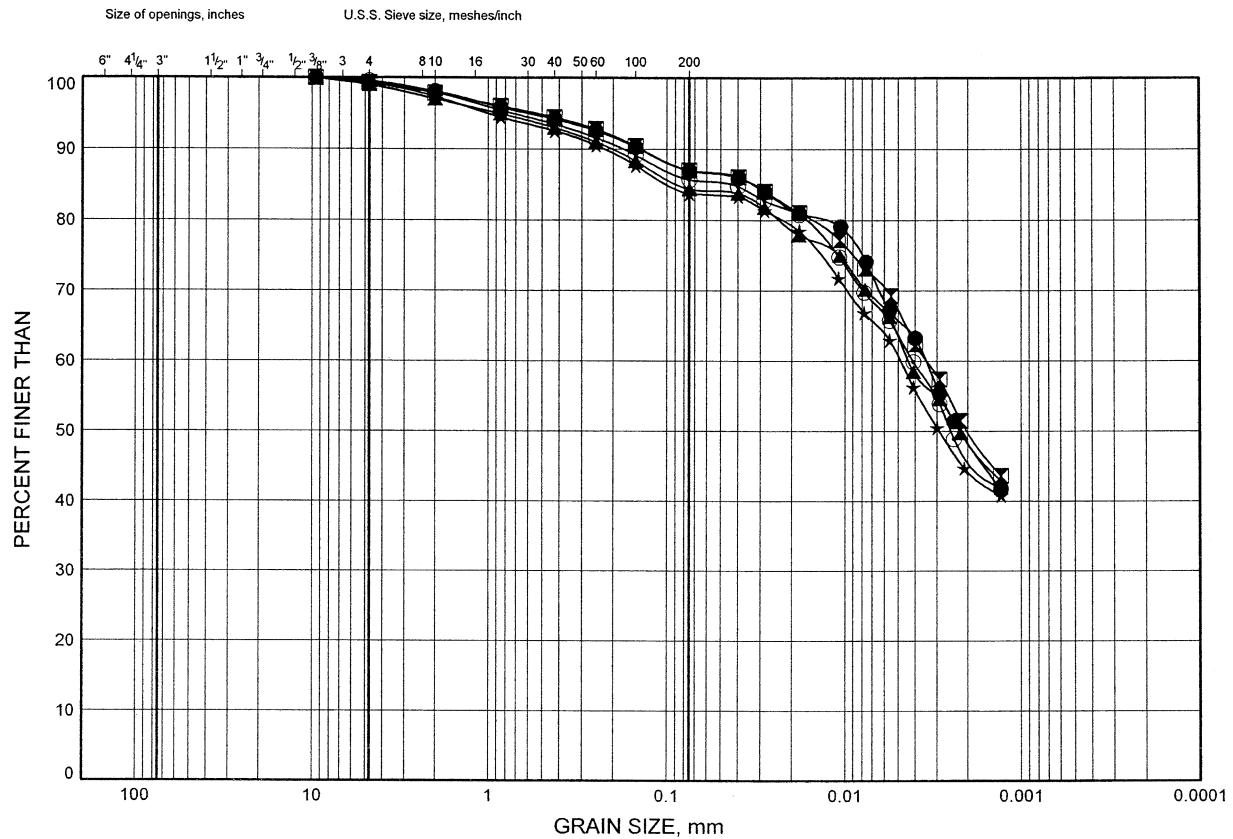
Prep'd WM
Chkd. SKP

Hwy 401 Culverts and Embankments

GRAIN SIZE DISTRIBUTION

SILTY CLAY (TILL)

FIGURE C3

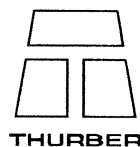


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-1	4.88	178.32
⊠	02-11	4.11	179.39
▲	02-11	7.16	176.34
★	02-2	12.50	170.70
⊙	02-9	7.92	175.78

Date March 2003

Project G.W.P. 61-00-00



Prep'd WM

Chkd. SKP

APPENDIX D
Oedometer Test Results

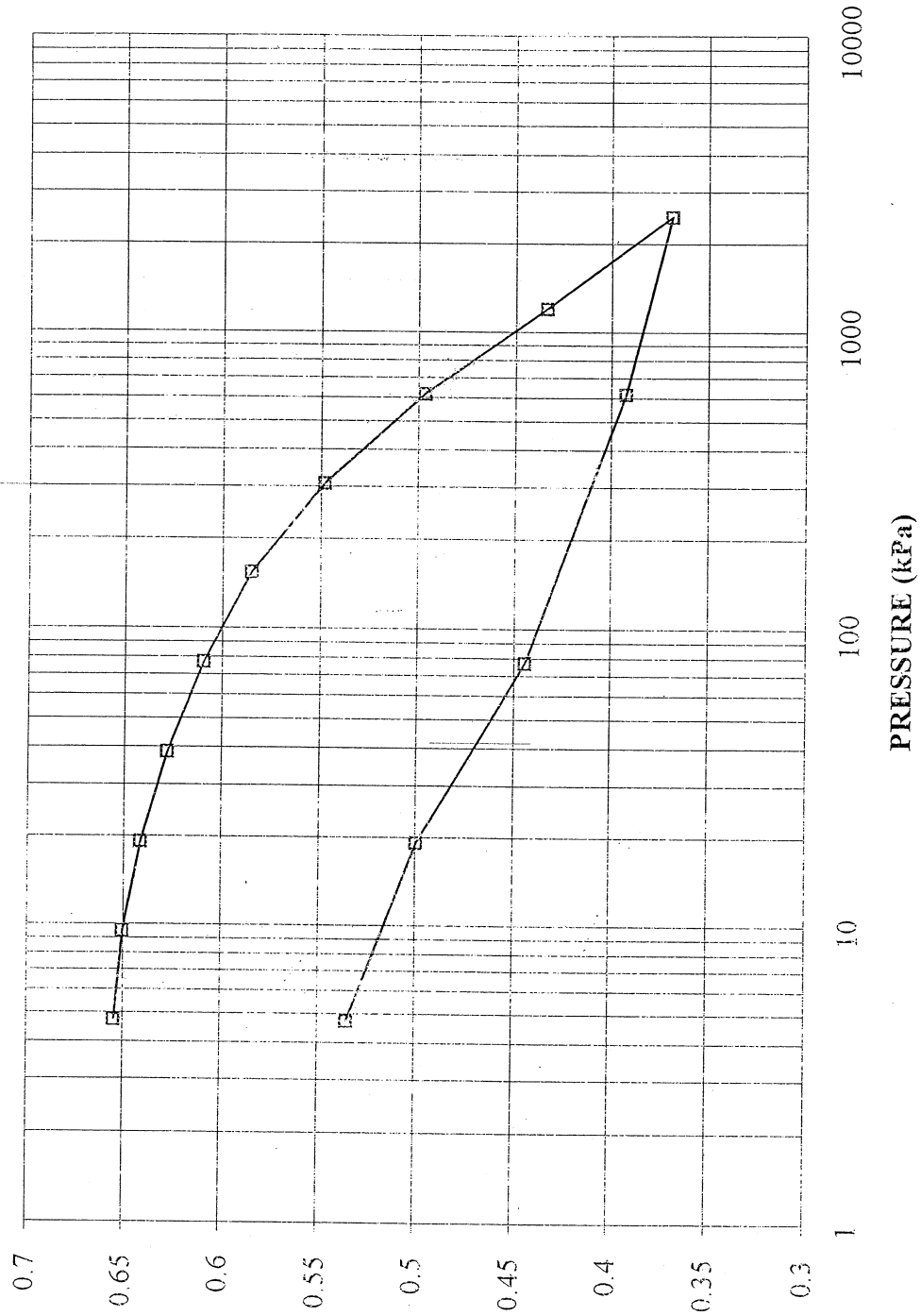
19-2005-16

March, 2003

CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE

FIGURE D1

CONSOLIDATION TEST
VOID RATIO vs PRESSURE
BH 02-9 ST #1



Project No. 021-101036

VOID RATIO

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	021-101036	Sample Number	ST #1
Borehole Number	02-9	Sample Depth, m	12.2-12.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	6		
Date Started	02-12-05		
Date Completed	02-12-16		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.91	Unit Weight, kN/m ³	19.92
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.03
Area, cm ²	31.61	Specific Gravity, measured	2.71
Volume, cm ³	60.37	Solids Height, cm	1.152
Water Content, %	24.26	Volume of Solids, cm ³	36.41
Wet Mass, g	122.61	Volume of Voids, cm ³	23.96
Dry Mass, g	98.67	Degree of Saturation, %	99.9

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	1.910	0.658	1.910				
4.76	1.906	0.655	1.908	156	4.95E-03	4.29E-04	2.08E-07
9.56	1.901	0.650	1.904	184	4.17E-03	5.67E-04	2.32E-07
19.29	1.891	0.642	1.896	240	3.17E-03	5.44E-04	1.69E-07
38.75	1.875	0.628	1.883	321	2.34E-03	4.25E-04	9.75E-08
77.53	1.854	0.609	1.864	375	1.96E-03	2.88E-04	5.54E-08
154.98	1.826	0.585	1.840	240	2.99E-03	1.91E-04	5.58E-08
308.13	1.783	0.548	1.804	287	2.40E-03	1.46E-04	3.43E-08
618.62	1.724	0.497	1.753	475	1.37E-03	9.97E-05	1.34E-08
1204.38	1.651	0.433	1.687	394	1.53E-03	6.52E-05	9.78E-09
2476.47	1.576	0.368	1.614	240	2.30E-03	3.07E-05	6.93E-09
618.62	1.604	0.392	1.590				
77.53	1.663	0.444	1.634				
19.29	1.727	0.499	1.695				
4.76	1.768	0.535	1.748				

Notes:

k calculated using cv based on t₉₀ values.

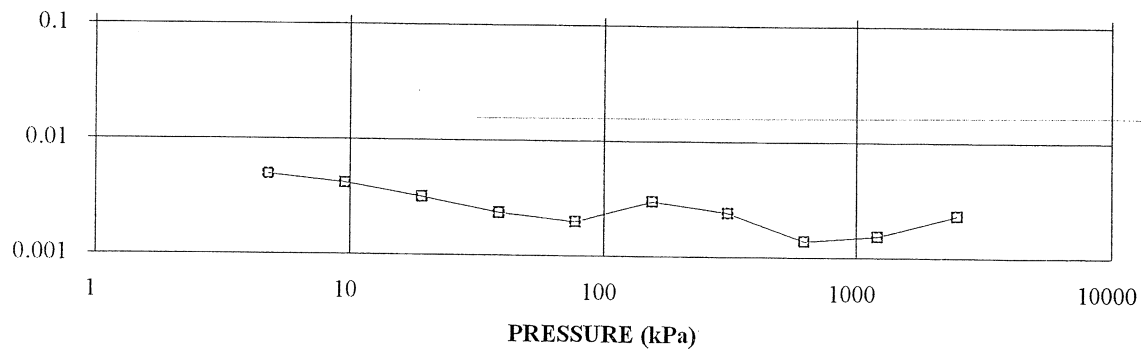
SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.77	Unit Weight, kN/m ³	21.27
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	17.31
Area, cm ²	31.61	Specific Gravity, measured	2.71
Volume, cm ³	55.89	Solids Height, cm	1.152
Water Content, %	22.88	Volume of Solids, cm ³	36.41
Wet Mass, g	121.25	Volume of Voids, cm ³	19.48
Dry Mass, g	98.67		

OEDOMETER CONSOLIDATION SUMMARY

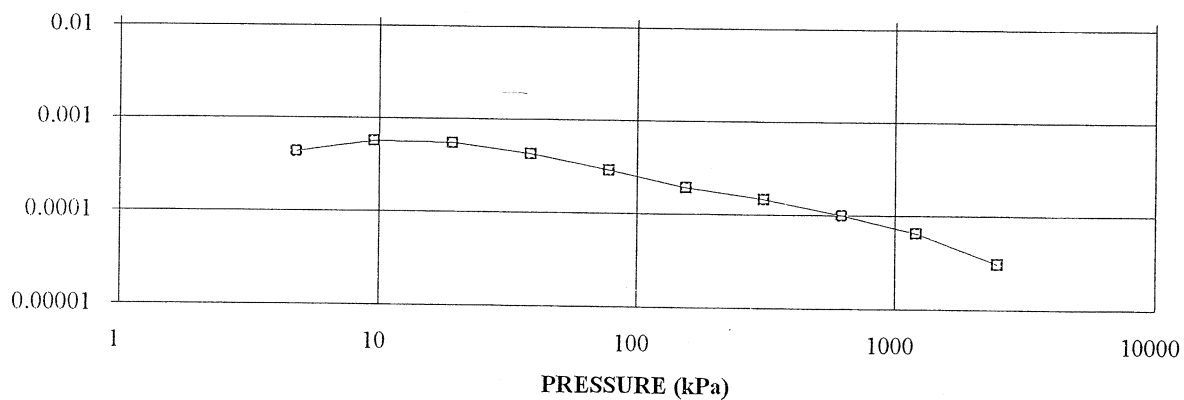
COEFFICIENT OF CONSOLIDATION, cm^2/s

CONSOLIDATION TEST
 $\text{cv cm}^2/\text{s}$ vs PRESSURE (kPa)
 BH 02-9 ST #1



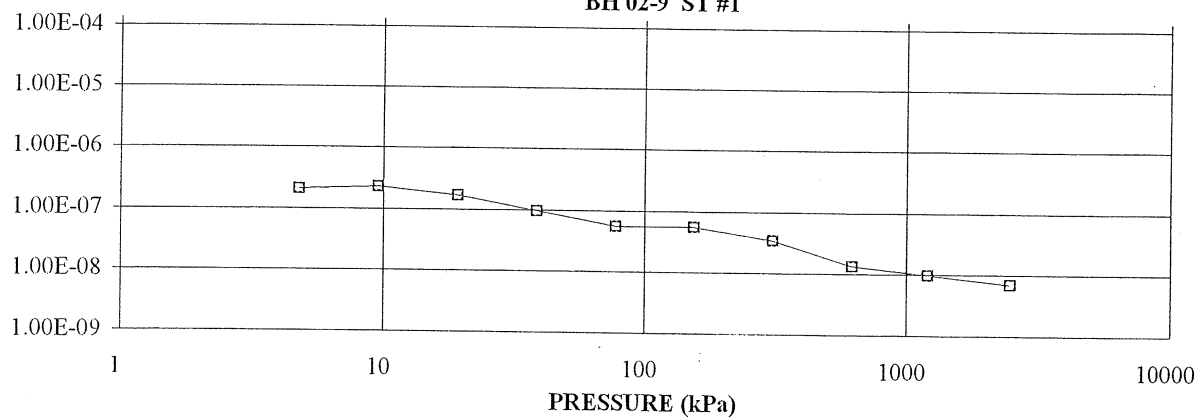
VOLUME
 COMPRESSIBILITY,
 m^2/kN

CONSOLIDATION TEST
 $\text{mv, m}^2/\text{kN}$ vs PRESSURE (kPa)
 BH 02-9 ST #1



HYDRAULIC
 CONDUCTIVITY, cm/s

CONSOLIDATION TEST
 HYDRAULIC CONDUCTIVITY vs PRESSURE
 BH 02-9 ST #1

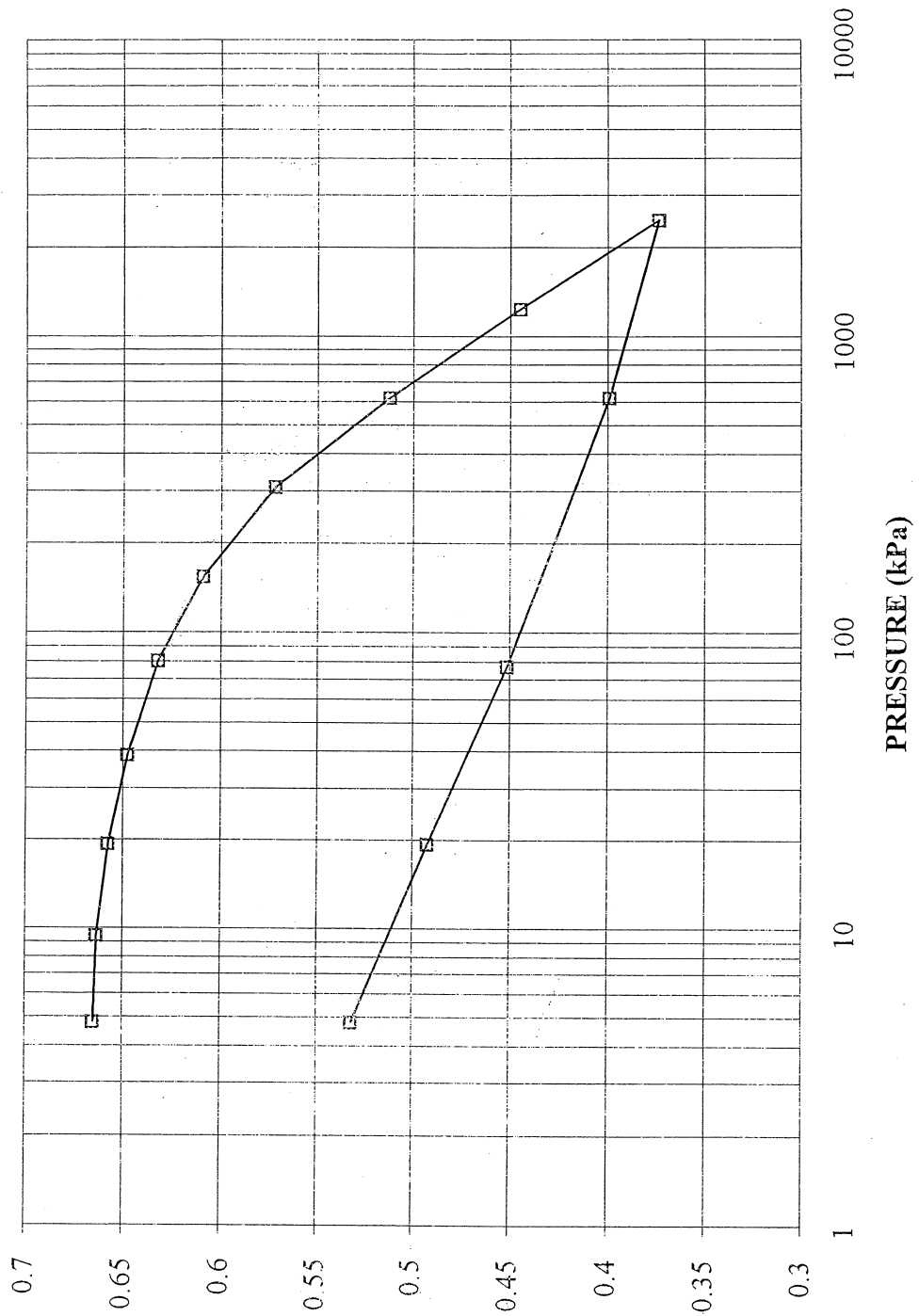


Project No. 021-101036

CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE

FIGURE D2

CONSOLIDATION TEST
VOID RATIO vs PRESSURE
BH 02-11 ST #2



Project No. 021-101036

VOID RATIO

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	021-101036	Sample Number	ST #2
Borehole Number	02-11	Sample Depth, m	18.3-18.9

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	7		
Date Started	02-12-09		
Date Completed	02-12-19		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.91	Unit Weight, kN/m ³	19.80
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	15.89
Area, cm ²	31.67	Specific Gravity, measured	2.70
Volume, cm ³	60.49	Solids Height, cm	1.146
Water Content, %	24.58	Volume of Solids, cm ³	36.30
Wet Mass, g	122.11	Volume of Voids, cm ³	24.18
Dry Mass, g	98.02	Degree of Saturation, %	99.6

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	1.910	0.666	1.910				
4.82	1.908	0.665	1.909	21	3.68E-02	1.85E-04	6.65E-07
9.45	1.907	0.663	1.908	68	1.13E-02	1.70E-04	1.89E-07
19.49	1.900	0.657	1.903	171	4.49E-03	3.55E-04	1.56E-07
38.88	1.889	0.648	1.894	454	1.68E-03	3.05E-04	5.01E-08
80.74	1.871	0.632	1.880	240	3.12E-03	2.23E-04	6.81E-08
154.78	1.845	0.609	1.858	146	5.01E-03	1.87E-04	9.17E-08
309.18	1.802	0.572	1.823	338	2.09E-03	1.44E-04	2.94E-08
618.73	1.734	0.512	1.768	356	1.86E-03	1.16E-04	2.12E-08
1236.18	1.656	0.445	1.695	356	1.71E-03	6.57E-05	1.10E-08
2471.81	1.574	0.373	1.615	240	2.30E-03	3.46E-05	7.81E-09
618.73	1.604	0.399	1.589				
77.52	1.664	0.451	1.634				
19.49	1.711	0.492	1.687				
4.82	1.756	0.532	1.733				

Notes:

k calculated using cv based on t₉₀ values.

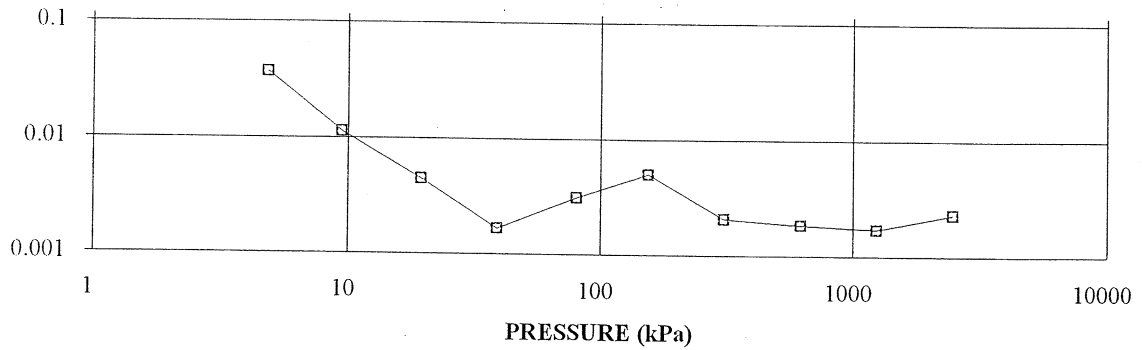
SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.76	Unit Weight, kN/m ³	20.90
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	17.29
Area, cm ²	31.67	Specific Gravity, measured	2.70
Volume, cm ³	55.61	Solids Height, cm	1.146
Water Content, %	20.90	Volume of Solids, cm ³	36.30
Wet Mass, g	118.51	Volume of Voids, cm ³	19.30
Dry Mass, g	98.02		

OEDOMETER CONSOLIDATION SUMMARY

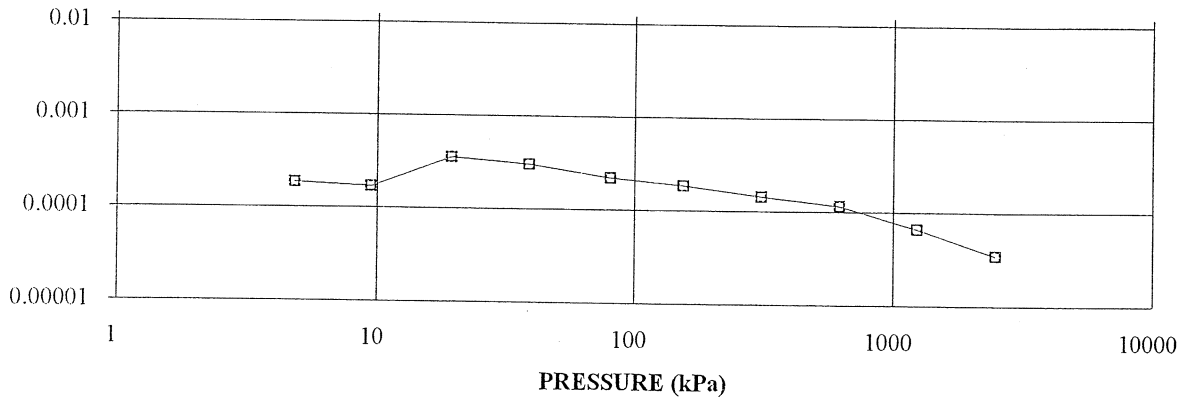
COEFFICIENT OF CONSOLIDATION, cm^2/s

CONSOLIDATION TEST
 $\text{cv cm}^2/\text{s}$ vs PRESSURE (kPa)
 BH 02-11 ST #2



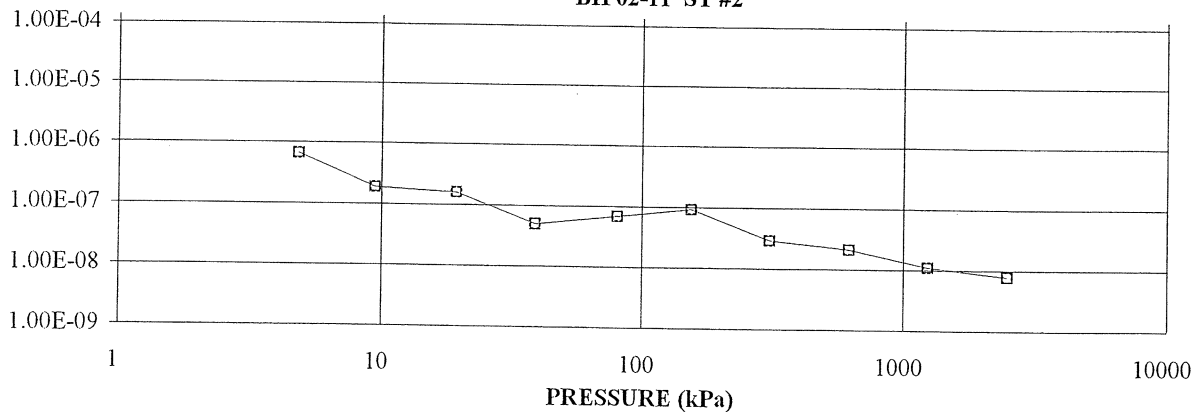
VOLUME
COMPRESSIBILITY,
 m^2/kN

CONSOLIDATION TEST
 $\text{mv, m}^2/\text{kN}$ vs PRESSURE (kPa)
 BH 02-11 ST #2



HYDRAULIC
CONDUCTIVITY, cm/s

CONSOLIDATION TEST
 HYDRAULIC CONDUCTIVITY vs PRESSURE
 BH 02-11 ST #2



Project No. 021-101036