



Terraprobe

*Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing*

**FOUNDATION INVESTIGATION REPORT
WATERMAIN AND SANITARY SEWER INSTALLATIONS
HIGHWAY 406 AT WOODLAWN ROAD
THE CITY OF WELLAND, ONTARIO
GEOCRES No. 30M3-254**

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted along proposed watermain and sanitary sewer alignments crossing (by tunnelling) under the existing Highway 406 north of the Woodlawn Road intersection, in the City of Welland, Ontario.

Foundation investigations for the Woodlawn Road overpasses were carried out by Terraprobe Inc. (Terraprobe) and the data from these investigations were used to supplement the field investigation programme for this work.

The purpose of this investigation was to explore the subsurface conditions along the alignments and based on the data obtained, to provide borehole location plans, records of boreholes, stratigraphic profiles, laboratory test results and descriptions of the subsurface conditions. Models of the subsurface conditions were developed from the data obtained.

Terraprobe conducted the investigation as a sub-consultant to Giffels Associates Ltd./IBI Group, under the Ministry of Transportation Ontario (MTO) Agreement Number 2008-E-0016.

For reporting purposes the investigated sections are designated as Watermain Alignment and Sanitary Sewer Alignment. Further details are outlined below.

Watermain Alignment

A 300 mm diameter watermain installed in a 56.5 m long, 500 mm diameter steel casing crossing the North Bound and South Bound lanes of Highway 406 Sta. 12+725. The casing will be installed between Sta. 0+170 and Sta. 0+227 approximately.

Sanitary Sewer Alignment

A 300 mm sanitary sewer installed in a 55 m long, 500 mm diameter steel casing crossing the North Bound and South Bound lanes of Highway 406 Sta. 12+714. The casing will be installed between Sta. 0+167 and Sta. 0+222 approximately.

2 SITE DESCRIPTION & PHYSIOGRAPHY

The site is located about 50 m north of the signalised Highway 406/Woodlawn Road intersection in the City of Welland, Ontario. Within the project limits, Highway 406 is a two-lane highway with gravel shoulders carrying both north and south bound traffic. There is a dedicated right turn lane that carries southbound traffic on Highway 406 to Woodlawn Road.



The site is located between the Niagara Escarpment and Lake Erie in the physiographic region of Southern Ontario referred to as the Haldimand Clay Plain. The Haldimand Clay Plain is best described as falling into a series of parallel belts with the highest ground adjacent to the Escarpment. Generally this region is flat and poorly drained although it includes several distinctive landforms such as dunes, cobble, clay and sand beaches, limestone pavements and back-shore wetland basins¹.

The Niagara Region is underlain by a sequence of very gently south-dipping dolostones, limestones, shales and sandstones overlying Precambrian basement rock. The key elements in the bedrock geology of the region are the multiple layers of softer sedimentary limestones, shale, sandstone and dolostone.

The bedrock unit at this site is the Salina Formation of Upper Silurian Age². This unit consists essentially of easily weathered, grey, very finely crystalline, laminated argillaceous dolostone with grey, calcareous shale partings and gypsum veins and lenses of varying thicknesses.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out on April 28, 2010 and consisted of drilling and sampling two boreholes (WM1 and SS1) to depths of 6.6 m and 7.4 m below ground surface. The field investigation programme is supplemented with two boreholes (WS2 and WN4) drilled for the Woodlawn Overpass structures. These structure boreholes were drilled during the period December 14, 2009 and February 1, 2010 to depths of 28.9 m and 29.9 m below ground surface. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix C.

Samples of the overburden soils were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT), as specified in ASTM Method D1586. In the cohesive (clayey) deposits the undrained shear strength of the soil was measured in-situ by means of field vane tests using an MTO type field vane. Relatively undisturbed soil samples were also collected with thin-walled Shelby Tube samplers. Boreholes WS2 and WN4 were also advanced into bedrock by NQ size diamond coring techniques.

Ground water conditions in the open boreholes were observed throughout the drilling operations and standpipe piezometers consisting of 19 mm diameter PVC pipe with a slotted screen enclosed in sand were installed in selected boreholes to permit longer term ground water level monitoring. The remaining boreholes were abandoned in accordance with MOE Regulation 903 by sealing/grouting with a bentonite slurry mixture after drilling was complete.

¹ Chapman and Putnam, "The Physiography of South Ontario", 3rd Edition, 1984.

² Ontario Division of Mines, "Quaternary Geology Of The Welland Area", Preliminary Map P.796, 1972.



The locations and completion details of the piezometers are shown in Table 3.1.

Table 3.1 – Piezometer Installation Details

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
Watermain Alignment		
WM1	6.8/176.1	Piezometer with 1.5 m slotted screen installed with filter sand to 5.0 m, bentonite seal from 5.0 m to 3.8 m and drill cuttings from 3.8 m to ground surface.
Sanitary Sewer Alignment		
SS1	6.0/175.8	Piezometer with 1.5 m slotted screen installed with filter sand to 4.2 m, bentonite seal from 4.2 m to 3.0 m and drill cuttings from 3.0 m to ground surface.

The drilling, sampling and coring operations were observed on a full time basis by members of Terraprobe's technical staff who logged the boreholes and rock cores and processed the recovered soil and rock samples for transport to Terraprobe's Brampton laboratory for further examination and testing.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and natural moisture content determination. Selected samples were also subjected to gradation analysis and Atterberg Limits tests. The results of the soils testing program are shown on the Record of Borehole sheets in Appendix A. The grain size distribution curves and plasticity charts are illustrated in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

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

5.1 Watermain Alignment - Sta. 0+170 to Sta. 0+227

In general, the site is underlain by surficial layer of topsoil, soft to stiff silty clay fill, compact silt, firm to very stiff silty clay, hard silty clay to clayey silt till and very dense silty sand to sandy silt till. These overburden soils are further underlain by bedrock consisting primarily of dolostone and shale of the Salina Formation.

5.1.1 Topsoil

Topsoil ranging from 150 mm to 250 mm was encountered at this site. Topsoil thickness may vary between and beyond the boreholes.



5.1.2 Fill – Silty Clay

Silty clay fill was encountered at this site extending to a depth of 3.7 m below ground surface (Elev. 178.8 m). The fill material was encountered in BH WN4 and not in BH WM1.

Grain size distribution curves of samples of this fill material are presented in Figures B1. These results show grain size distributions consisting of 0 to 5% gravel, 2 to 3% sand, 56 to 67% silt and 31 to 36% clay size particles.

A sample of the silty clay fill was also subjected to an Atterberg Limits test and the results are illustrated in Figure B2. The summarized index values from this test are presented herein.

Liquid Limit:	27%
Plastic Limit:	16%
Plasticity Index:	11%
Natural Moisture Content:	16%

These values are characteristic of clayey soils of low plasticity.

Standard Penetration tests in the silty clay fill material yielded 'N' values ranging from 3 blows to 9 blows for 0.3 m penetration. Based on these results the fill is considered to have a soft to stiff consistency.

The moisture content of samples of this fill ranged from 16% to 20% by weight.

5.1.3 Silt

A native cohesionless silt deposit was encountered at this site extending to a depth of 4.9 m below ground surface (Elev. 177.6 m). Based on visual and tactile examinations of the retrieved samples, the unit is essentially a cohesionless silt with frequent cohesive silty clay seams and partings. The silt was encountered in BH WN4 and not in BH WM1.

The silt is considered to have a compact relative density based on SPT 'N' values that ranged from 16 to 22 blows for 0.3 m penetration. The moisture content of samples from this deposit ranged from 17% to 21% by weight.

5.1.4 Silty Clay

A major silty clay deposit was encountered across the site. This deposit was fully penetrated in Borehole WN4 where it was found to extend to a depth of 14.7 m (Elev. 167.8 m) below ground surface. Borehole WM1 was terminated in this deposit at a depth of 7.4 m below ground surface (Elev. 175.5 m).

The grain size distribution plots of tested samples of the silty clay are presented in Figures B3 and B4. These results show a grain size distribution consisting of 0-17% gravel, 1-10% sand, 37-73% silt and 23-59% clay size particles.



Samples were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity charts, Figures B5 and B6. The index values from these tests are summarized below:

Liquid Limit:	24-51%
Plastic Limit:	14-22%
Plasticity Index:	9-29%
Natural Moisture Content:	17-25%

These values indicate that the silty clay has a generally low to intermediate plasticity with occasional zones of high plasticity.

Standard Penetration tests in this stratum gave 'N' values that ranged from 5 to 22 blows for 0.3 m penetration. Field vane tests gave in-situ undrained shear strengths ranging from 80 kPa to in excess of 100 kPa. These values indicate that the consistency of the silty clay is generally stiff to very stiff with infrequent firm zones. The moisture content of samples of the silty clay ranged from 16% to 30% by weight.

5.1.5 Silty Clay to Clayey Silt Till

Silty clay to clayey silt till was encountered at the site extending to a depth of 17.8 m below ground (Elev. 164.7 m). The till was encountered in BH WN4 and not in BH WM1. Till soils can also be expected to contain random cobble and boulder inclusions.

Standard Penetration tests in the till yielded 'N' values ranging from 37 to 43 blows per 0.3 m penetration. Based on these results the clayey silt to silty clay till is considered to have a hard consistency. The moisture content of samples from this deposit was 10% by weight.

5.1.6 Silty Sand to Sandy Silt Till

A deposit of silty sand to sandy silt till was encountered in Borehole WN4 overlying the bedrock surface. This deposit extends to a depth of 26.0 m below ground surface (Elev. 156.5 m). The till was encountered in BH WN4 and not in BH WM1.

Samples from this deposit were subjected to grain size distribution tests and the results are illustrated in Figure B7. These results show a grain size distribution consisting of 6-18 % gravel, 35-41 % sand, 31-47 % silt and 10-12 % clay size particles. Till soils can also be expected to contain random cobble and boulder inclusions.

Standard Penetration tests in this deposit gave 'N' values that ranged from 64 to more than 100 blows per 0.3 m penetration indicating a very dense relative density. The moisture content of samples from this stratum ranged from 6% to 9% by weight.



5.1.7 Bedrock

The overburden soils described above are underlain by the Salina Formation. Bedrock was proved by coring in Borehole WN4. Table 5.1 summarizes the bedrock depth and the elevation to the top of bedrock.

Table 5.1 – Depth to Bedrock

BH No.	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
WN4	26.0	156.5

The bedrock is described as unweathered and its colour is generally grey. It is thinly laminated with white unweathered gypsum and calcite veins. Total core recovery in the bedrock ranged from 92% to 100%. The RQD values ranged from 35% to 44% indicating poor rock quality.

5.2 Sanitary Sewer Alignment – Sta. 0+167 to Sta. 0+222

In general, the site is underlain by surficial layer of topsoil, firm to hard silty clay, dense silt, hard silty clay to clayey silt till and very dense sandy silt till. These overburden soils are further underlain by bedrock consisting primarily of dolostone and shale of the Salina Formation.

5.2.1 Topsoil

A 230 mm thick layer of topsoil was encountered in Borehole SS1. Topsoil thickness may vary between and beyond the boreholes.

5.2.2 Silt

A native cohesionless silt deposit was encountered at this site extending to a depth of 5.9 m (Elev. 177.2 m) below ground surface. Based on visual and tactile examinations of the retrieved samples, the unit is essentially a cohesionless silt with frequent cohesive silty clay seams and partings. The silt was encountered in BH WS2 and not in BH SS1.

The grain size distribution curve of a sample of this silt is shown in Figure B8. The results show a grain size distribution consisting of 0% gravel, 1% sand, 79% silt and 20% clay size particles.

Standard Penetration tests in this deposit gave 'N' values ranging from 36 to 37 blows per 0.3 m penetration. Based on these results the deposit is considered to have a dense relative density. The moisture content of samples from this stratum ranged from 18% to 22% by weight.

5.2.3 Silty Clay

A major silty clay deposit was encountered across the site. This deposit was fully penetrated in Borehole WS2 where it was found to extend to a depth of 14.7 m



(Elev. 168.4 m) below ground surface. Borehole SS1 was terminated in this deposit at a depth of 6.6 m below ground surface (Elev. 175.2 m).

The grain size distribution plots of tested samples of the silty clay are presented in Figures B9 and B10. These results show a grain size distribution consisting of 0-2% gravel, 1-5% sand, 37-72% silt and 26-58% clay size particles.

Samples were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity charts, Figures B11 and B12. The index values from these tests are summarized below:

Liquid Limit:	26-47%
Plastic Limit:	16-23%
Plasticity Index:	10-24%
Natural Moisture Content:	17-24%

These values indicate that the silty clay has a generally low to intermediate plasticity.

Standard Penetration tests in this stratum gave 'N' values that ranged from 6 to 43 blows for 0.3 m penetration. Field vane tests gave in-situ undrained shear strengths ranging from 64 kPa to in excess of 100 kPa. These values indicate that the consistency of the silty clay is generally stiff to hard with infrequent firm zones. The moisture content of samples of the silty clay ranged from 16% to 27% by weight.

5.2.4 Silty Clay to Clayey Silt Till

Discontinuous layers of silty clay to clayey silt till were encountered at the site extending to a depth of 22.3 m below ground surface (Elev. 160.8 m). The till was encountered in BH WS2 and not in BH SS1.

The results of a grain size distribution test conducted on a sample of clayey silt till is shown in Figure B13. These results show a grain size distribution consisting of 15% gravel, 35% sand, 35% silt and 15% clay size particles. Till soils can also be expected to contain random cobble and boulder inclusions.

A sample of the clayey silt till was also subjected to an Atterberg Limits test and the results are plotted on the plasticity chart in Figure B14. The summarized index values from this test are presented herein.

Liquid Limit:	15%
Plastic Limit:	11%
Plasticity Index:	4%
Natural Moisture Content:	7%

These values are characteristic of clayey soils of low plasticity.



Standard Penetration tests in these deposits yielded 'N' values ranging from 40 blows to 87 blows for 0.3 m. Based on these results the silty clay to clayey silt till is considered to have a hard consistency.

The moisture content of samples of the till ranged from 7% to 13% by weight.

5.2.5 Sandy Silt Till

Sandy silt till strata were encountered at this site extending to a depth of 27.3 m below ground surface (Elev. 155.8 m). This till was encountered in BH WS2 and not in BH SS1.

The grain size distribution curve of a sample of this sandy silt till is shown in Figure B15. The results show a grain size distribution consisting of 26% gravel, 17% sand, 45% silt and 12% clay size particles. Till soils can also be expected to contain random cobble and boulder inclusions.

Based on recorded 'N' values of more than 100 blows for 0.3 m penetration, the deposit is considered to have a very dense relative density. The moisture content of samples of the till ranged from 3% to 8% by weight.

5.2.6 Bedrock

The overburden soils described above are underlain by the Salina Formation. Bedrock was proved by coring in Borehole WS2. Table 5.2 summarizes the bedrock depth and the elevation to the top of bedrock.

Table 5.2 – Depth to Bedrock

BH No.	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
WS2	27.3	155.8

The bedrock is described as unweathered and its colour is generally grey. It is thinly laminated with white unweathered gypsum and calcite veins. Total core recovery in the bedrock ranged from 71% to 89%. The RQD values ranged from 18% to 30% indicating very poor to poor rock quality.



5.3 Water Levels

Standpipe piezometers were installed in selected boreholes and water level readings were taken on separate visits made after the completion of drilling. The water level records are presented in Table 5.3.

Table 5.3 – Water Level Measurements

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
Watermain Alignment			
WM1	May 04, 2010	6.8	176.1
	May 06, 2010	6.8	176.1
	May 18, 2010	1.0	181.9
Sanitary Sewer Alignment			
SS1	May 04, 2010	1.3	180.5
	May 06, 2010	1.2	180.6
	May 18, 2010	1.0	180.8

The ground water table was estimated based on the recorded water levels in the standpipe piezometers and our review of moisture contents of the retrieved samples. This interpretation indicates a ground water table that is estimated to range between Elev. ± 180.8 m and Elev. ± 181.9 m.

All ground water observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

5.4 Miscellaneous

The borehole locations were marked in the field by surveyors from Callon Dietz Inc. who also provided Terraprobe with their coordinates and geodetic elevations. Terraprobe obtained utility clearances and permits prior to drilling.

The drilling, sampling and in-situ testing operations were conducted with track-mounted drill rigs owned and operated by Groundworks Drilling Limited of Toronto, Ontario and Determination Drilling & Soil Investigations of Hamilton, Ontario.

The boreholes were advanced using hollow-stem augers and rock cores were retrieved by NQ size diamond coring techniques.

Messrs. Alexander Winkelmann, E.I.T, and Phil Khuu, B.A.T, carried out the field work. The laboratory testing was performed at Terraprobe's Brampton laboratory. The report was written by Rehman Abdul, P.Eng. and reviewed by Michael Tanos, P.Eng.



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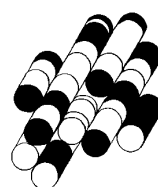
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APPENDIX A

TERRAPROBE INC.



LIMITATIONS AND RISK

Procedures

The soil conditions were confirmed at the borehole and test pit locations only and conditions may vary between and beyond the boreholes. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of stratigraphic change.

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities.

Changes In Site And Scope

It must be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Groundwater levels are particularly susceptible to seasonal fluctuations.

The design advice is based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, or there is any additional information relevant to the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report

This report was prepared for the express use of the Ministry of Transportation, its retained design consultants and Giffels Associates Ltd./IBI Group. It is not for use by others. This report is copyright of Terraprobe Inc. and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe Inc. The Ministry of Transportation, its retained design consultants and Giffels Associates Ltd./IBI Group, are authorized users.

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg. FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0-12	12-25	25-50	50-100	100-200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0-5	5-10	10-30	30-50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0-25	25-50	50-75	75-90	90-100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

	SPACING	50mm	50-300mm	0.3m-1m	1m-3m	>3m
JOINTING		VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING		VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u	kPa	PORE WATER PRESSURE
u_v	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ_{ve}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ_p	kPa	PRECONSOLIDATION PRESSURE
τ_i	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_u	kPa	REMOULDED SHEAR STRENGTH
S_r	1	SENSITIVITY = c_u / τ_u

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_p	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_u	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ² /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(w - w_p)$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(w - w_p) / I_p$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_c	1	CONSISTENCY INDEX = $(w - w_p) / I_p$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ²	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No WM1

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764185.0 E:327299.1 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 04.28.10 CHECKED BY RA

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			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							x LAB VANE	
182.9	Ground Surface							20	40	60	80	100						
0.0	250mm TOPSOIL							20	40	60	80	100						
182.7																		
0.3	trace rootlets		1	SS	5													
	SILTY CLAY trace sand, trace gravel, firm to very stiff, brown / reddish brown, moist		2	SS	16		182										0 3 38 59	
			3	SS	18		181											
			4	SS	22		180											
			5	SS	18		179										0 1 47 52	
			6	SS	11		178										0 2 55 43	
			7	SS	12		177											
			8	SS	11		176											
			9	SS	11												0 2 47 51	
			10	SS	10													
175.5	End of Borehole																	
7.4	Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) May 04.10 6.8 176.1 May 06.10 6.8 176.1 May 18.10 1.0 181.9																	

RECORD OF BOREHOLE No WN4

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764228.4 E:327343.4 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.14.09 - 12.15.09 CHECKED BY RA

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 (%)			
								○ UNCONFINED	+ FIELD VANE							● QUICK TRIAXIAL	× LAB VANE	20
182.5	Ground Surface																	
182.4	150mm TOPSOIL																	
0.2	soft		1	SS	3		182											
	FILL - Silty Clay, trace sand, trace gravel, firm to stiff, brown, damp		2	SS	6		181							0 2 67 31				
			3	SS	9		180							5 3 56 36				
			4	SS	8		179											
			5	SS	5		178											
178.8	SILT trace clay, trace sand, frequent silty clay seams and partings, compact, brown, damp		6	SS	16		177											
3.7			7	SS	22		176											
177.6	SILTY CLAY trace to some gravel, trace sand, stiff to very stiff, brown, damp		8	SS	5		175							17 10 37 36				
4.9			9	SS	10		174											
			10	TW	PH		173							1 2 72 25				
			11	SS	9		172							1 3 73 23				
			12	SS	8		171							Dec.14				
			13	SS	12		170							Dec.15				
			14	SS	12		169							1 8 68 23				
167.8							168											
14.7																		

Continued Next Page

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

METRIC

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					
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
								WATER CONTENT (%) 20 40 60 80 100						

DEPTH (m)	DEPTH (ft)	UNIT	TEST	VALUE	DEPTH (m)	DEPTH (ft)	UNIT	TEST	VALUE	DEPTH (m)	DEPTH (ft)	UNIT	TEST	VALUE
164.7	17.8	SILTY CLAY TO CLAYEY SILT sandy, trace to some gravel, occasional cobbles, hard, brown, damp (GLACIAL TILL)	15	SS	37	167								
	16		SS	43	166									
	17		SS	64	165									
	18		SS	100/ 13cm	164									
	19		SS	89	163									
	20		SS	84	162									
156.5	26.0	SILTY SAND TO SANDY SILT trace to some clay, trace to some gravel, very dense, brown, damp (GLACIAL TILL) ----- frequent cobbles	21	SS	90	161								
	22		SS		160									
	23		SS		159									
	24		SS		158									
153.6	28.9	BEDROCK - INTERBEDDED DOLOSTONE AND SHALE Unweathered, thinly laminated, grey, medium strength, argillaceous with unweathered, laminated, white, very low strength gypsum and calcite layers / veins and frequent unweathered, white, low strength, coarse grained calcitic vugs.	1	RUN	NQ	157								
	2		RUN	NQ	156									
	3		RUN	NQ	155									
		End of Borehole				154								

Continued Next Page

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

○ 3% STRAIN AT FAILURE

ONTARIO MOT 1-09-4135 WM & SS.GPJ ONTARIO MOT.GDT 05/31/10

RECORD OF BOREHOLE No WN4

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764228.4 E:327343.4 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.14.09 - 12.15.09 CHECKED BY RA

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					
	<p>Borehole open to full depth and filled with drill water upon completion of drilling.</p> <p>Borehole sealed with bentonite slurry to ground surface.</p> <p>Resistance to augering at 22.9m and 24.3m.</p> <p>Unable to push vane beyond 13.1m and 14.2m.</p>																

ONTARIO MOT 1-09-4135 WM & SS GPJ ONTARIO MOT.GDT 05/31/10

RECORD OF BOREHOLE No SS1

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764215.0 E:327350.7 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 04.28.10 CHECKED BY RA

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			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
							WATER CONTENT (%)										
							20 40 60 80 100					10 20 30					
181.8	Ground Surface																
0.0 181.6 0.2	230mm TOPSOIL		1	SS	22									44	0 1 48 51		
	trace rootlets																
	SILTY CLAY trace sand, trace gravel, firm to very stiff, brown / reddish brown, moist		2	SS	26		181										
			3	SS	18		180										
			4	SS	20		179						41		0 1 49 50		
			5	SS	18		178										
			6	SS	20		177										
			7	SS	13		176										
			8	SS	12										0 4 67 29		
			9	SS	6												
175.2 6.6	End of Borehole																
	Borehole was dry (not stabilized) and hole open to full depth on completion.																
	Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.																
	Water Level Readings:																
	Date Depth(m) Elevation(m)																
	May.04.10 1.3 180.5																
	May.06.10 1.2 180.6																
	May.18.10 1.0 180.8																

RECORD OF BOREHOLE No WS2

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764174.7 E:327313.4 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 01.28.10 - 02.01.10 CHECKED BY RA


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 40 60 80 100					
183.1 0.0	Ground Surface						183							
	firm		1	SS	7									

	SILTY CLAY trace sand, trace gravel, hard, brown, damp		2	SS	38		182					45		2 3 37 58
			3	SS	43									
			4	SS	36		181					47		0 1 51 48
			5	SS	29		180							
			6	SS	24		179							
178.7 4.4	SILT trace sand, frequent silty clay seams and partings, dense, brown, damp		7	SS	37		178							0 1 79 20
			8	SS	36									
177.2 5.9	SILTY CLAY trace sand, trace gravel, stiff to very stiff, brown, damp to moist		9	SS	21		177							0 5 68 27
			10	SS	22		176							
			11	TW	PH		175							
			12	SS	10		174							
			13	SS	15		173		1.6					
			14	SS	28		172		1.2					0 3 70 27
							171		1.1					
							170		1.3					0 2 72 26
168.4 14.7							169		2.5					

Continued Next Page

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

METRIC

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 C
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	20 40 60 80 100				W _p	W	W _L			
									SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100			WATER CONTENT (%) 10 20 30			

[illegible]

Continued Next Page

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

○ 3% STRAIN AT FAILURE

ONTARIO MOT 1-09-4135 WM & SS.GPJ ONTARIO MOT.GDT 05/31/10

RECORD OF BOREHOLE No WS2

3 OF 3

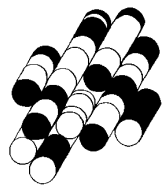
METRIC

W.P. 280-99-00 LOCATION Coords: N:4764174.7 E:327313.4 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 01.28.10 - 02.01.10 CHECKED BY RA

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					
29.9	End of Borehole No sample recovery at SS12. Sampler redriven and disturbed sample collected. Unable to push vane beyond 12m. Borehole open to full depth and filled with drill water upon completion of drilling. Borehole sealed with bentonite slurry to ground surface.															

APPENDIX B

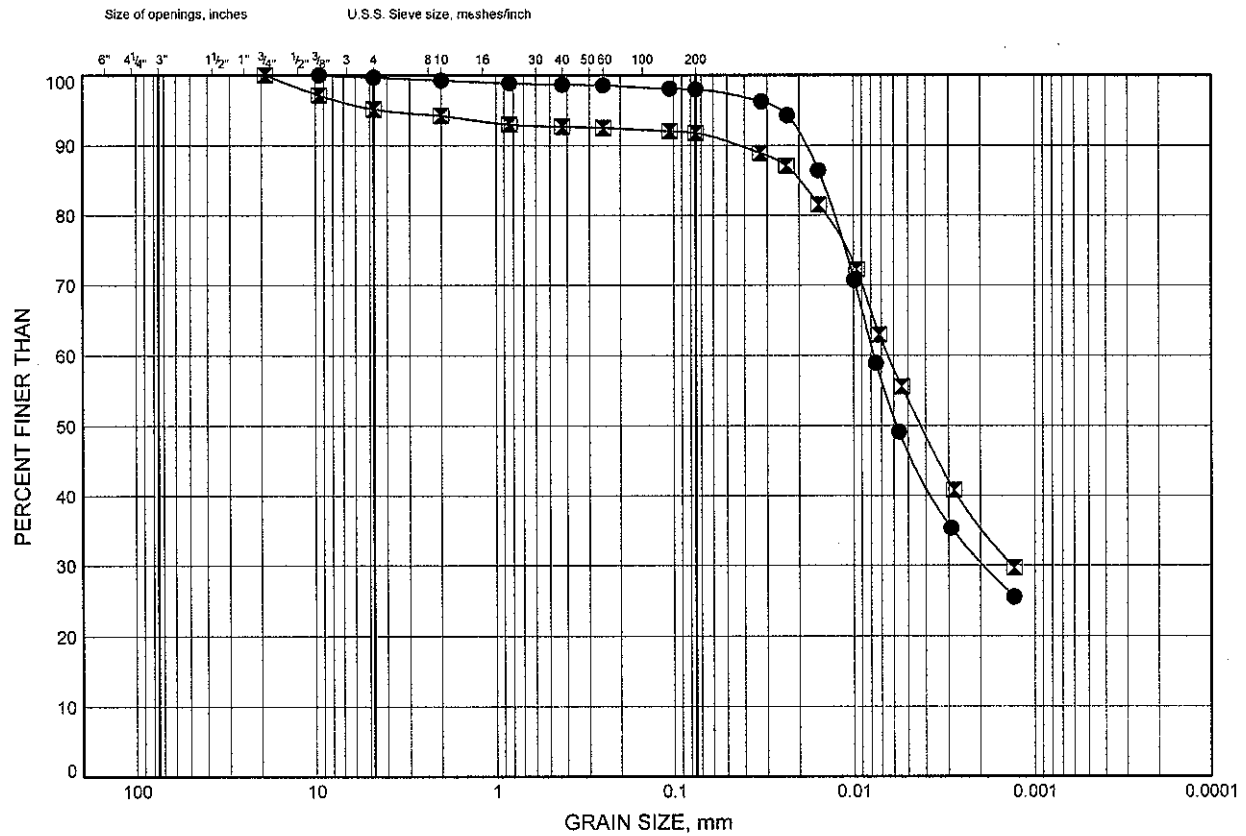
TERRAPROBE INC.



GRAIN SIZE DISTRIBUTION

FIGURE B1

FILL - Silty Clay



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

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN4	1.0	181.5
⊠	WN4	2.5	180.0

Date May 2010

Project 1-09-4135



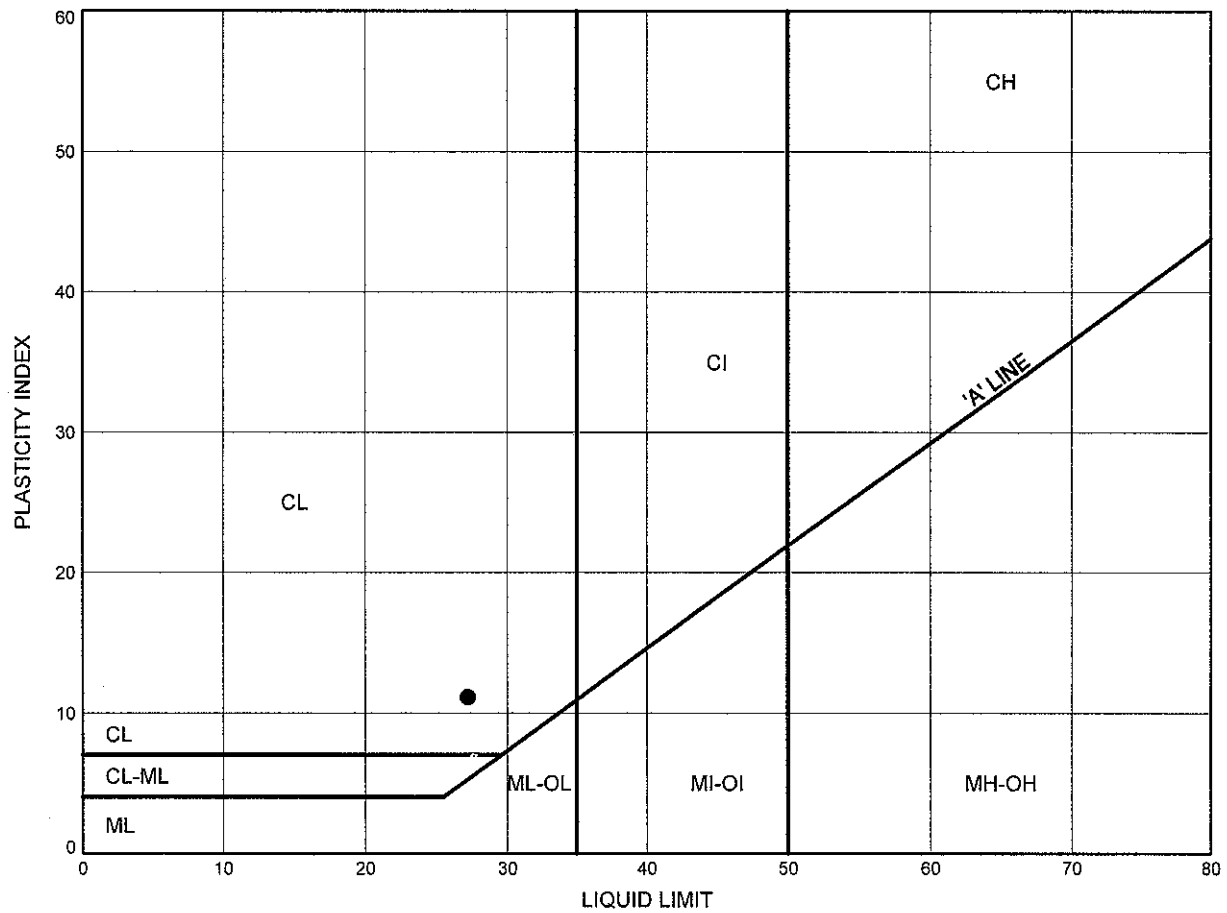
Prep'd DB

Chkd. HA

ATTERBERG LIMITS TEST RESULTS

FIGURE B2

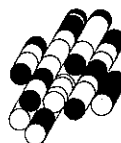
FILL - Silty Clay



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN4	1.0	181.5

Date May 2010

Project 1-09-4135



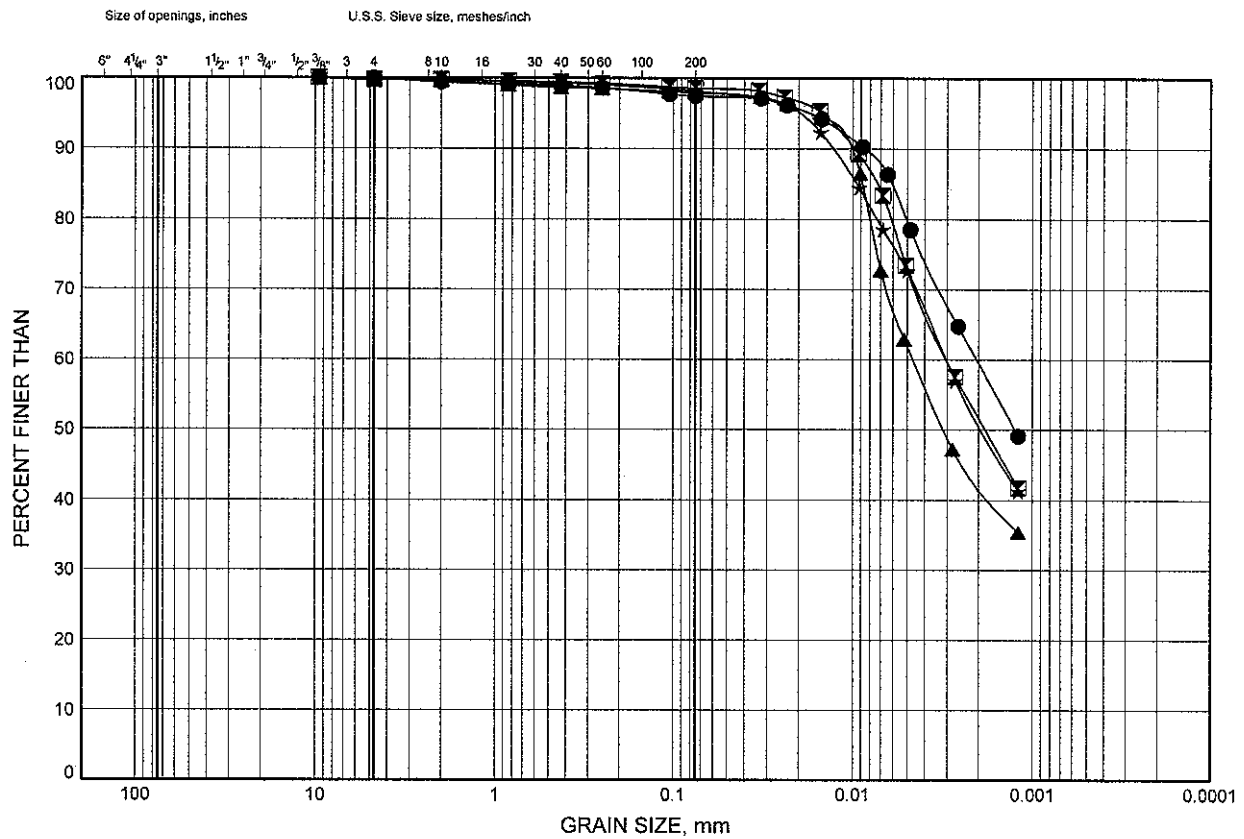
Prep'd DB

Chkd. HA

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



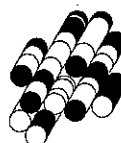
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	WM1	1.0	181.9
⊠	WM1	3.2	179.7
▲	WM1	4.0	178.9
★	WM1	6.3	176.6

Date May 2010

Project 1-09-4135



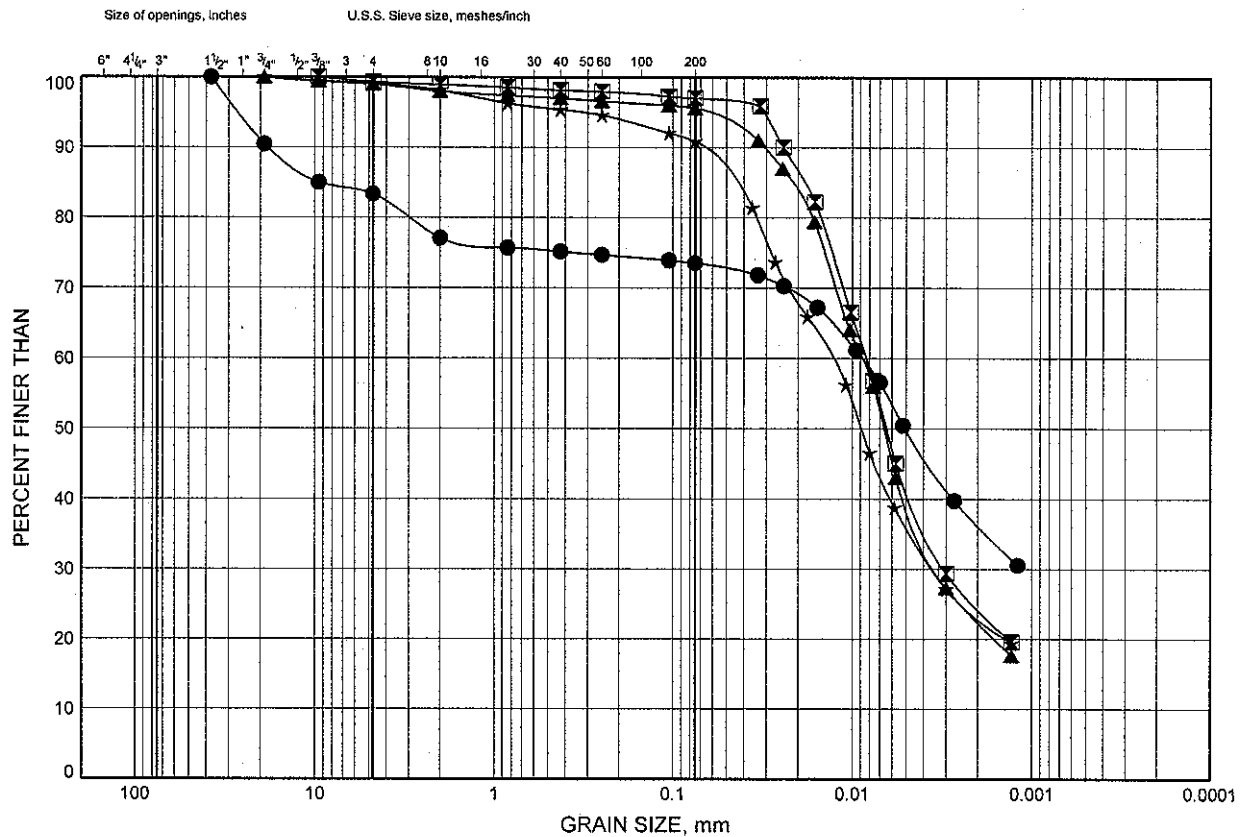
Prep'd DB

Chkd HA

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY



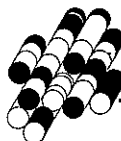
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	WN4	5.5	177.0
⊠	WN4	9.3	173.2
▲	WN4	10.9	171.6
★	WN4	13.9	168.6

Date May 2010

Project 1-09-4135



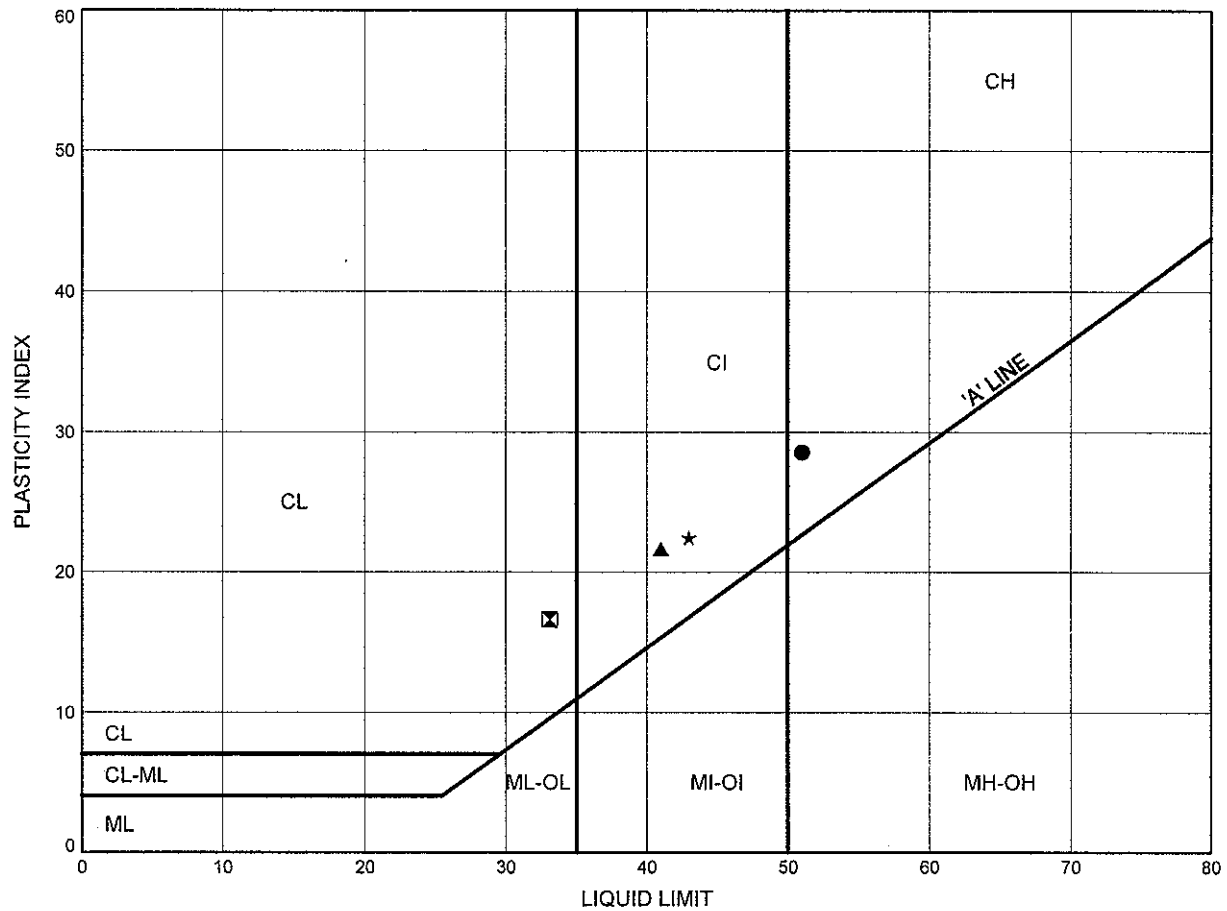
Prep'd DB

Chkd. HA

ATTERBERG LIMITS TEST RESULTS

FIGURE B5

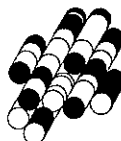
SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WM1	1.0	181.9
⊠	WM1	4.0	178.9
▲	WM1	6.3	176.6
★	WN4	5.5	177.0

Date May 2010

Project 1-09-4135



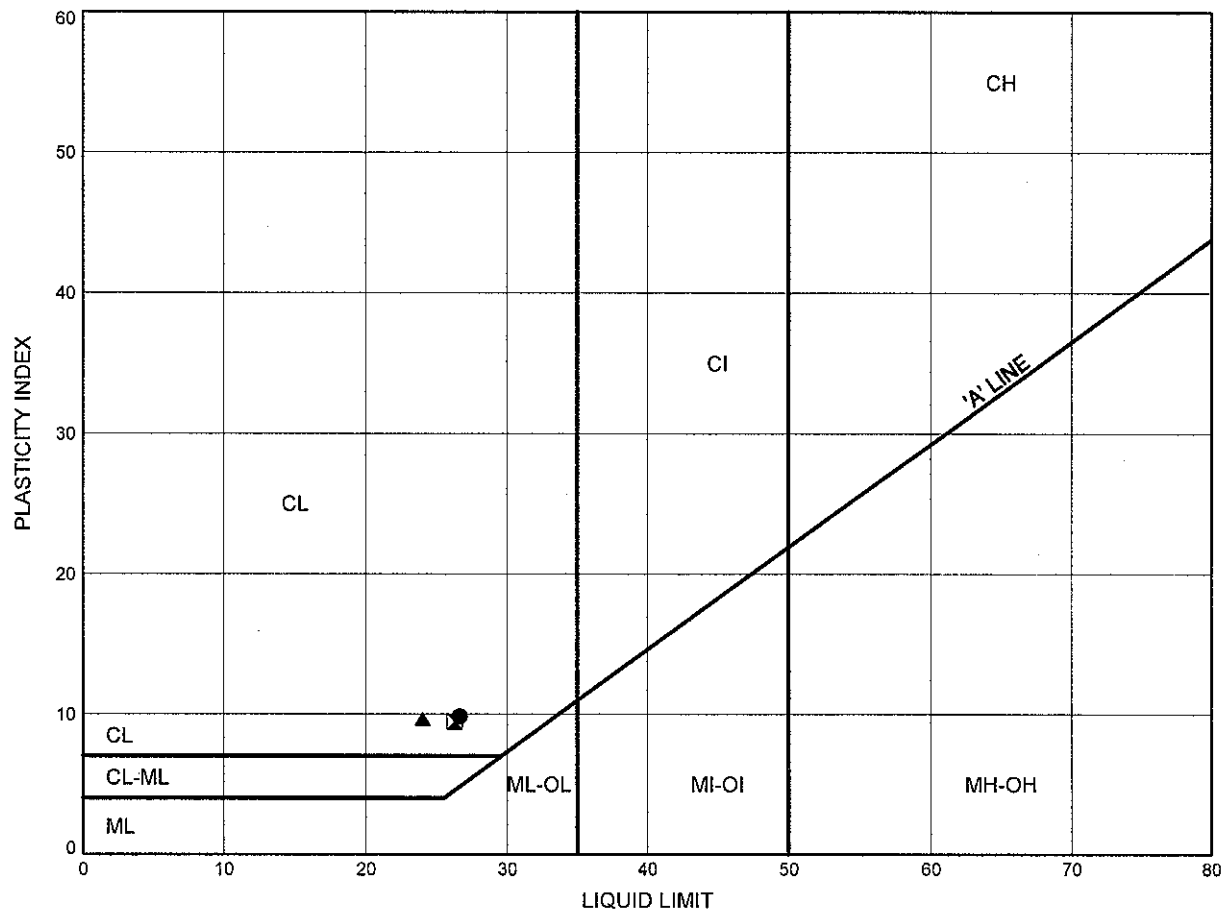
Prep'd DB

Chkd. HA

ATTERBERG LIMITS TEST RESULTS

FIGURE B6

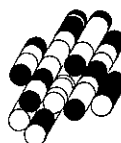
SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN4	9.3	173.2
⊠	WN4	10.9	171.6
▲	WN4	13.9	168.6

Date May 2010

Project 1-09-4135



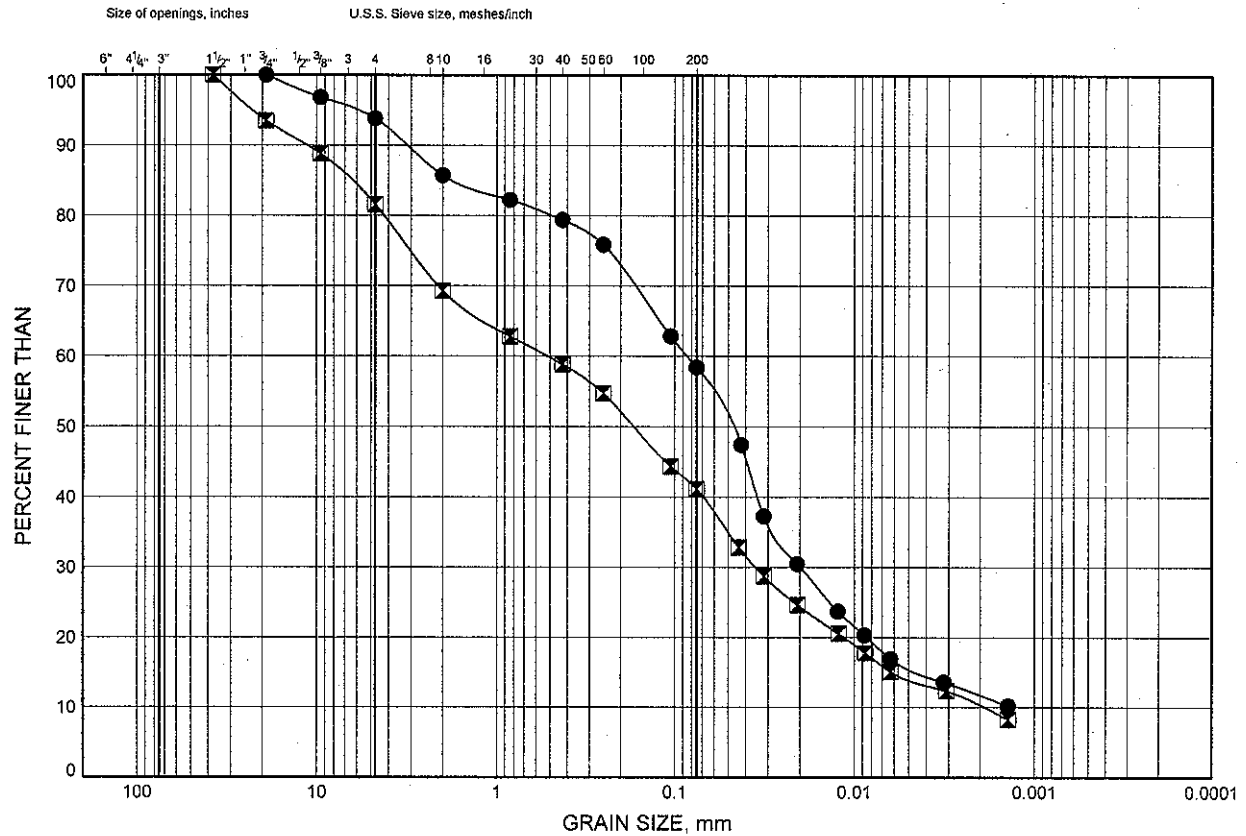
Prep'd DB

Chkd. HA

GRAIN SIZE DISTRIBUTION

FIGURE B7

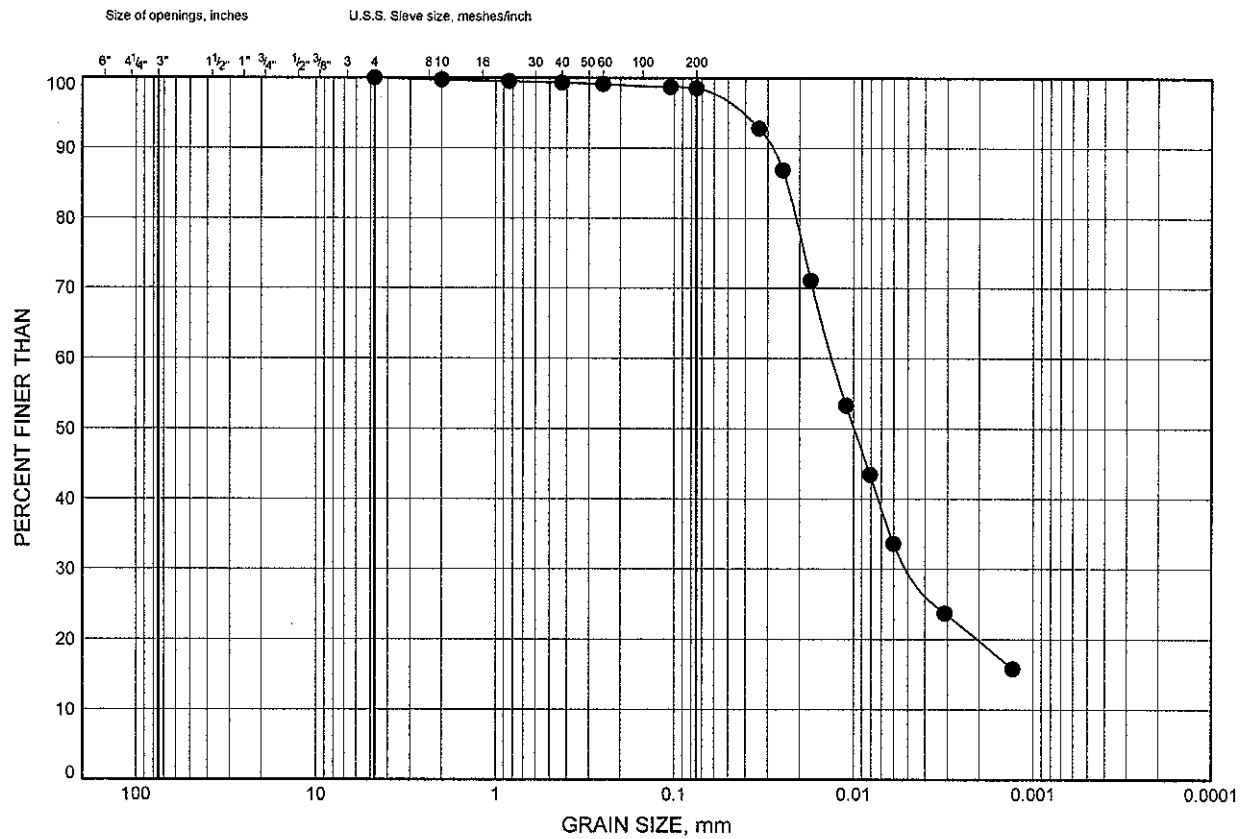
SILTY SAND TO SANDY SILT TILL



GRAIN SIZE DISTRIBUTION

FIGURE B8

SILT

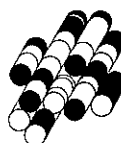


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS2	4.7	178.4

Date May 2010

Project 1-09-4135



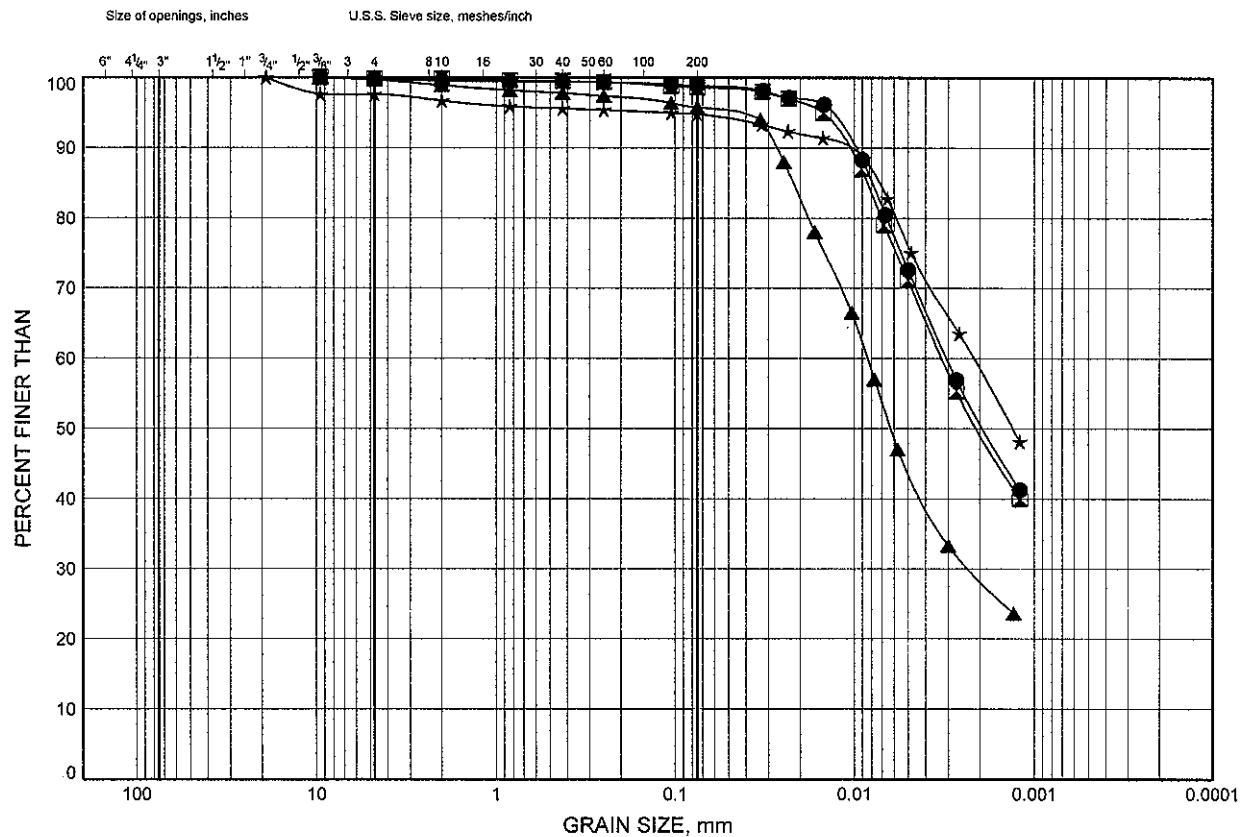
Prep'd DB

Chkd. HA

GRAIN SIZE DISTRIBUTION

FIGURE B9

SILTY CLAY



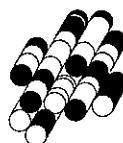
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	SS1	0.3	181.5
⊠	SS1	2.5	179.3
▲	SS1	5.5	176.3
★	WS2	1.0	182.1

Date May 2010

Project 1-09-4135



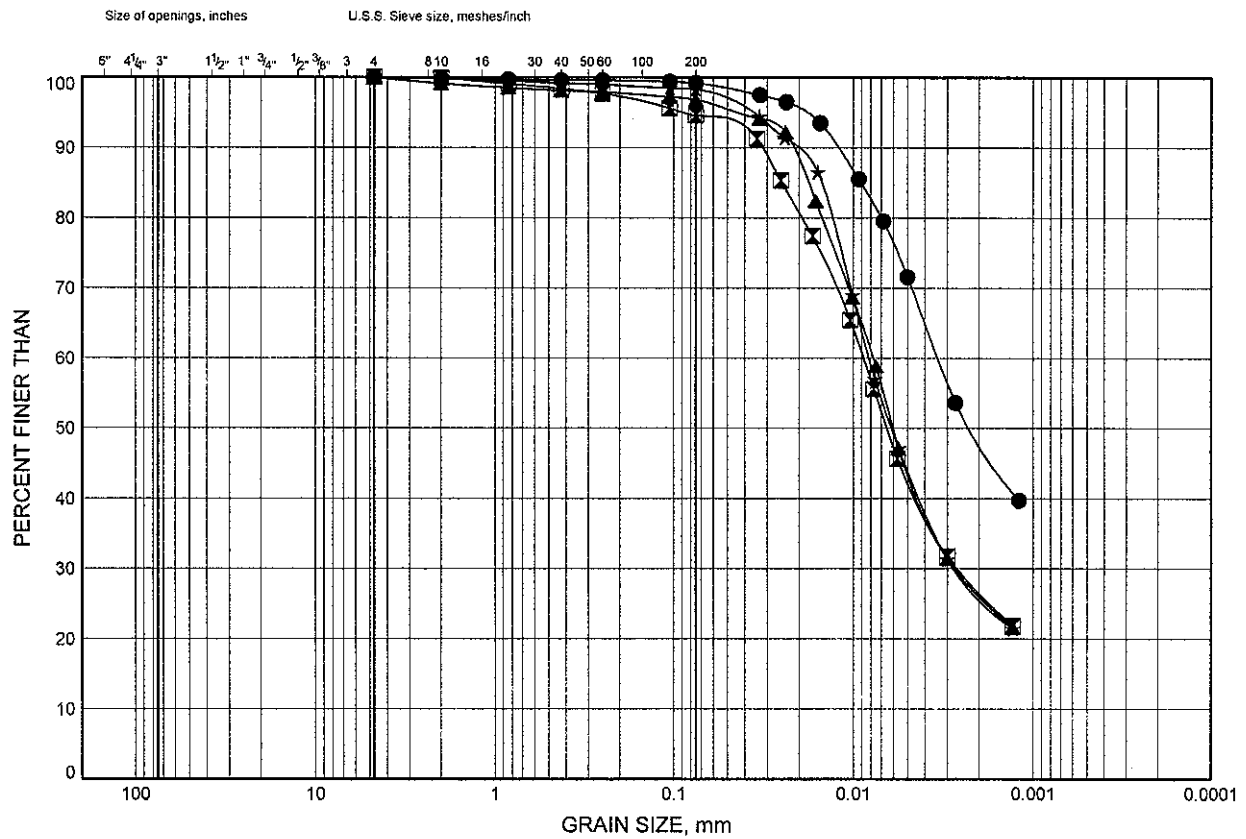
Prep'd DB

Chkd. HA

GRAIN SIZE DISTRIBUTION

FIGURE B10

SILTY CLAY



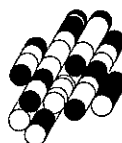
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	WS2	2.5	180.6
⊠	WS2	6.3	176.8
▲	WS2	10.9	172.2
★	WS2	12.4	170.7

Date May 2010

Project 1-09-4135



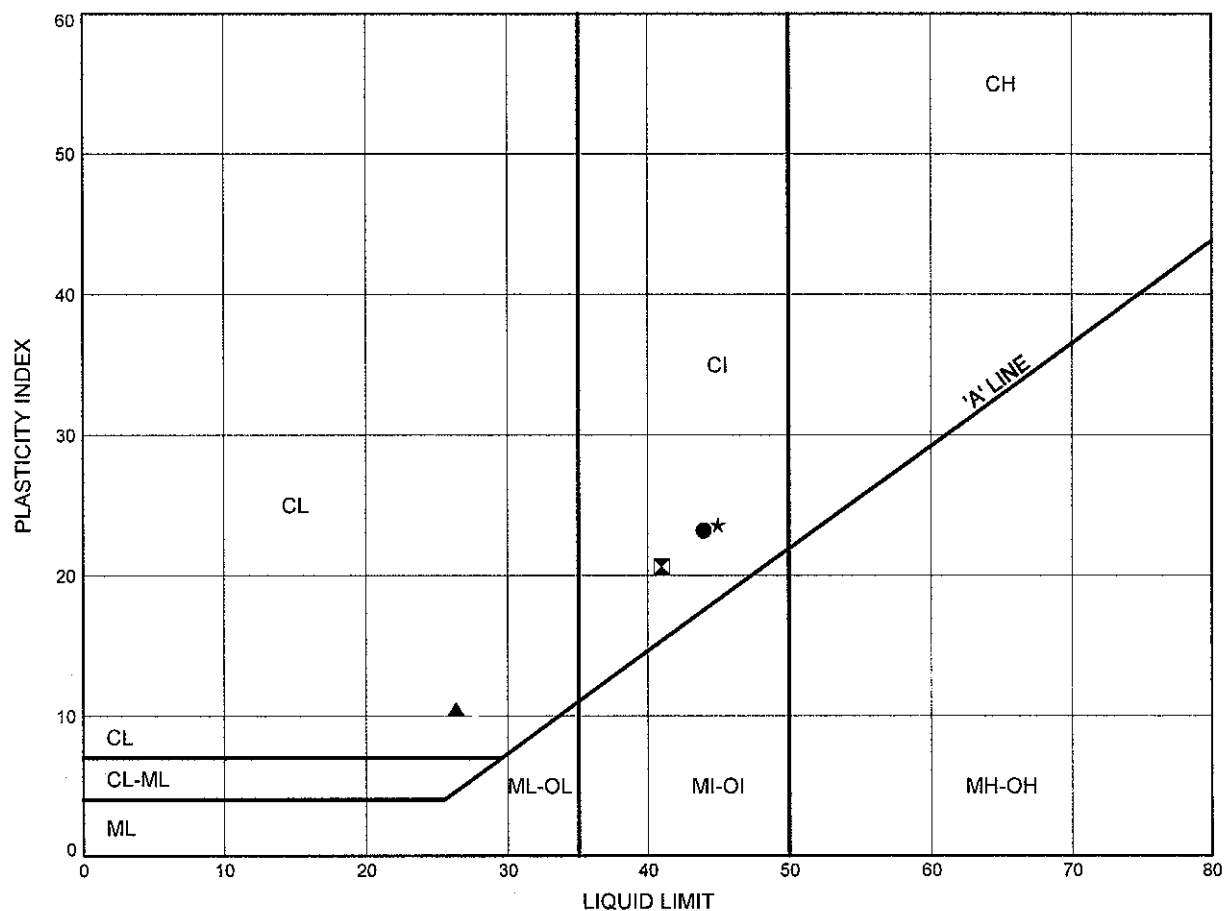
Prep'd DB

Chkd. HA

ATTERBERG LIMITS TEST RESULTS

FIGURE B11

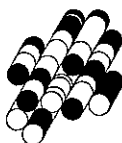
SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	SS1	0.3	181.5
⊠	SS1	2.5	179.3
▲	SS1	5.5	176.3
★	WS2	1.0	182.1

Date May 2010

Project 1-09-4135



Prep'd DB

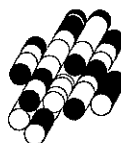
Chkd. HA

FIGURE B12

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS2	2.5	180.6
⊠	WS2	6.3	176.8
▲	WS2	10.9	172.2
★	WS2	12.4	170.7

Date May 2010

Project 1-09-4135...



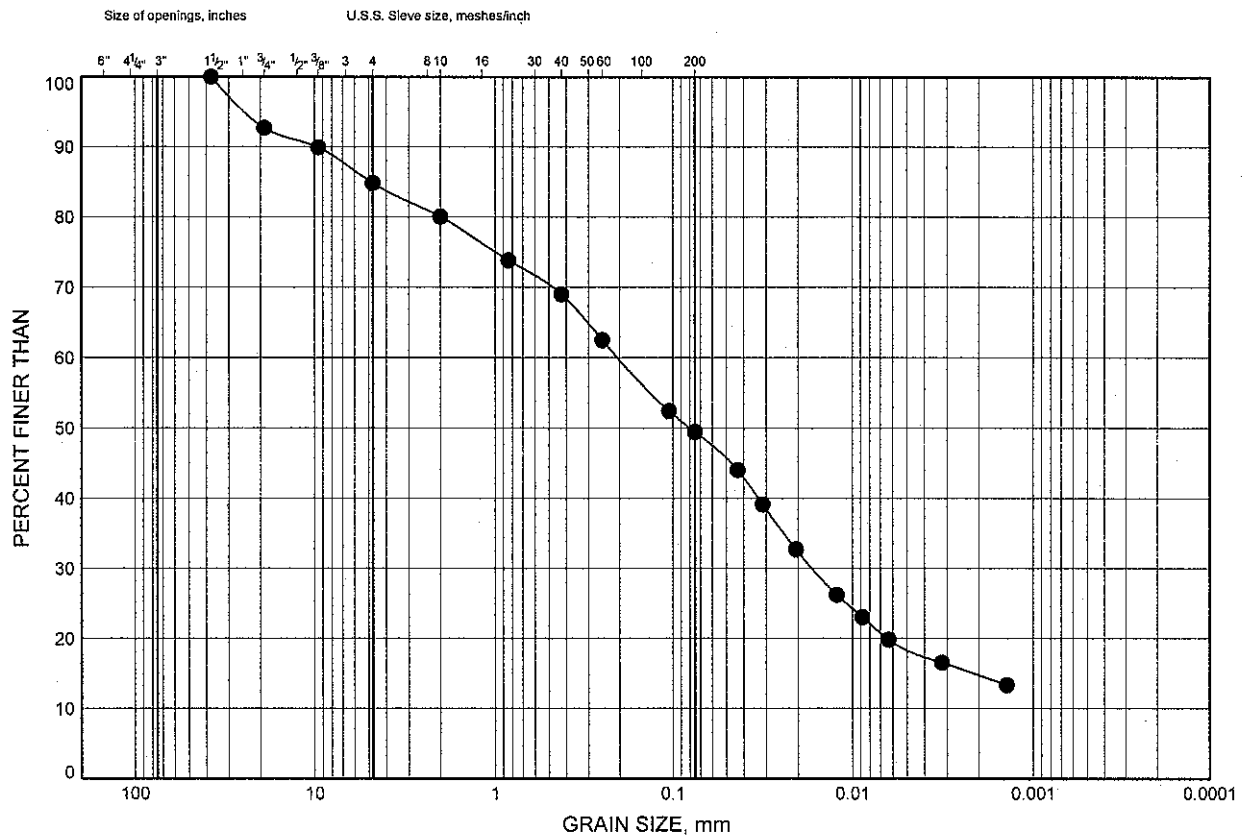
Prep'dDB.....

Chkd. HA

GRAIN SIZE DISTRIBUTION

FIGURE B13

CLAYEY SILT TILL

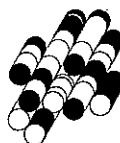


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS2	21.5	161.6

Date May 2010

Project 1-09-4135



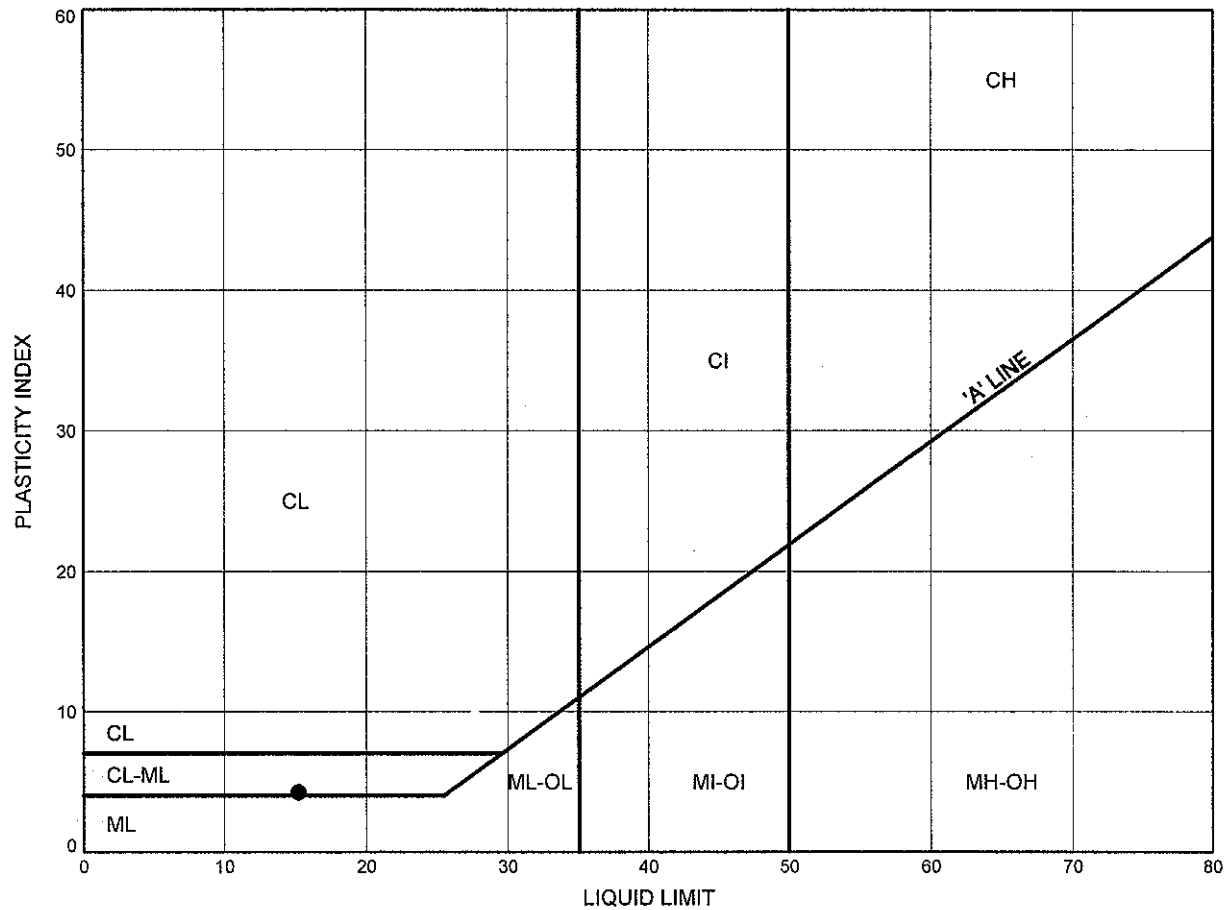
Prep'd DB

Chkd. HA

ATTERBERG LIMITS TEST RESULTS

FIGURE B14

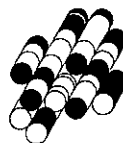
CLAYEY SILT TILL



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS2	21.5	161.6

Date May 2010

Project 1-09-4135



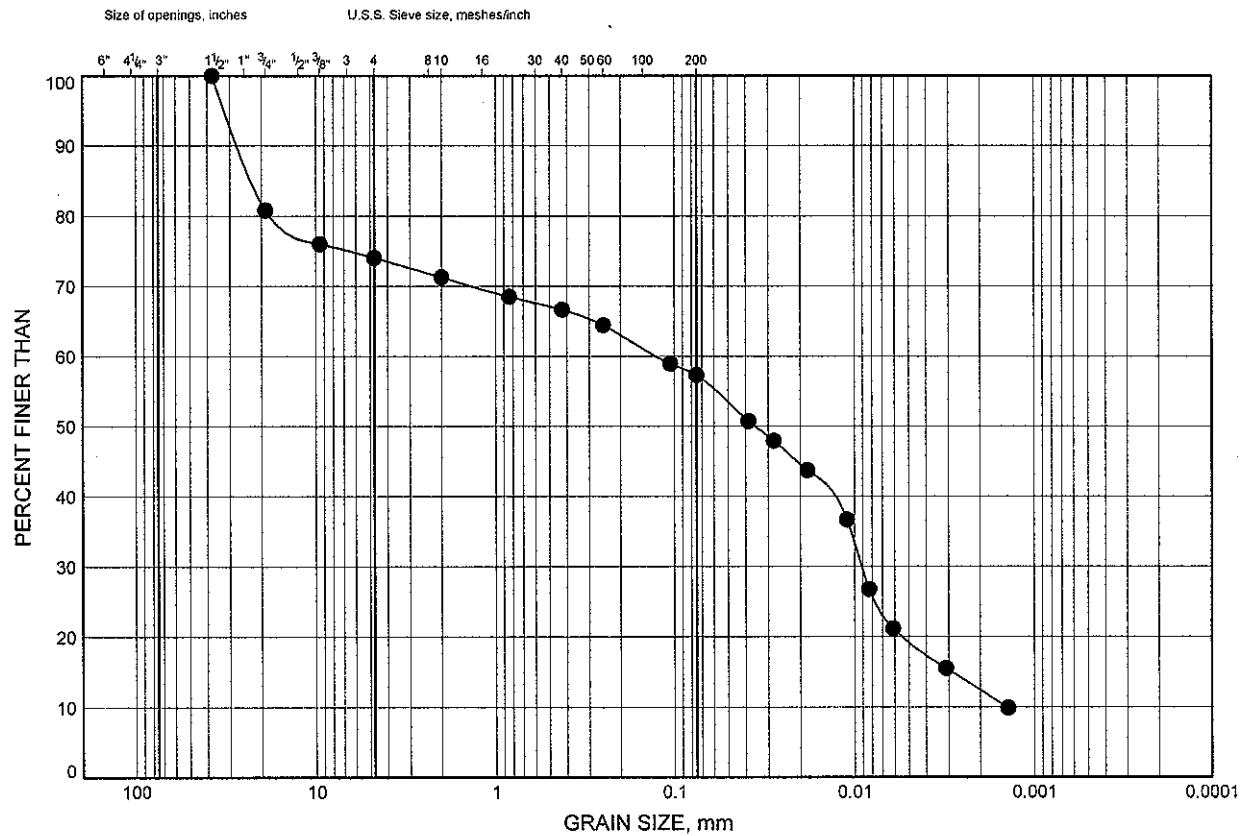
Prep'd DB

Chkd. HA

GRAIN SIZE DISTRIBUTION

FIGURE B15

SANDY SILT TILL

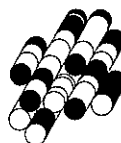


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS2	18.5	164.6

Date May 2010

Project 1-09-4135

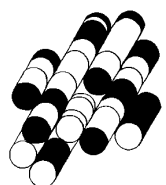


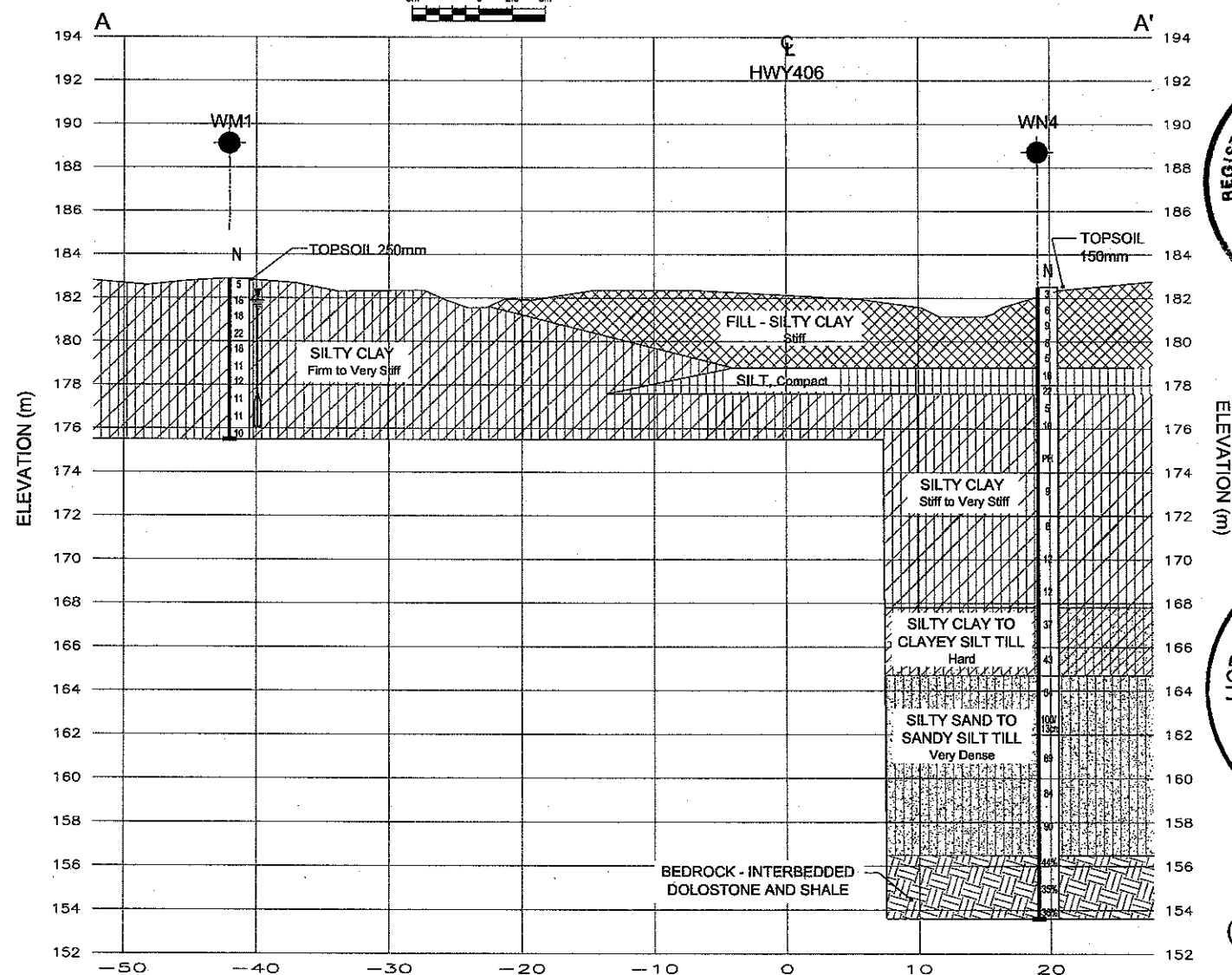
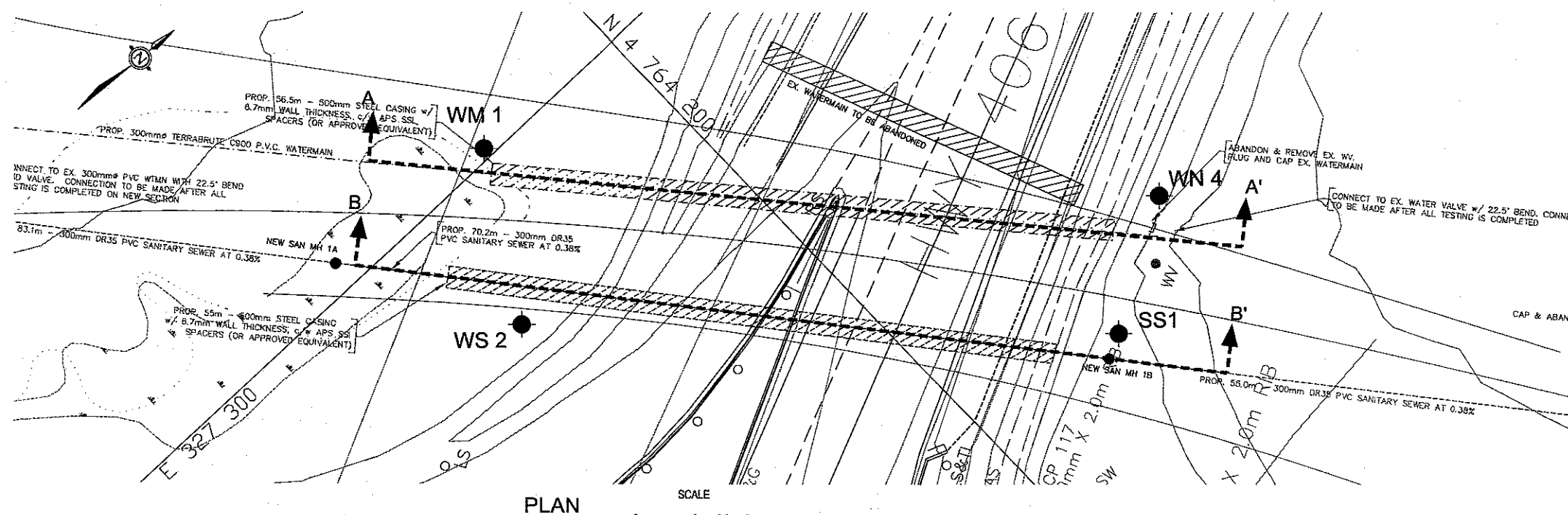
Prep'd DB

Chkd. HA

APPENDIX C

TERRAPROBE INC.





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

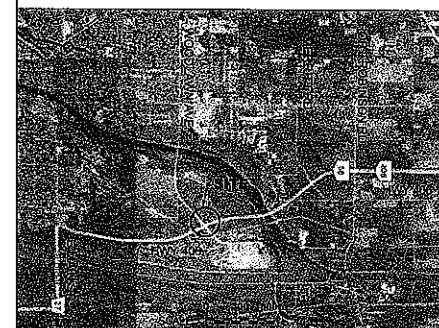
CONT No
WP No 280-99-00






HIGHWAY 406
CITY OF WELLAND
WATERMAIN AND SANITARY SEWER



SHEET
1 OF

Giffels Associates Limited
Consulting Engineers and Architects
An IBI Group Company



LEGEND	
	Bore Hole
	Dynamic Cone Penetration Test
	Bore Hole And Cone
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
	WL at Time of Investigation
	WL in Piezometer (MAY 2010)
	Piezometer
90%	Rock Quality Designation
A/R	Auger Refusal

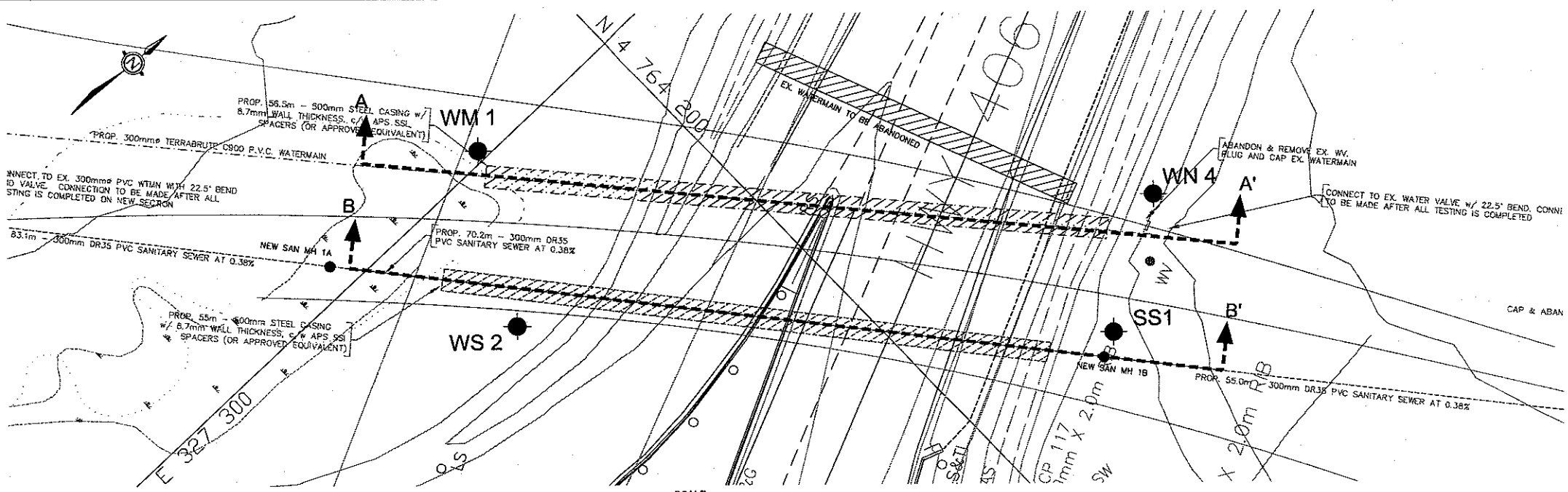
No	ELEV.	COORDINATES	
		NORTHING	EASTING
WM1	182.9	4 764 185	327 299.1
WN4	182.5	4 764 228.4	327 343.4
WS2	183.1	4 764 174.7	327 313.4
SS1	181.8	4 764 215	327 350.7

GEOCRES No. 30M3-254

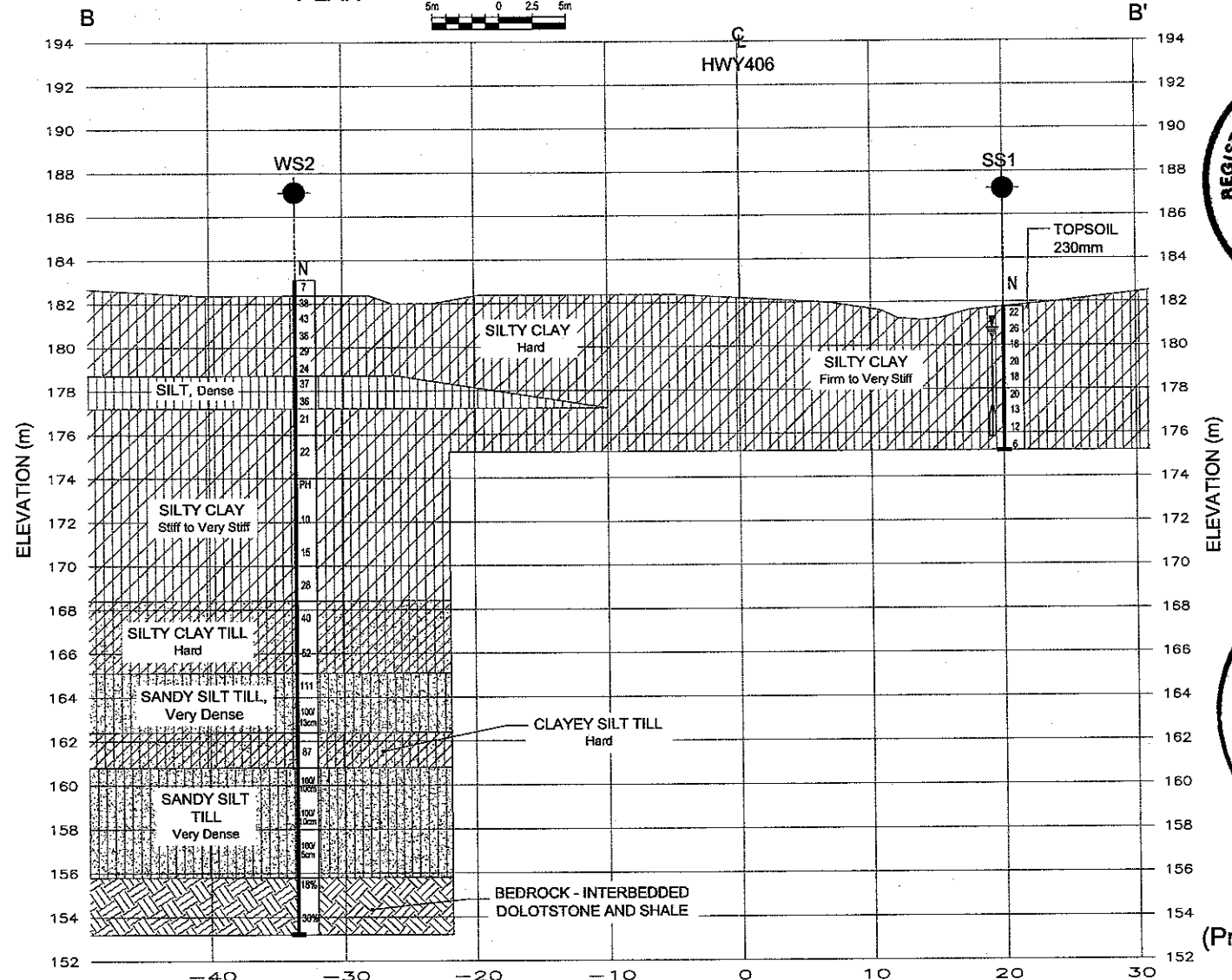
NOTE

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	
DESIGN	R.A.	CODE	CHBDC2006	LOAD
				DATE JUNE 2010
DRAWN	J.B.	CHK	R.A.	STRUCT



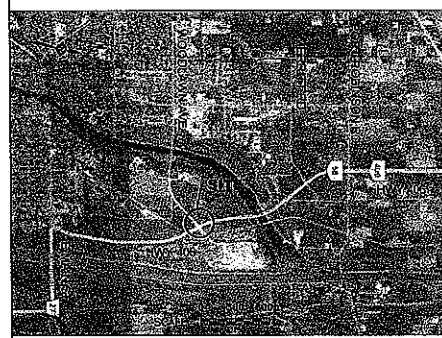
PLAN



SECTION B-B'
(Proposed Sanitary Sewer)

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

CONT No	WP No 280-99-00	SHEET 1 OF 1
HIGHWAY 406 CITY OF WELLAND WATERMAIN AND SANITARY SEWER		
Giffels Associates Limited Consulting Engineers and Architects An IBI Group Company		



KEY PLAN

LEGEND	
●	Bore Hole
⊕	Dynamic Cone Penetration Test
⊙	Bore Hole And Cone
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
⊕	Blows/0.3m (60' Cone, 475 J/blow)
⊕	WL at Time of Investigation
⊕	WL in Piezometer (MAY 2010)
⊕	Piezometer
90°	Rock Quality Designation
A/R	Auger Refusal

No	ELEV.	COORDINATES	
		NORTHING	EASTING
WM1	182.9	4 764 185	327 299.1
WN4	182.5	4 764 228.4	327 343.4
WS2	183.1	4 764 174.7	327 313.4
SS1	181.8	4 764 215	327 350.7

GEOCRETS No. 30M3-254

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.
The drawing is for subsurface information only. Surface details are for conceptual illustration.

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	R.A.	CODE	CHBDC2005	LOAD
DRAWN	J.B.	CHK	R.A.	STRUCT
				DATE JUNE 2010

[\\TERAPROBE\\F\\Server\\Terraprobe\\Limited\\All Projects\\2010\\File\\1-59-1100-1199\\1-09-1135A.Dwg. Log\\WELLAND WM & SANIT-09-4135 HWY 406 Welland WM & SANIT.dwg, KAWAL