

**PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
E-S RAMP AND CONNECTION ROAD UNDER CNR TRACKS
HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00**

Geocres Number: 40P8-166

Report to

**Ministry of Transportation Ontario
Southwestern Region**

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a preliminary foundation investigation conducted at the site of the proposed E-S Ramp and Connection Road for Highway 7-New under CNR in the Regional Municipality of Waterloo.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions under the potential foundation footprint was developed from the data obtained in the course of the investigation.

The information collected in the course of the investigation and presented in this report is intended for preliminary design purposes only. Additional site investigation, field testing and engineering analysis will be required at the detail design stage. The extent of the additional investigation will depend, in part, on the final location and General Arrangement of the structure.

Thurber carried out the investigation for the Ministry of Transportation Ontario, Southwestern Region (MTO) under Purchase Order Number 3006-E-0123.

In the preparation of this report, general reference has been made to information on subsurface conditions contained in a previous foundation report. The title of the report is listed as follows:

- Foundation investigation report for C.N.R. Subway, Kitchener-Waterloo Expressway, District #4 (Hamilton), Geocres No. 40P8-45, W.J. 66-F-37, W.P. 636-64, dated July 4, 1966. (Reference 1).

Records of boreholes from the previous report are attached in Appendix C for reference.

2 SITE DESCRIPTION

The site lies on the west side of Kitchener-Waterloo Expressway (KWE), approximately 250 m to the south of Wellington Street and 110 m north of Victoria Street. At this location, the proposed E-S Ramp and Connection Road will pass under the existing twin CNR tracks running east-west. Approximately 160 m west of the existing CNR bridge, the double tracks emerge from a CNR yard with a number of tracks as well as a spur line. The CNR yard extends some 980 m west, to Lancaster Street East. The site lies within an area of industrial and commercial lands and is generally flat.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Waterloo Hills, characterized by ridges of sandy till and kames or kame moraines, with outwash sands occupying the intervening hollows.

Two photographs of the site, looking at the west abutment of the existing CNR bridge over KWE are included in Appendix E and show the general nature of the surrounding land.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing at this site was carried out from August 11 to 14, 2008. Two boreholes, numbered 08-041 and 08-042, were drilled approximately near the west and east abutments of the proposed structure. The depths of Boreholes 08-041 and 08-042 were 37.2 m and 20.1 m (Elevations 289.1 and 302.7), respectively. The Record of Borehole sheets for the boreholes are included in Appendix A. The approximate locations of the two boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix F.

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area.

The boreholes were drilled using hollow stem auger equipment operated by a CME75 truck-mounted drill rig. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. In Borehole 08-042, drilled near the proposed east abutment, a standpipe piezometer consisting of 25 mm diameter PVC pipe with a slotted screen was installed and enclosed in filter sand to permit longer term groundwater level monitoring. The location and completion details of the piezometer are shown in Table 3.1. Borehole 08-041 was grouted upon completion. The borehole completion details are also shown in Table 3.1.

The completion of the boreholes and the standpipe piezometer installation was carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07).

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole Location	Piezometer Tip Depth/ Elevation (m)	Completion Details
West Abutment	08-041	No Installation	Grout to 0.6 m then holeplug to ground surface.
East Abutment	08-042	19.2/303.6	Piezometer with 1.5 m slotted screen installed with sand filter to 17.4 m, holeplug from 17.4 m to 16.8 m, grout from 16.8 m to 0.6 m, then holeplug to surface.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A. Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

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

In general, the site is underlain by topsoil and a layer of fill consisting of various materials (sand, silty sand and clayey silt) overlying native compact to very dense sand, very stiff to hard silty clay till and silty clay and very dense silt till.

5.1 Topsoil

Topsoil was encountered surficially in both boreholes. Topsoil thickness was 40 mm and 300 mm in Boreholes 08-041 and 08-042, respectively.

The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities

5.2 Fill

Fill was encountered below the topsoil. The fill consists of sand, silty sand and clayey silt containing trace to some gravel and occasional topsoil. Thickness of the fill was 1.3 m and 1.2 m in Boreholes 08-041 and 08-042, respectively. The depth to the base of the fill was 1.4 m and 1.5 m (Elevations 324.9 and 321.3).

The sand and silty sand fill are classified as compact to dense based on SPT 'N' values of 25 and 32 blows for 0.3 m of penetration. The clayey silt is classified as very stiff in consistency based on SPT value of 26 blows for 0.3 m of penetration. The natural moisture content ranged from 10% to 18%.

5.3 Sand

Native brown to grey sand containing trace to some silt and trace gravel was encountered below the fill in both boreholes. Thickness of the sand was 10.4 m and 2.8 m in Boreholes 08-041 and 08-042, respectively. The depths to the base of the native sand layer were 11.8 m and 4.3 m (Elevations 314.5 and 318.5), in Boreholes 08-041 and 08-042, respectively.

The sand is classified as compact to very dense, based on SPT 'N' values of 13 blows for 0.3 m of penetration to higher than 100 blows for 0.225 m of penetration. The natural moisture content ranged from 3% to 19%.

Grain size distribution curves for five selected samples of sand are presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 2
Sand	86 to 92
Silt & Clay	8 to 14

5.4 Silty Clay Till

Native grey silty clay till containing some sand to sandy, trace gravel and occasional sand seams was contacted below the native sand at 11.8 m and 4.3 m depth (Elevations 314.5 and 318.5), in Boreholes 08-041 and 08-042, respectively. Thickness of the silty clay till was 8.2 m and 5.7 m. The depth to the base of the silty clay till was 20.0 m and 10.0 m (Elevations 306.3 and 312.8) in Boreholes 08-041 and 08-042, respectively.

The cohesive layer is very stiff to hard in consistency, based on SPT 'N' values ranging from 21 to 82 blows per 0.3 m of penetration. The moisture content varied from 8% to 22%.

Grain size distribution curve for one sample of silty clay till is presented on the Record of Borehole sheets and on Figure B2 of Appendix B. Atterberg Limits test results are presented on Figure B5 of Appendix B.

The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	1
Sand	16
Silt	48
Clay	35

Liquid Limit	30 -38
Plastic Limit	16 - 18

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

Although not encountered in the boreholes, this glacial till layer may contain cobbles and boulders.

5.5 Silty Clay

Native grey silty clay containing trace sand to sandy, trace gravel and occasional silt seams were contacted below the silty clay till deposit at 20.0 m and 10.0 m depth (Elevations 306.3 and 312.8) in Boreholes 08-041 and 08-042, respectively. Thickness of the silty clay layer was 14.4 m in Borehole 08-041.

The depth to the base of the silty clay was 34.4 m (Elevation 291.9) in Borehole 08-041. Borehole 08-042 was terminated within the silty clay at 20.1 m (Elevation 302.7).

The cohesive layer is very stiff to hard in consistency, based on SPT 'N' values ranging from 23 blows per 0.3 m of penetration to higher than 100 blows for 0.15 m of penetration. The moisture content varied from 18% to 39%.

Grain size distribution curves for seven samples of silty clay are presented on the Record of Borehole sheets and on Figure B3 of Appendix B. Atterberg Limits test results are presented on Figure B6 of Appendix B.

The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 1
Sand	1 to 36
Silt	32 to 56
Clay	16 to 66

Liquid Limit	39 to 48
Plastic Limit	19 to 21

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

5.6 Silt Till

Grey silt till containing some sand and trace clay was contacted below the silty clay in Borehole 08-041, at 34.4 m depth (Elevation 291.9). Borehole 08-041 was terminated within the silt till at 37.2 m depth (Elevation 289.1).

SPT 'N' values were higher than 100 blows for 0.15 m of penetration, indicating a very dense relative density. Moisture content was 20%.

Grain size distribution curve for a silt till sample is presented on the Record of Borehole sheets and on Figure B4 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	19
Silt	75
Clay	6

Although not encountered in the boreholes, this glacial till layer may contain cobbles and boulders which may account for the high SPT 'N'.

5.7 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. A standpipe piezometer was installed in Borehole 08-042 (at the proposed east abutment) to monitor water levels after completion of drilling. The water levels measured in the piezometer are summarized in Table 5.1, along with the measurements in the boreholes upon completion of drilling.

Table 5.1 – Water Level Measurements

Foundation Unit	Borehole	Date (2008)	Water Level (m)		Comment
			Depth	Elevation	
East Abutment	08-042	August 14	4.5	318.3	During drilling In piezometer
		August 20	7.9	314.9	

The piezometric reading indicates that the groundwater level is near Elevation 314.9 m.

Previous geotechnical investigation conducted in 1966 (Reference 1), indicates that groundwater level is near Elevation 318.0.

These are short term water level readings and seasonal fluctuations of the groundwater level are to be expected, in particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

All-Terrain Drilling of Waterloo, Ontario supplied a truck-mounted CME75 drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Stephane Loranger, C.E.T. and Mr. Shane Aziz of Thurber, under the direction of Mr. Alastair E. Gorman, P.Eng and Mr. Mark Farrant, P. Eng.

The coordinates for the boreholes and the ground surface elevations were determined by Thurber Engineering Ltd. using GPS equipment.

Overall supervision of the field program was conducted by Mr. Alastair E. Gorman, P.Eng. and Mr. M. Farrant, P. Eng. Interpretation of the data and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng. and Ms. R. Palomeque Reyna, P.Eng.

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

Thurber Engineering Ltd

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents preliminary geotechnical design recommendations to assist the design team to select and design a suitable foundation system for the new structure to carry the E-S Ramp and Connection Road below the CNR tracks.

Based on the Plates 2A and 2B of the E.A:

- The proposed E-S Ramp and Connection Road will pass under the existing twin CNR tracks.
- CNR tracks at the site location are currently near Elevations 325.0 to 326.0.
- Existing ground surface elevations near the proposed west and east abutment are 326.5 and 322.8, respectively.
- The proposed E-S Ramp and Connection Road grade will be in a cut with base elevation 318.0 to 318.5. A cut ranging in depth from 5.0 to 8.0 m will be required to pass the E-S Ramp and Connection Road under CNR tracks.
- Subject to discussions with CNR, construction of the structure will likely have to be done in stages in order to keep at least one track operational. Track protection will be required for this stage construction.
- Although no GA is available, this structure is assumed to be two span including two abutments and one pier.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of this investigation.

8 STRUCTURE FOUNDATIONS

The stratigraphy identified in the preliminary investigation consisted primarily of topsoil and sand, silty sand and clayey silt fill overlying a native layer of compact to very dense sand, very stiff to hard silty clay till and silty clay and very dense silt till.

Based on previous data (Reference 1), groundwater level was observed at Elevation 318.0. The piezometric reading installed during the current investigation, indicates that the groundwater level is near Elevation 314.9 m. The groundwater level may have been lowered by drainage created by the existing highway.

In the preparation of the preliminary geotechnical design recommendations, consideration was given to the following foundation types:

- Spread footings bearing on native soil
- Steel H-piles driven into the very dense soil

A comparison of the foundation alternatives based on advantages and disadvantages of each is included in Appendix D.

8.1 Spread Footings on Native Soil

Spread footings bearing on native soil generally are the least expensive form of construction.

The footings may be founded on native dense sand or very stiff to hard silty clay till. Bearing resistances and founding elevations, based on the stratigraphy encountered at the site, are given in Table 8.1. These elevations represent the highest elevations at which the foundations can be founded. It is recognized that, for a subway structure, the actual founding elevations may be below Elevation 318.0.

Table 8.1 – Bearing Resistances for Spread Footings

Element	Depth (m)	Elev. (m)	ULS _r (kPa)	SLS (kPa)
West Abutment (BH 08-041)	1.4 m below base of cut or deeper	323.5	450	300
		320.5	600	400
East Abutment (BH 08-042)		320.5	450	300

The bearing resistances in Table 8.1 are for vertical, concentric loading. In the case of eccentric or inclined loading, the bearing resistance must be adjusted as shown in the CHBDC (2006) Clause 6.7.3 and Clause 6.7.4.

The geotechnical SLS resistance values given above are based on an estimated total settlement not exceeding 25 mm. This settlement is expected to be substantially complete

by the end of construction. Differential settlement is not expected to exceed 20 mm across the width of the structure or between foundation elements.

Founding elevations presented in Table 8.1 are above the groundwater level measured in the piezometer. However, water was observed at Elevation 318.3 during drilling in Borehole 08-042. If water is observed during excavation, local groundwater control will be required to construct the footings in the dry and to prevent disturbance, instability and sloughing of the sides of the excavation, boiling of the footing base and loss in geotechnical resistance of the soils.

8.2 Steel H-Piles

The soil stratigraphy encountered at this site is considered to be suitable for the support of foundations on driven steel piles.

It is recommended that the H-piles be driven to achieve resistance in the hard silty clay encountered at this site. The depths and elevations at which the H-piles are expected to develop the required resistance are given in Table 8.3.

Table 8.3 – Estimated Pile Tip Elevation

Foundation Unit	Pile Tip Depth (m)	Pile Tip Elevation
West Abutment (BH 08-041)	25.3	301.0
East Abutment (BH 08-042)	17.3	305.5

8.2.1 Axial Resistance

For preliminary design, the vertical, axial, factored geotechnical resistance at Ultimate Limit States (ULS) and geotechnical resistance at Serviceability Limit States (SLS) for two pile sections when driven into the hard silty clay and silty clay till are presented in Table 8.4.

Table 8.4 – Axial Resistance of Two Pile Sections Founded on Hard Soils

Pile Section	Geotechnical Resistance (kN)	
	Factored ULS	SLS
HP 310 X 110	1,400	1,200
HP 360 X 132	1,600	1,400

The structural resistance of the pile must be checked by the structural designer.

Installation of the piles must be in accordance with SP 903S01 and must be controlled using the Hiley Formula and an ultimate resistance of 2,800 kN for an HP 310 X 110 pile and 3,200 kN for the HP 360 X 132 pile.

These are preliminary recommendations and may change during detail design based on the final alignment, final bridge arrangement and the results of the site investigation and field testing to be completed at that time.

Due to the possible presence of cobbles and boulders in the silty clay till through which the piles will be driven, the tips of all driven piles should be fitted with steel H-Pile driving shoes in accordance with OPSD 3000.100.

8.2.2 Downdrag

Downdrag on the piles is not an issue at this site.

8.3 Abutment Design Considerations

Since the preliminary design is for a subway, it is assumed that the railway bridge will be constructed with conventional abutments.

However, from a geotechnical perspective, the conditions at this site are considered to be suitable for the design of conventional, semi-integral or integral abutments.

8.4 Frost Cover

The design depth of frost penetration for this site is 1.4 m. All footing bases and undersides of pile caps/abutment stems must be provided with at least 1.4 m of soil cover.

8.5 Recommended Foundation

From a geotechnical perspective, and based on current information, the recommended abutment foundation consists of steel H-piles driven into the hard silty clay and silty clay till, despite the higher cost noted in Appendix D. Any piers may be founded on driven piles or spread footings.

9 PERMANENT CUT

Permanent earth cuts are required to construct the E-S Ramp and Connection Road at this site. The cut will be formed predominantly through about 5.0 to 8.0 m of existing fill and native compact to dense sand.

All excavations must be carried out in accordance with the requirements of the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the soils within the likely depth of excavation at this site may be classed as Type 3 soils for fills and Type 2 for very dense native sands; sands below the groundwater level may be classed as Type 3.

Based on this stratigraphy, cuts slopes through the sand and clay fills and native soils are expected to be stable at inclinations not steeper than 2H : 1V. It is anticipated that the base of the cut will generally consist of very dense sand and very stiff to hard silty clay till. MTO policy requires a mid-height bench in cut slopes higher than 6.0 m.

The proposed cut at E-S Ramp and Connection Road grades shown on EA Plates 2A and 2B will be at Elevations 318.0 to 318.5, approximately 3.5 m above the groundwater table observed in the site during present and previous investigations. However, perched water might be also observed during excavation within the fill sand and native sand layers.

During detail design, when the grade has been finalized, permanent drainage (if necessary) and slope protection requirements must be addressed.

10 TRACK PROTECTION

It is anticipated that track protection or trestles will be required to facilitate construction staging.

The geotechnical design requirements should be addressed during the detail design stage, at which time the staging requirements should be better understood.

11 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

1. Pile refusal at higher elevation.

Although there was little direct evidence of their presence during drilling, glacial till deposits inherently contain boulders. It is possible that a pile will achieve refusal at a higher elevation than anticipated due to encountering a boulder. If it is suspected that this is happening, the QVE must immediately bring it to the attention of the CA. If the CA cannot resolve the issue, it must be referred to the design team for resolution.

2. Pile fails to develop specified resistance.

If a pile has not developed the specified resistance after being driven 3 m beyond the anticipated pile tip elevation, stop driving and check the Hiley calculation and all input values. If the calculation still shows that the pile has not reached the specified resistance, the following procedure should be implemented:

- a) Stop driving in that pile group for 48 hours (minimum)
- b) After 48 hours, warm up the hammer on another pile then commence re-driving the subject pile and measure the resistance.
- c) If the pile still does not reach the specified resistance, the QVE must immediately advise the CA who, in turn, should refer the issue to the design team.

3. Destabilization of excavations

If excavation is carried out in cohesionless soil without prior implementation of adequate measures to control groundwater and surface water, there is a risk that the sides and or base of the excavation will be destabilized. This could lead to a risk to personnel working on site, or to a loss of bearing resistance in the soil.

Accordingly, it must be emphasized to the contractor that proper groundwater and surface water control measures must be in place prior to commencing excavation.

12 INVESTIGATION FOR DETAIL DESIGN

During the detail design phase of the project, additional site investigation and field testing will be required. The following minimum program is recommended:

1. Boreholes for structure foundations.

Additional boreholes may be required for the structure foundations, especially if the structure is built off the current E-S Ramp and Connection Road over CNR alignment and thus removed from the alignment of the current investigation.

If the final design involves a two-span structure, boreholes should be drilled at the proposed pier location.

Particular attention should be paid to assessing the depth of pile foundation during detail investigation. Attention should also be paid to groundwater levels and exploration off the existing road embankment is recommended.

2. If a rail detour is proposed, boreholes should be drilled along the detour alignment.

3. Cut stability

At least one borehole is required in the mainline cut to either side of the structure. The boreholes in the cut must include piezometers for groundwater monitoring. Stability of the cut must be investigated during detail design phase.

4. Since the bridge will carry CNR tracks, discussions will be held between CNR and MTO regarding a number of issues such as design of the bridge and staging of construction to maintain rail traffic. The foundation design should be done in accordance with AREMA manual.

13 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng and Ms. R. Palomeque Reyna, P.Eng.

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

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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






 Water Level
 Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.

TERMS					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No 08-041

1 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 110.33 E 226 090.75 ORIGINATED BY SLL
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK
 DATUM Geodetic DATE 2008.08.11 - 2008.08.13 CHECKED BY RPR

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					
326.3							20 40 60 80 100						
0.0	TOPSOIL: (40mm), occasional rootlets and roots												
0.1													
325.7	SAND, some gravel												
0.6	Brown Moist (FILL)												
	Clayey SILT, some sand to sandy, trace gravel		1	SS	26								
	Very Stiff												
324.9	Brown (FILL)												
1.4	SAND, trace to some silt, trace gravel		2	SS	36								
	Compact to Dense												
	Brown												
	Moist												
	occasional topsoil, black		3	SS	32								
			4	SS	28								
			5	SS	13								
			6	SS	100/ .225								
	Very Dense Grey												
			7	SS	100/ .200								
			8	SS	76								

Continued Next Page

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

RECORD OF BOREHOLE No 08-041

2 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 110.33 E 226 090.75 ORIGINATED BY SLL
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK
DATUM Geodetic DATE 2008.08.11 - 2008.08.13 CHECKED BY RPR

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	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	W _P	W	W _L	
								20 40 60 80 100				
314.5	SAND, trace to some silt, trace gravel Very Dense Grey Moist		9	SS	63		316					2 86 12 (SI+CL)
11.8	Silty CLAY, some sand to sandy, trace gravel Hard Grey (TILL)		10	SS	54		314					
			11	SS	33		313					1 16 48 35
							312					
							311					
			12	SS	31		310					
			13	SS	33		309					
							308					
			14	SS	31		307					
306.3												

Continued Next Page

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

RECORD OF BOREHOLE No 08-041

3 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 110.33 E 226 090.75 ORIGINATED BY SLL
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK
 DATUM Geodetic DATE 2008.08.11 - 2008.08.13 CHECKED BY RPR

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	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w			LIQUID LIMIT w _L	
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%)				
							20 40 60 80 100	20 40 60						
20.0	Continued From Previous Page		15	SS	23		306						0 6 30 64	
	Silty CLAY, trace to some sand Hard Grey													
				16	SS		73							
				17	SS		108							0 6 41 53
		18	SS	101/ .275										
		19	SS	58										
		20	SS	76										
		</												

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE


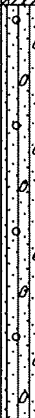
ONTMT4S 6417R GPJ 10/24/08

RECORD OF BOREHOLE No 08-041

4 OF 4

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 110.33 E 226 090.75 ORIGINATED BY SLL
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY FK
 DATUM Geodetic DATE 2008.08.11 - 2008.08.13 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								20 40 60 80 100							20 40 60		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							w _p w w _L		
	Continued From Previous Page																
	Silty CLAY Hard Grey		21	SS	55		296										
	silt seams		22	SS	74		295										
			23	SS	100/ .150		294										
291.9							293										
34.4	SILT , some sand, trace clay Very Dense Grey Moist (TILL)		24	SS	100/ .175		292										
							291										
							290										
289.1				25	SS	100/ .150									0 19 75 6		
37.2	END OF BOREHOLE AT 37.2m BOREHOLE BACK FILLED WITH GROUT TO 0.61m HOLEPLUG TO SURFACE																

ONTMT4S 6417R.GPJ 11/12/09

RECORD OF BOREHOLE No 08-042

1 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 134.35 E 226 152.53 ORIGINATED BY SA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2008.08.14 - 2008.08.14 CHECKED BY RPR

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		
322.8												
0.0	TOPSOIL: (300mm), occasional roots											
322.5	Dark Brown		1	SS	32							
0.3	Moist											
	Silty SAND, trace gravel, occasional											
	topsoil											
	Compact to Dense		2	SS	25		322					
	Brown to Dark Brown											
	Moist											
	(FILL)											
321.3												
1.5	SAND, trace to some silt		3	SS	17		321					0 86 14
	Compact to Very Dense											(SI+CL)
	Brown		4	SS	52							
	Moist											
			5	SS	100		320					0 92 8
												(SI+CL)
							319					
318.5												
4.3	Silty CLAY, some sand, trace gravel,		6	SS	21		318					
	occasional silty sand seams											
	Very Stiff to Hard											
	Grey						317					
	(TILL)		7	SS	36							
							316					
			8	SS	82		315					
							314					
	Occasional sand seams		9	SS	42							
312.8							313					

Continued Next Page

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

ONTMT4S 6417R.GPJ 10/28/08

RECORD OF BOREHOLE No 08-042

2 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 814 134.35 E 226 152.53 ORIGINATED BY SA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2008.08.14 - 2008.08.14 CHECKED BY RPR

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	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	W _P	W	W _L	
10.0	Silty CLAY, trace gravel, trace sand Hard Grey		10	SS	39		312					
			11	SS	36		311					0 1 36 63
			12	SS	61		310					
			13	SS	100/ .225		309					1 36 38 25
	sandy		14	SS	100/ .150		308					1 27 57 16
			15	SS	118/ .100		307					0 1 41 58
							306					
							305					
							304					
							303					

Continued Next Page

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

METRIC

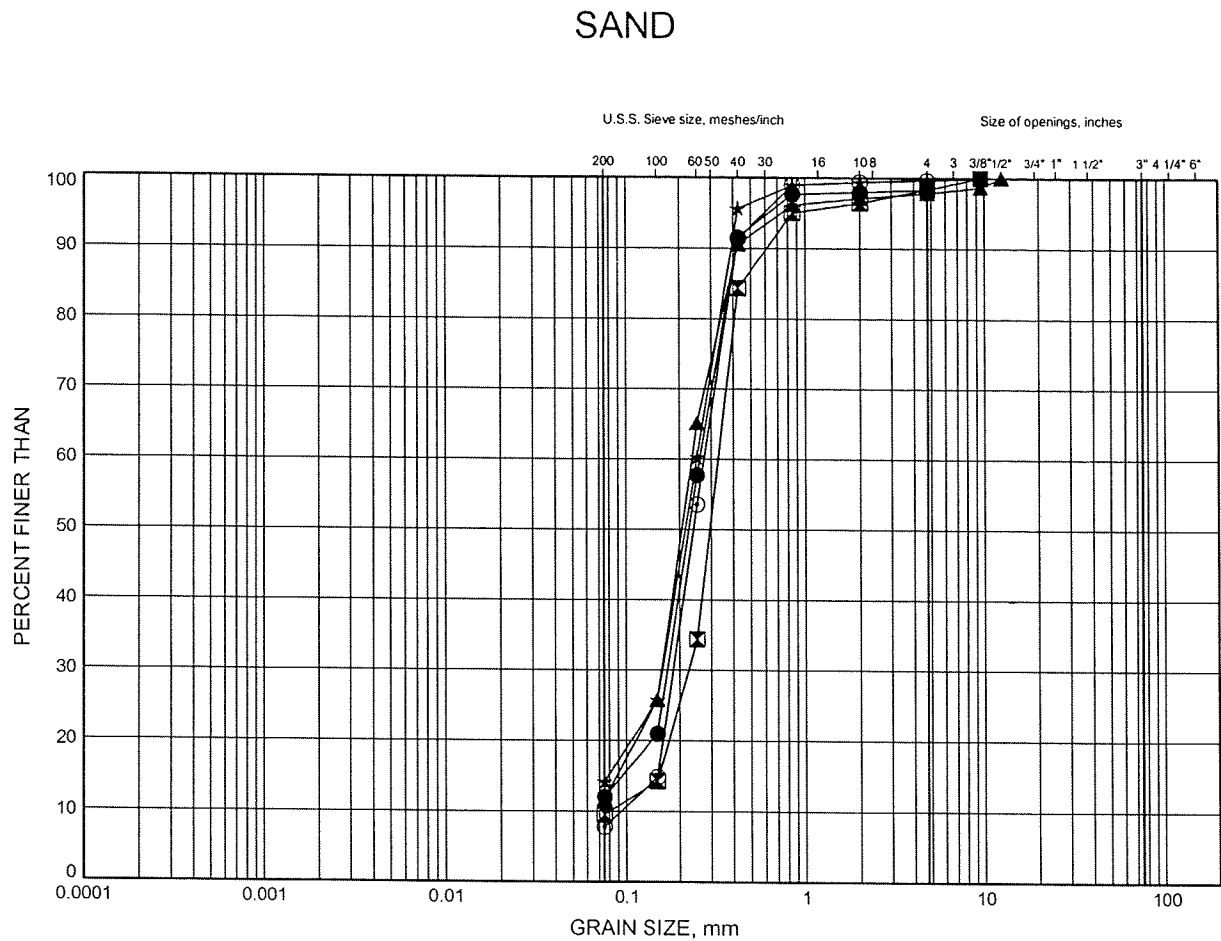
SOIL PROFILE																				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER TYPE "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
						20 40 60 80 100 					W _p	W	W _L	γ						
						SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)			kN/m ³	GR SA SI C					
						20	40	60	80	100	20	40	60							
302.7	Continued From Previous Page	/ / /	16 SS 100%	A A B																
20.1	END OF BOREHOLE AT 20.1m. WATER LEVEL OBSERVED AT 4.5m DURING DRILLING. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.08.20 7.9 314.9		.150		302															

Appendix B

Laboratory Test Results

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B1



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-041	3.35	322.95
⊠	08-041	7.80	318.50
▲	08-041	10.96	315.34
☆	08-042	1.83	320.95
⊙	08-042	3.35	319.43

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 10/28/08

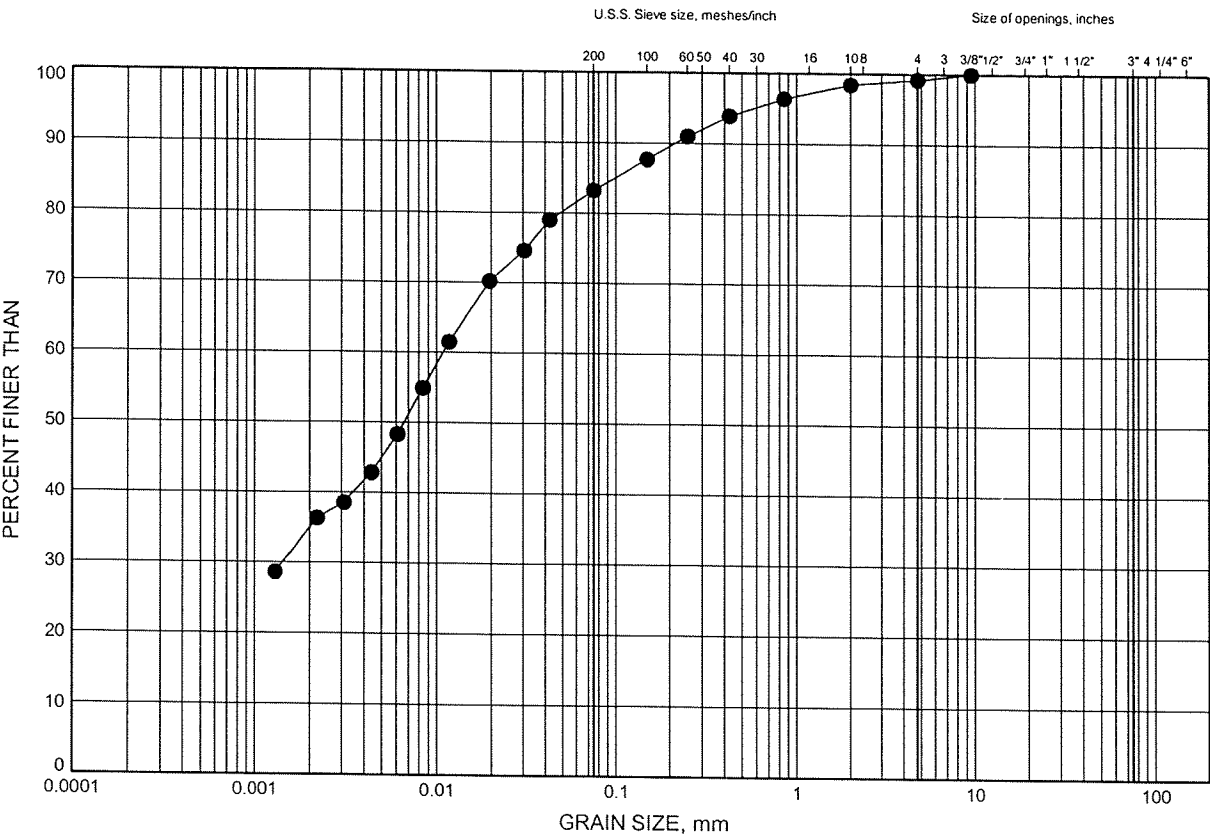
W.P.# 408-88-00
Prepared By AN
Checked By RPR



Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty Clay Till



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

LEGEND

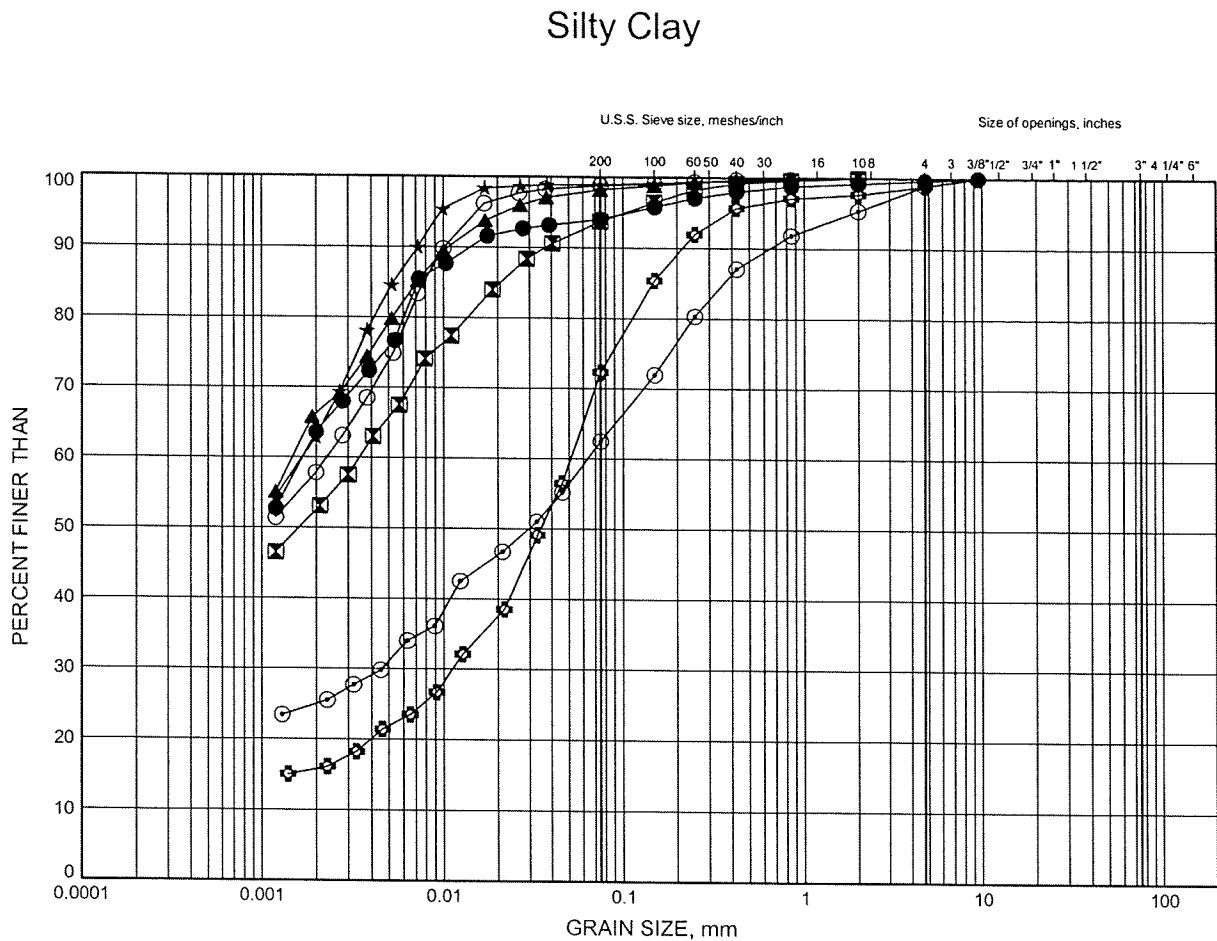
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-041	14.02	312.28



W.P.# 408-88-00.....
 Prepared By AN.....
 Checked By RPR.....

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B3



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-041	20.12	306.18
⊠	08-041	24.46	301.84
▲	08-041	29.26	297.04
☆	08-042	12.50	310.29
⊙	08-042	15.29	307.49
⊛	08-042	16.92	305.87

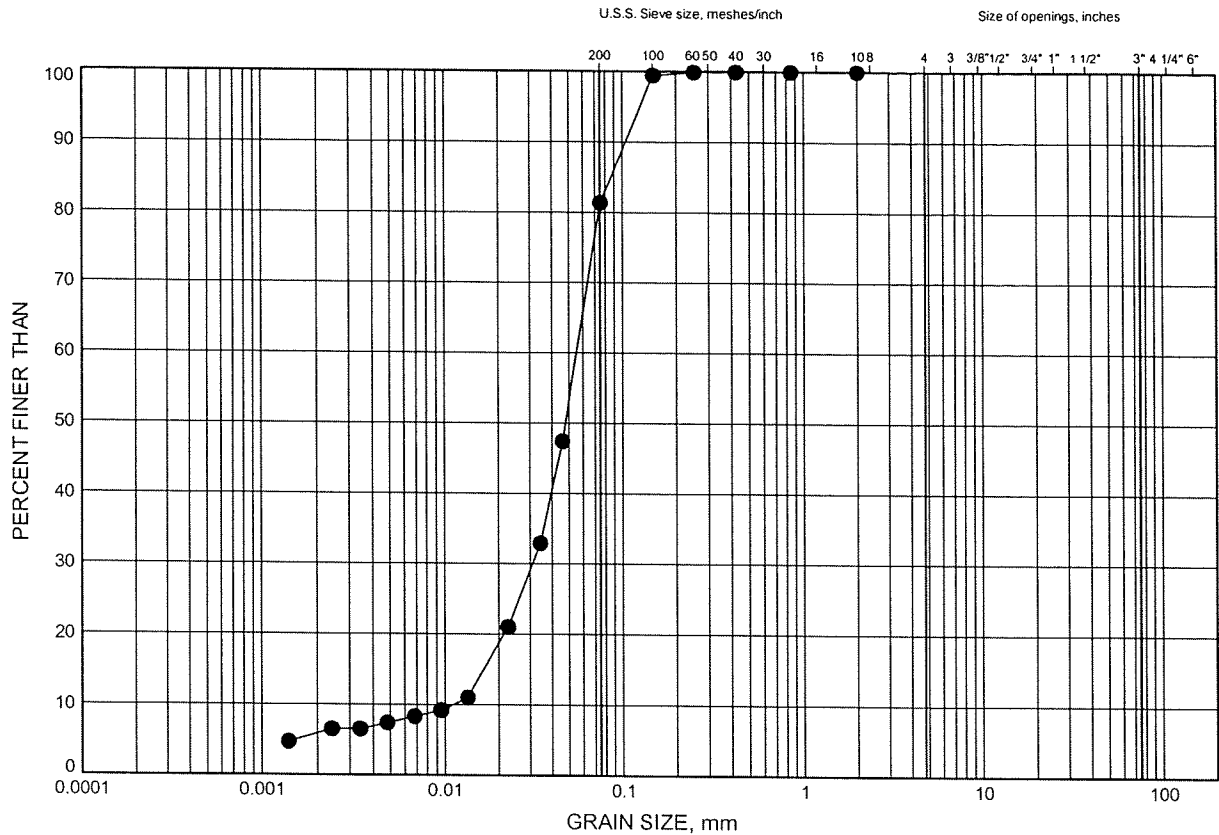


W.P.# 408-88-00
Prepared By AN
Checked By RPR

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B4

Silt Till



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

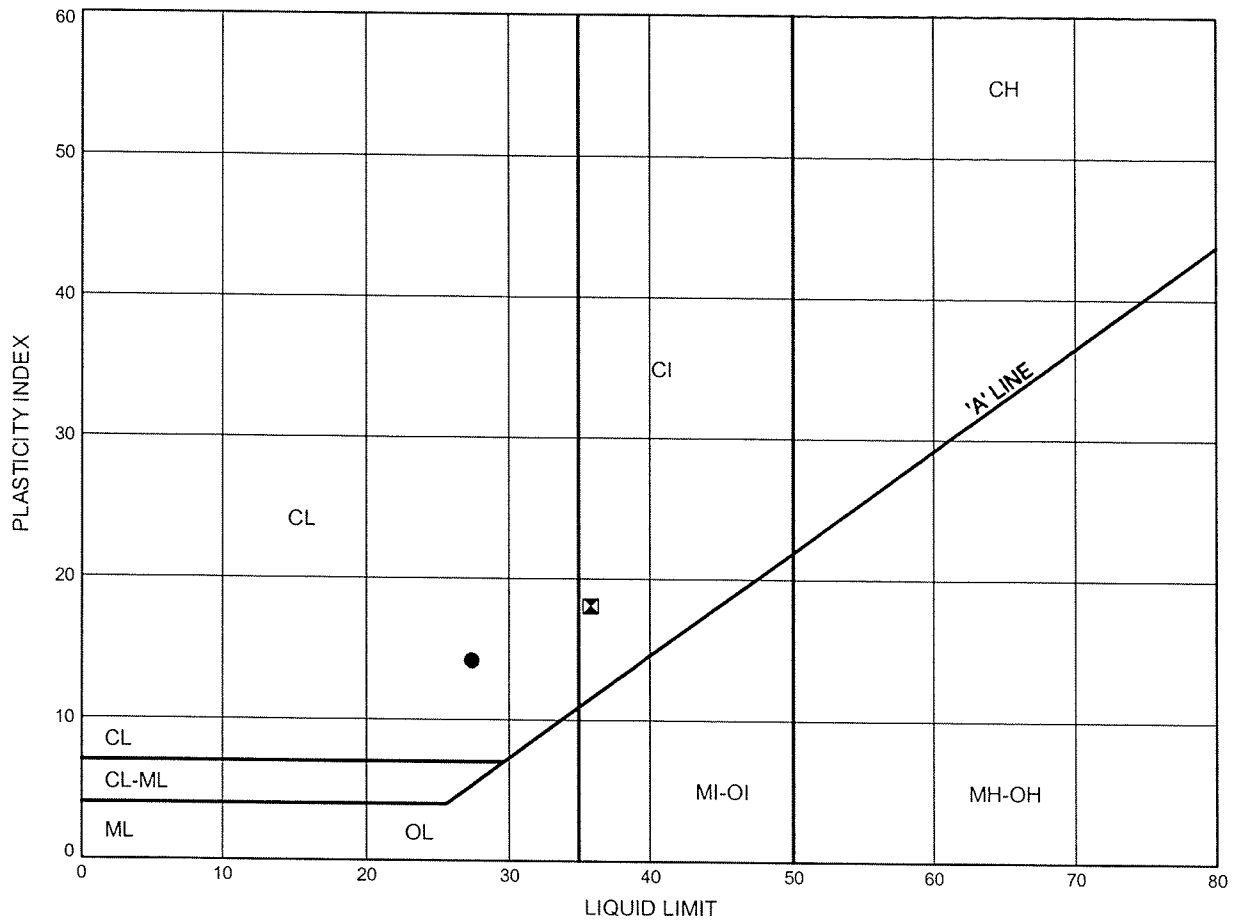
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-041	36.73	289.57

Highway 7 - New ATTERBERG LIMITS TEST RESULTS

FIGURE B5

Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-041	14.02	312.28
⊠	08-042	9.45	313.33

Date October 2008
 Project 408-88-00

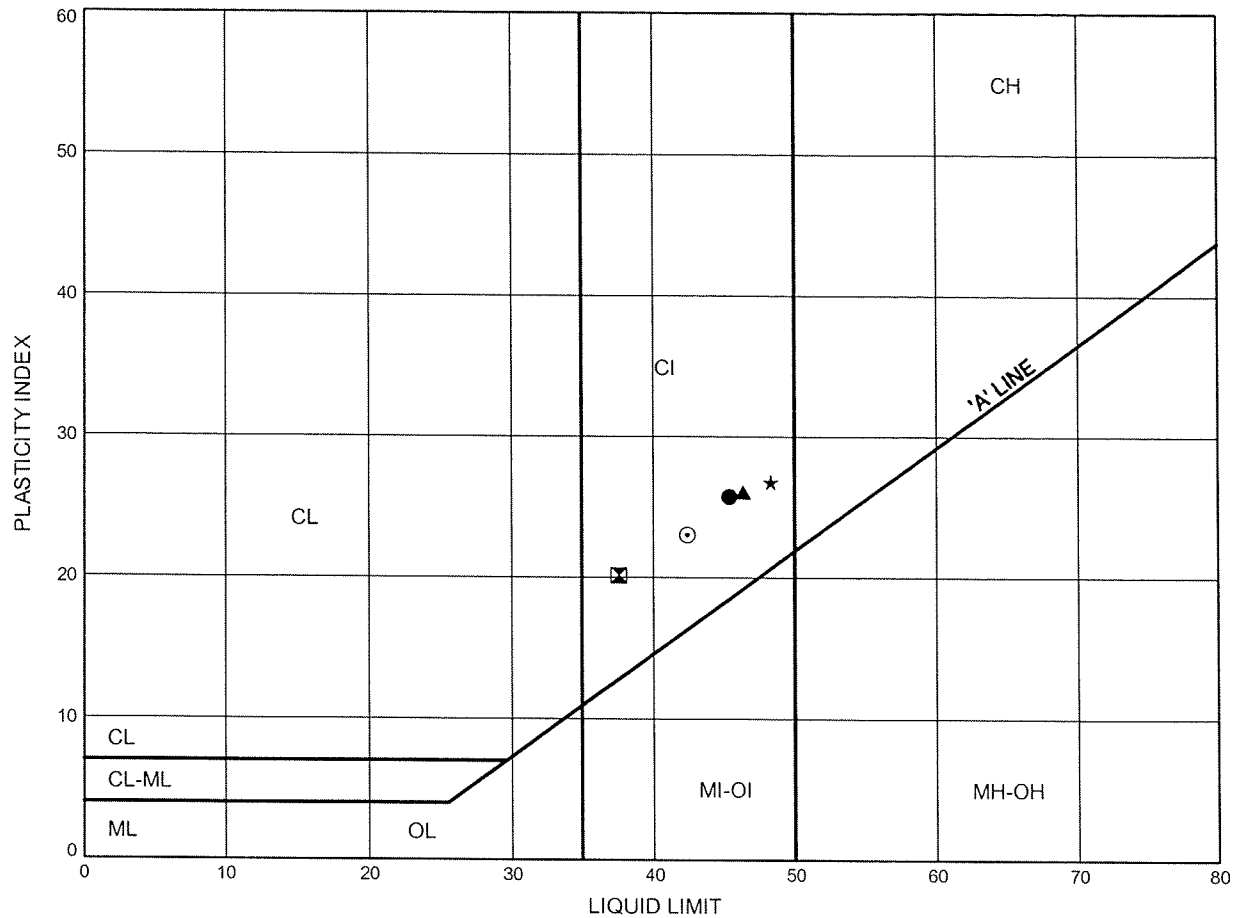


Prep'd AN
 Chkd. RPR

Highway 7 - New ATTERBERG LIMITS TEST RESULTS

FIGURE B6

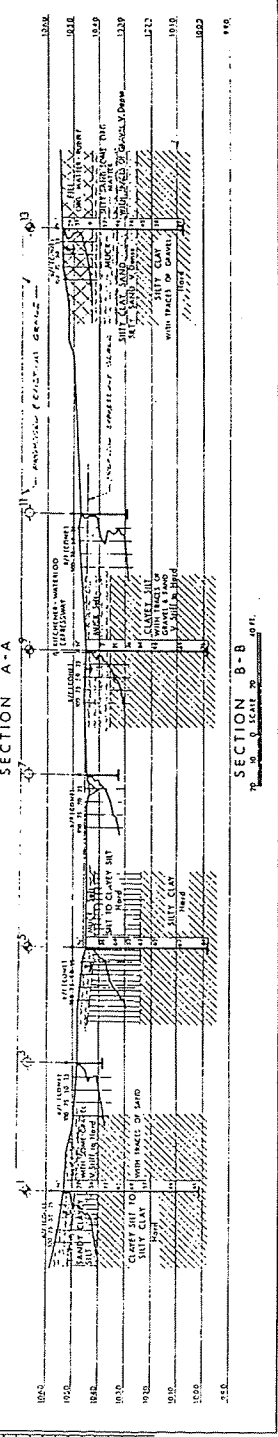
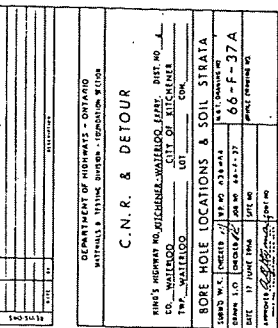
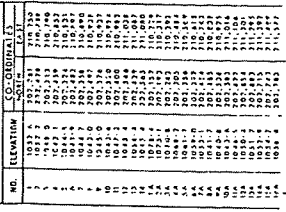
Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-041	20.12	306.18
⊠	08-041	24.61	301.69
▲	08-041	29.26	297.04
★	08-042	12.50	310.29
⊙	08-042	18.59	304.19

Appendix C

Record of Borehole Sheets (Previous Investigation)



OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO				RECORD OF BOREHOLE NO. 1				FOUNDATION SECTION			
MATERIALS & TESTING DIVISION				LOCATION <u>N202, 281.476; E 210, 750.638</u>				ORIGINATED BY <u>W.K.K.</u>			
JOB <u>66-F-37</u>				BORING DATE <u>May 3, 1966</u>				COMPILED BY <u>W.E.</u>			
W.P. <u>636-64</u>				BOREHOLE TYPE <u>Washboring NX Casing</u>				CHECKED BY <u>g/k</u>			
DATUM <u>1052.65</u>											
ELEV. DEPTH	SOIL PROFILE	SAMPLES	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W	WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS			
1052.65	Ground Level										
1048.6	Muck Soft		1050					W.L. El. 1051.3 Observed in Casing			
4.0	Sand Clayey Silt with some Gravel Very Stiff to Hard	1 SS 30						Gravel 10% Sand 34% Silt 37% Clay 19%			
1039.6		2 SS 56	1040								
13.0		3 SS 77									
	Clayey Silt to Silty Clay	4 SS 62	1030								
	with traces of Sand	5 SS 49									
	Hard	6 SS 57	1020					Sand 8% Silt 60% Clay 32%			
		7 SS 46	1010								
1001.5	End of Borehole	8 SS 61									
51.5			1000								

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1A

FOUNDATION SECTION

JOB 66-P-37 LOCATION N 202,157.733 ; E 210,229.947 ORIGINATED BY W.W.K.
 W.P. 636-64 BORING DATE May 13, 1966 COMPILED BY W.E.
 DATUM 1076.47 BOREHOLE TYPE Washboring NX Casing CHECKED BY W.E.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT PLASTIC LIMIT WATER CONTENT		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	W.P.	W.L.		
1076.47	Ground Level									
1075.5	Black Org. topsoil									
1.0	Silty Sand Dense	1	SS	1070	28					
1164.9		2	SS	1060	40					
11.5	End of Borehole									Sand 80% Silt 20% Clay

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO		RECORD OF BOREHOLE NO. 2		FOUNDATION SECTION	
MATERIALS & TESTING DIVISION		LOCATION <u>N 202, 428, 668: E 210, 788.941</u>		ORIGINATED BY <u>W.W.K.</u>	
JOB <u>66-F-37</u>		BORING DATE <u>May 4, 1966</u>		COMPILED BY <u>W.E.</u>	
W.P. <u>636-64</u>		BOREHOLE TYPE <u>Penetration Only</u>		CHECKED BY <u>W.E.</u>	
DATUM <u>1052.28</u>					

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			REMARKS
			NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.				
1052.28 0.0	Ground Level					1050						
1039.28 13.0	Penetration Only					1040						
	End of Penetration					1030						

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,193.911 ; E 210,317.885 ORIGINATED BY W.W.K.
W.P. 636-64 BORING DATE May 13, 1966 COMPILED BY W.E.
DATUM 1075.10 BOREHOLE TYPE Washboring NX Casing CHECKED BY gll

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WATER CONTENT % 10 20 30	BULK DENSITY P.C.F.	
1075.10	Ground Level								
1074.1	Black Org. Topsoil								
1.0	Silty Sand Compact to Dense	1	SS 23				0		
1063.6		2	SS 33				0		
11.5									
	End of Borehole								Sand 89% Silt 11% Clay

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,243.57 ; E 210,392.179 ORIGINATED BY W.W.K.
W.P. 636-64 BORING DATE May 13, 1966 COMPILED BY W.E.
DATUM 1070.88 BOREHOLE TYPE Washboring NX Casing CHECKED BY ak

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.	WATER CONTENT %		
1070.88	Ground Level	1070								
1069.9	Black Org. Topsoil	1070								
1.0	Silty Sand		1	SS	17					
	Compact									
1059.3			2	SS	29	1060				
11.5	End of Borehole					1050				

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,459.731; E210,853.370 ORIGINATED BY W.W.K.
W.P. 636-64 BORING DATE May 5, 1966 COMPILED BY W.E.
DATUM 1043.16 BOREHOLE TYPE Washboring NX Casing CHECKED BY W.E.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		20	40	60	
1043.16	Ground Level							
1039.1	Muck Soft	1	SS	26				
4.0		2	SS	80				
	Silty Clay with Traces of Sand	3	SS	26				
		4	SS	52				
	Stiff to Hard	5	SS	53				
		6	SS	62				
		7	SS	68				
1001.66		8	SS	135				
41.5	End of Borehole							

W.L. El. 1041.7
Observed in Casing
Sand 6%
Silt 44%
Clay 50%

Sand 10%
Silt 39%
Clay 51%

OFFICE REPORT ON SOIL EXPLORATION

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4A

FOUNDATION SECTION

ORIGINATED BY W.W.K.

COMPILED BY
W. E.

CHECKED BY *h-l*

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202.324.399 ; E 210.831.709 ORIGINATED BY W.W.K.
 W.P. 636-64 BORING DATE May 3, 1966 COMPILED BY W.E.
 DATUM 1044.85 BOREHOLE TYPE Washboring NX Casing CHECKED BY W.E.

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W	BULK DENSITY P.C.F.	REMARKS
		NUMBER	TYPE		20	40			
1044.85	Ground Level								
1041.8	Muck Soft								
3.0	Silt to Clayey Silt	1	SS 36	1040					
		2	SS 64						
	Hard	3	SS 52	1030					
		4	SS 63						
1024.3		5	SS 62	1020					
20.5	Silty Clay								
	Hard	6	SS 67	1010					
		7	SS 84	1000					
998.35									
45.5	End of Borehole								

N.L. EL.
1043.6
Observed in
Casing
Sand 14%
Silt 80%
Clay 6%

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202.356.975 : E 210.569.960 ORIGINATED BY W.W.K.
 W.P. 636-64 BORING DATE May 11, 1966 COMPILED BY W.E.
 DATUM 1061.73 BOREHOLE TYPE Washboring NX Casing CHECKED BY HL

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WP	WATER CONTENT %		
1061.73 Ground Level				1060						
1060.23 Black Org. Topsoil										
1.5	Silty Sand	1	SS							
	Loose to V. Dense	2	SS							
		3	SS							
1040.2		4	SS							
21.5	End of Borehole									

W.L. EL.
 ▼ 1053.2
 Observed in
 Casing
 Gravel 4%
 Sand 88%
 Silt 7%
 Clay

MATERIALS & TESTING DIVISION

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,483.115: E 210,897.822 ORIGINATED BY W.W.K.
 W.P. 636-64 BORING DATE May 3, 1966 COMPILED BY W.E.
 DATUM 1041.90 BOREHOLE TYPE Penetration Only CHECKED BY OK

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 66-F-37

W.P. 636-64

DATUM 1059.09

RECORD OF BOREHOLE NO. 6A

FOUNDATION SECTION

LOCATION N 202,399.565 ; E 210,618.220

BORING DATE May 11, 1966

BOREHOLE TYPE Washboring NX Casing

ORIGINATED BY W.W.K.

COMPILED BY W.E.

CHECKED BY *W.E.*

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — w	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1059.09	Ground Level							
1058.09	Black Org. Topsoil							
1.0		1	SS 35	1050				
	Silty Sand	2	SS 77					
	Dense to V. Dense	3	SS 100/6"	1040				
1036.09		4	SS 100					
23.0	Clayey Silt with							
1032.49	some Sand	5	SS 108	1030				
26.6	End of Borehole			1020				

W.L. El.
1051.4
Observed in
Casing

Sand 19%
Silt 52%
Clay 29%

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO			RECORD OF BOREHOLE NO. 7			FOUNDATION SECTION		
MATERIALS & TESTING DIVISION			LOCATION			ORIGINATED BY		
JOB			BORING DATE			COMPILED BY		
W.P.			BOREHOLE TYPE			CHECKED BY		
DATUM			Penetration Only					
ELEV. DEPTH	SOIL PROFILE	STRAT. PLOT	SAMPLES		DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT PLASTIC LIMIT WATER CONTENT	BULK DENSITY	REMARKS
			NUMBER	TYPE				
1044.77 0.0	Ground Level							
1032.77 12.0	Penetration Only							
	End of Penetration							

MATERIALS & TESTING DIVISION

DATUM 1053.17

BOREHOLE TYPE Washboring NX Casing

CHECKED BY

SOIL PROFILE		STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	SHEAR STRENGTH P.S.F.	LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— w WP ——— w ——— WL WATER CONTENT % 10 20 30	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT						
1053.17	Ground Level										
0.0	Silty Sand Compact to Dense					1050					
1040.17			1	SS	23						
13.0			2	SS	53						
1031.6	Clayey Silt with Traces of Sand and Fine Gravel Hard		3	SS	53						
21.5			4	SS	82						
	End of Borehole					1030					
						1020					

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,497.114 ; E 210,938.122 ORIGINATED BY W.W.K.
W.P. 636-64 BORING DATE May 5, 1966 COMPILED BY W.E.
DATUM 1043.04 BOREHOLE TYPE Washboring NX Casing CHECKED BY W.E.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT SHEAR STRENGTH P.S.F.	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1043.04	Ground Level							
1039.5	Muck	1	SS	18				
3.5	Soft	2	SS	41				
	Silty Clay with Traces of Sand	3	SS	44				
	Stiff to Hard	4	SS	45				
		5	SS	25				
		6	SS	43				
		7	SS	34				
		8	SS	104				
996.54	End of Borehole							

W.L. El.
1041.5
Observed in
Casing

Gravel 1%
Sand 2%
Silt 34%
Clay 63%

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 8A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N202, 485.565 : E 210, 838.988 ORIGINATED BY W.W.K.
 W.P. 636-64 BORING DATE May 11, 1966 COMPILED BY W.T.E.
 DATUM 1041.76 BOREHOLE TYPE Washboring NX Casing CHECKED BY W.T.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — w	WATER CONTENT % 10 20 30	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE						
1041.76	Ground Level								
1039.76	Black Org. Topsoil			1040					
2.0									
	Silty Clay with Traces of Sand and occ. Gravel	1	SS 27						
	Very Stiff to Hard	2	SS 42	1030					
		3	SS 77						
1025.2									
16.5	End of Borehole			1020					

1040.6
W.I. El.
Observed in
Casing
Sand 2%
Silt 47%
Clay 51%

MATERIALS & TESTING DIVISION

DATUM 1045.02

BOREHOLE TYPE Washboring NX Casing

RECORD OF BOREHOLE NO. 9

FOUNDATION SECTION

CHECKED BY

[illegible]

MATERIALS & TESTING DIVISION

LOCATION N 202, 536, 090 ; E 210, 925, 818
BORING DATE May 10, 1966
BOREHOLE TYPE Washboring NX Casing

RECORD OF BOREHOLE NO. 9A

FOUNDATION SECTION

ORIGINATED BY W.W.K.
COMPILED BY W.E.
CHECKED BY sk

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE					
1040.88	Ground Level								
1039.38	Black Org. Topsoil								1039.4 W.L. El. Observed in Casing
1.5	Clayey Silt with Traces of Sand and occ. Gravel		1	SS	31				
	Very Stiff to Hard		2	SS	57				Sand 5% Silt 57% Clay 38%
1024.3			3	SS	64				
16.5	End of Borehole								

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO		RECORD OF BOREHOLE NO. 10		FOUNDATION SECTION	
MATERIALS & TESTING DIVISION		LOCATION <u>N 202,520,538 ; E 210,984,640</u>		ORIGINATED BY <u>W.W.K.</u>	
JOB <u>66-F-37</u>		BORING DATE <u>May 6, 1966</u>		COMPILED BY <u>W.E.</u>	
W.P. <u>636-64</u>		BOREHOLE TYPE <u>Penetration Only</u>		CHECKED BY <u>off</u>	
DATUM <u>1043.63</u>					

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w	BULK DENSITY γ P.C.F.	REMARKS
			NUMBER	TYPE	BLOWS / FOOT				
1043.63 0.0	Ground Level								
	Penetration Only								
1029.63 14.0	End of Penetration								

FOUNDATION SECTION

CHECKED BY

SOIL PROFILE		STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.			
1043.63	Ground Level										1041.4 W.L. El. Observed in Casing Gr. 4% Sa. 13% Si. 57% Cl. 26%
1042.63	Black Org. Topsoil										
2.0	Clayey Silt with some Sand and Traces of Gravel	1	SS	24							
	Very Stiff to Hard	2	SS	41							
1027.1											
16.5	End of Borehole		3	SS	68						

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 11

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202.400.356 ; E 210.983.633 ORIGINATED BY W.W.K.
W.P. 636-64 BORING DATE May 2, 1966 COMPILED BY W.E.
DATUM 1047.23 BOREHOLE TYPE Penetration Only CHECKED BY SK

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1047.23	Ground Level							
0.0	Penetration Only			1040				
1029.23				1030				
18.0	End of Penetration							

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 11A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,622,339 : E 211,106,332 ORIGINATED BY W.W.K.W.P. 636-54 BORING DATE May 10, 1966 COMPILED BY W.T.E.DATUM 1046.54 BOREHOLE TYPE Washboring NX Casing CHECKED BY SK

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.			
1046.54	Ground Level									
1043.54	Black Org. Topsoil	1	SS	17	1040					
3.0	Clayey Silt with some Sand and Traces of Gravel	2	SS	32						
	V. Stiff to Hard	3	SS	72	1030					
1040.54	End of Borehole				1020					

V. 1044.3

W.L. = EL.

Observed

In Casing

Gr. 2%

Sa. 15%

Si. 57%

Cl. 26%

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 12

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,546.057 ; E211,038.933 ORIGINATED BY W.W.K.
W.P. 636-64 BORING DATE May 6, 1966 COMPILED BY W.C.
DATUM 1045.43 BOREHOLE TYPE Washboring NX Casing CHECKED BY [Signature]

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		REMARKS				
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		20	40	60		80	100	W.P.	W.L.
1045.43	Ground Level											
1042.9	Black Org. Topsoil	1	SS	34								
2.5	Clayey Silt to Silty Clay with traces of Sand	2	SS	27								
	Very Stiff to Hard	3	SS	65								
		4	SS	93								
		5	SS	102								
		6	SS	70								
		7	SS	63								
		8	SS	87								

W.L. El. 1043.2
Observed in
Casing
Gravel 18%
Sand 19%
Silt 53%
Clay 24%

Gravel 18%
Sand 6%
Silt 68%
Clay 25%

WATER CONTENT 15.5%

W.P. — W.L.

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 12A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202.654.890 : E 211.201.213 ORIGINATED BY W.W.K.
 W.P. 636-64 BORING DATE May 10, 1966 COMPILED BY W.T.E.
 DATUM 1050.41 BOREHOLE TYPE Washboring NX Casing CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			ELEV. SCALE		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT PLASTIC LIMIT WATER CONTENT		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WL PL WP	WATER CONTENT %		
1050.41	Ground Level											
1047.11	Black Org. Topsoil											
3.3	Silty Sand		1	SS	25							
1043.41	Compact											
7.0	Clayey Silt with some Sand and traces of Gravel.		2	SS	57							
1033.9	Hard		3	SS	78							
16.5	End of Borehole											
						1040						W.L. El. <u>1046.7</u> Observed in Casing Gr. 2% Sa. 12% Sl. 52% Cl. 34%
						1030						
						1020						

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 13

FOUNDATION SECTION

JOB 66-E-37 LOCATION N 202,439.340 ; 211,087.105 ORIGINATED BY W.W.K.
W.P. 636-64 BORING DATE May 2, 1966 COMPILED BY W.E.
DATUM 1054.46 BOREHOLE TYPE Washboring NX Casing CHECKED BY W.E.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WATER CONTENT %	BULK DENSITY	
1054.46	Ground Level				20 40 60 80 100				
1043.5	Org. matter - Rubble City Dump Fill	1	SS	1050					W.L. El. 1050.7 Observed in Casing
11.0	Muck Silty Sand Some Org. Matter	2	SS						Gravel 2% Sand 58% Silt 35% Clay 5%
1034.0		3	SS	1040					
20.5	Silty Clay Sand with traces of Gravel	4	SS						
1030.5		5	SS	1030					
24.0	Silty Sand Very Dense	6	SS						
1026.5		7	SS	1020					Sand 95% Silt 1% Clay 5%
28.0	Silty Clay with Traces of Gravel	8	SS						
1007.96	Hard	9	SS	1010					Sand 1% Silt 48% Clay 51%
16.5	End of Borehole								

DEPARTMENT OF HIGHWAYS - ONTARIO				RECORD OF BOREHOLE NO. 13A				FOUNDATION SECTION					
MATERIALS & TESTING DIVISION				LOCATION <u>N 202.683.675 : E 211.295.186</u>				ORIGINATED BY <u>W.W.K.</u>					
JOB <u>66-F-37</u>				BORING DATE <u>May 10, 1966</u>				COMPILED BY <u>W.T.E.</u>					
W.P. <u>636-54</u>				BOREHOLE TYPE <u>Washboring NX Casing</u>				CHECKED BY <u>[Signature]</u>					
DATUM <u>1051.75</u>													
SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		PLASTIC LIMIT		WATER CONTENT		REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLAT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	W.P.	W.L.	W.P.	W.L.	W.P.	W.L.	
1051.75	Ground Level												
1048.75	Black Org. Topsoil												
3.0	Sandy Silt Dense		1	SS	30	1050							
1043.75													
5.0	Clayey Silt with some Sand and traces of Gravel.		2	SS	47	1040							
1035.2	Hard		3	SS	94	1030							
16.5	End of Borehole					1020							

1048.6
W.L. Bl.
Observed in
Casing
Gr. 48%
Sa. 14%
Sl. 55%
Cl. 27%

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 66-F-37

W.P. 636-64

DATUM 1045.49

RECORD OF BOREHOLE NO.14

FOUNDATION SECTION

LOCATION N 202,565.448 ; E 211,080.483

ORIGINATED BY W.W.K.

BORING DATE May 6, 1966

COMPILED BY W.E.

BOREHOLE TYPE Penetration Only

CHECKED BY *[Signature]*

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1045.49	Ground Level							
0.0	Penetration Only			1040				
1033.49								
12.0	End of Borehole			1030				

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 14A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202.715.647 : E 211.392.946 ORIGINATED BY W.W.K.
 W.P. 636-64 BORING DATE May 10, 1966 COMPILED BY W.T.E.
 DATUM 1052.95 BOREHOLE TYPE Washboring NX Casing CHECKED BY SKL

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — w	BULK DENSITY P.C.F.	REMARKS
			NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.			
1052.95	Ground Level										
0.0						1050					
1049.45	Black Org. Topsoil										
3.5											
1044.45	Sandy Silt Dense		1	SS	30						
8.5											
1040.45	Clayey Silt with some Sand and Gravel		2	SS	60	1040					
1036.4			3	SS	95						
16.5	Hard					1030					
	End of Borehole					1020					

Y 1051.9
 W.L. El.
 Observed
 in Casing
 Gr. 16%
 Sa. 15%
 Si. 44%
 Cl. 25%

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 15A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,743.706 ; E 211,489.961 ORIGINATED BY W.W.K.
W.P. 636-64 BORING DATE May 9, 1966 COMPILED BY W.T.E.
DATUM 1054.26 BOREHOLE TYPE Washboring NX Casing CHECKED BY W.T.E.

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT PLASTIC LIMIT WATER CONTENT W.P. ——— W.L. W.P. ——— W.L. WATER CONTENT % 10 20 30	BULK DENSITY P.C.F.	REMARKS
			NUMBER	TYPE	BLOWS / FOOT						
1054.26 C.O.	Ground Level										
1051.26 3.0	Black Org. Top Soil		1	SS	54	1050					W.L. El.
	Silty Sand with traces of Clay and Gravel		2	SS	14					Gr. 28	Observed
	Compact to V. Dense		3	SS	45					Sl. 17	in Casing
1037.2 16.5	Clayey Silt with some Sand		4	SS	85	1040				Cl. 11	
	End of Borehole					1030					

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 16A

FOUNDATION SECTION

JOB 66-F-37 LOCATION N 202,783.026 ; E 211,577.289 ORIGINATED BY W.W.K.
 W.P. 636-64 BORING DATE May 9, 1966 COMPILED BY W.T.E.
 DATUM 1056.47 BOREHOLE TYPE Washboring NX Casing CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.	WP	WL			
1056.47	Ground Level										
0.0											
1053.47	Black Org. Top Soil	1	SS	20							
3.0		2	SS	33	1050						
	Silty Sand with traces of Clay and Gravel	3	SS	57							
	Compact to V. Dense	4	SS	74	1040						
1038.47		5	SS	126	1030						
18.0	Clayey Silt with some Sand - Hard										
1034.97											
21.5	End of Borehole										

W.L. El. 1049.4
 P.C.F. 11.4%
 Observed in Casing

Appendix D

Foundation Comparison

COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Foundation Element	Spread Footings	Driven Piles
Abutments	<p>Advantages:</p> <ul style="list-style-type: none">i. Generally less costly construction than deep foundation elements. <p>Disadvantages:</p> <ul style="list-style-type: none">i. Lower geotechnical resistance available due to founding on compact soils near the surface.ii. Dewatering may be required, depending on depth of excavation.	<p>Advantages:</p> <ul style="list-style-type: none">i. High geotechnical resistance may be developed by driving the piles into hard soils.ii. Comparatively short abutment stem possibleiii. Permits integral abutment design <p>Disadvantages:</p> <ul style="list-style-type: none">i. Higher unit cost compared to footings.
	NOT RECOMMENDED	RECOMMENDED

Appendix E
Site photographs

E-S Ramp under CNR
Highway 7-New, Kitchener to Guelph

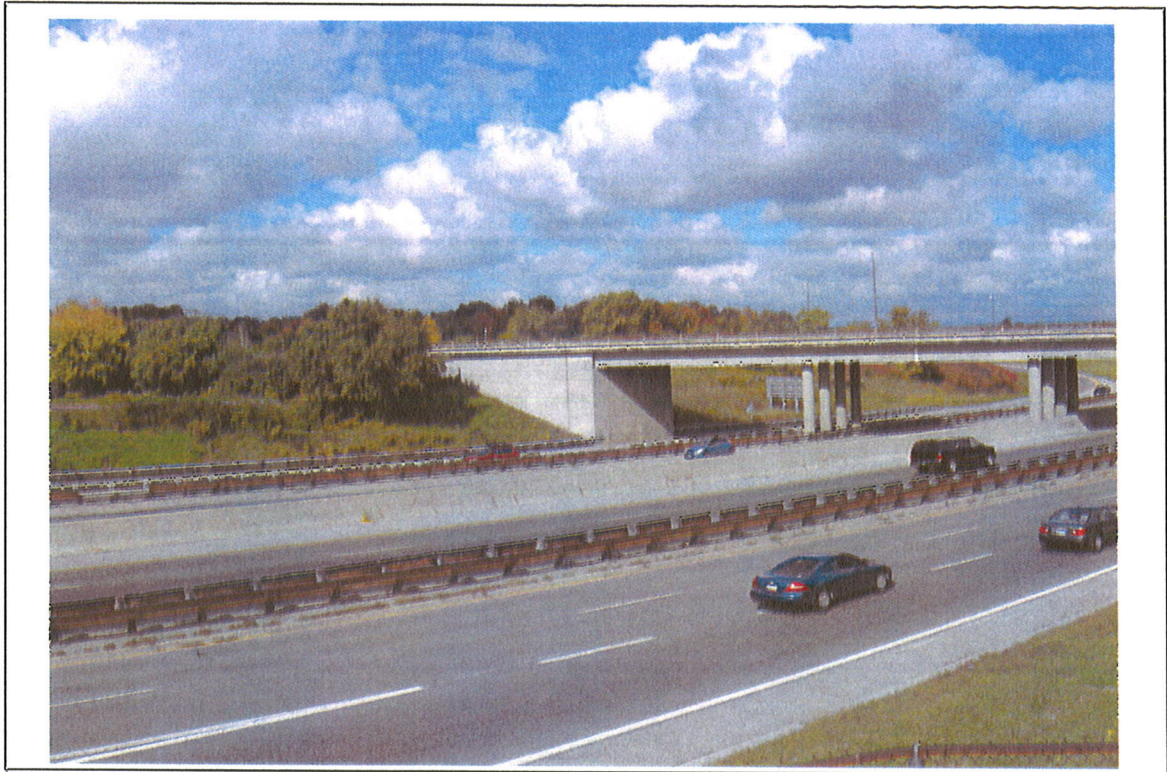


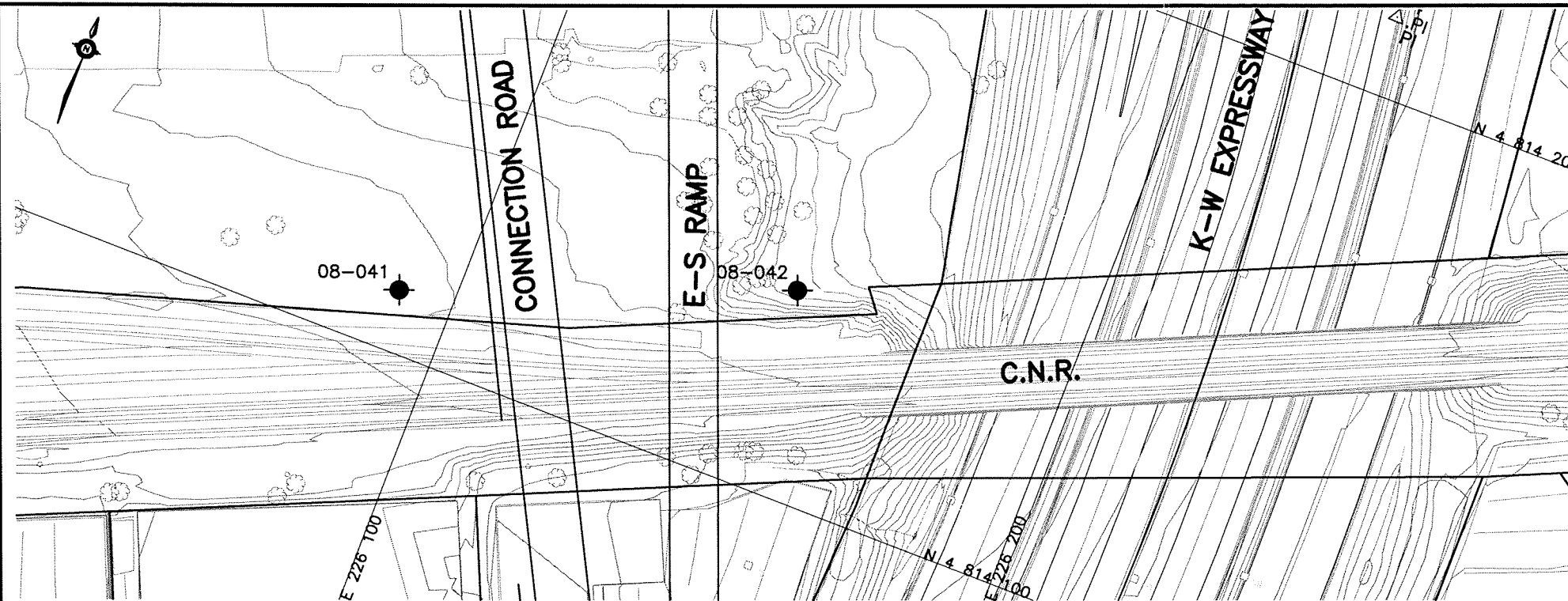
Photo 1. Looking at the existing west abutment of CNR over KWE



Photo 2. Looking at the existing west abutment of CNR over KWE

Appendix F

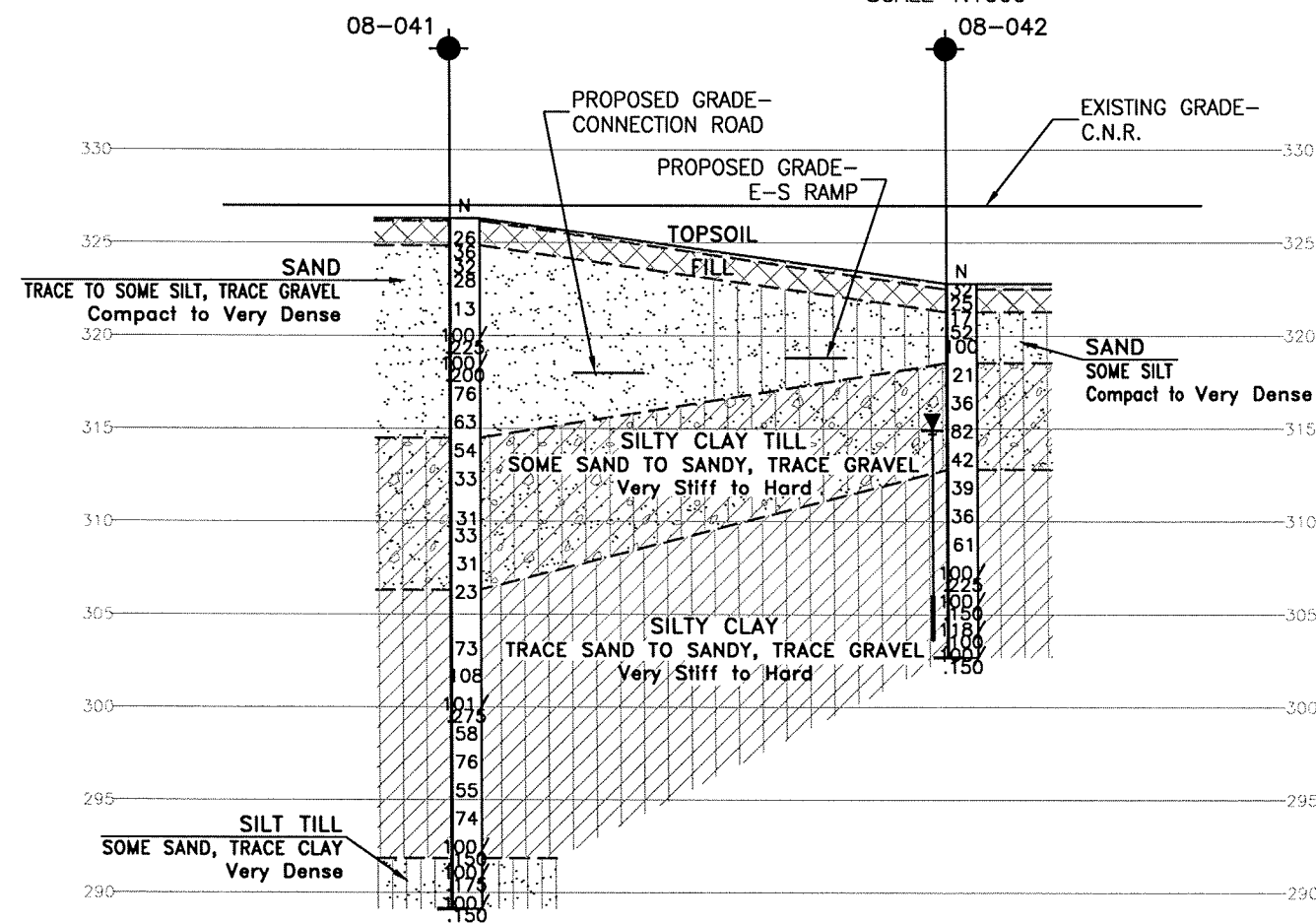
Drawing titled “Borehole Locations and Soil Strata”



PLAN



SCALE 1:1000



PROFILE ALONG \mathbb{C} OF PROP. E-S RAMP & CONNECTION UNDER CNR



HOR 1:1000

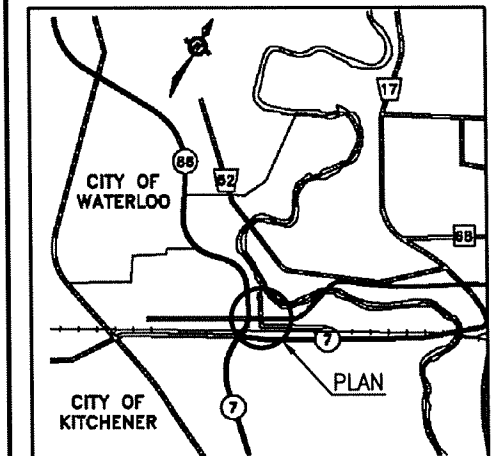
VER 1:40C

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

CONT No
GWP No 408-88-00






HIGHWAY 7
RECOMMENDED ROUTE
E-S RAMP & CONNECTION UNDER CNR
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

- | | |
|---|---------------------------------------|
|  | Borehole |
|  | Borehole (Previous Investigation) |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
|  | Water Level |
|  | Head Artesian Water |
|  | Piezometer |
| 90% | Rock Quality Designation (RQD) |
| A/R | Auger Refusal |

NO	ELEVATION	NORTHING	EASTING
08-041	326.3	4 814 110.3	226 090.8
08-042	322.8	4 814 134.3	226 152.5

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Proposed grades are from Plate 2A and 2B of the E.A. Study.

GEOCRES No. 40P8-166

REVISIONS								
	DATE	BY	DESCRIPTION					
DESIGN	AFG	CHK	PKC	CODE	LOAD	DATE NOV. 2009		
DRAWN	MEA	CHK	AFG	SITE	STRUCT	DWG		

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

FILENAME: H:\Drafting\15\64\17\bed8417-Rampae(041,042).dwg
PLOTDATE: Nov 12, 2009 - 4:24pm