

**FEASIBILITY  
FOUNDATION INVESTIGATION AND DESIGN REPORT  
HIGHWAYS 7/8 RECONSTRUCTION  
0.7 KM WEST OF FISCHER-HALLMAN ROAD INTERCHANGE  
TO 0.4 KM EAST OF COURTLAND AVENUE INTERCHANGE  
KITCHENER, ONTARIO  
G.W.P. 131-98-00**

**GEOCRES Number: 40P8-142**

**Report to**

**Morrison Hershfield Limited**

Thurber Engineering Ltd.  
2010 Winston Park Drive, Suite 103  
Oakville, Ontario  
L6H 5R7  
Phone: (905) 829 8666  
Fax: (905) 829 1166

February 5, 2008

File: 19-479-35

C:\Thurber Projects 2005\19-479-35\Hwy 7-8 Feasibility  
FINAL Feb05-08.doc

## TABLE OF CONTENTS

SECTION	PAGE
<b>PART 1      FACTUAL INFORMATION</b>	
1    INTRODUCTION .....	1
2    SITE DESCRIPTION .....	2
2.1    General .....	2
2.2    Geology .....	2
2.3    Topography and Land Use .....	2
2.4    Structures and Associated Works .....	2
3    INVESTIGATION PROCEDURES .....	3
3.1    MTO GEOCRES Files .....	4
3.2    General Arrangement and Structural/Foundations Layout Drawings .....	5
3.3    Geological Information .....	5
3.4    Site Reconnaissance Visit .....	5
4    DESCRIPTION OF SUBSURFACE CONDITIONS .....	6
4.1    General .....	6
4.2    Site 33-281-C Borden Creek Under Hwy 7 & 8 (west of Fischer-Hallman) .....	6
4.3    Site 33-282-C Borden Creek Under Fischer-Hallman (north of highway) .....	6
4.4    Site 33-229 Fischer-Hallman Road Underpass .....	6
4.5    Site 33-228-W Westmount Road Overpass WBL .....	8
4.6    Site 33-228-E Westmount Road Overpass EBL .....	8
4.7    Site 33-283-C Culvert - Borden Creek (east of Westmount) .....	9
4.8    Site 33-227-W Homer Watson Boulevard Overpass WBL .....	9
4.9    Site 33-227-E Homer Watson Blvd. Overpass EBL .....	10
4.10    Site 33-226-W Ottawa Street South Overpass WBL .....	11
4.11    Site 33-226-E Ottawa Street South Overpass EBL .....	12
4.12    Site 33-225W CNR Overhead WBL .....	12
4.13    Site 33-225E CNR Overhead EBL .....	13
4.14    Site 33-224-W Courtland Avenue Overpass WBL .....	14
4.15    Site 33-224-E Courtland Avenue Overpass EBL .....	16
4.16    Site 33-260 Pedestrian Bridge .....	19
<b>PART 2      ENGINEERING DISCUSSION AND RECOMMENDATIONS</b>	
5    GENERAL .....	21
5.1    Borden Creek Culvert Under Highway 7/8 – west of Fischer-Hallman (Site 33-281-C) .....	21
5.1.1    Foundation Alternatives .....	21
5.1.2    Embankment Stability .....	22
5.1.3    Embankment Settlement .....	22
5.1.4    Construction Feasibility and Considerations .....	22
5.2    Borden Creek Culvert Under Fischer-Hallman Road (Site 33-282-C) .....	23



5.2.1	Foundation Alternatives.....	23
5.2.2	Embankment Stability .....	23
5.2.3	Embankment Settlement.....	23
5.2.4	Construction Feasibility and Considerations .....	23
5.3	Fischer-Hallman Road Underpass (Site 33-229) .....	24
5.3.1	Foundation Alternatives.....	24
5.3.2	Embankment Stability .....	24
5.3.3	Embankment Settlement.....	25
5.3.4	Construction Feasibility and Considerations .....	25
5.4	Westmount Road Overpass WBL and EBL (Site 33-228-W and Site 33-228-E).....	25
5.4.1	Foundation Alternatives.....	25
5.4.2	Embankment Stability .....	25
5.4.3	Embankment Settlement.....	26
5.4.4	Construction Feasibility and Considerations .....	26
5.5	Borden Creek Culvert Under Highway 7/8 – east of Westmount (Site 33-283-C).....	26
5.5.1	Foundation Alternatives.....	26
5.5.2	Embankment Stability .....	27
5.5.3	Embankment Settlement.....	27
5.5.4	Construction Feasibility and Considerations .....	27
5.6	Homer Watson Boulevard Overpass WBL and EBL (Site 33-227-W and 33-227-E)....	28
5.6.1	Foundation Alternatives.....	28
5.6.2	Embankment Stability .....	28
5.6.3	Embankment Settlement.....	28
5.6.4	Construction Feasibility and Considerations .....	28
5.7	Ottawa Street (South) Overpass WBL and EBL (Site 33-226-W and 33-226-E).....	29
5.7.1	Foundation Alternatives.....	29
5.7.2	Embankment Stability .....	29
5.7.3	Embankment Settlement.....	29
5.7.4	Construction Feasibility and Considerations .....	30
5.8	CNR Overhead WBL and EBL (Site 33-225-W and 33-225-E).....	30
5.8.1	Foundation Alternatives.....	30
5.8.2	Embankment Stability .....	30
5.8.3	Embankment Settlement.....	31
5.8.4	Construction Feasibility and Considerations .....	31
5.9	Courtland Avenue Overpass WBL and EBL (Site 33-224-W and 33-224-E) .....	31
5.9.1	Foundation Alternatives.....	31
5.9.2	Embankment Stability .....	32
5.9.3	Embankment Settlement.....	32
5.9.4	Construction Feasibility and Considerations .....	32
5.10	Pedestrian Bridge – East of Courtland (Site 33-260).....	33
5.10.1	Foundation Alternatives .....	33
5.10.2	Embankment Stability .....	33
5.10.3	Embankment Settlement.....	33
5.10.4	Construction Feasibility and Considerations.....	33
6	FUTURE WORKS .....	34
7	CLOSURE .....	35



---

## Appendices

Drawing 19-479-35-1	Structure Locations and Sources of Foundation References
Appendix A	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Borden Creek Culvert Under Highway 7/8 (west of Fischer-Hallman) Records of Boreholes, Plans and Profiles from References 1 and 2
Appendix B	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Borden Creek Culvert Under Fischer-Hallman Road (north of highway) Records of Boreholes, Plans and Profiles from References 1 and 2
Appendix C	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Fischer-Hallman Road Underpass Records of Boreholes, Plans and Profiles from References 1 and 2
Appendix D	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Westmount Road Overpass WBL and EBL Records of Boreholes, Plans and Profiles from Reference 3
Appendix E	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Borden Creek Culvert Under Highway 7/8 (east of Westmount) Records of Boreholes, Plans and Profiles from Reference 3
Appendix F	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Homer Watson Boulevard Overpass WBL and EBL Records of Boreholes, Plans and Profiles from Reference 4
Appendix G	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Ottawa Street (South) Overpass WBL and EBL Records of Boreholes, Plans and Profiles from Reference 5
Appendix H	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations CNR Overhead WBL and EBL Records of Boreholes, Plans and Profiles from References 6 and 7
Appendix I	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Courtland Avenue Overpass WBL and EBL Records of Boreholes, Plans and Profiles from Reference 7





---

Appendix J	Foundation Alternatives Comparison Geotechnical Resistances and Founding Elevations Pedestrian Bridge (east of Courtland) Records of Boreholes, Plans and Profiles from Reference 7
Appendix K	Selected Photographs Showing Existing Structures Thurber Site Visit of July 8, 2005



**FEASIBILITY  
FOUNDATION INVESTIGATION AND DESIGN REPORT  
HIGHWAYS 7/8 RECONSTRUCTION  
0.7 KM WEST OF FISCHER-HALLMAN ROAD INTERCHANGE  
TO 0.4 KM EAST OF COURTLAND AVENUE INTERCHANGE  
KITCHENER, ONTARIO  
G.W.P. 131-98-00**

**GEOCRES Number: 40P8-142**

**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the available foundation/geotechnical information for ten structures along the existing Highway 7/8 from 0.7 km west of the Fischer-Hallman Road Interchange to 0.4 km east of the Courtland Avenue Interchange in Kitchener, Ontario. From west to east, these structures are listed as follows:

- Site No. 33-281-C - Borden Creek Culvert Under Hwy. 7/8 (west of Fischer-Hallman)
- Site No. 33-282-C - Borden Creek Culvert Under Fischer-Hallman Road (north of highway)
- Site No. 33-229 - Fischer-Hallman Underpass
- Site No. 33-228-W/E - Westmount Road Overpass (WBL and EBL)
- Site No. 33-283-C - Borden Creek Culvert (east of Westmount)
- Site No. 33-227-W/E - Homer Watson Boulevard Overpass (WBL and EBL)
- Site No. 33-226-W/E - Ottawa Street (South) Overpass (WBL and EBL)
- Site No. 33-225-W/E - CNR Overhead (WBL and EBL)
- Site No. 33-224-W/E - Courtland Avenue Overpass (WBL and EBL)
- Site No. 33-260 - Pedestrian Bridge (east of Courtland)

The purpose of this report was to summarize currently available information pertinent to foundation design of the above referenced structures. This information includes those from previous foundation/geotechnical investigation reports, geological reports and maps, general arrangement and structural design drawings, as well as results of a recent site reconnaissance visit. The information constitutes the basis for a feasibility assessment with respect to foundation design for the proposed widening and/or replacement of these structures.

Thurber carried out this assessment as a sub-consultant to Morrison Hershfield Limited under the Ministry of Transportation Ontario (MTO) Purchase Order Number 3005-A-000372.



## **2 SITE DESCRIPTION**

### **2.1 General**

The site is located in the City of Kitchener, Ontario. The section of Highway 7/8 under consideration extends from about 0.7 km west of the Fischer-Hallman Road Interchange easterly to about 0.4 km east of the Courtland Avenue Interchange, for a distance of approximately 5 km. Drawing 19-479-35-1 shows a key plan of this section of highway with the relevant structure locations identified.

### **2.2 Geology**

The project area is located within a physiographic region known as Waterloo Hills. The region is characterized by surficial sandy hills including sandy tills and kame moraines with glacial outwash sands and gravels occupying the depressions. Swampy valleys are also present between moraines. These surficial deposits are underlain by clayey to silty tills at depth.

The subject section of highway is located in an area of kame moraines and sandy tills. The easterly limit of this section of highway lies in a glacial spillway. Moving westward, the highway traverses a band mapped as peat and muck and terminates in an area of kame moraine. The westerly limit of the peat and muck band coincides approximately with Strasburg Road.

### **2.3 Topography and Land Use**

West of Homer Watson Boulevard, the highway is mostly at grade with only minor cuts and fills. East of Homer Watson Boulevard, the highway is mainly on a fill embankment up to approximately 8 m high, though some minor cut areas are also present. In the vicinity of the CN Overhead, the embankment is supported by a retaining wall on the south side. Borden Creek flows under the highway immediately west of Fisher-Hallman Road and also just east of Westmount Road. Schneider Creek also flows under the highway at Courtland Avenue, below the west approach span of the structure.

The eastern half of the study area is bordered mainly by commercial and industrial development. To the west of Homer Watson Boulevard, residential development mixed with some parkland predominates with commercial development at the major intersections.

### **2.4 Structures and Associated Works**

The general layout of each of the structures and embankments is outlined as follows:

#### **Borden Creek Culvert Under Hwy. 7/8 (west of Fischer-Hallman)**

Twin box culvert each of approximately 3 m wide and 2.5 m high, with wingwalls at all four quadrants (SW, SE, NW and NE).



Borden Creek Culvert Under Fischer-Hallman Road (north of highway)

Twin box culverts each of approximately 3 m wide and 2.5 m high, with wingwalls at two quadrants (SW and NW).

Fischer-Hallman Underpass

Triple span, cast-in-place post-tensioned concrete bridge, both perched abutments and both piers are supported by piles, and approach embankment forward slopes at nominal 4H : 1V inclination.

Westmount Road Overpass

Triple span, cast-in-place post-tensioned concrete bridge, both perched abutments and both piers are supported by piles, and approach embankment forward slopes at nominal 2H : 1V inclination.

Borden Creek Culvert (east of Westmount)

Twin multi-plate pipe arch culverts each of approximately 5 m wide at the base and 3.5m high.

Homer Watson Boulevard Overpass

Four-span, prestressed concrete bridge, with both abutments and all three piers supported on piles, and approach embankment forward slopes at nominal 2H : 1V inclination.

Ottawa Street (South) Overpass

Three-span, prestressed concrete bridge, with both abutments supported on piles and both piers supported on footings, and approach embankment forward slopes at nominal 2H : 1V inclination.

CNR Overhead

Single span, rigid frame concrete bridge supported on piles; adjacent retaining walls parallel to highway supported on footings.

Courtland Avenue Overpass

Four-span, prestressed concrete bridge, with both abutments and all three piers supported on piles, and approach embankment forward slopes at nominal 2H : 1V inclination.

Pedestrian Bridge (east of Courtland)

Prestressed concrete bridge supported on piles, except for the south approach ramp which is supported on footings.

### **3 INVESTIGATION PROCEDURES**

The services provided under this assignment do not include subsurface investigation, i.e. no borehole drilling and sampling.

Existing subsurface and surface conditions relevant to the design and construction of the existing structures and embankments, and pertinent to the proposed widening and/or replacement works referenced above, have been investigated by the following methods:



- Review of existing Foundation Investigation and Design Reports available at the MTO GEOCRES library.
- Review of design drawings, including general arrangement and structural layout drawings, for the existing structures.
- Request for information from the City of Kitchener.
- Search of Thurber's in-house database.
- Review of published geological information for the study area.
- Site reconnaissance visit by senior geotechnical staff to observe and document, including taking photographs, of the existing structures, embankments and any visible geological/geotechnical features.

A request for information was made to the City of Kitchener, but no information was available for the study area.

A search for information into Thurber's in-house database also did not reveal any relevant information for the study area.

### **3.1 MTO GEOCRES Files**

Existing foundation/geotechnical information relevant to the subject sites has been obtained from the MTO GEOCRES library. This information is listed in the following:

#### Reference 1

Foundation Investigation Report for Fischer Drive Underpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 67-F-103, W.P. 629-64, GEOCRES No. 40P7-23, dated January 1968, prepared by Foundation Section, Department of Highways Ontario.

#### Reference 2

Foundation Investigation Report for Kitchener-Waterloo Expressway – Fischer Drive Underpass, Henry Sturm Blvd., W.P. 629-64, District #4, GEOCRES No. 40P7-23, dated March 1965, prepared for Department of Highways Ontario by E.M. Peto Associates Limited.

#### Reference 3

Foundation Investigation Report for Filsinger Road Overpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 67-F-102, W.P. 628-64, GEOCRES No. 40P7-31, dated January 1968, prepared by Foundation Section, Department of Highways Ontario.

#### Reference 4

Foundation Investigation Report for Kitchener-Waterloo Expressway and Homer Watson Blvd., City of Kitchener, District #4 (Hamilton), W.J. 66-F-70, W.P. 627-64, GEOCRES No. 40P08-52, dated September 1966, prepared by Foundation Section, Department of Highways Ontario.



Reference 5

Foundation Investigation Report for Ottawa Street South Overpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 66-F-69, W.P. 626-64, GEOCRE No. 40P08-114, dated September 1996, prepared by Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.

Reference 6

Foundation Investigation Report For Retaining Wall Along Highway 7 EBL From Sta. 19+525 to Sta. 20+000, W.P. 95-94-00, District 31, London, GEOCRE No. 40P08-52, dated September 1966, prepared by Foundation Section, Department of Highways Ontario.

Reference 7

Soil Investigation Report For Kitchener-Waterloo Expressway, Henry Sturm Boulevard; C.N.R. WP-625-64, GEOCRE No. 40P08-36, dated January 1965, prepared for Department of Highways Ontario by E.M. Peto Associates Limited.

Reference 8

Foundation Report for Kitchener-Waterloo Expressway, Structures WP 624-64, WP 644-64, WP 645-64 and Part of WP 618-64, GEOCRE No. 40P08-39, dated February 1965, prepared for Department of Highways Ontario by E.M. Peto Associates Limited.

### **3.2 General Arrangement and Structural/Foundations Layout Drawings**

General arrangement and structural/foundation layout drawings pertinent to the structure sites covered in this study have been provided by Morrison Hershfield Limited. It is understood that all of these drawings were prepared for the then Department of Highways Ontario as part of the design and construction of the original Kitchener-Waterloo Expressway (now Highway 7/8).

### **3.3 Geological Information**

During the preparation of this report, reference was made to two geological publications listed as follows:

1. Chapman and Putnam, "The Physiography of Southern Ontario", Third Edition, Ontario Geological Survey, Special Volume 2, Ministry of Natural Resources, 1984.
2. Karrow and White, "Urban Geology of Canadian Cities", GAC Special Paper 42, Geological Association of Canada, 1998.

### **3.4 Site Reconnaissance Visit**

A site reconnaissance visit was carried out on July 8, 2005 by Mr. Alastair Gorman, P.Eng., a Thurber Senior Foundation Engineer. Each of the sites was observed and documented for visible geological/geotechnical features and for assessing structure/embankment performance. The



documentation includes photographs of the subject bridges and culverts. Selected photographs showing the existing structures are included in Appendix K.

Based on the site observations, it is considered that the structures and immediate approach embankments (i.e. within 20 m of the abutments) under consideration did not show visible signs of distress and appeared to be functioning for their intended purposes.

## 4 DESCRIPTION OF SUBSURFACE CONDITIONS

### 4.1 General

Based on the information documented in References 1 to 8, the following sections present summaries of the available subsurface information for various site locations. Relevant borehole records and drawings from these references are included in Appendices A to J.

The information in References 1 to 8 is presented in Imperial Units and has been converted to Metric Units for the purpose of this report.

The soil stratigraphy at the foundation locations is summarized in the following tables. The range of elevations and thicknesses are from west to east where applicable.

### 4.2 Site 33-281-C Borden Creek Under Hwy 7 & 8 (west of Fischer-Hallman)

No site specific subsurface information is available for this structure. Extrapolation of information from the nearby Fischer-Hallman Road Underpass is considered appropriate for the feasibility assessment.

### 4.3 Site 33-282-C Borden Creek Under Fischer-Hallman (north of highway)

No site specific subsurface information is available for this structure. Extrapolation of information from the nearby Fischer-Hallman Road Underpass is considered appropriate for the feasibility assessment.

### 4.4 Site 33-229 Fischer-Hallman Road Underpass

#### North Abutment

Elevation (m)	Thickness (m)	Soil Description 'N' values in blows for 0.3 m penetration
From 342.0 (OGL) to 336.2 – 337.7	5.8 to 4.3	Clayey silt, some sand 'N' = 6 to 55, firm to hard
From 336.2 – 337.7 to 333.5 – 334.0	2.7 to 3.7	Sandy silt 'N' = 12 to 32, compact to dense.
From 333.5 – 334.0 to 329.5 – 330.8	4.0 to 3.2	Silty sand to sand 'N' = 27 to 56, compact to very dense.
From 329.5 – 330.8 to 323.3 – 327.6	6.2 to 3.2	Sandy silt, some clay 'N' = 10 to >100, compact to very dense.
323.3 – 327.6		Limit of borehole information.

Groundwater at Elevations 340.5 to 335.3.



**North Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration</b>
From 340.6 – 341.1 (OGL) to 338.0 – 339.8	2.6 to 1.3	Sandy silt to gravelly sand, some silt and clay. 'N' = 8 to 45, loose to dense.
From 338.0 – 339.8 to 335.1 – 333.8	2.9 to 6.0	Clayey silt, some sand 'N' = 14 to 42, stiff to hard.
From 335.1 – 333.8 to 331.7 – 332.0	3.4 to 1.8	Sand to silty sand 'N' = 15 to 35, compact to dense.
From 331.7 to 330.2	1.5	Clayey silt 'N' = 24, very stiff.
From 330.2 to 323.4	6.8	Sandy silt to sand, trace clay. 'N' = 21 to 89, compact to very dense.
323.4		Limit of borehole information.

Groundwater at Elevation 339.9.

**South Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
342.6 (OGL) to 341.1	1.5	Gravel, some sand 'N' = 34, dense.
341.1 to 334.7	6.4	Gravelly sand, some silt and clay. 'N' = 46 to >100, dense to very dense.
334.7 to 326.9	7.8	Clayey silt to silt 'N' = 15 to >100, compact to very dense.
326.9		Limit of borehole information.

**South Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
From 343.9 – 344.4 (OGL) to 341.5 – 342.3	2.4 to 2.1	Clayey silt to silt 'N' = 6 to 18, firm to very stiff.
From 341.5 to 333.8 (West end of abutment)	7.7	Gravelly sand 'N' = 55 to >100, very dense.
From 342.3 to 339.5 (East end of abutment)	2.8	Sandy silt, trace gravel. 'N' = 17 to 74, compact to very dense.
From 339.5 to 334.3 (East end of abutment)	5.2	Clayey silt 'N' = 40 to 52, hard.
From 333.8 – 334.3 to 328.2 – 328.7	5.6	Silty sand to sandy silt 'N' = 14 to >100, compact to very dense.
328.2 – 328.7		Limit of borehole information.

Groundwater at Elevation 343.0





**4.5 Site 33-228-W Westmount Road Overpass WBL****West Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
333.0 (OGL) to 328.1	4.9	Clayey silt 'N' = 11 to 98, very stiff to hard.
328.1 to 326.0	2.1	Sandy silt 'N' = 22 to 53, compact to very dense.
326.0 to 320.3	5.7	Sand, fine to medium grained. 'N' = 55 to >100, very dense.
320.3		Limit of borehole information.

Groundwater at Elevation 331.8.

**West Pier**

Dynamic Cone Penetration Test was conducted at the west pier from Elevation 332.7 (OGL) to refusal (112 blows for 0.3 m penetration) at Elevation 329.3.

**East Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
332.2 (OGL) to 330.7	1.5	Sand, trace silt, trace gravel. 'N' = 7, loose.
330.7 to 320.5	10.2	Clayey silt, some sand 'N' = 5 to 46, firm to hard.
320.5 to 318.2	2.3	Silty sand. 'N' = 70 to >100, very dense.
318.2		Limit of borehole information.

Groundwater at Elevation 331.5.

**4.6 Site 33-228-E Westmount Road Overpass EBL****West Abutment**

Dynamic Cone Penetration Test was conducted at the west abutment from Elevation 333.5 (OGL) to refusal (112 blows for 0.3 m penetration) at Elevation 327.4.

**West Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
332.6 (OGL) to 328.7	3.9	Clayey silt 'N' = 17 to 48, very stiff to hard.
328.7 to 327.0	1.7	Silty Sand. 'N' = 13 to 27, compact.
327.0 to 321.0	6.0	Silty clay. 'N' = 20 to >100, very stiff to hard.



321.0 to 318.5	2.5	Sand to silty sand 'N' = 60 to >100, very dense.
318.5		Limit of borehole information.

Groundwater at Elevation 331.5.

#### East Pier

Dynamic Cone Penetration Test was conducted at the east pier from Elevation 330.7 (OGL) to refusal (124 blows for 0.3 m penetration) at Elevation 326.5.

#### East Abutment

Elevation (m)	Thickness (m)	Soil Description 'N' values in blows for 0.3 m penetration.
330.0 (OGL) to 327.6	2.4	Sand, fine to medium grained 'N' = 16 to 43, compact to dense.
327.6 to 325.8	1.8	Clayey silt to silt 'N' = 42 to 48, hard.
325.8 to 317.5	8.3	Clayey silt to silty clay 'N' = 36 to >100, hard.
317.5		Limit of borehole information.

Groundwater at Elevation 329.5.

#### 4.7 Site 33-283-C Culvert - Borden Creek (east of Westmount)

No site specific subsurface information is available for this structure. Extrapolation of information from the nearby Westmount Road Overpass is considered appropriate for the feasibility assessment.

#### 4.8 Site 33-227-W Homer Watson Boulevard Overpass WBL

##### West Abutment

Elevation (m)	Thickness (m)	Soil Description 'N' values in blows for 0.3 m penetration.
329.6 (OGL) to 322.0	7.6	Clayey silt to silt very stiff to hard.
322.0 to 308.9	13.1	Sandy silt 'N' = 64 to 200, very dense.
308.9 to 298.2	10.7	Clayey silt to silt 'N' >100, hard.
298.2 to 298.2	0.04	Silty sand. 'N' >100, very dense.
298.2		Limit of borehole information.

Groundwater at Elevation 320.0.



**Centre of Site**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
326.8 (OGL) to 322.4	4.4	Silty clay to clayey silt. 'N' = 14 to 46, stiff to hard.
322.4 to 314.6	7.8	Sandy silt to silty sand. 'N' = 48 to 260, very dense.
314.6 to 308.4	6.3	Clayey silt to silt 'N' = 84 to 137, hard.
308.4		Limit of borehole information.

Groundwater at Elevation 321.9

**East Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
327.0 (OGL) to 323.0	4.0	Sandy silt 'N' = 12 to 25, compact.
323.0 to 315.6	7.4	Clayey silt to silt. 'N' = 20 to 28, very stiff.
315.6 to 314.5	1.1	Sandy silt. 'N' = 55, very dense.
314.5 to 310.0	4.5	Clayey silt to silt. 'N' = 73 to 104, hard.
310.0 to 307.2	2.8	Silty sand. 'N' >100, very dense.
307.2		Limit of borehole information.

Groundwater at Elevation 322.2.

**4.9 Site 33-227-E Homer Watson Blvd. Overpass EBL****West Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
327.5 (OGL) to 315.9	11.6	Clayey silt to silt, Stiff to hard.
315.9 to 311.4	4.5	Sandy silt 'N' = 17 to 40, compact to dense.
311.4 to 295.7	15.7	Clayey silt 'N' = 28 to 164, hard.
295.7 to 294.9	0.8	Silty sand. 'N' >100, very dense.
294.9		Limit of borehole information.

Groundwater at Elevation 320.0.



**Centre of site**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
326.8 (OGL) to 322.4	4.4	Silty clay to clayey silt. 'N' = 14 to 46, stiff to hard.
322.4 to 314.6	7.8	Sandy silt to silty sand. 'N' = 48 to 260, dense to very dense.
314.6 to 308.4	6.3	Clayey silt to silt 'N' = 84 to 137, hard.
308.4		Limit of borehole information.

Groundwater at Elevation 321.9.

**East Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
326.3 (OGL) to 320.8	5.5	Sandy silt 'N' = 15 to 37, compact to dense.
320.8 to 319.4	1.4	Clayey silt. 'N' = 13 to 29, stiff to very stiff.
319.4 to 313.6	5.8	Sandy silt 'N' = 17 to 25, compact.
313.6 to 295.4	18.3	Clayey silt to silt. 'N' = 24 to 327, hard.
295.4 to 291.4	4.0	Silty sand 'N' >100, very dense.
291.4		Limit of borehole information.

Groundwater at Elevation 323.4.

**4.10 Site 33-226-W Ottawa Street South Overpass WBL****West Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
328.5 (OGL) to 319.3	9.2	Sandy silt, fine grained to silty sand, fine to medium grained 'N' = 54 to >100, very dense.
319.3 to 315.8	3.5	Sandy silt to silt, trace gravel. 'N' >100, very dense. Moisture content 17%.
315.8		Limit of borehole information.

Groundwater at Elevation 319.5.



**East Pier**

The soil stratigraphy at the east pier is described as follows:

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
329.7 (OGL) to 314.5	15.2	Sandy silt to silty sand 'N' = 21 to >100, compact to very dense.
314.5 to 311.0	3.5	Silty clay to clayey silt 'N' = 98 to 186, hard.
311.0		Limit of borehole information.

Groundwater at Elevation 319.4.

**4.11 Site 33-226-E Ottawa Street South Overpass EBL****West Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
329.0 (OGL) to 316.4	12.6	Sandy silt to silty sand 'N' = 24 to 65, compact to very dense.
316.4		Limit of borehole information.

Groundwater at Elevation 319.9.

**East Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
332.6 (OGL) to 318.9	13.7	Sandy silt to silty sand 'N' = 26 to 139, compact to very dense.
318.9 to 317.3	1.6	Fine to medium sand 'N' >100, very dense.
317.3		Limit of borehole information.

Groundwater at Elevation 321.0.

**4.12 Site 33-225W CNR Overhead WBL****West Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
318.6 (OGL) to 318.5	0.1	Topsoil.
318.5 to 317.9	0.6	Silty fine sand.
317.9 to 317.4	0.5	Interlayered sandy and clayey silt. 'N' = 9, loose.
317.4 to 316.1	1.3	Sandy silt and silty clay (interlayered). 'N' = 13, compact.
316.1 to 312.5	3.6	Sandy silt. 'N' = 13 to 20, compact.



312.5 to 308.8	3.7	Interlayered sandy and clayey silt. 'N' = 15 to 20, compact.
308.8 to 306.9	1.9	Silty clay 'N' = 40, hard.
306.9 to 305.8	1.1	Gravel and sand, medium grained. 'N' = 47, dense
305.8 to 305.3	0.5	Clayey silt till. 'N' = >100, hard.
305.3 to 304.7	0.6	Gravel.
304.7 to 304.1	0.6	Clayey silt till. 'N' = 53, hard.
304.1		Limit of borehole information.

Groundwater at Elevation 317.4.

#### East Abutment

Elevation (m)	Thickness (m)	Soil Description 'N' values in blows for 0.3 m penetration.
316.6 (OGL) to 316.4	0.2	Topsoil.
316.4 to 315.4	1.0	Silty clay 'N' = 6, firm.
315.4 to 314.1	1.3	Clayey silt with sandy silt pockets. 'N' = 12 to 14, stiff.
314.1 to 312.0	2.1	Sandy silt and silty fine sand. 'N' = 18, compact.
312.0 to 310.2	1.8	Interlayered clayey and sandy silt. 'N' = 14 to 20, stiff to very stiff.
310.2		Limit of borehole information.

#### 4.13 Site 33-225E CNR Overhead EBL

##### West Abutment

Elevation (m)	Thickness (m)	Soil Description 'N' values in blows for 0.3 m penetration.
318.5 (OGL) to 318.4	0.1	Sand and gravel fill.
318.4 to 317.8	0.6	Medium sand.
317.8 to 316.5	1.3	Clayey silt. 'N' = 13 to 32, stiff to very stiff.
316.5 to 315.3	1.2	Silty fine sand, some sandy silt layers
315.3 to 313.9	1.4	Clayey silt with sand seams 'N' = 18, very stiff.
313.9 to 306.9	7.0	Silty fine sand 'N' = 16 to 29, compact.
306.9 to 302.8	4.1	Clayey silt 'N' = 20 to 32, very stiff to hard.
302.8		Limit of borehole information.

Groundwater at Elevation 317.8.



**East Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
317.8 (OGL) to 317.0	0.8	Sand and gravel, some organic sandy silt (fill).
317.0 to 316.1	0.9	Silty sand, some gravel (fill). 'N' = 10, loose to compact.
316.1 to 314.6	1.5	Clayey silt with sand seams. 'N' = 16 to 17, very stiff.
314.6 to 311.7	2.9	Interlayered clayey and sandy silt. 'N' = 10, stiff.
311.7 to 308.7	3.0	Sandy silt with clayey silt and silty clay seams. 'N' = 15 to 18, compact.
308.7 to 305.7	3.0	Clayey silt with sandy silt and silty sand seams. 'N' = 20 to 26, very stiff.
305.7 to 303.0	2.7	Silty clay with silt and sand seams. 'N' = 20, very stiff.
303.0 to 297.8	5.2	Silty fine sand. 'N' = 23 to 78, compact to very dense.
297.8 to 296.5	1.3	Silty clay, some sand and gravel. 'N' = 27, very stiff.
296.5 to 293.0	3.5	Clayey silt, some sand and gravel. 'N' = 39 to 43, hard.
293.0		Limit of borehole information.

Groundwater at Elevation 315.8.

**4.14 Site 33-224-W Courtland Avenue Overpass WBL****West Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
315.8 (OGL) to 314.9	0.9	Sand and gravel (fill). 'N' = 19, compact.
314.9 to 312.2	2.7	Fine sand, some organic silt. 'N' = 2 to 7, very loose to loose.
312.2 to 309.7	2.5	Clayey silt 'N' = 10 to 19, stiff to very stiff.
309.7 to 308.2	1.5	Silty clay, trace sand. 'N' = 19, very stiff.
308.2 to 307.3	0.9	Clayey silt, some sand pockets. 'N' = 19, very stiff.
307.3 to 304.7	2.6	Silty fine sand 'N' = 19 to 20, compact.
304.7		Limit of borehole information.



**West Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
313.9 (OGL) to 313.8	0.1	Topsoil.
313.8 to 312.7	1.1	Silty sand loam with organic sandy silt interlayers, trace wood fragments. 'N' = 7, loose.
312.7 to 311.8	0.9	Sand, coarse to fine, some gravel, trace peat. 'N' = 30, compact to dense.
311.8 to 311.0	0.8	Sandy gravel. 'N' = 16, compact.
311.0 to 308.7	2.3	Silty clay, some fine sand seams. 'N' = 17 to 18, stiff.
308.7 to 306.3	2.4	Silty fine sand 'N' = 39, dense.
306.3 to 304.8	1.5	Sandy silt and silty clay interlayers. 'N' = 39, hard.
304.8 to 301.6	3.2	Clayey silt, some sand. 'N' = 30, hard.
301.6 to 298.7	2.9	Sandy, clayey silt till. 'N' = 31 to 75, hard.
298.7 to 297.4	1.3	Sandy silt till. 'N' = 70, very dense.
297.4 to 296.7	0.7	Sand, coarse to medium, some gravel. 'N' = 71, very dense.
296.7		Limit of borehole information.

**Centre Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
314.7 (OGL) to 314.3	0.4	Sand and gravel (fill).
314.3 to 313.2	1.1	Sandy silt, some gravel. 'N' = 19, compact.
313.2 to 312.2	1.0	Silty fine sand, some gravel. 'N' = 8, loose.
312.2 to 311.5	0.7	Gravelly sand, some organic silt. 'N' = 15, compact.
311.5 to 310.1	1.4	Sandy silt. 'N' = 14, compact.
310.1 to 307.7	2.4	Silty fine sand, some silty clay seams. 'N' = 28 to 51, dense to very dense.
307.7 to 305.6	2.1	Clayey silt with sandy silt seams. 'N' = 23, very stiff.
305.6 to 304.6	1.0	Silty clay, some sand. 'N' = 23, very stiff.
304.6 to 301.7	2.9	Sandy clayey silt till. 'N' = 59 to 77, hard.





301.7 to 300.5	1.2	Sand, coarse to fine, some gravel. 'N' = 59, very dense.
300.5		Limit of borehole information.

**East Pier**

Elevation (m)	Thickness (m)	Soil Description 'N' values in blows for 0.3 m penetration.
314.6 (OGL) to 313.1	1.5	Silty sand, some gravel, some clay and organic silt (fill). 'N' = 21, compact.
313.1 to 312.8	0.3	Organic silt. 'N' = 5, firm.
312.8 to 312.5	0.3	Silty fine sand.
312.5 to 311.7	0.8	Sand, some gravel. 'N' = 30, compact to dense.
311.7 to 310.3	1.4	Silty fine sand with clayey silt interlayers. 'N' = 20, compact.
310.3 to 308.6	1.7	Clayey silt, some sand and gravel. 'N' = 8, firm to stiff.
308.6 to 306.5	2.1	Sandy to clayey silt. 'N' = 19 to 50, compact to very dense.
306.5 to 304.1	2.4	Sandy silt till. 'N' = 26, compact.
304.1 to 303.9	0.2	Sand, fine to coarse
303.9 to 302.2	1.7	Sandy silt till. 'N' = 39 to 42, dense.
302.2 to 300.4	1.8	Sand, fine to medium, occasional gravel. 'N' = 30, dense.
300.4		Limit of borehole information.

**East Abutment**

No site specific subsurface information is available for this location. Extrapolation of information from nearby foundation locations is considered appropriate for the feasibility assessment.

**4.15 Site 33-224-E Courtland Avenue Overpass EBL**

The soil stratigraphy at the foundation locations is summarized in the following tables. The range of elevations and thicknesses are from west to east where applicable.

**West Abutment**

Elevation (m)	Thickness (m)	Soil Description 'N' values in blows for 0.3 m penetration.
315.8 (OGL) to 314.9	0.9	Medium sand and gravel (fill). 'N' = 19, compact.
314.9 to 312.2	2.7	Sand, fine, some organic silt.



		'N' = 2 to 7, very loose to loose.
312.2 to 309.7	2.5	Clayey silt 'N' = 10 to 19, stiff to very stiff.
309.7 to 308.2	1.5	Silty clay 'N' = 19, very stiff.
308.2 to 307.3	0.9	Clayey silt, some sand pockets. 'N' = 19, very stiff.
307.3 to 304.7	2.6	Silty fine sand 'N' = 19 to 20, compact.
304.7		Limit of borehole information.

**West Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
315.0 (OGL) to 313.4	1.6	Sand, medium to fine, some gravel (fill). 'N' = 3, very loose.
313.4 to 312.6	0.8	Silty clay, some sand pockets, some gravel. 'N' = 5 to 7, firm.
312.6 to 312.0	0.6	Medium to fine sand, some peat.
312.0 to 310.8	1.2	Silty fine sand, some organic matter, some gravel. 'N' = 13 to 15, compact.
310.8 to 307.8	3.0	Clayey silt, some sand. 'N' = 18 to 22, very stiff.
307.8 to 307.4	0.4	Silty fine sand, some clayey silt pockets. 'N' = 22, compact.
307.4 to 302.2	5.2	Clayey silt and silty clay interlayers, some fine sand. 'N' = 17 to 32, very stiff to hard.
302.2 to 298.1	4.1	Sandy silt till. 'N' = 31 to 84, dense to very dense.
298.1		Limit of borehole information.

**Centre Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
314.7 (OGL) to 314.3	0.4	Sand and gravel (fill).
314.3 to 313.2	1.1	Sandy silt, some gravel. 'N' = 19, compact.
313.2 to 312.2	1.0	Silty fine sand, some gravel. 'N' = 8, loose.
312.2 to 311.5	0.7	Gravelly sand, some organic silt. 'N' = 15, compact.
311.5 to 310.1	1.4	Sandy silt. 'N' = 14, compact.
310.1 to 307.7	2.4	Silty fine sand, some silty clay seams. 'N' = 28 to 51, dense to very dense.



307.7 to 305.6	2.1	Clayey silt with sandy silt seams. 'N' = 23, very stiff.
305.6 to 304.6	1.0	Silty clay, some sand. 'N' = 23, very stiff.
304.6 to 301.7	2.9	Sandy, clayey silt till. 'N' = 59 to 77, hard.
301.7 to 300.5	1.2	Coarse to fine sand, some gravel. 'N' = 59, very dense.
300.5		Limit of borehole information

**East Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
315.1 (OGL) to 314.5	0.6	Sand, fine to medium, some asphalt fragments (fill).
314.5 to 313.6	0.9	Sandy silt, some gravel. 'N' = 7, loose.
313.6 to 312.7	0.9	Interlayered fine sand, sandy clay and organic silt. 'N' = 2, very soft.
312.7 to 312.0	0.7	Sand, fine 'N' = 11, compact.
312.0 to 310.0	2.0	Sandy, clayey silt. 'N' = 13 to 18, compact.
310.0 to 306.0	4.0	Clayey silt till. 'N' = 44 to 51, hard.
306.0 to 305.5	0.5	Sandy silt till, some sand pockets. 'N' = 71, very dense.
305.5 to 301.4	4.1	Sandy gravel, some fine sand layers. 'N' = 40 to 63, dense to very dense.
301.4 to 300.9	0.5	Sandy silt till. 'N' = 165, very dense.
300.9 to 299.9	1.0	Fine sand, some gravel.
299.9 to 299.4	0.5	Sand, coarse to medium, some silt seams. 'N' = 69, very dense.
299.4		Limit of borehole information.

**East Abutment**

No site specific subsurface information is available for this location. Extrapolation of information from nearby foundation locations is considered appropriate for the feasibility assessment.



**4.16 Site 33-260 Pedestrian Bridge****North Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
325.5 (OGL) to 319.4	6.1	Sand, fine to coarse grained. 'N' = 12 to 29, compact.
319.4 to 318.2	1.2	Silty sand, fine grained. 'N' = 31, dense.
318.2 to 315.8	2.4	Silty clay interlayered with clayey silt and sandy silt. 'N' = 25 to 57, very stiff to hard.
315.8		Limit of borehole information.

Groundwater at Elevation 321.0.

**Centre Pier**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
321.9 (OGL) to 320.7	1.2	Sand, fine to medium grained. 'N' = 21, compact.
320.7 to 319.6	1.1	Silty clay. Stiff.
319.6 to 315.4	4.2	Silty sand, fine grained with silty clay seams. 'N' = 13 to 48, compact to dense.
315.4 to 312.3	3.1	Silty clay, interlayered with sandy silt. 'N' = 27 to 44, very stiff to hard.
312.3		Limit of borehole information.

Groundwater at Elevation 320.0

**South Abutment**

<b>Elevation (m)</b>	<b>Thickness (m)</b>	<b>Soil Description 'N' values in blows for 0.3 m penetration.</b>
322.1 (OGL) to 317.8	4.3	Silty sand, fine grained. 'N' = 12 to 16, compact.
317.8 to 315.6	2.2	Silty clay, interlayered with sandy silt. 'N' = 22 to 38, very stiff to hard.
315.6		Limit of borehole information.

Groundwater at Elevation 320.3.



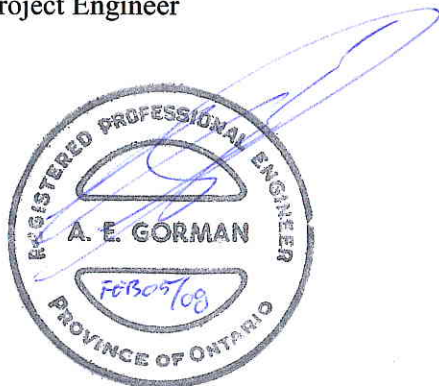
Data collection and report preparation was carried out by Mr. Sydney Pang, P.Eng. with the assistance of Mr. Mark Farrant, P.Eng..

Overall supervision of the data collection and report preparation was carried out by Mr. Alastair E. Gorman, P.Eng.

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



Sydney Pang, P.Eng.  
Senior Project Engineer



Alastair E. Gorman, P.Eng.  
Senior Foundation Engineer



P.K. Chatterji, P.Eng.  
Review Principal, Designated MTO Contact



**FEASIBILITY  
FOUNDATION INVESTIGATION AND DESIGN REPORT  
HIGHWAYS 7/8 RECONSTRUCTION  
0.7 KM WEST OF FISCHER-HALLMAN ROAD INTERCHANGE  
TO 0.4 KM EAST OF COURTLAND AVENUE INTERCHANGE  
KITCHENER, ONTARIO  
G.W.P. 131-98-00**

**GEOCRES Number: 40P8-142**

**PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**5 GENERAL**

This report presents interpretation of the available geotechnical data described in Part 1 Factual Information, and assessment of the feasibility of the proposed widening or replacement at each of the subject sites. The design team is provided with preliminary foundation design recommendations including comparisons of the various foundation alternatives for each site.

For the purposes of this report, it has been assumed that structure widenings or replacements will have the same span configurations as the original structures, and that the final profile grades will be comparable to the existing ones.

It is also noted that one or more of the items such as ground surface elevations, groundwater and surface water conditions, and subsurface conditions, may have been altered as a result of past construction activities. Therefore, the recommended geotechnical resistances and founding elevations, which are largely based on pre-construction investigations, should be considered approximate. These recommendations must be confirmed by additional investigation and assessment during detailed design.

**5.1 Borden Creek Culvert Under Highway 7/8 – west of Fischer-Hallman (Site 33-281-C)**

**5.1.1 Foundation Alternatives**

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

Site specific subsurface data is not available for this structure. Based on subsurface data from the nearby Fischer-Hallman Road Underpass and the existing structural layout of this site, it is considered feasible to support the box culvert extension or replacement, and the wingwalls on spread footings.

Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix A.



### **5.1.2 Embankment Stability**

Based on an assessment of the SPT 'N' values and DCPT results at the Fischer-Hallman Underpass, the subsurface conditions at this site are inferred to consist of firm to very stiff cohesive soils of low plasticity, in addition to compact to very dense cohesionless soils. Groundwater levels are within shallow depths below grade.

Existing subsurface information and results of the visual inspection do not indicate the presence of soft ground or swamp at this site. However, soft or loose alluvial deposits and organics are anticipated to be present within the flow channel and floodplain of the creek. These materials are expected to be removed prior to fill placement.

From the perspective of global stability, new road widening embankments with slope inclinations not steeper than 2H : 1V, and with heights similar to those of the existing embankments, are anticipated to be stable.

### **5.1.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils will be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed on native soils for widening of the existing highway embankment to a similar height will induce some settlement, but this additional settlement will be largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

### **5.1.4 Construction Feasibility and Considerations**

In general, the construction of the box culvert extension, wingwalls and adjacent road embankment widening, or for new replacement structures, is considered to be feasible at this site.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be "red-flagged".

Groundwater control will be required for constructing the culvert extension, replacement and the wingwalls. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles. Temporary diversion of the creek may also be required during construction.

Shoring is likely required for foundation construction. Temporary traffic detour such as lane shifting may also be required.



## **5.2 Borden Creek Culvert Under Fischer-Hallman Road (Site 33-282-C)**

### **5.2.1 Foundation Alternatives**

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

Subsurface data is not available for this site. Based on subsurface data from the nearby Fischer-Hallman Road Underpass and the existing structural layout for this site, it is considered feasible to support the box culvert extension or replacement, and the wingwalls on spread footings.

Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix B.

### **5.2.2 Embankment Stability**

Based on an assessment of the SPT 'N' values and DCPT results at the Fischer-Hallman Underpass, the subsurface conditions at this site are inferred to consist of firm to very stiff cohesive soils of low plasticity, in addition to compact to very dense cohesionless soils. Groundwater levels are within shallow depths below grade.

Existing subsurface information and results of the visual inspection do not indicate the presence of soft ground or swamp at this site. However, soft or loose alluvial deposits and organics are expected to be present within the flow channel and floodplain of the creek. These materials are expected to be removed prior to fill placement.

From the perspective of global stability, new road widening embankments with slope inclinations not steeper than 2H : 1V, and with heights similar to the existing embankments, are anticipated to be stable.

### **5.2.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils will be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed on native soils for widening of the existing highway embankment to a similar height will induce some settlement, but this additional settlement will be largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

### **5.2.4 Construction Feasibility and Considerations**

In general, the construction of the box culvert extension, wingwalls and adjacent road embankment widening, or for new replacement structures, is considered to be feasible at this site.





This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be “red-flagged”.

Groundwater control will be required for constructing the culvert extension, replacement and the wingwalls. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles. Temporary diversion of the creek may also be required during construction.

Shoring is likely required for foundation construction. Temporary traffic detour such as lane shifting may also be required.

### **5.3 Fischer-Hallman Road Underpass (Site 33-229)**

#### **5.3.1 Foundation Alternatives**

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

Based on currently available data for this site, it is considered feasible to support the new construction on either driven steel H-piles or spread footings. It is our understanding that the existing structures were designed to be supported on driven 12¾ in. O.D. steel tube (pipe) piles. This type of pile may still be used although it has become less common in this area.

Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix C.

#### **5.3.2 Embankment Stability**

Based on an assessment of the SPT ‘N’ values and DCPT results, the subsurface conditions at this site typically consist of either firm to hard cohesive soils of low plasticity, in addition to compact to dense cohesionless soils. Groundwater levels are within shallow depths below grade.

Results of the 1965 investigation (Reference 2) indicate the presence of some surficial organic materials. It is not known whether any of these materials have been removed during past construction activities. However, results of the visual inspection do not indicate the presence of soft ground or swamp at this site.

From the perspective of global stability, new embankments with slope inclinations not steeper than 2H : 1V, and with heights similar to those of the existing embankments, are anticipated to be stable.



### **5.3.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils will be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed for widening of the existing road embankment to a similar height will induce some settlement, but this additional settlement will be largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

### **5.3.4 Construction Feasibility and Considerations**

In general, the construction of foundations and embankments for widening the existing structures, or for new replacement structures, is considered to be feasible at this site.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be “red-flagged”.

Groundwater control may be required for any excavation penetrating below the groundwater level. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles.

Shoring is likely required for foundation construction.

## **5.4 Westmount Road Overpass WBL and EBL (Site 33-228-W and Site 33-228-E)**

### **5.4.1 Foundation Alternatives**

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

Based on currently available data for this site, it is considered feasible to support the new construction on either driven steel H-piles or spread footings. It is our understanding that the existing structures were designed to be supported on driven 12¾ in. O.D. steel tube (pipe) piles. This type of pile may still be used although it has become less common in this area. Spread footings may not be feasible at some pier locations where extensive excavation is anticipated to reach competent founding strata.

Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix D.

### **5.4.2 Embankment Stability**

Based on an assessment of the SPT ‘N’ values and DCPT results, the subsurface conditions at this site typically consist of firm to hard cohesive soils with some medium to high



plasticity zones, and compact to very dense cohesionless soils, with occasional loose/firm soils present at shallow depth in the vicinity of the WBL east pier.

Existing subsurface information and results of the visual inspection do not indicate the presence of soft ground or swamp at this site.

From the perspective of global stability, new embankments with slope inclinations not steeper than 2H : 1V, and with heights similar to those of the existing embankments, are anticipated to be stable.

#### **5.4.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils should be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed for widening of the existing highway embankment to a similar height will induce some settlement, but this additional settlement will be largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

#### **5.4.4 Construction Feasibility and Considerations**

In general, the construction of foundations and embankments for widening the existing structures, or for new replacement structures, is considered to be feasible at this site.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be “red-flagged”.

Groundwater control may be required for any excavation penetrating below the groundwater level. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles.

Shoring is likely required for foundation and embankment construction.

### **5.5 Borden Creek Culvert Under Highway 7/8 – east of Westmount (Site 33-283-C)**

#### **5.5.1 Foundation Alternatives**

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

Site specific subsurface data is not available for this structure. Based on subsurface data from the nearby Westmount Road Overpass and the existing structural layout of this site, it is considered feasible to support the arch culvert extension, or replacement, on the native soils.



Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances that can be used in the feasibility study are presented in Appendix E.

#### **5.5.2 Embankment Stability**

Based on an assessment of the SPT 'N' values and DCPT results at the Westmount Road Overpass, the subsurface conditions at this site are inferred to consist of typically firm to hard cohesive soils and compact to very dense cohesionless soils, with occasional loose/firm soils present at shallow depth.

Existing subsurface information and results of the visual inspection do not indicate the presence of swampy conditions that need to be addressed at this site. However, soft or loose alluvial deposits and organics are expected to be present within the flow channel and floodplain of the creek. The alluvium and organics should be sub-excavated and replaced with compacted granular materials prior to culvert construction.

From the perspective of global stability, new road widening embankments with slope inclinations not steeper than 2H : 1V, and with heights similar to those of the existing embankments, are anticipated to be stable.

#### **5.5.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils will be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed on the prepared subgrade, as outlined above, for widening of the existing highway embankment to a similar height will induce some settlement, but this additional settlement will be largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

#### **5.5.4 Construction Feasibility and Considerations**

In general, the construction of the culvert extension and adjacent road embankment widening, or for a new replacement culvert, is considered to be feasible at this site.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be "red-flagged".

Groundwater control will be required for constructing the culvert extension or replacement. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles. Temporary diversion of the creek may also be required.

Shoring is likely required for culvert extension or replacement. Temporary traffic detour such as lane shifting may also be required especially for culvert replacement.



## **5.6 Homer Watson Boulevard Overpass WBL and EBL (Site 33-227-W and 33-227-E)**

### **5.6.1 Foundation Alternatives**

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

Based on currently available data for this site, it is considered feasible to support the new construction on either driven steel H-piles or spread footings. It is our understanding that the existing structures were designed to be supported on driven 12¾ in. O.D. steel tube (pipe) piles. This type of pile may still be used although it has become less common in this area.

Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix F.

### **5.6.2 Embankment Stability**

Based on an assessment of the SPT 'N' values and DCPT results, the subsurface conditions at this site typically consist of very stiff to hard cohesive soils of low plasticity, in addition to dense to very dense cohesionless soils.

Existing subsurface information and results of the visual inspection do not indicate the presence of soft ground or swamp at this site.

From the perspective of global stability, new embankments with slope inclinations not steeper than 2H : 1V, and with heights similar to the existing embankments, are anticipated to be stable.

### **5.6.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils will be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed for widening of the existing highway embankment to a similar height will induce some settlement, but this additional settlement will be largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

### **5.6.4 Construction Feasibility and Considerations**

In general, the construction of foundations and embankments for widening the existing structures, or for new replacement structures, is considered to be feasible at this site.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be "red-flagged".



Groundwater control may be required for any excavation penetrating below the groundwater level. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles.

Shoring is likely required for foundation construction.

## **5.7 Ottawa Street (South) Overpass WBL and EBL (Site 33-226-W and 33-226-E)**

### **5.7.1 Foundation Alternatives**

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

Based on currently available data for this site, it is considered feasible to support the new construction on either driven steel H-piles or spread footings. To be consistent with the existing structures, it is also preferable that the new abutments be supported on piles and the new footings be supported on footings. It is our understanding that the existing abutments were designed to be supported on driven 12¾ in. O.D. steel tube (pipe) piles. This type of pile may still be used although it has become less common in this area.

Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix G.

### **5.7.2 Embankment Stability**

Based on an assessment of the SPT 'N' values and DCPT results, the subsurface conditions at this site typically consist of compact to very dense cohesionless soils.

Existing subsurface information and results of the visual inspection do not indicate the presence of soft ground or swamp at this site. However, surficial organics and fill materials from past construction activities may be present. These materials should be removed prior to new fill placement.

From the perspective of global stability, new embankments founded on prepared subgrade with slope inclinations not steeper than 2H : 1V, and with heights similar to those of the existing embankments, are anticipated to be stable.

### **5.7.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils will be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed on prepared subgrade for widening of the existing highway embankment to a similar height will induce some settlement, but this additional settlement will be



largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

#### **5.7.4 Construction Feasibility and Considerations**

In general, the construction of foundations and embankments for widening the existing structures, or for new replacement structures, is considered to be feasible at this site.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be “red-flagged”.

Groundwater control may be required for any excavation, such as those for footing construction, penetrating below the groundwater level. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles.

Shoring is likely required for foundation construction.

### **5.8 CNR Overhead WBL and EBL (Site 33-225-W and 33-225-E)**

#### **5.8.1 Foundation Alternatives**

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

Based on currently available data for this site, it is considered feasible to support the new abutments on driven steel H-piles, and the new retaining walls on spread footings. It is our understanding that the existing structures were designed to be supported on driven 12¾ in. O.D. steel tube (pipe) piles. This type of pile may still be used although it has become less common in this area.

Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix H.

#### **5.8.2 Embankment Stability**

Based on an assessment of the SPT ‘N’ values and DCPT results, the subsurface conditions at this site generally consist of interlayered, compact cohesionless soils and stiff cohesive soils of low plasticity, overlying very stiff to hard cohesive till.

Existing subsurface information and results of the visual inspection do not indicate the presence of soft ground or swamp to be addressed at this site. However, surficial organics and fill materials from past construction activities may be present. These materials should be removed prior to new fill placement.



From the perspective of global stability, new embankments founded on prepared subgrade with slope inclinations not steeper than 2H : 1V, and with heights similar to those of the existing embankments, are anticipated to be stable.

### **5.8.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils will be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed on prepared subgrade for widening of the existing highway embankment to a similar height will induce settlement. This additional settlement will be largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

### **5.8.4 Construction Feasibility and Considerations**

In general, the construction of foundations and embankments for widening the existing structures, or for new replacement structures, is considered to be feasible at this site.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be “red-flagged”. However, it should be noted that the new construction in close proximity to the railway must be coordinated with the railway company and must take into account train operational requirements.

Groundwater control may be required for any excavation, such as those for footing construction, penetrating below the groundwater level. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles.

Shoring is likely required for foundation construction.

## **5.9 Courtland Avenue Overpass WBL and EBL (Site 33-224-W and 33-224-E)**

### **5.9.1 Foundation Alternatives**

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

Based on currently available data for this site, it is considered feasible to support the new abutments on either driven steel H-piles or spread footings. To be consistent with the existing structures, it is preferable that the new foundations be supported on driven piles. It is our understanding that the existing structures were designed to be supported on driven 12¾ in. O.D. steel tube (pipe) piles. This type of piles may still be used although it has become less common in this area.





Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix I.

### **5.9.2 Embankment Stability**

Based on an assessment of the SPT 'N' values and DCPT results, the subsurface conditions at this site typically consist of interlayered, compact cohesionless soils and stiff to very stiff cohesive soils, grading to a dense to very dense cohesionless till with depth.

Existing subsurface information and results of the visual inspection do not indicate the presence of soft ground or swamp at this site. However, surficial organics and fill materials from past construction activities may be present. These materials should be removed prior to new fill placement.

From the perspective of global stability, new embankments founded on prepared subgrade with slope inclinations not steeper than 2H : 1V, and with heights similar to those of the existing embankments, are anticipated to be stable.

### **5.9.3 Embankment Settlement**

It is assumed that surficial alluvial and organic deposits, loose, soft or otherwise disturbed soils will be removed from the footprint of the new construction prior to placing new fill.

Fill to be placed on prepared subgrade for widening of the existing highway embankment to a similar height will induce settlement. This additional settlement will be largely elastic and is anticipated to be complete by the end of construction. Long term settlement should be negligible.

### **5.9.4 Construction Feasibility and Considerations**

In general, the construction of foundations and embankments for widening the existing structures, or for new replacement structures, is considered to be feasible at this site.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be "red-flagged".

Groundwater control may be required for any excavation, such as those for footing construction, penetrating below the groundwater level. The groundwater control measures that are considered feasible, depending on depth and size of the excavations, may consist of pumping from filtered sumps, wellpoints or driven sheetpiles.

Shoring is likely required for foundation construction.



## **5.10 Pedestrian Bridge – East of Courtland (Site 33-260)**

### **5.10.1 Foundation Alternatives**

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

Based on currently available data for this site, it is considered feasible to support the new construction on either driven steel H-piles or spread footings. To be consistent with the existing structures, it is preferable that the new piers be supported on driven piles, and that the approaches be supported on footings.

Provided a minimum footing width of 2 m is maintained, anticipated geotechnical resistances and founding elevations that can be used in the feasibility study are presented in Appendix J.

### **5.10.2 Embankment Stability**

Based on an assessment of the SPT 'N' values and DCPT results, the subsurface conditions at this site typically consist of loose to compact cohesionless soils overlying interlayered, very stiff cohesive and compact to dense cohesionless soils.

Existing subsurface information and results of the visual inspection do not indicate the presence of soft ground or swamp at this site. However, surficial organics and fill materials from past construction activities may be present, and should be removed prior to fill placement at the approaches.

Global stability of embankments is not a design issue at this site. Any new approach fills that are required, with heights similar to the existing embankments, are anticipated to be stable at inclinations not steeper than 2 H : 1 V.

### **5.10.3 Embankment Settlement**

New fill to be placed at the new approaches on prepared subgrade will induce some elastic settlement that is anticipated to be complete by the end of construction. Long term settlement should be negligible.

### **5.10.4 Construction Feasibility and Considerations**

In general, the construction of foundations for lengthening the pedestrian bridge, in order to accommodate the widened highway, is considered to be feasible at this site. However, space and property line restrictions could be an issue at some locations.

This feasibility investigation to date has not revealed any issues requiring special materials or techniques that should be "red-flagged".



Major dewatering should not be required at this site. Depending on the depth and size of the excavations, groundwater control measures consisting of pumping from filtered sumps may be required.

## **6 FUTURE WORKS**

The discussion and recommendations presented in this report have been based on existing information from much earlier investigations. In many cases, the available information was obtained from boreholes that do not coincide with the final foundation locations. While this information is considered to be acceptable for feasibility studies, it is not sufficient for design purposes.

It is recommended that a complete site investigation and field testing program be implemented during the design process. This investigation must be conducted for each structure and high fill, and must, as a minimum, meet the Southwestern Region guidelines in effect at the time.



## 7 CLOSURE

Data collection and report preparation was carried out by Mr. Sydney Pang, P.Eng. with the assistance of Mr. Mark Farrant, P.Eng.

Overall supervision of the data collection and report preparation was carried out by Mr. Alastair E. Gorman, P.Eng.

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



Sydney Pang, P.Eng.  
Senior Project Engineer



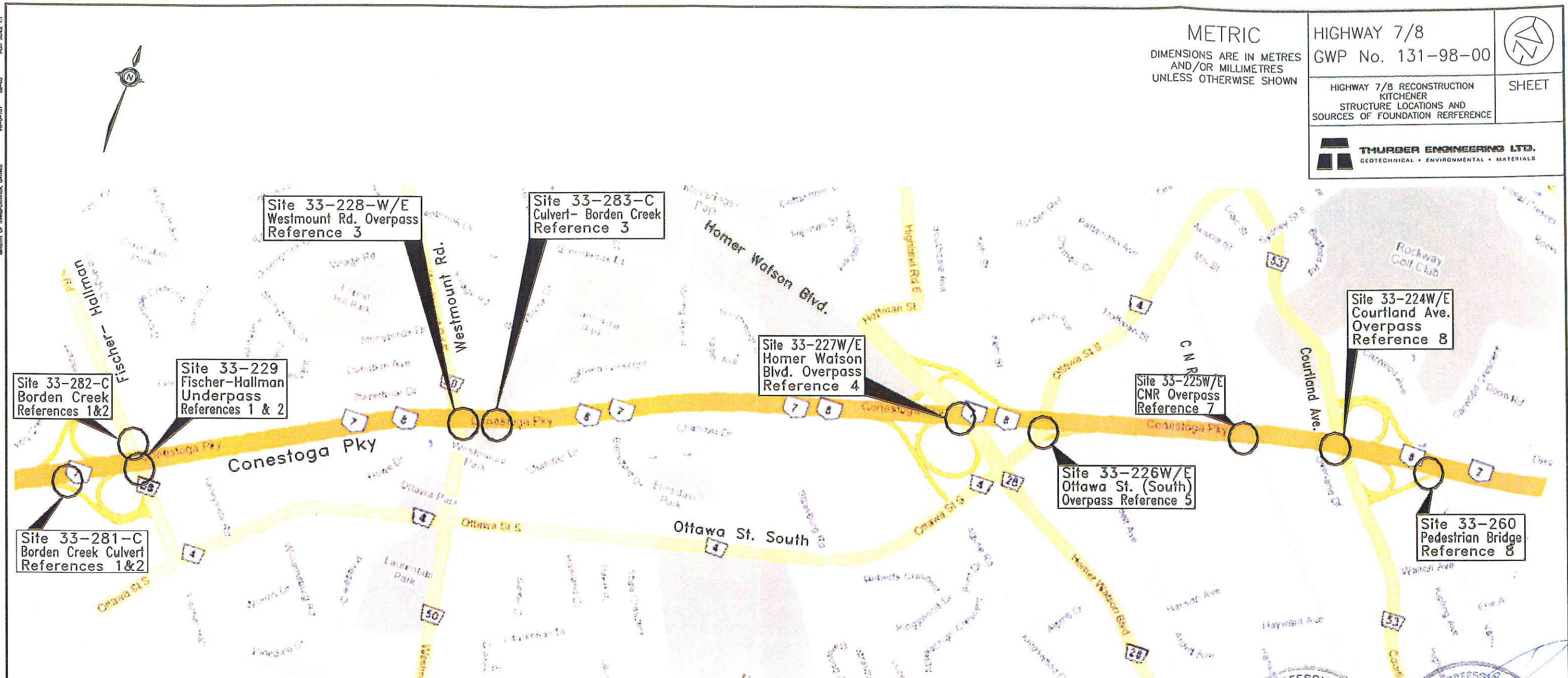
Alastair E. Gorman, P.Eng.  
Senior Foundation Engineer



P.K. Chatterji, P.Eng.  
Review Principal, Designated MTO Contact



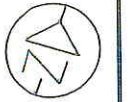




METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

HIGHWAY 7/8  
GWP No. 131-98-00

HIGHWAY 7/8 RECONSTRUCTION  
KITCHENER  
STRUCTURE LOCATIONS AND  
SOURCES OF FOUNDATION REFERENCE



SHEET

**THURBER ENGINEERING LTD.**  
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

# LIST OF FOUNDATION / GEOTECHNICAL REFERENCES

## Reference 1

Foundation Investigation Report for Fischer Drive Underpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 67-F-103, W.P. 629-64, GEOCRE No. 40P7-23, dated January 1968, prepared by Foundation Section, Department of Highways Ontario.

## Reference 2

Foundation Investigation Report for Kitchener-Waterloo Expressway Fischer Drive Underpass, Henry Sturm Blvd., W.P. 629-64, District #4, GEOCRE No. 40P7-23, dated March 1965, prepared for Department of Highways Ontario by E.M. Peto Associates Limited.

## Reference 3

Foundation Investigation Report for Filsinger Road Overpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 67-F-102, W.P. 628-64, GEOCRE No. 40P7-31, dated January 1968, prepared by Foundation Section, Department of Highways Ontario.

## Reference 4

Foundation Investigation Report for Kitchener-Waterloo Expressway and Homer Watson Blvd., City of Kitchener, District #4 (Hamilton), W.J. 66-F-70, W.P. 627-64, GEOCRE No. 40P08-52, dated September 1966, prepared by Foundation Section, Department of Highways Ontario.

## Reference 5

Foundation Investigation Report for Ottawa Street South Overpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 66-F-69, W.P. 626-64, GEOCRE No. 40P08-114, dated September 1996, prepared by Foundation Design Section, Engineering Materials Office, Ministry of Transportation and Communications.

## Reference 6

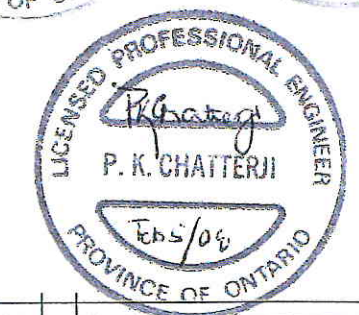
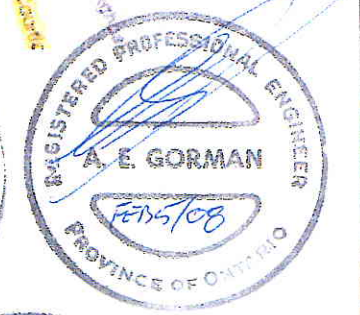
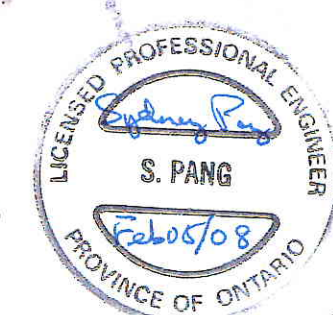
Foundation Investigation Report For Retaining Wall Along Highway 7 EBL From Sta. 19+525 to Sta. 20+000, W.P. 95-94-00, District 31, London, GEOCRE No. 40P08-52, dated September 1966, prepared by Foundation Section, Department of Highways Ontario.

## Reference 7

Soil Investigation Report For Kitchener-Waterloo Expressway, Henry Sturm Boulevard; C.N.R. WP-625-64, GEOCRE No. 40P08-36, dated January 1965, prepared for Department of Highways Ontario by E.M. Peto Associates Limited.

## Reference 8

Foundation Report for Kitchener-Waterloo Expressway, Structures WP 624-64, WP 644-64, WP 645-64 and Part of WP 618-64, GEOCRE No. 40P08-39, dated February 1965, prepared for Department of Highways Ontario by E.M. Peto Associates Limited.



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	SKP	CHK	PKC
DRAWN	MFA	CHK	SKP
DATE	FEB 2008	DATE	FEB 2008
LOAD	STRUCT	LOAD	STRUCT
DATE	FEB 2008	DATE	FEB 2008
DWG	19-479-35-1	DWG	19-479-35-1

**Appendix A**

**Foundation Alternatives Comparison**

**Geotechnical Resistances and Founding Elevations**

**Borden Creek Culvert Under Highway 7/8 (west of Fischer-Hallman)**





COMPARISON OF FOUNDATION ALTERNATIVES

BORDEN CREEK CULVERT UNDER HIGHWAY 7/8 (WEST OF FISCHER-HALLMAN)

Foundation Element	Driven Piles	Box Culvert on Compacted Granular Pad	Spread Footings on Native Soils for Wingwalls	Angered Caissons (Drilled Shafts)
<b>Twin Box Culvert Extension or Replacement</b>	<p><i>Advantages:</i></p> <ul style="list-style-type: none"> <li>i. None identified for this type of structure at this site.</li> </ul> <p><i>Disadvantages:</i></p> <ul style="list-style-type: none"> <li>i. Unnecessary due to the relatively small loads imposed by this type of structure.</li> <li>ii. Relatively cost ineffective for this type of structure.</li> </ul>	<p><i>Advantages:</i></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction and likely the most cost effective alternative.</li> <li>ii. Compatibility with the existing structure.</li> </ul> <p><i>Disadvantages:</i></p> <ul style="list-style-type: none"> <li>i. Some settlements due to foundation compression (anticipated to be complete by end of construction) must be taken into account during culvert design and construction.</li> </ul>	<p><i>Advantages:</i></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction.</li> </ul> <p><i>Disadvantages:</i></p> <ul style="list-style-type: none"> <li>i. Some settlements due to foundation compression (anticipated to be complete by end of construction) must be taken into account during wall design and construction.</li> </ul>	<p><i>Advantages:</i></p> <ul style="list-style-type: none"> <li>i. None identified for this type of structure at this site.</li> </ul> <p><i>Disadvantages:</i></p> <ul style="list-style-type: none"> <li>i. Unnecessary due to the relatively small loads imposed by this type of structure.</li> <li>ii. Relatively cost ineffective for this type of structure.</li> </ul>



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**Borden Creek Culvert Under Highway 7/8 (west of Fischer-Hallman)**

Box Culvert Base and Spread Footings		
Elevation (m)	ULS (kPa)	SLS (kPa)
340.0 or below	300	200





**Records of Boreholes**

**Plans and Profiles**



FOUNDATION SECTION

ORIGINATED BY AMS

COMPILED BY \_\_\_\_\_ AMS

CHECKED BY                     

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 14

FOUNDATION SECTION

JOB 67-F-103 LOCATION Co. rd. N 186,291; E 199,577 ORIGINATED BY AMS  
W.P. 629-64 BORING DATE November 1 & 2, 1967 COMPILED BY AMS  
DATUM Geodetic BOREHOLE TYPE BX Casing & Washboring CHECKED BY [Signature]

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. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.				WATER CONTENT % 10 20 30			
1128.3	Ground Level													Gr.Sa.Si.Cl
0.0	Clayey silt to silt, traces of sand & gravel.		1	SS	6									
1120.3	Firm to very stiff.		2	SS	18	1120								
8.0	Gravelly sand, trace of silt and clay.		3	SS	143									57 31 ( 12 )
			4	SS	82									
			5	SS	68	1110								
			6	SS	103									
	Very dense,		7	SS	55	1100								61 29 8 2
			8	SS	69									
1095.3	Silty sand, trace of gravel.  Dense to very dense.		9	SS	40	1090								3 47 46 1
33.0			10	SS	38									
			11	SS	54	1080								
			12	SS	90									
1076.8	End of Borehole					1070								
51.5														

\_\_\_\_\_

## FOUNDATION SECTION

ORIGINATED BY AMS  
COMPILED BY AMB  
CHECKED BY [Signature]

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 17

FOUNDATION SECTION

JOB 67-F-103

LOCATION Co-ord. N 186,527; E 199,382

ORIGINATED BY AMS

W.P. 629-64

BORING DATE Nov. 6 & 7, 1967

COMPILED BY AMS

DATUM Geodetic

BOREHOLE TYPE BX Casing, Washboring & Cone Test

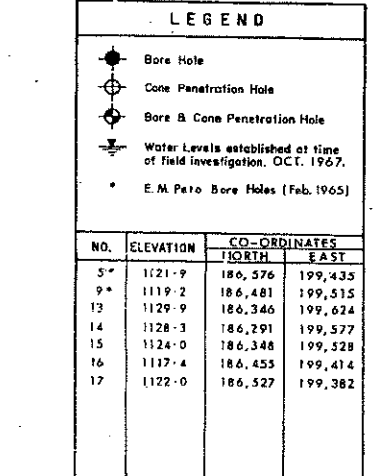
CHECKED BY

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	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80			100	10
1122.0	Ground Level													
0.0	Clayey silt, some sand and trace of gravel.		1	SS	17	1120								
			2	SS	7									
			3	SS	55									
	Firm to hard.		4	SS	30	1110								
			5	SS	32									
1103.0														
19.0	Sandy silt, traces of clay and gravel.		6	SS	20	1100								
			7	SS	13									
1094.0														
28.0	Silty sand to sand, trace of gravel.		8	SS	35	1090								
	Compact to dense.		9	SS	27									
1081.0			10	SS	22	1080								
41.0	Sandy silt, some clay and trace of gravel.		11	SS	11									
	Compact to very dense.		12	SS	90	1070								
1060.7			13	SS	1187	1060								
61.3	End of Borehole													

1117.2

1 37 56 6

2 33 55 10



- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS			
DATE	BY	DESCRIPTION	

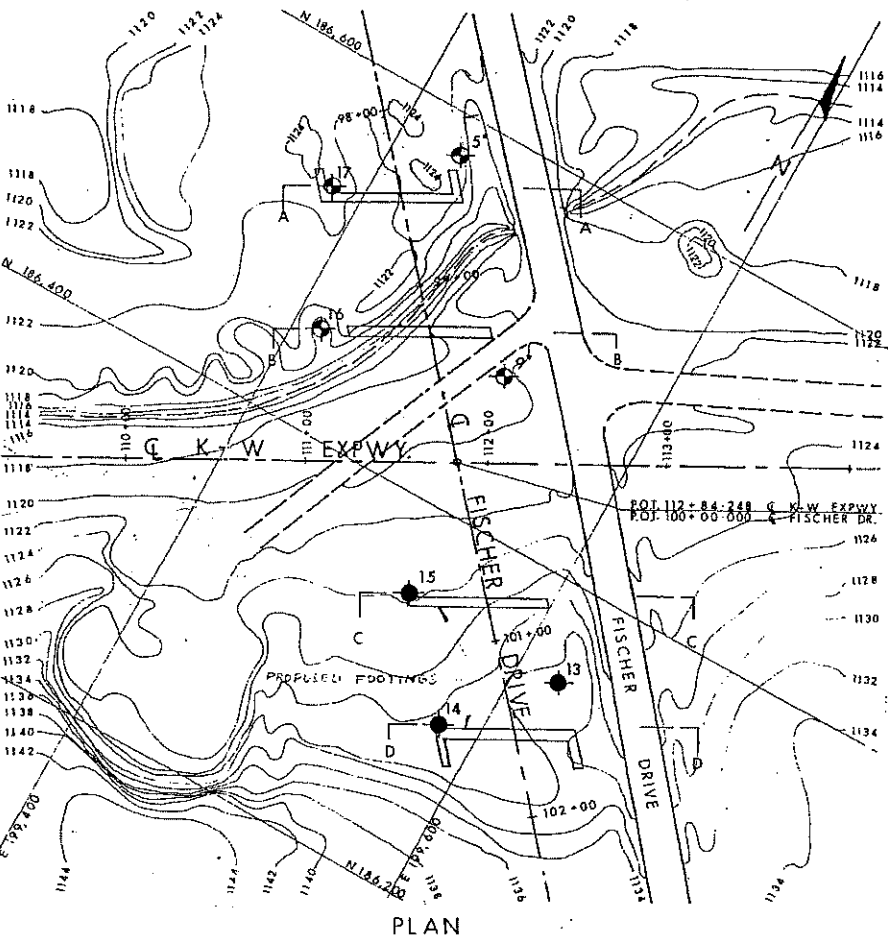
DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

## FISCHER DRIVE

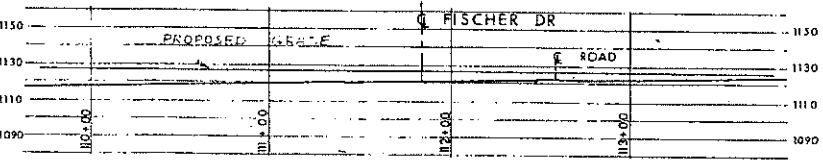
KING'S HIGHWAY NO. K - W EXPWY. DIST. NO. 4  
CO. WATERLOO  
TWP. WATERLOO LOT \_\_\_\_\_ CON. \_\_\_\_\_

## BORE HOLE LOCATIONS &amp; SOIL STRATA

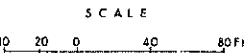
SUBMIT A.S.	CHECKED <i>[initials]</i>	W.P. NO. 629 - 6A	M.R.T. DRAWING NO.
DRAWN A.B.	CHECKED <i>[initials]</i>	JOB NO. 67-F-103	<b>67-F-103A</b>
DATE DEC. 19, 1967.	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>[Signature]</i>	CONT. NO.		



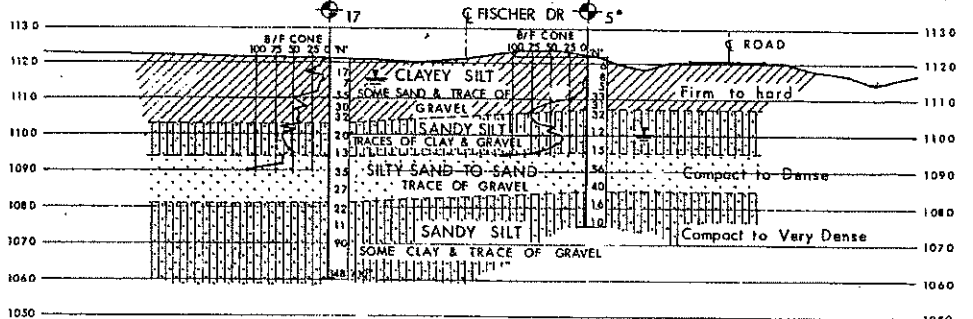
## PLAN



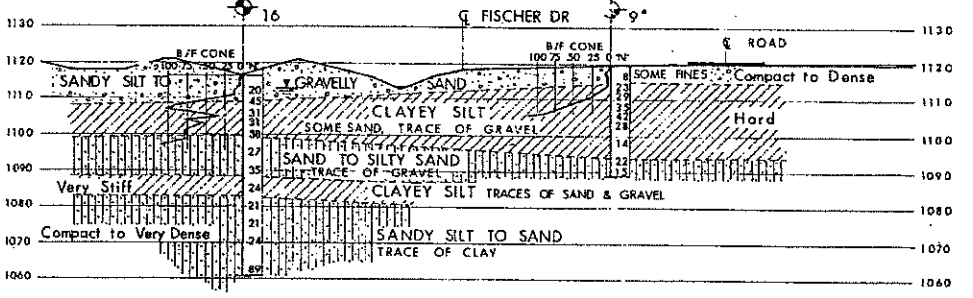
## PROFILE



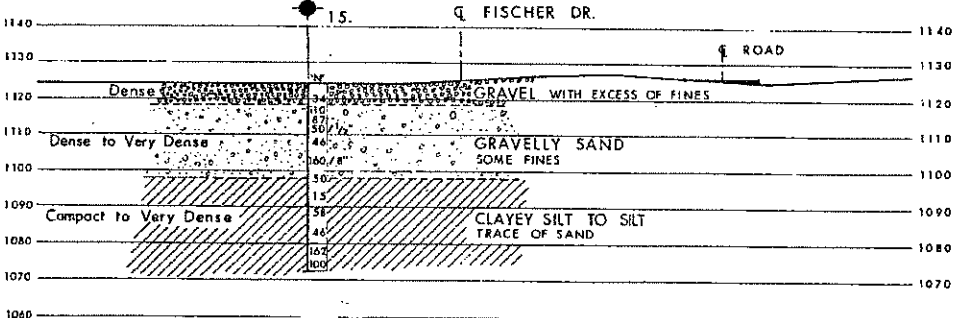
REF. NO 5962-44-M243 M.M. DILLON LTD



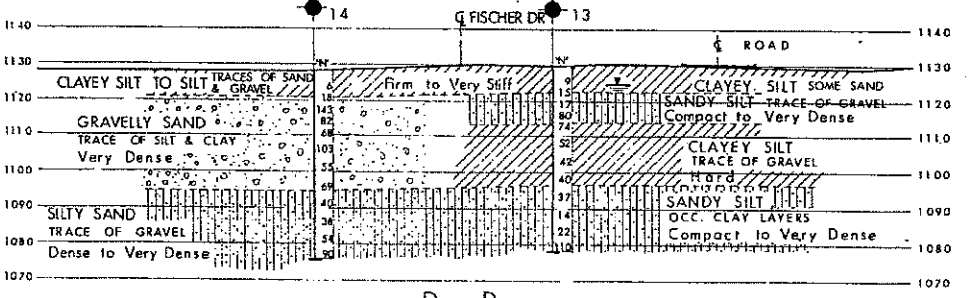
A - A



100

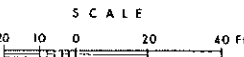


—



**SELECT**

## SECTIONS

[illegible]

## **Appendix B**

### **Foundation Alternatives Comparison**

#### **Geotechnical Resistances and Founding Elevations**

#### **Borden Creek Culvert Under Fischer-Hallman Road**





**COMPARISON OF FOUNDATION ALTERNATIVES**  
**BORDEN CREEK UNDER FISCHER-HALLMAN ROAD (NORTH OF HIGHWAY)**

Foundation Element	Driven Piles	Box Culvert on Compacted Granular Pad	Spread Footings on Native Soils for Wingwalls	Augered Caissons (Drilled Shafts)
<b>Twin Box Culvert Extension or Replacement</b>	<p><i><b>Advantages:</b></i></p> <ul style="list-style-type: none"> <li>i. None identified for this type of structure at this site.</li> </ul> <p><i><b>Disadvantages:</b></i></p> <ul style="list-style-type: none"> <li>i. Unnecessary due to the relatively small loads imposed by this type of structure.</li> <li>ii. Relatively cost ineffective for this type of structure.</li> </ul>	<p><i><b>Advantages:</b></i></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction and likely the most cost effective alternative.</li> <li>ii. Compatibility with the existing structure.</li> </ul> <p><i><b>Disadvantages:</b></i></p> <ul style="list-style-type: none"> <li>i. Some settlements due to foundation compression (anticipated to be complete by end of construction) must be taken into account during culvert design and construction.</li> </ul>	<p><i><b>Advantages:</b></i></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction.</li> </ul> <p><i><b>Disadvantages:</b></i></p> <ul style="list-style-type: none"> <li>i. Some settlements due to foundation compression (anticipated to be complete by end of construction) must be taken into account during wall design and construction.</li> </ul>	<p><i><b>Advantages:</b></i></p> <ul style="list-style-type: none"> <li>i. None identified for this type of structure at this site.</li> </ul> <p><i><b>Disadvantages:</b></i></p> <ul style="list-style-type: none"> <li>i. Unnecessary due to the relatively small loads imposed by this type of structure.</li> <li>ii. Relatively cost ineffective for this type of structure.</li> </ul>



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**Borden Creek Culvert Under Fischer-Hallman Road**

Box Culvert Base and Spread Footings		
Elevation (m)	ULS (kPa)	SLS (kPa)
340.0 or below	300	200



**Records of Boreholes**

**Plans and Profiles**



CHECKED BY

DEPARTMENT OF HIGHWAYS - ONTARIO

## RECORD OF BOREHOLE NO. 14

FOUNDATION SECTION

MATERIALS &amp; TESTING DIVISION

JOB 67-F-103

LOCATION Cofford, N 186.291; E 199.577

ORIGINATED BY AMS

W.P. 629-64

BORING DATE November 1 & 2, 1967

COMPILED BY                      **AMS**

DATUM Geodetic

BOREHOLE TYPE BX Casing & Washboring

CHECKED BY                     

[illegible]

## RECORD OF BOREHOLE NO. 15

FOUNDATION SECTION

## MATERIALS & TESTING DIVISION

JOB 67-F-103

LOCATION Co-ord. N 186,348; E 199,528

ORIGINATED BY AMS

W.P. 629-64

BORING DATE Oct. 31 & Nov. 1, 1967

COMPILED BY \_\_\_\_\_ AMS

DATUM Geodetic

BOREHOLE TYPE BX Casing & Washboring

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT — W <sub>L</sub>			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT — W <sub>P</sub>	WATER CONTENT — W	WATER CONTENT %		
1124.0	Ground Level												
0.0	Gravel with excess of fines.												
1119.0	Dense.		1	SS	34	1120							73 19 ( 8 )
5.0	Gravelly sand, some fines.		2	SS	110								32 45 (23)
			3	SS	87								
			4	SS	50.4	1110							
			5	SS	46								
	Dense to very dense.		6	SS	160.8	1100							
1098.0			7	SS	50								
26.0	Clayey silt to silt, trace of sand.		8	SS	15								
			9	SS	58	1090							
	Compact to very dense.		10	SS	46								
			11	SS	162	1080							
1072.5			12	SS	100								
51.5	End of Borehole					1070							

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

## RECORD OF BOREHOLE NO. 16

FOUNDATION SECTION

JOB 67-F-103

LOCATION Co-ord. N 186,455; E 199,414

ORIGINATED BY AMS

W. P. 629-64

**BORING DATE** Nov. 8 & 9, 1967

COMPILED BY                      **AMG**

DATUM Geodetic

BOREHOLE TYPE BX Casing, Washboring & Cone Test

CHECKED BY                     

[illegible]

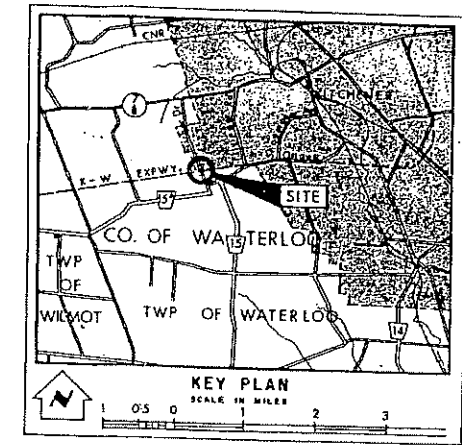
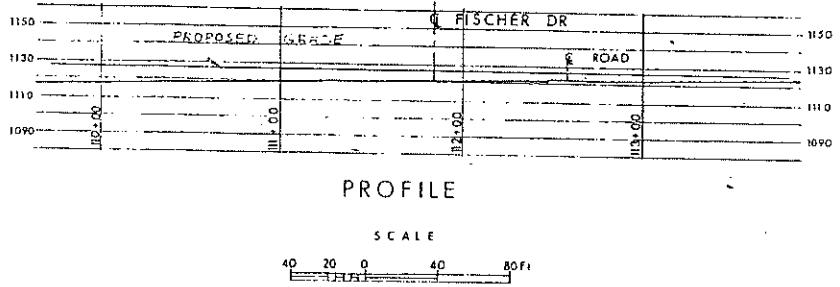
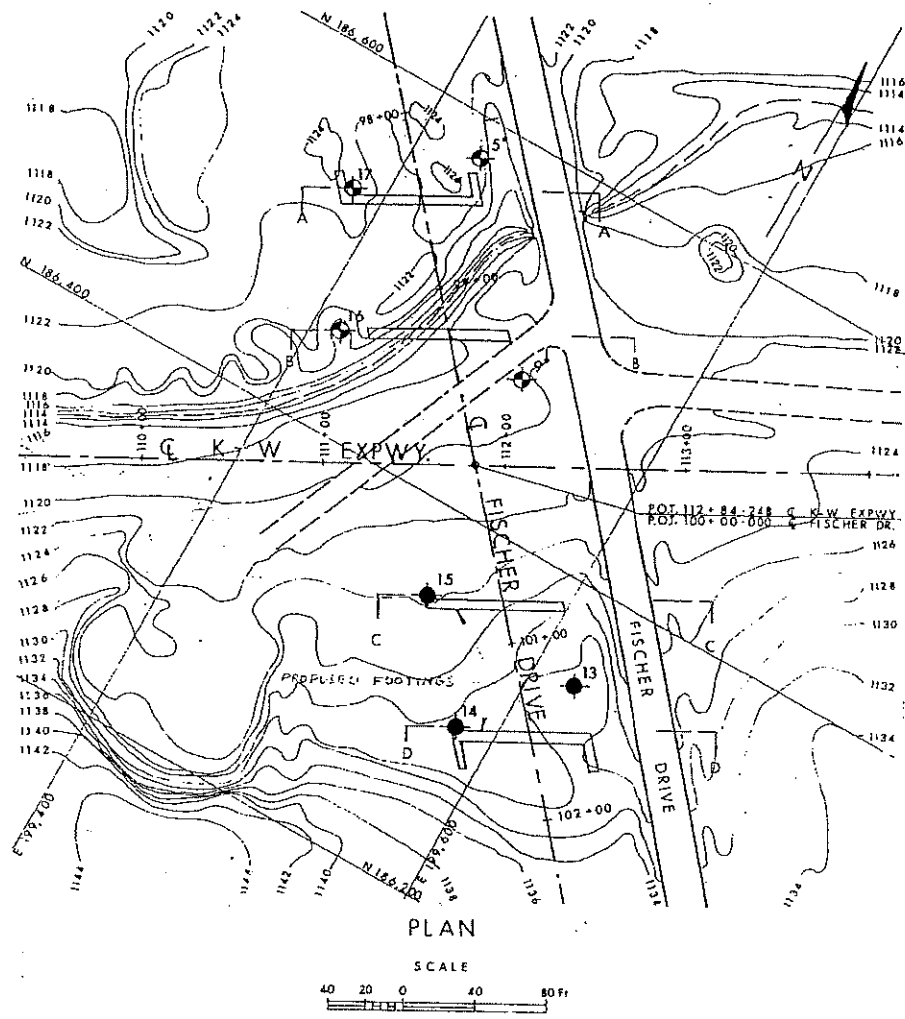
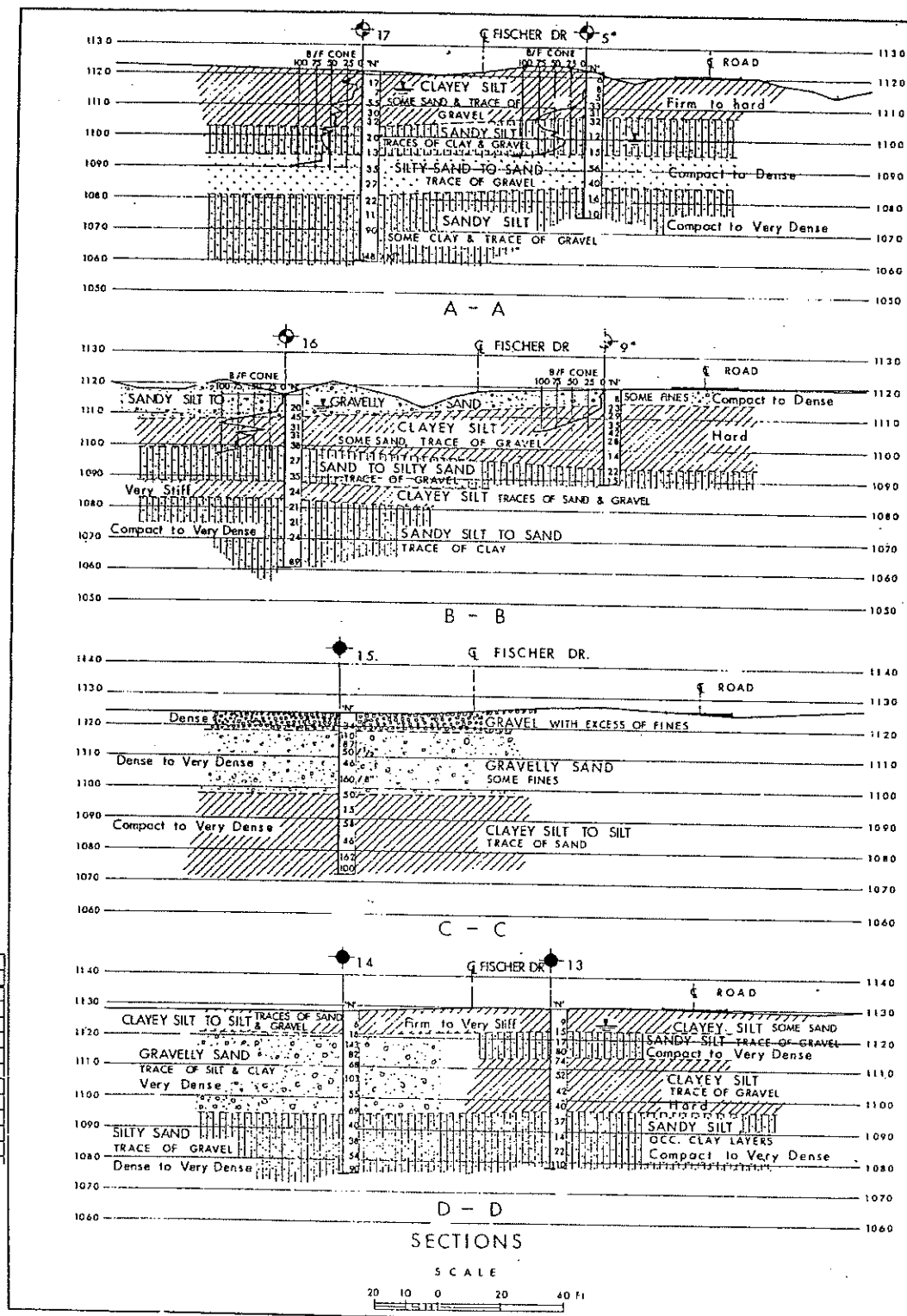
FOUNDATION SECTION

ORIGINATED BY AMS  
COMPILED BY AMS  
CHECKED BY [Signature]

[illegible]



PRINT RECORD		
NO.	FOR	DATE



LEGEND			
●	Bore Hole		
⊙	Cone Penetration Hole		
⊕	Bore A Cone Penetration Hole		
⊖	Water Levels established at time of field investigation, OCT. 1967.		
•	E.M. Petro Bore Holes (Feb. 1965)		
CO-ORDINATES			
NO.	ELEVATION	NORTH	EAST
5*	1121.9	186,576	199,435
9*	1119.2	186,481	199,515
13	1129.9	186,346	199,624
14	1128.3	186,291	199,577
15	1124.0	186,348	199,528
16	1117.4	186,455	199,414
17	1122.0	186,527	199,382

NOTE -  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

DATE	BY	REVISION

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

FISCHER DRIVE

KING'S HIGHWAY NO. K-W EXPWY. DIST. NO. 4  
CO. WATERLOO  
TWP. WATERLOO LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBWD. A. S. CHECKED	W.P. NO. 629-64	W.B.T. DRAWING NO.
DRAWN A. S. CHECKED	JOB NO. 67-F-103	67-F-103A
DATE DEC. 19, 1967.	SITE NO.	BRIDGE DRAWING NO.
APPROVED	CONT. NO.	

**Appendix C**

**Foundation Alternatives Comparison**

**Geotechnical Resistances and Founding Elevations**

**Fischer-Hallman Road Underpass**



**COMPARISON OF FOUNDATION ALTERNATIVES  
FISCHER-HALLMAN UNDERPASS**

Foundation Element	Driven Steel H-Piles	Driven Tube (Pipe) Piles	Spread Footings	Augered Caissons (Drilled Shafts)
North and South Abutments	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively high geotechnical resistance is available for end bearing piles.</li> <li>ii. Minimal excavation required for foundation construction.</li> <li>iii. Commonly used deep foundation type.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Vibration and potential adverse effects on the existing foundations must be addressed during design and construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Compatibility with the existing foundations and relatively high geotechnical resistance.</li> <li>ii. Minimal excavation required for foundation construction.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively uncommon pile type nowadays that may include concrete filling.</li> <li>ii. Lesser geotechnical resistance than H-piles of comparable size and driven depth.</li> <li>iii. Large displacement piles that could have more severe adverse effects on the existing foundations. Vibration effects must also be addressed during design and construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction at the piers.</li> <li>ii. More cost effective assuming extensive dewatering and shoring is not required during construction.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Impractical for use at the abutments if perched abutments similar to the existing structures are used.</li> <li>ii. Requires larger excavation than pile cap construction.</li> <li>iii. Larger settlements anticipated during construction than those associated with piled foundations.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Larger geotechnical resistance than other deep foundation types is available for comparable founding depths.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Specific requirements during installation through water-bearing cohesionless soils, including the use of temporary liners, drilling fluids and tremie concrete.</li> <li>ii. Caisson equipment must be equipped to handle obstructions, boulders and cobbles etc.</li> <li>iii. May require manual cleaning and inspection of the caisson base.</li> </ul>
North and South Piers				



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**Fischer-Hallman Underpass**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS <sub>r</sub> (kN)	SLS (kN)
<b>North Abutment</b>					
340.5	300	200	Below 327.0	1,500	1,000
Below 338.3	450	300			
<b>North Pier</b>					
339.0	300	200	Below 327.0	1,200	800
Below 338.3	450	300	Below 323.0	1,500	1,000
<b>South Pier</b>					
341.0	300	200	Below 327.0	1,500	1,000
Below 340.7	450	300			
<b>South Abutment</b>					
341.7	300	200	Below 327.0	1,500	1,000
Below 341.0	450	300			

Concrete filled, 12¾" O.D. steel tube (pipe) piles driven to the above elevations may be designed for factored geotechnical resistance at ULS of 900 kN per pile, and geotechnical resistance at SLS of 600 kN per pile.



**Records of Boreholes**

**Plans and Profiles**



FOUNDATION SECTION

ORIGINATED BY AMS

COMPILED BY \_\_\_\_\_ AMS

CHECKED BY                     

[illegible]

[illegible]

FOUNDATION SECTION

ORIGINATED BY AMS

COMPILED BY \_\_\_\_\_ AMS

CHECKED BY                     

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT ——— W <sub>L</sub>			BULK DENSITY P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT			PLASTIC LIMIT ——— W <sub>P</sub>				
							SHEAR STRENGTH P.S.F.			WATER CONTENT ——— W				
									WATER CONTENT % 10 20 30					
1124.0	Ground Level												Gr.Sa.Si.Cl	
0.0	Gravel with excess of fines.												73 19 ( 8 )  32 45 (23)	
1119.0	Dense.		1	SS	34	1120								
5.0	Gravelly sand,  some fines.		2	SS	110									
			3	SS	87									
			4	SS	50.4	1110								
			5	SS	46									
	Dense to very dense.	6	SS	160/8"	1100									
1098.0	Clayey silt to silt,  trace of sand.  Compact to very dense.		7	SS	50									
26.0			8	SS	15									
			9	SS	58	1090								
			10	SS	46									
			11	SS	162	1080								
			12	SS	100									
1072.5	End of Borehole					1070								



FOUNDATION SECTION

ORIGINATED BY AMS  
COMPILED BY AMS  
CHECKED BY [Signature]

[illegible]

FOUNDATION SECTION

JOB 67-F-103

LOCATION Co-ord. N 186,527; E 199,382

ORIGINATED BY AMS

W. P. 629-64

BORING DATE Nov. 6 & 7, 1967

COMPILED BY           AMS          

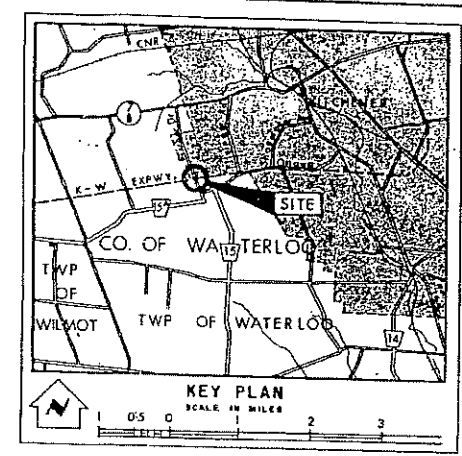
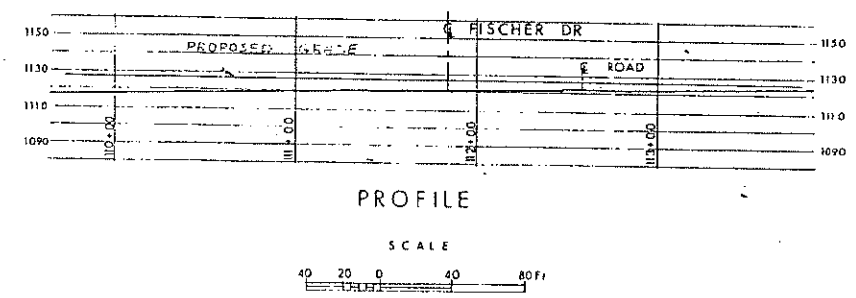
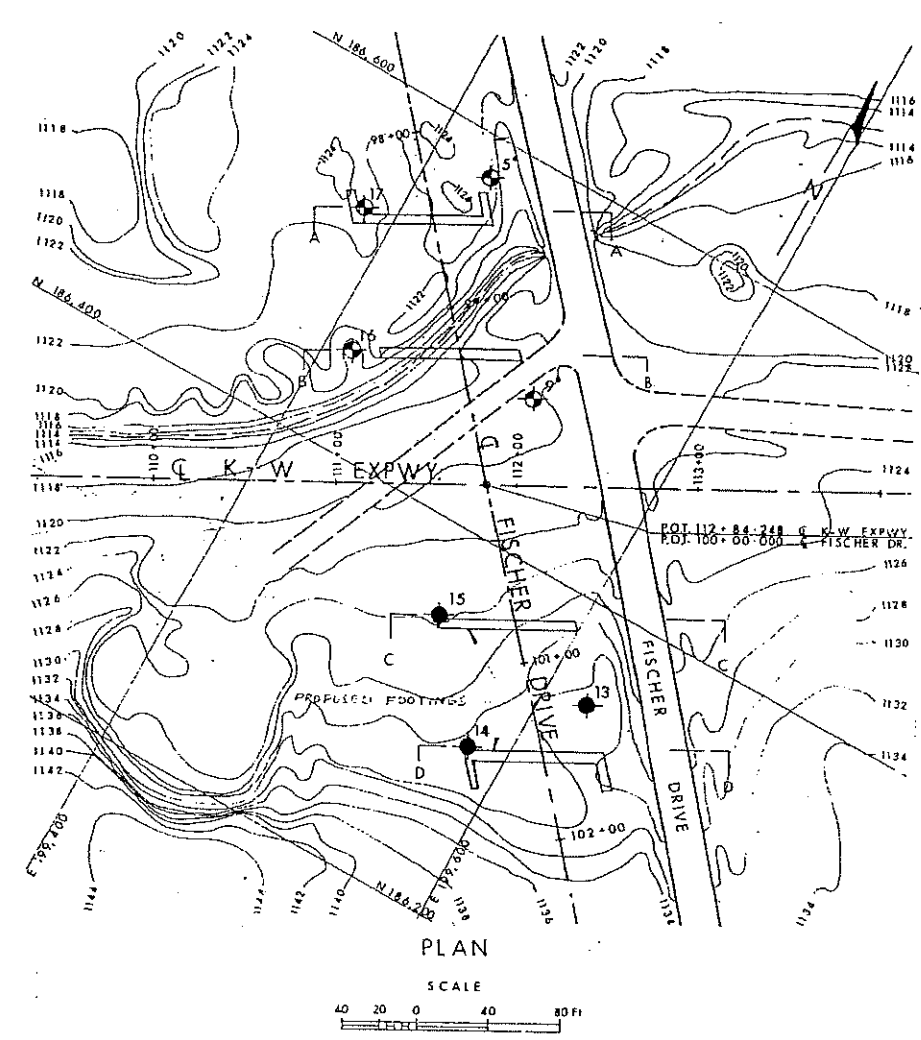
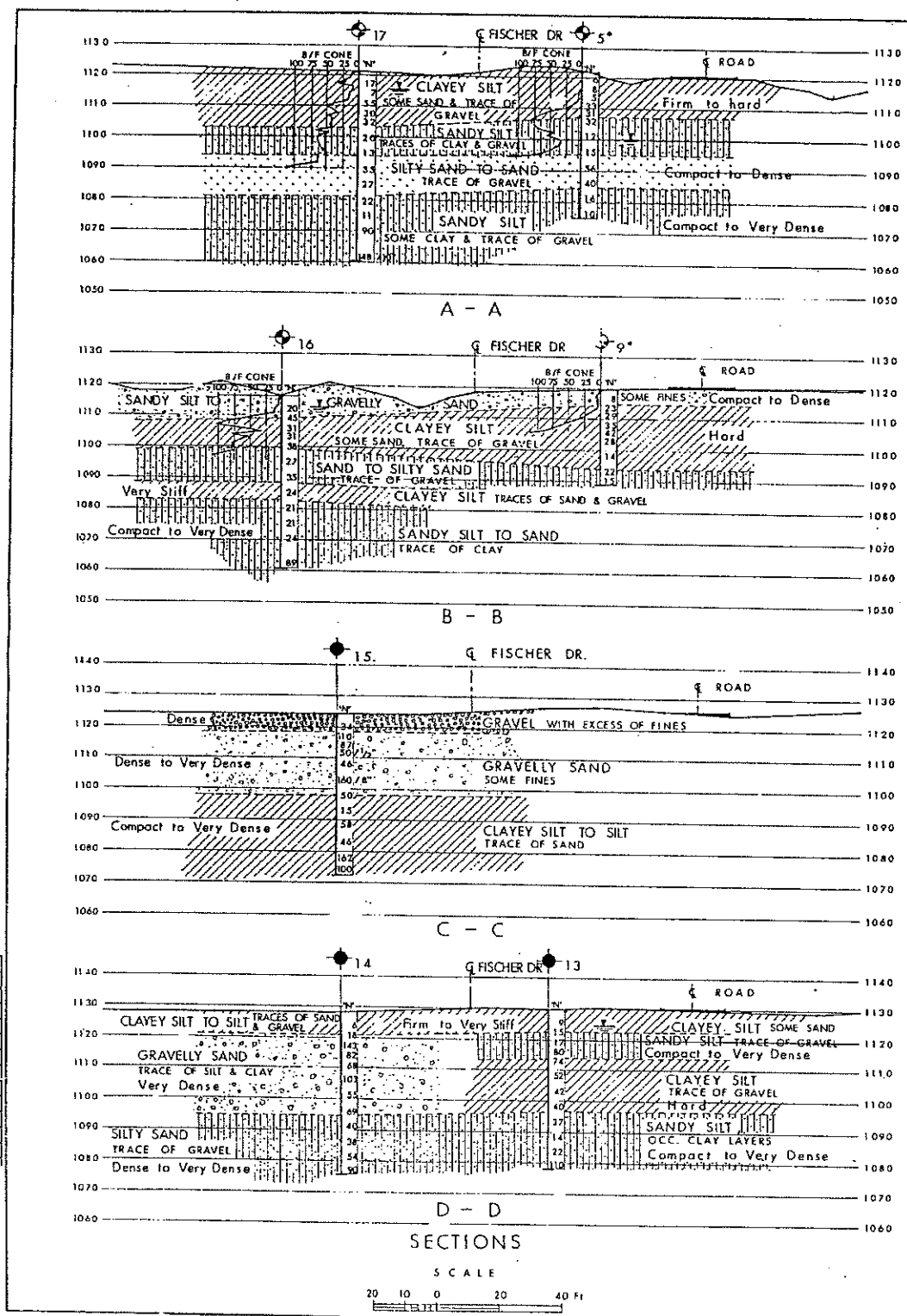
DATUM Geodetic

BOREHOLE TYPE BX Casing, Washboring & Cone Test

CHECKED BY                     

[illegible]

PRINT RECORD		
NO.	FOR	DATE



LEGEND			
●	Bore Hole		
○	Cone Penetration Hole		
⊙	Bore & Cone Penetration Hole		
—	Water Levels established at time of field investigation, OCT. 1967.		
•	E.M. Peto Bore Holes (Feb. 1965)		

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
5	1121.9	186,576	199,435
9	1119.2	186,481	199,515
13	1129.9	186,346	199,624
14	1128.3	186,291	199,577
15	1124.0	186,348	199,528
16	1117.4	186,455	199,414
17	1122.0	186,527	199,382

**NOTE**

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISION	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

**FISCHER DRIVE**

KING'S HIGHWAY NO. K-W EXPWY. DIST. NO. 4  
CO. WATERLOO  
TWP. WATERLOO LOT CDW.

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBMIT A.S. CHECKED	W.P. NO. 629-64	W.P. DRAWING NO.
DRAWN A.B. CHECKED	JOB NO. 67-F-103	67-F-103 A
DATE DEC. 19, 1967	SITE NO.	BRIDGE DRAWING NO.
APPROVED	FOOT. NO.	

## Consulting soil engineers

## TECHNICIAN

ENGINEER B. L.

TYPED BY: V.M.

Water level  
at  
27 Ft.

e.m. peto associates ltd.

## RECORD OF BOREHOLE NO. 2

Consulting soil engineers

JOB NO. 6503

JOB NAME Kitchener - Waterloo Expressway System W.P. 629-64

TECHNICIAN

BORING DATE Feb. 9-11/65

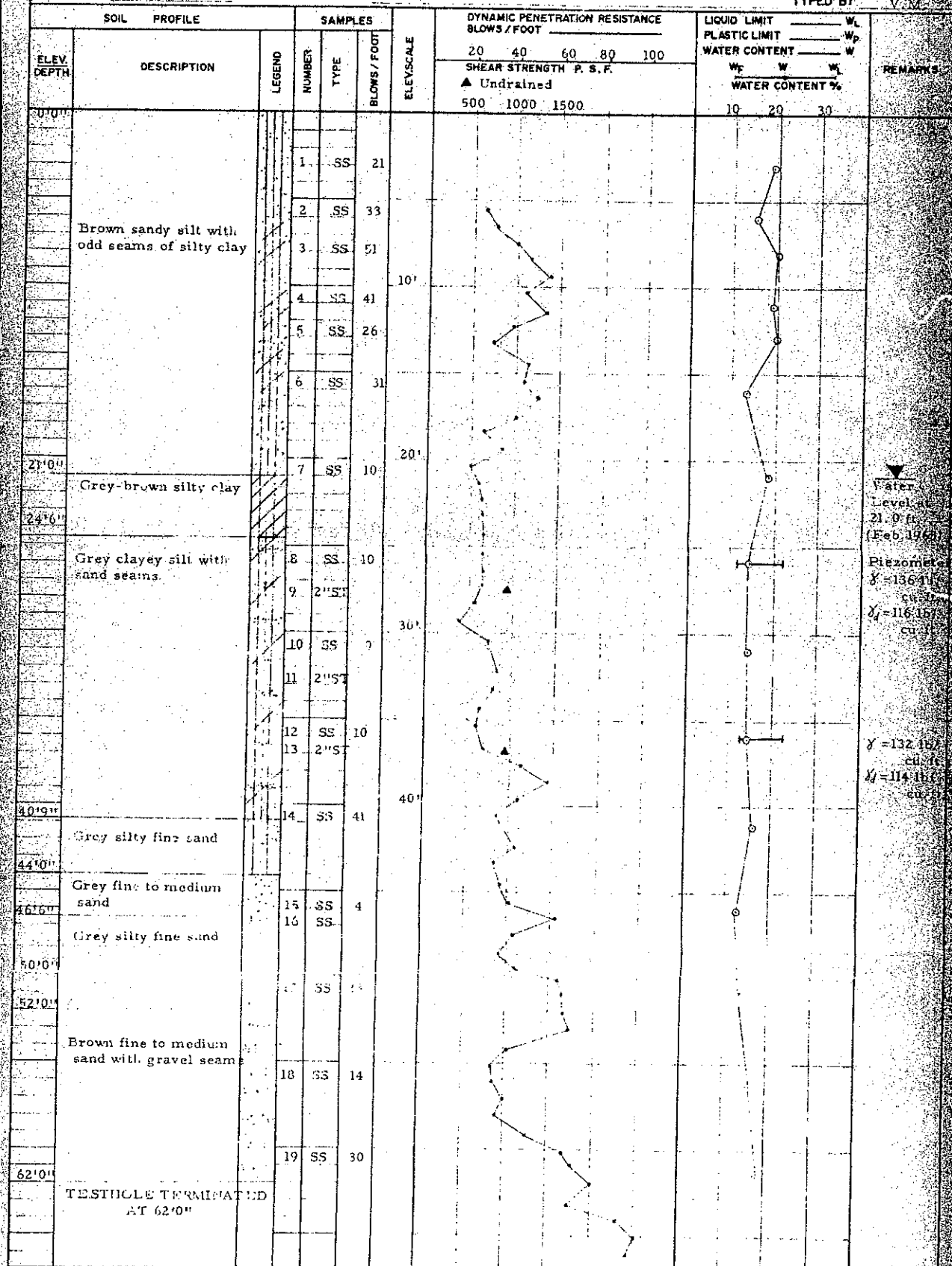
CLIENT D. H. O.

ENGINEER B. L.

DATUM 1118.0

BOREHOLE TYPE 4" + BX

TYPED BY V. M.



e. m. peto associates ltd.

## RECORD OF BOREHOLE NO. 3

Consulting soil engineers

JOB NO. 6503

JOB NAME Kitchener-Waterloo Expressway System

TECHNICIAN

BORING DATE Jan. 20-21/65

CLIENT Department of Highways, Ontario

ENGINEER B. L.

DATUM 1120.7

BOREHOLE TYPE Auger

TYPED BY H. E.

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		PLASTIC LIMIT		WATER CONTENT		REMARKS			
ELEV. DEPTH	DESCRIPTION	LEGEND	NUMBER	TYPE	BLOWS / FOOT	BLOWS / FOOT					Wp		W		
						20 40 60 80 100					10 20 30		10 20 30		
						SHEAR STRENGTH P. S. F.					Wp		W		
	Fill (silty sand, some clay organic matter)		1	CS	4										
			2	SS	4										
51'7"			3	SS	2										
8'0"	Silty fine sand with peat layers		4	SS	7										
	Brown Clayey to sandy silt till		5	SS	23										
			6	SS	23										
15'4"			7	SS	17										
	Grey Clayey silt till		8	SS	25										
24'6"			9	SS	20										
	Grey Fine gravel		10	SS	16										
			11	SS	57										
			12	SS	63										
			13	SS	178										
50'0"			14	SS	70										
			15	SS	181										
61'6"			16	SS	72										
	Testhole terminated at 61'6"														

Boulder at 9'0"

Water level at 22'4" (Feb. 1965) Piezometer

JOB NO. 6503

JOB NAME Kitchener-Waterloo Expressway System

TECHNICIAN

BORING DATE Jan. 22-29/65

CLIENT Department of Highways, Ontario

ENGINEER D.L.

DATUM 1115.6

BOREHOLE TYPE Auger

TYPED BY HF

ELEV DEPTH	SOIL PROFILE	LEGEND	SAMPLES		BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT $W_L$			REMARKS
			NUMBER	TYPE			20	40	60	80	100	PLASTIC LIMIT $W_p$	WATER CONTENT $W$	WATER CONTENT %	
							SHEAR STRENGTH P. S. F.					$W_p$	$W$	$W_L$	
							▲ Triaxial quick undrained					10	20	30	
							500	1000	1500	2000	2500				
31.2'	Fill		1	SS	14										
	Grey brown		2	SS	28										
7.6'	Sandy silt till		3	SS	26										
			4	SS	19										
32.0'	Grey brown		5	SS	24										
14.0'			6	SS	13										
	Grey Silty sand till		7	SS	3										
20.0'	Grey Interlayered Silty clay, silt and fine sand		8	3'SS											
			9	SS	15										
			10	SS	22										
			11	SS	13										
38.0'	Grey brown sandy silt		12	SS	10										
44.0'			13	SS	10										
	Brown to grey-brown		14	SS	15										
	Fine to med. sand		15	SS	58										
50.0'	Odd seams of clayey silt		16	SS	27										
58.6'			17	SS	89										
	Grey-brown medium to coarse sand with gravel layers		18	SS	65										
75.3'			19	SS	44										
	Grey - brown sandy silt		20	SS	62										
80.6'			21	SS	44										
	Grey silty clay till														
86.3'	Testhole terminated at 86.3'														

Water lay  
1016  
 $\gamma = 135.16 / \text{cu ft}$   
 $\gamma_s = 116.16 / \text{cu ft}$

e.m. peto associates ltd.

## RECORD OF BOREHOLE NO. 5

Consulting soil engineers

JOB NO. 6503

JOB NAME Kitchener-Waterloo Expressway System

TECHNICIAN

BORING DATE Feb. 12, 13/65

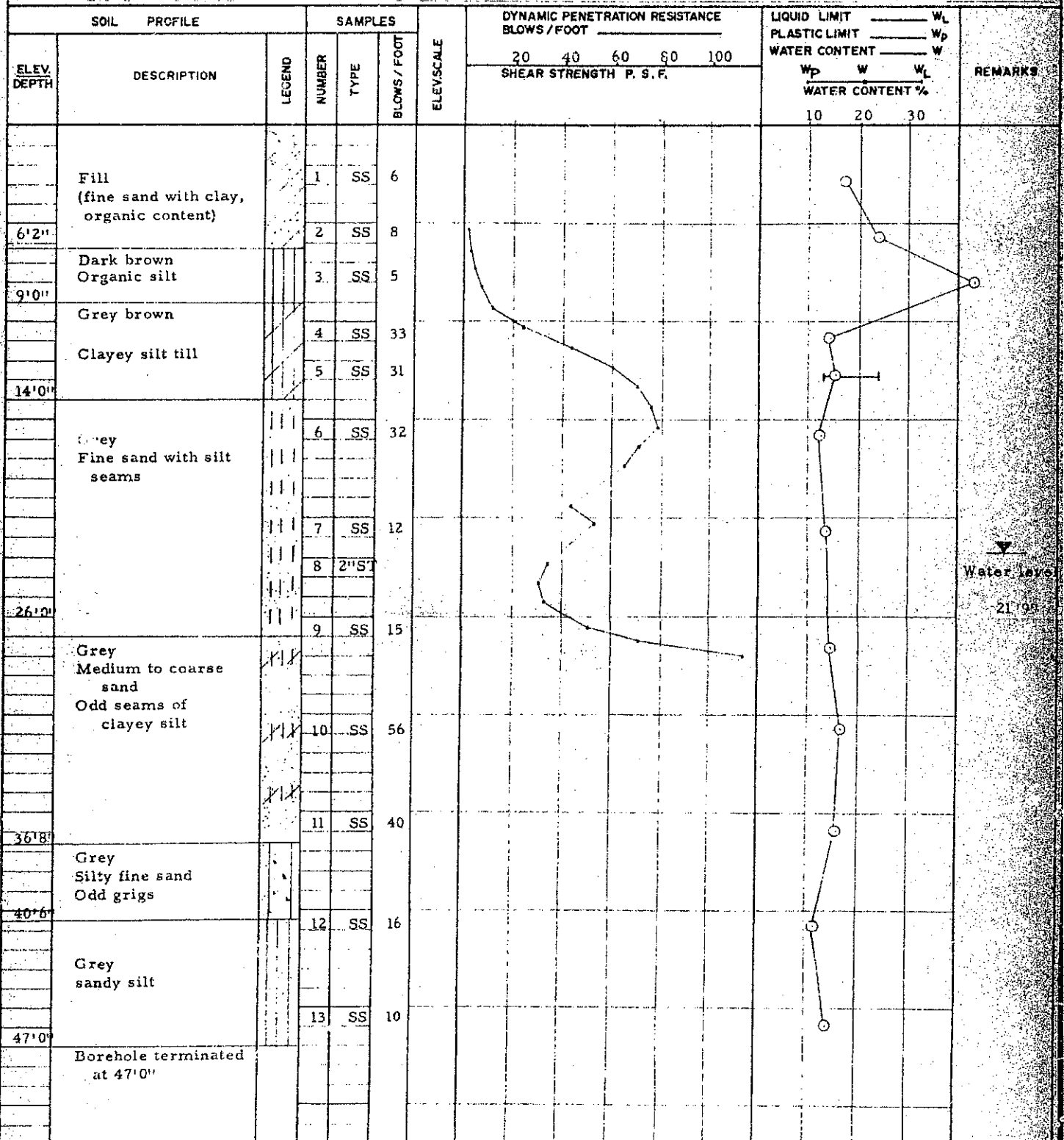
CLIENT Department of Highways, Ontario

ENGINEER BL

DATUM 1121.9

BOREHOLE TYPE 4" + B.K.

TYPED BY HF





e.m. peto associates ltd.

## RECORD OF BOREHOLE NO. 6

Consulting soil engineers

JOB NO. 6503

JOB NAME

Kitchener-Waterloo Expressway System  
WP 529 - 64

TECHNICIAN

BORING DATE Jan 29, Feb 1

CLIENT Department of Highways, Ontario

ENGINEER BL

DATUM 1.118.2

BOREHOLE TYPE

Auger

TYPED BY HF

ELEV. DEPTH	SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_p$ WATER CONTENT $W$			REMARKS
	DESCRIPTION	LEGEND	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	$W_p$	$W$	$W_L$	
	Fill (sandy silt with grits and pebbles)		1	SS	6										
4'11"															
	Brown sandy silt grits, pebbles with sand seams and layers of clay (till)		2	SS	19										
			3	SS	28										
			4	SS	29										
			5	SS	21										
14'0"															
	Brown Fine to medium sand		6	SS	28										
			7	SS	50										
			8	SS	40										
30'4"															
	Light grey Silty sand		9	SS	83										
36'2"			10	SS	54										
	Grey, Silty clay till														
41'6"			11	SS	58										
	Borehole terminated at 41'6"														

Water level  
19'6"



JOB NO. 6503

JOB NAME Kitchener-Waterloo Expressway System WP-629 - 64

TECHNICIAN

BORING DATE Feb. 4/65

CLIENT Department of Highways, Ontario

ENGINEER BL

DATUM 1121.4

BOREHOLE TYPE      Auger

TYPED BY HF

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT $W_L$		PLASTIC LIMIT $W_p$		WATER CONTENT $W$		REMARKS
ELEV. DEPTH	DESCRIPTION	LEGEND	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P. S. F.		WATER CONTENT %		WATER CONTENT %			
							20	40	60	80	100	$W_p$	$W$	
4'0"	Mixed brown Fine sand, organic matter, roots		1	SS	4									
	Grey brown clayey silt till with sand seams		2	SS	20									
			3	SS	20									
12'2"			4	SS	19									
			5	SS	21									
14'6"	Grey Interlayered sandy silt silty clay and sand		6	SS	20									
	Grey Sandy silt		7	SS	19									
24'0"			8	SS	18									
27'6"	Grey Clayey silt		9	SS	15									
	Grey Sandy silt		10	SS	9									
35'0"			11	2"ST										
			12	SS	19									
50'0"	Grey Interlayered clayey silt and fine sand		13	SS	14									
53'6"			14	SS	41									
60'0"	Grey Fine sand with gravel seam													
	Borehole terminated at 60'0"													

$\gamma = 134 \text{ lb/ft}^3$   
 $\gamma_d = 114 \text{ lb/ft}^3$   
 $\phi' = 35^\circ$   
 $C' = 280 \text{ lb/ft}^2$

e. m. peto associates ltd.

Consulting soil engineers

## RECORD OF BOREHOLE NO. 9

JOB NO. 6503

JOB NAME

Kitchener - Waterloo Expressway System W.P. 629-64

TECHNICIAN

BORING DATE Feb. 16-17/65

CLIENT

D. H. O.

ENGINEER

B. I.

DATUM 1119.2

BOREHOLE TYPE

Auger

TYPED BY

V. M.

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT _____ W <sub>L</sub> PLASTIC LIMIT _____ W <sub>P</sub> WATER CONTENT _____ W W <sub>P</sub> W    W <sub>L</sub> WATER CONTENT %			REMARKS
ELEV. DEPTH	DESCRIPTION	LEGEND	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	20   40   60   80   100 SHEAR STRENGTH P. S. F.				
0'8"	Topsoil										
	Mixed brown clayey sand		1	SS	8						
4'4"			2	SS	23						
	Brown clayey silt till		3	SS	29						
			4	SS	35						
			5	SS	42						
			6	SS	28						
			7	SS	14						
			8	2" ST							
24'0"											
	Grey-brown silty clay till with sand layers		9	SS	22						
30'0"			10	SS	15						
	BOREHOLE TERMINATED AT 30'0"										

**Appendix D**

**Foundation Alternatives Comparison**

**Geotechnical Resistances and Founding Elevations**

**Westmount Road Overpass WBL and EBL**



**COMPARISON OF FOUNDATION ALTERNATIVES  
WESTMOUNT ROAD OVERPASS (WBL AND EBL)**

Foundation Element	Driven Steel H-Piles	Driven Tube (Pipe) Piles	Spread Footings	Augered Caissons (Drilled Shafts)
<b>East and West Abutments</b>  <b>East and West Piers</b>	<b>Advantages:</b> i. Relatively high geotechnical resistance is available for end-bearing piles. ii. Minimal excavation required for foundation construction. iii. Commonly used deep foundation type.	<b>Advantages:</b> i. Compatibility with the existing foundations and relatively high geotechnical resistance. ii. Minimal excavation required for foundation construction.	<b>Advantages:</b> i. Relative ease of foundation construction at locations where excavation is shallow. ii. More cost effective if extensive dewatering and shoring is not required during construction.	<b>Advantages:</b> i. Larger geotechnical resistance is available for comparable founding depths.
	<b>Disadvantages:</b> i. Potential vibration and adverse effects on the existing foundations must be addressed during design and construction.	<b>Disadvantages:</b> i. Relatively uncommon pile type nowadays that may include concrete filling. ii. Lesser geotechnical resistance than H-piles of comparable size and driven depth. iii. Large displacement piles that could have more severe adverse effects on the existing foundations. Vibration effects must also be addressed during design and construction.	<b>Disadvantages:</b> i. Impractical for use at pier locations where deep excavation may be required. ii. Impractical for use at the abutments if perched abutments similar to the existing structures are used. iii. Requires larger excavation than pile cap construction. iv. Larger settlements during construction than those associated with piled foundations.	<b>Disadvantages:</b> i. Specific requirements during installation through water-bearing cohesionless soils, including the use of temporary liners, drilling fluids and tremie concrete. ii. Caisson equipment must be equipped to handle obstructions, boulders and cobbles etc. iii. May require manual cleaning and inspection of the caisson base.



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**Westmount Road Overpass WBL**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS (kN)	SLS (kN)
<b>West Abutment</b>					
331.3	300	200	Below 323.0	1,500	1,000
<b>West Pier</b>					
330.7	300	200	Below 321.5	1,500	1,000
<b>East Pier</b>					
329.0	300	200	Below 321.5	1,500	1,000
<b>East Abutment</b>					
327.8	300	200	Below 323.0	1,500	1,000

**Westmount Road Overpass EBL**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS (kN)	SLS (kN)
<b>West Abutment</b>					
330.7	300	200	Below 323.0	1,500	1,000
<b>West Pier</b>					
330.7	300	200	Below 321.5	1,500	1,000
<b>East Pier</b>					
329.0	300	200	Below 321.5	1,500	1,000
<b>East Abutment</b>					
329.0	300	200	Below 323.0	1,500	1,000

Concrete filled, 12¾" O.D. steel tube (pipe) piles driven to the above elevations may be designed for factored geotechnical resistance at ULS of 900 kN per pile, and geotechnical resistance at SLS of 600 kN per pile.



**Records of Boreholes**

**Plans and Profiles**





DEPARTMENT OF HIGHWAYS - ONTARIO

# MATERIALS & TESTING DIVISION

JOB 67-E-102

W. P. 628-61.

DATUM Geodetic

## RECORD OF BOREHOLE NO. 2

LOCATION	N 187,991;	E 202,531

BOILING DATE November 9, 1967

Washbore - BX Casing

## FOUNDATION SECTION

AMS

**ORIGINATED BY**

**COMPILED BY**

**CHECKED BY**

[illegible]

## OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

## MATERIALS &amp; TESTING DIVISION

## RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 67-F-102

LOCATION Co-ord. N 187,950; E 202,154.

ORIGINATED BY AMS

W.P. 628-64

BORING DATE November 14, 1967

COMPILED BY AMS

DATUM Geodetic

BOREHOLE TYPE

Cone Test only

CHECKED BY

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 25 50 75 100 125 SHEAR STRENGTH P.S.F.	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WATER CONTENT % WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1091.5	Ground Level			1090				
0.0								
1080.5				1080				
11.0	End of cone test							

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 67-F-102 LOCATION Co-ord. N 187,937; E 202,111. ORIGINATED BY AMS  
 W.P. 628-64 BORING DATE November 13. and 14, 1967 COMPILED BY AMS  
 DATUM Geodetic BOREHOLE TYPE Washbore - BX Casing CHECKED BY [Signature]

ELEV. DEPTH	SOIL PROFILE	SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		REMARKS
		NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WATER CONTENT %	BULK DENSITY	
1092.5	Ground Level								
0.0	Clayey silt, traces of sand and gravel.	1	SS	11					Gr.Sa.Si.Cl
	Very stiff to hard.	2	SS	35					1088.5
		3	SS	98					7 6 41 15
		4	SS	19					0 23 71 6
1076.5		5	SS	22					
16.0	Fine sandy silt, trace of clay.								
1069.5	Compact to very dense	6	SS	53					
23.0	Fine to medium sand	7	SS	55					
	Very dense.	8	SS	107					
		9	SS	107					
1051.0		10	SS	70					
41.5	End of Borehole								

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 67-F-102

W.P. 628-64

DATUM Geodetic

RECORD OF BOREHOLE NO. 5

LOCATION Co-ord. N 187,821; E 202,464

BORING DATE November 14, 1967

BOREHOLE TYPE Cone Test only

FOUNDATION SECTION

ORIGINATED BY AMS

COMPILED BY AMS

CHECKED BY *AMS*

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					
1094.2	Ground Level				25 50 75 100 125	WP — WL		
0.0								
1074.3								
19.9	End of Cone Test							

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 67-F-102

W.P. 628-64

DATUM Geodetic

RECORD OF BOREHOLE NO. 6

LOCATION C-ord. N 187,854; E 202,500

BORING DATE November 15 and 16, 1967

BOREHOLE TYPE Washbore - BX Casing

FOUNDATION SECTION

ORIGINATED BY AMS

COMPILED BY AMS

CHECKED BY *[Signature]*

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					
1091.3	Ground Level							
0.0	Clayey silt, traces of sand and gravel.	1	SS	17				
	Stiff to hard.	2	SS	15				
		3	SS	18				
1078.3		4	SS	13				
13.0	Silty sand.	5	SS	27				
1072.8	Compact							
18.5		6	SS	75				
	Silty clay.	7	SS	132/8"				
	Very stiff to hard.	8	SS	20				
		9	SS	45				
1053.3								
38.0	Sand to silty sand, occ. layers of clay.	10	SS	110				
1044.8	Very dense.							
46.5	End of Borehole	11	SS	0				

Gr. Sa. S1. Cl  
2' 11 48 39

12.9 End of Cone Test

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 67-F-102

W.P. 628-64

DATUM Geodetic

RECORD OF BOREHOLE NO. 8

LOCATION Co-ord. N 187,890; E 202,614

BORING DATE November 16 and 17, 1967

BOREHOLE TYPE Washbore - BX Casing

FOUNDATION SECTION

ORIGINATED BY AMS

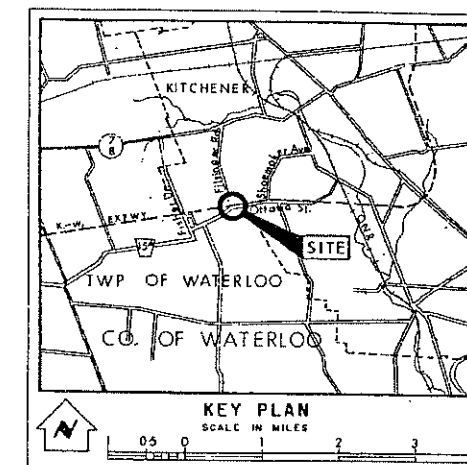
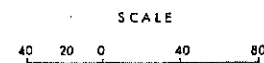
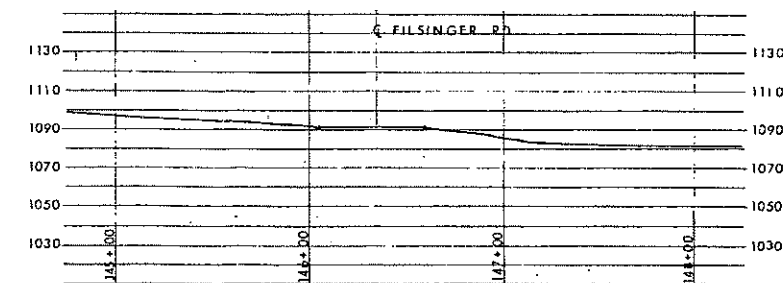
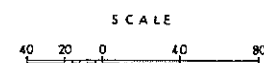
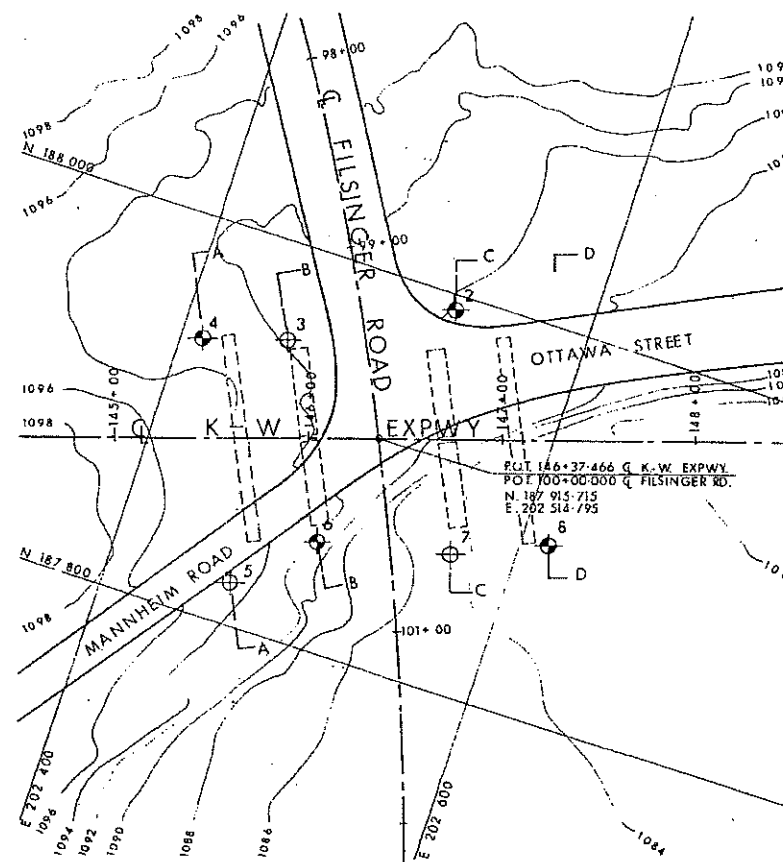
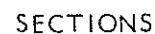
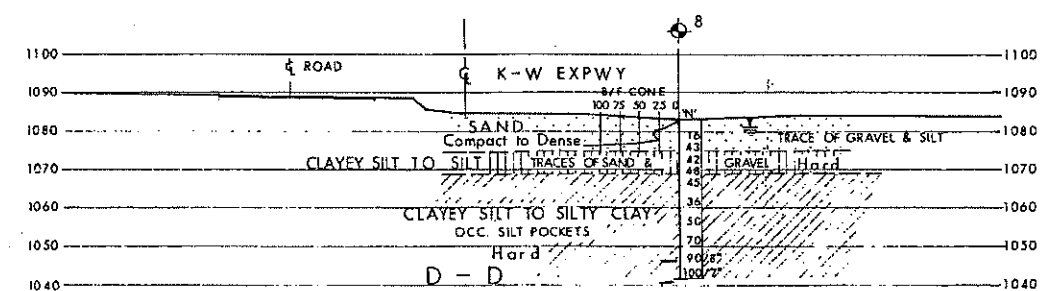
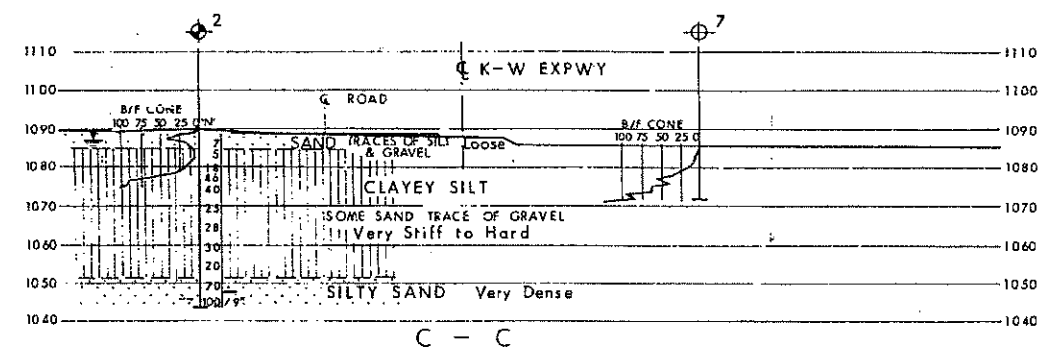
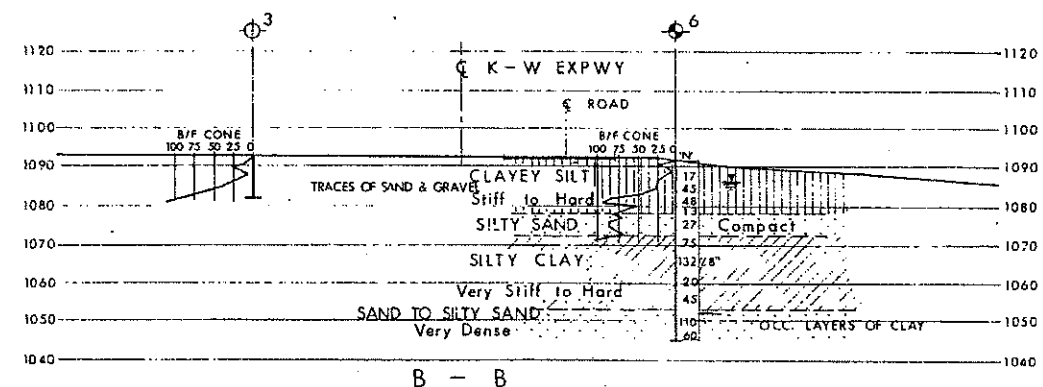
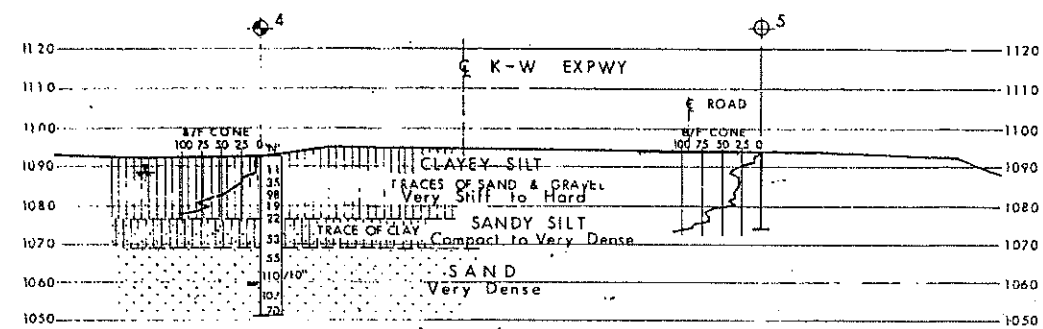
COMPILED BY AMS





CHECKED BY *AMS*

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		25	50	75	100		
1082.8	Ground Level									
0.0	Fine to medium sand, trace of gravel & silt.	1	SS	16						
1074.8	Compact to dense.	2	SS	43						
8.0	Clayey silt to silt, traces of sand and gravel. Hard.	3	SS	42						
1068.8		4	SS	48						
14.0	Clayey silt to silty clay, occ. silt pockets.	5	SS	45						
		6	SS	16						
		7	SS	50						
		8	SS	70						
		9	SS	90/8"						
1041.7		10	SS	100/7"						
41.1	End of Borehole									

WATER CONTENT %  
10 20 30

Gr. Sa. S1.01  
Y1081.2  
17 70 ( 13 )  
0 2 39 59



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation. NOV. 1967		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
2	1090.0	187,991	202,537
3	1091.5	187,950	202,457
4	1092.5	187,937	202,417
5	1094.2	187,821	202,467
6	1091.3	187,854	202,507
7	1084.2	187,875	202,567
8	1082.8	187,890	202,617

**NOTE -**

The boundaries between soil strata have been established only at Bare Hole locations. Between Bare Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & TESTING DIVISION - FOUNDATION SECTION			
FILSINGER ROAD			
KING'S HIGHWAY NO. <u>K-W EXPWY</u>		DIST. NO. <u>4</u>	
CO. <u>WATERLOO</u>		CON. _____	
TWP. <u>WATERLOO</u>		LOT _____	
BORE HOLE LOCATIONS & SOIL STRATA			
SUBM'D A.S. <input checked="" type="checkbox"/>	CHECKED <input checked="" type="checkbox"/>	W.F. NO. <u>628 - 64</u>	M.B.T. DRAWING NO.
DRAWN A. B. <input checked="" type="checkbox"/>	CHECKED <input checked="" type="checkbox"/>	JOB NO. <u>67-F-102</u>	<u>67-F-102</u>
DATE <u>DEC. 15, 1967</u>		SITE NO. <u>33-22B</u>	BRIDGE DRAWING NO.
APPROVED <i>A. B. Thompson</i>		CONT. NO.	<u>D-6345-2</u>



**Appendix E**

**Geotechnical Resistances and Founding Elevations**

**Borden Creek Culvert Under Highway 7/8 (east of Westmount)**



**COMPARISON OF FOUNDATION ALTERNATIVES**  
**BORDEN CREEK CULVERT UNDER HIGHWAY 7/8 (EAST OF WESTMOUNT)**

Foundation Element	Driven Piles	Multi-Plate Arch Culvert on Compacted Granular	Concrete Box or Open Footing Culvert	Augered Caissons (Drilled Shafts)
<b>Culvert Extension or Replacement</b>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. None identified for this type of structure.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Unnecessary due to the relatively small loads imposed by this type of structure.</li> <li>ii. Relatively cost ineffective for this type of structure.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction and the most cost effective alternative.</li> <li>ii. Compatible with the existing structure.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. More deformation should be anticipated due to its relative flexibility.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. A technically feasible alternative if culvert is to be replaced entirely.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Some settlements due to foundation compression (anticipated to be complete by end of construction) must be taken into account during culvert design and construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. None identified for this type of structure at this site.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Unnecessary due to the relatively small loads imposed by this type of structure.</li> <li>ii. Relatively cost ineffective for this type of structures.</li> </ul>



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**Borden Creek Culvert Under Highway 7/8 (east of Westmount)**

Multi-Plate Arch Culvert Base		
Elevation (m)	ULS (kPa)	SLS (kPa)
329.0 or below	300	200



**Records of Boreholes**

**Plans and Profiles**





OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 67-F-102

LOCATION Co-ord. N 187,950; E 202,454.

ORIGINATED BY AMS

W.P. 628-64

BORING DATE November 14, 1967

COMPILED BY AMS

DATUM Geodetic

BOREHOLE TYPE Cone Test 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					
1091.5	Ground Level			1090				
0.0								
1080.5				1080				
11.0	End of cone test							







OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 67-F-102

W.P. 628-64

DATUM Geodetic

RECORD OF BOREHOLE NO. 6

LOCATION C-ord. N 187,854; E 202,500

BORING DATE November 15 and 16, 1967

BOREHOLE TYPE Washbore - BX Casing

FOUNDATION SECTION

ORIGINATED BY AMS

COMPILED BY AMS

CHECKED BY *AMS*

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					
1091.3	Ground Level							
0.0	Clayey silt, traces of sand and gravel.	1	SS	17				
	Stiff to hard.	2	SS	15				
		3	SS	18				
1078.3		4	SS	13				
13.0	Silty sand.	5	SS	27				
1072.8	Compact							
18.5		6	SS	75				
	Silty clay.	7	SS	132/8"				
	Very stiff to hard.	8	SS	20				
		9	SS	15				
1053.3								
38.0	Sand to silty sand, occ. layers of clay.	10	SS	110				
	Very dense.							
1044.8		11	SS	5				
46.5	End of Borehole							

Gr. Sa. Sl. Cl.  
2-11 48 39

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 67-F-102

W.P. 628-64

DATUM Geodetic

# RECORD OF BOREHOLE NO. 7

LOCATION Co-ord. N 187.875; E 202.567

BORING DATE November 16, 1967

BOREHOLE TYPE Cone Test Only

FOUNDATION SECTION

ORIGINATED BY AMS

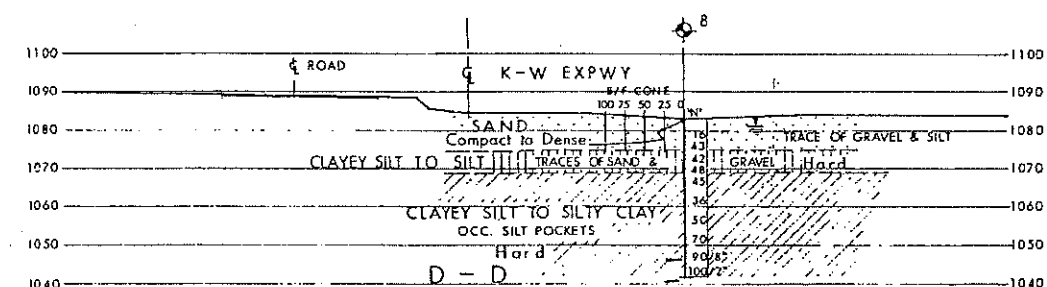
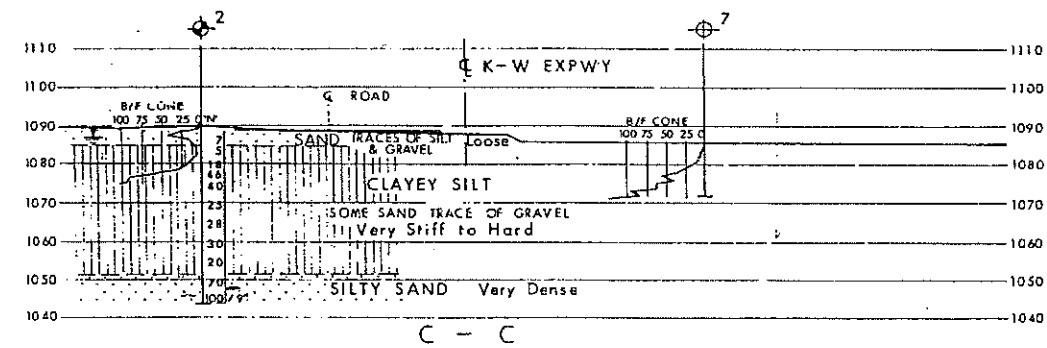
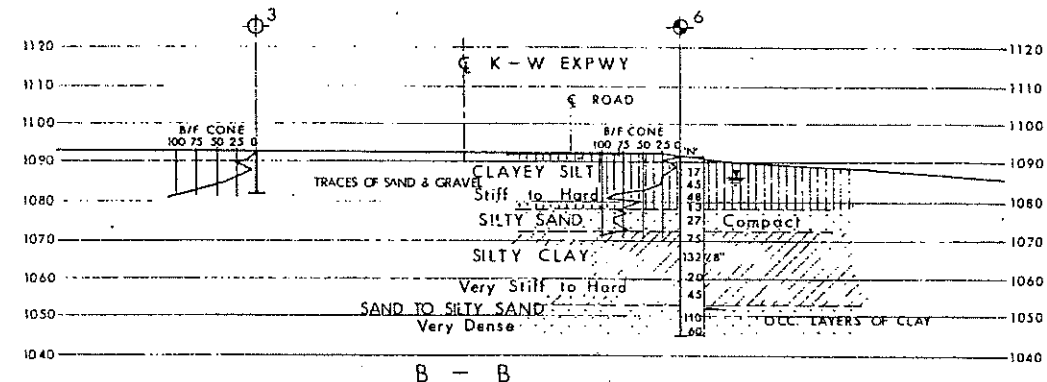
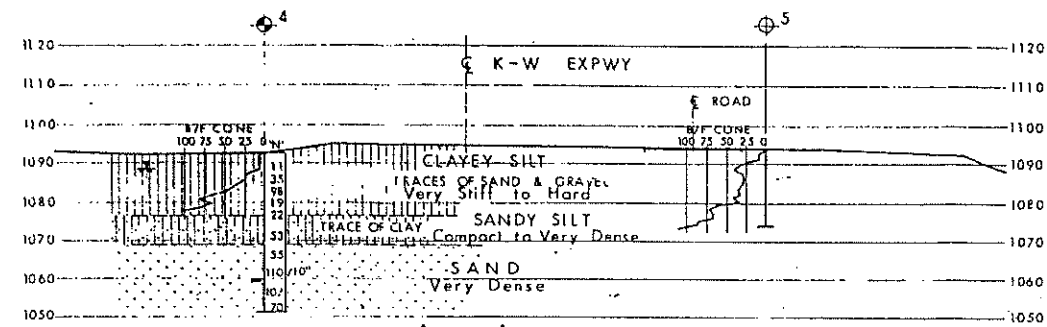
COMPILED BY AMS

CHECKED BY AMS

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 25 50 75 100 125 SHEAR STRENGTH P.S.F.	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W WP — WL WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
1084.9 0.0	Ground Level			1080				
1071.3 12.9	End of Cone Test			1070				

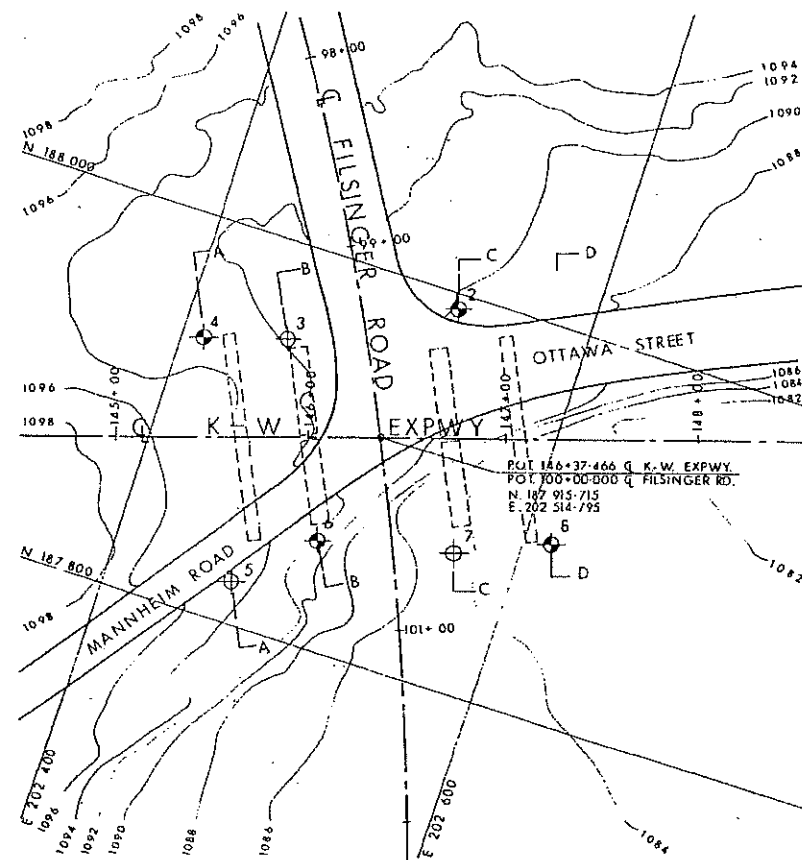
**CHECKED BY**

[illegible]



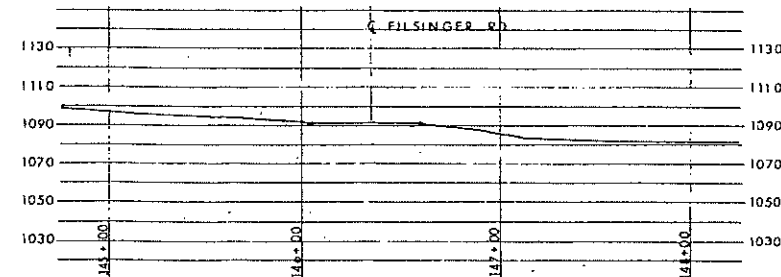
SECTIONS

SCALE  
20 10 0 20 40 Ft



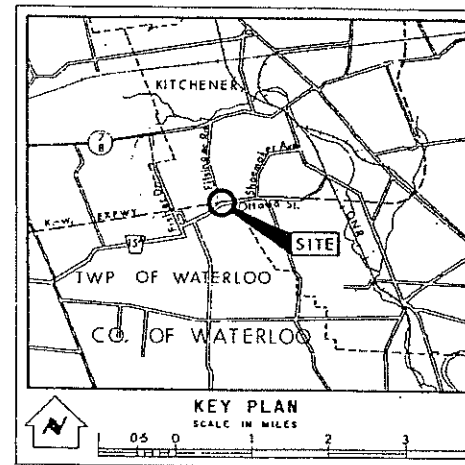
PLAN

SCALE  
40 20 0 40 80 Ft



PROFILE

SCALE  
40 20 0 40 80 Ft



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation, NOV. 1967.

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
2	1090.0	187,991	202,531
3	1091.5	187,950	202,454
4	1092.5	187,937	202,411
5	1094.2	187,821	202,464
6	1091.3	187,854	202,500
7	1084.2	187,875	202,567
8	1082.8	187,890	202,614

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD		
NO.	FCR	DATE

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO			
MATERIALS & TESTING DIVISION - FOUNDATION SECTION			
FILSINGER ROAD			
KING'S HIGHWAY NO. K-W EXPWY		DIST. NO. 4	
CO. WATERLOO		LOT CON.	
TWP. WATERLOO		CON.	
BORE HOLE LOCATIONS & SOIL STRATA			
SUBM'D A. S.	CHECKED	W.P. NO. 628-64	M.S.T. DRAWING NO.
DRAWN A. B.	CHECKED	JOB NO. 67-F-102	67-F-102 A
DATE DEC. 15, 1967	SITE NO. 33-228	BRIDGE DRAWING NO.	
APPROVED	CONT. NO.	D-6345-2	

**Appendix F**

**Foundation Alternatives Comparison**

**Geotechnical Resistances and Founding Elevations**

**Homer Watson Boulevard Overpass WBL and EBL**



**COMPARISON OF FOUNDATION ALTERNATIVES**  
**HOMER WATSON BOULEVARD OVERPASS (WBL AND EBL)**

Foundation Element	Driven Steel H-Piles	Driven Tube (Pipe) Piles	Spread Footings	Augered Caissons (Drilled Shafts)
<b>East and West Abutments</b>  <b>East, West and Centre Piers</b>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively high geotechnical resistance is available for end-bearing piles.</li> <li>ii. Minimal excavation required for foundation construction.</li> <li>iii. Commonly used deep foundation types.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Potential vibration and adverse effects on the existing foundations must be addressed during design and construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Compatible with the existing foundations and relatively high geotechnical resistance.</li> <li>ii. Minimal excavation required for foundation construction.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively uncommon pile type nowadays that may include concrete filling.</li> <li>ii. Lesser geotechnical resistance than H-piles of comparable size and driven depth.</li> <li>iii. Large displacement piles that could have more severe adverse effects on the existing foundations. Vibration effects must also be addressed during design and construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction at the piers.</li> <li>ii. More cost effective assuming extensive dewatering and shoring is not required during construction.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Impractical for use at the abutments if perched abutments similar to the existing structures are used.</li> <li>ii. Requires larger excavation than pile cap construction.</li> <li>iii. Larger settlements during construction than those associated with piled foundations.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Larger geotechnical resistance than other deep foundation types is available for comparable founding depths.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Specific requirements during installation through water-bearing cohesionless soils, including the use of temporary liners, drilling fluids and tremie concrete.</li> <li>ii. Caisson equipment must be equipped to handle obstructions, boulders or cobbles.</li> <li>iii. May require manual cleaning and inspection of the caisson base.</li> </ul>



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**Homer Watson Boulevard Overpass WBL**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS <sub>f</sub> (kN)	SLS (kN)
<b>West Abutment and West Pier</b>					
324.6 to 321.8	300	200	Below 314.0	1,500	1,000
Below 321.8	450	300			
<b>Centre Pier</b>					
324.6 to 322.2	300	200	Below 314.0	1,500	1,000
Below 322.2	450	300			
<b>East Abutment and East Pier</b>					
323.7 to 322.8	300	200	Below 314.0	1,500	1,000
Below 322.8	450	300			

**Homer Watson Boulevard Overpass EBL**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS (Kn)	SLS (kN)
<b>West Abutment and West Pier</b>					
324.6 to 320.0	300	200	Below 307.8	1,500	1,000
Below 320.0	450	300			
<b>Centre Pier</b>					
324.6 to 322.2	300	200	Below 317.0	1,500	1,000
Below 322.2	450	300			
<b>East Abutment and East Pier</b>					
324.0 to 319.4	300	200	Below 307.0	1,500	1,000

Concrete filled, 12¾" O.D. steel tube (pipe) piles driven to the above elevations may be designed for factored geotechnical resistance at ULS of 900 kN per pile, and geotechnical resistance at SLS of 600 kN per pile.



**Records of Boreholes**

**Plans and Profiles**





DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS &amp; TESTING DIVISION

## RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 66-F-70

LOCATION Kitchener-Waterloo Expwy - Homer Watson Blvd.

ORIGINATED BY V.K.

W.P. 627-64

BORING DATE July 27/66

COMPILED BY W.T.E.

DATUM Geodetic

BOREHOLE TYPE Washboring Nx Casing; Cone

CHECKED BY A.B. JR

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	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	W.P.	W	W.L.		
1070.4	Groundlevel															
0.0	Sandy Silt		1	SS	37											
	Traces Of Clay		2	SS	18											
	And Gravel		3	SS	19	1060										
			4	SS	15											
1052.5	Compact		5	SS	18											
18.0	Clayey Silt		6	SS	13	1050										
1048.0	Stiff to Very Stiff		7	SS	29											
22.5	Sandy Silt		8	SS	25											
	Traces Of Clay		9	SS	17	1040										
	And Gravel		10	SS	23											
	Compact		11	SS	22	1030										
1029.0																
41.5	Clayey Silt															
	To Silt		12	SS	24	1020										
	Hard		13	SS	71											
			14	SS	75	1010										
			15	SS	196	1000										
			16	SS	43	990										
						980										
						970										
969.0			17	SS	327											
101.5	Silty Sand															
	Traces Of Gravel					960										
	Very Dense															
956.0			18	SS	100/2"											
114.5	End Of Borehole					950										

W.L.  
1061.0Gr25Sa24  
S144Cl7Gr1Sa27  
S162Cl.10  
Gr5Sa32  
S153Cl.10  
Gr8Sa34  
S150Cl8Gr5Sa60  
S134Cl.1

DEPARTMENT OF HIGHWAYS - ONTARIO		<b>RECORD OF BOREHOLE NO. 2</b>		FOUNDATION SECTION
MATERIALS & TESTING DIVISION				
JOB <u>66-F-70</u>	LOCATION <u>Kitchener-Waterloo Expwy. - Homer Watson Blvd.</u>	ORIGINATED BY <u>V.K.</u>		
W.P. <u>627-64</u>	BORING DATE <u>August 3/66</u>	COMPILED BY <u>W.T.E.</u>		
DATUM <u>Geodetic</u>	BOREHOLE TYPE <u>Washboring, No Casing; Cone</u>	CHECKED BY <u>A.R.</u> <i>AK</i>		

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	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT			SHEAR STRENGTH P.S.F.					WATER CONTENT %		
							20	40	60	80	100	WP			W	WL	
1072.7	Groundlevel																
0.0	Sandy Silt	•••••	1	SS	12	1070											
	Traces of Sand		2	SS	21												
	And Gravel		3	SS	19												
1059.8	Compact	•••••	4	SS	25	1060											
13.2	Clayey Silt		5	SS	22												
	To Silt		5A	TW	PM/12"												
	Very Stiff		6	SS	28												
			7	SS	23	1050											
			8	SS	28												
			9	SS	21	1040											
			10	SS	20												
1035.5			10A	TW	PM/12"												
37.5	Sandy Silt	•••••	11	SS	55	1030											
1031.8	Very Dense	•••••															
41.2	Clayey Silt		12A	TW	PM/12"												
	To Silt		12	SS	73												
	Hard					1020											
1017.0			13	SS	104												
56.0	Silty Sand	•••••	14	SS	116	1010											
	Very Dense	•••••															
1007.9			15	SS	10071"												
65.1	End Of Borehole					1000											

Gr2Sa33  
S158C17  
Gr0Sa20  
S170C1.10  
W.L.  
1057'

Gr0Sa17  
S172C1.11

Gr9Sa57  
S125C19

DEPARTMENT OF HIGHWAYS - ONTARIO			RECORD OF BOREHOLE NO.3				FOUNDATION SECTION														
MATERIALS & TESTING DIVISION																					
JOB <u>66-F-70</u>		LOCATION <u>Kitchener-Waterloo Expwy. - Homer Watson</u>		ORIGINATED BY <u>V.K.</u>																	
W.P. <u>627-64</u>		BORING DATE <u>August 5, 1966</u>		COMPILED BY <u>V.K.</u>																	
DATUM <u>Geodetic</u>		BOREHOLE TYPE <u>Drive Casing &amp; Wash</u>		CHECKED BY <u>A.B. AL</u>																	
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	STRAT. PLT	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WATER CONTENT % 10 20 30													
1072.3	Ground Level																				
1057.8	Silty Clay To Clayey Silt Stiff To Hard		1	SS	14	1070					GrO5a2 S147C151  Gr1Sa11 S163C125 W.L. 1056' GrO5a19 S178C13  GrO5a63 S134C13  GrO5a8 S181C1.11										
			2	SS	26	1060															
			3	SS	17	1060															
			4	SS	46	1060															
14.5	Sandy Silt To Silty Sand Very Dense		5	SS	52	1050															
			6	SS	48	1050															
			7	SS	59	1050															
			8	SS	91	1050															
			9	SS	72	1040															
			10	SS	260	1040															
			11	SS	137	1030															
40.0	Clayey Silt To Silt With Traces Of Sand Hard		12	SS	84	1020															
			13	SS	100	1010															
1011.7	End Of Borehole					1010															
60.6																					

DEPARTMENT OF HIGHWAYS - ONTARIO

## MATERIALS &amp; TESTING DIVISION

JOB 66-E-70

LOCATION K-W Expy. - Homer Watson Blvd.

ORIGINATED BY V.K.

W.P. 627-64

BORING DATE August 10, 1963

COMPILED BY V.K.

DATUM Gondatic

BOREHOLE TYPE Drive Casing & Wash

CHECKED BY     A.B.    

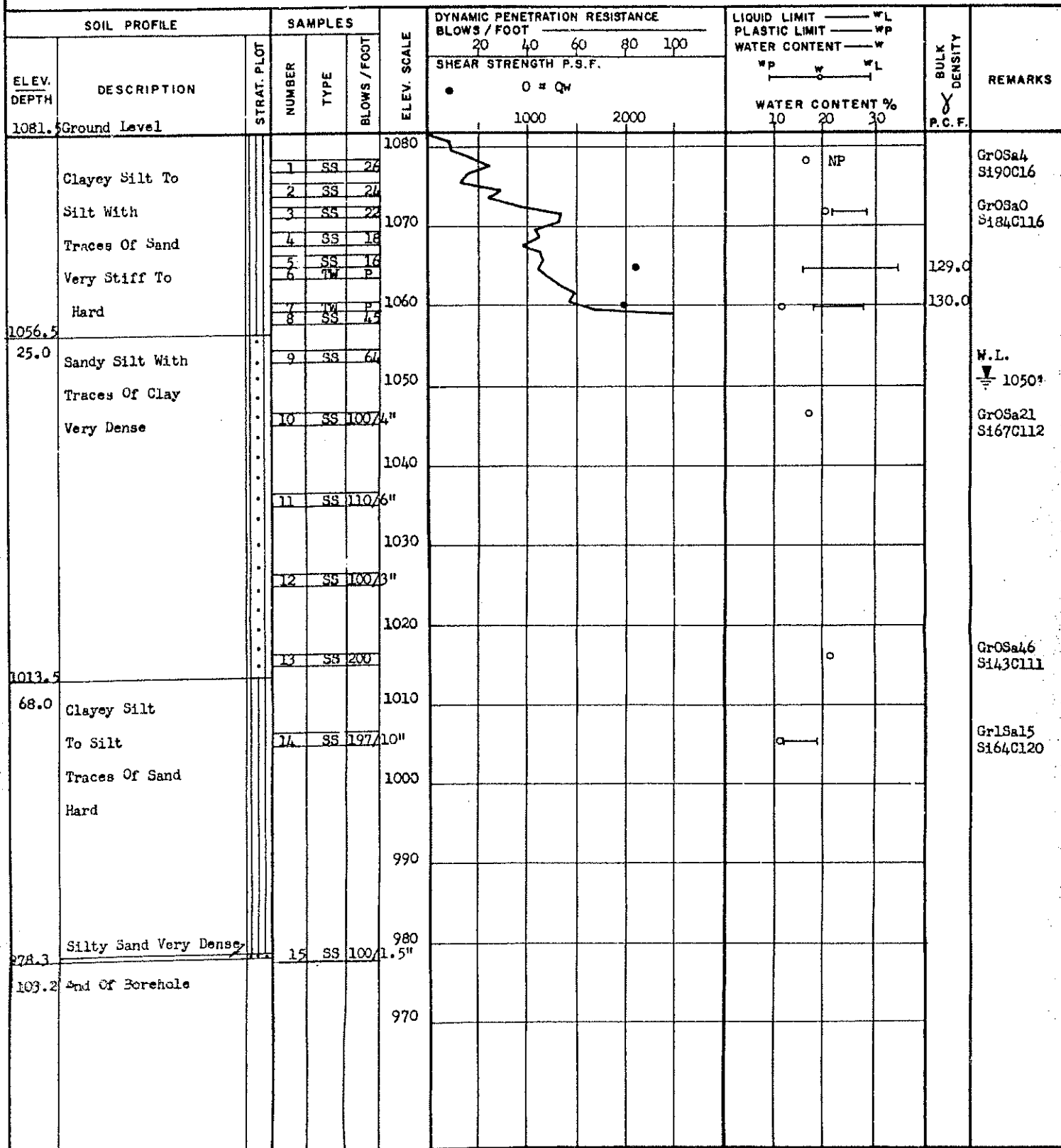
SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	Liquid Limit — WL	BULK DENSITY	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	PLASTIC LIMIT — WP			
							20 40 60 80 100	WATER CONTENT — W			
							SHEAR STRENGTH P.S.F.	WP — W — WL			
							0 = Qu	WATER CONTENT %		P.C.F.	
							1000 2000	10 20 30			
1074.6	Ground Level										
	Clayey Silt To		1	SS	42	1070					GrlSa5
	Silt		2	SS	41			○ —			Sl76C18
	Traces Of Sand		3	SS	34						
	Stiff To Hard		4	SS	32	1060					
			5	SS	29						
			6	TW	P			○ —		128.0	
			7	TW	P			○ —		121.0	W.L.
			8	TW	P	1050		○ —		131.0	BT = 1050'
			9	SS	43						
			10	SS	28	1040					
1036.6											
38.0	Sandy Silt		11	SS	17			○			GrOSa5l
	With Traces Of Clay		12	SS	40	1030					Sl46C13
	Compact To Dense		13	SS	29			○			GrlSa23
1021.6						1020					Sl72C14
53.0	Clayey Silt		14	SS	28						
	With		15	SS	45			○ —			GrlSa13
	Traces Of					1010					Sl49C157
	Sand		16	SS	164			○ —			
	Hard					1000					
						990					
						980					
						970					
970.0											
104.6	Silty Sand-Very Dense		17	SS	100/2"			○			Gr31Sa48
987.4											Sl16C15
107.2	End Of Borehole										

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 66-F-70 LOCATION K-1 Hwy. - Hower Watson Blvd. ORIGINATED BY V.K.  
W.P. 627-64 BORING DATE August 15, 1966 COMPILED BY V.K.  
DATUM Candetic BOREHOLE TYPE Drive Casing and Wash CHECKED BY A.B.



GrOSa4  
S190C16

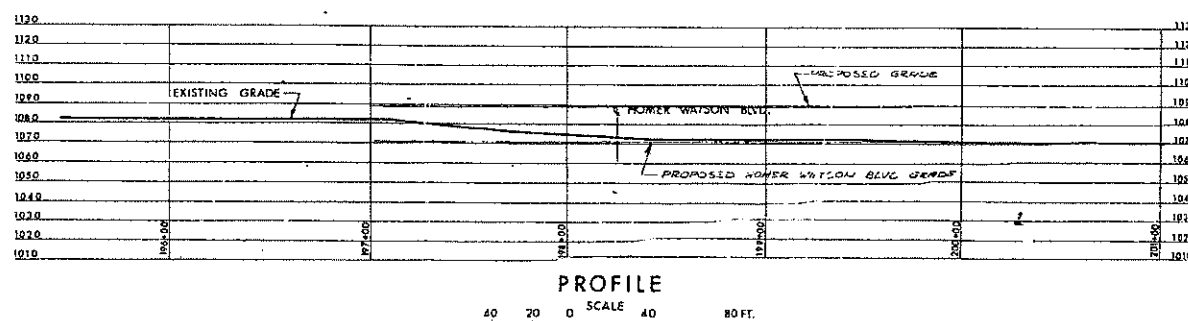
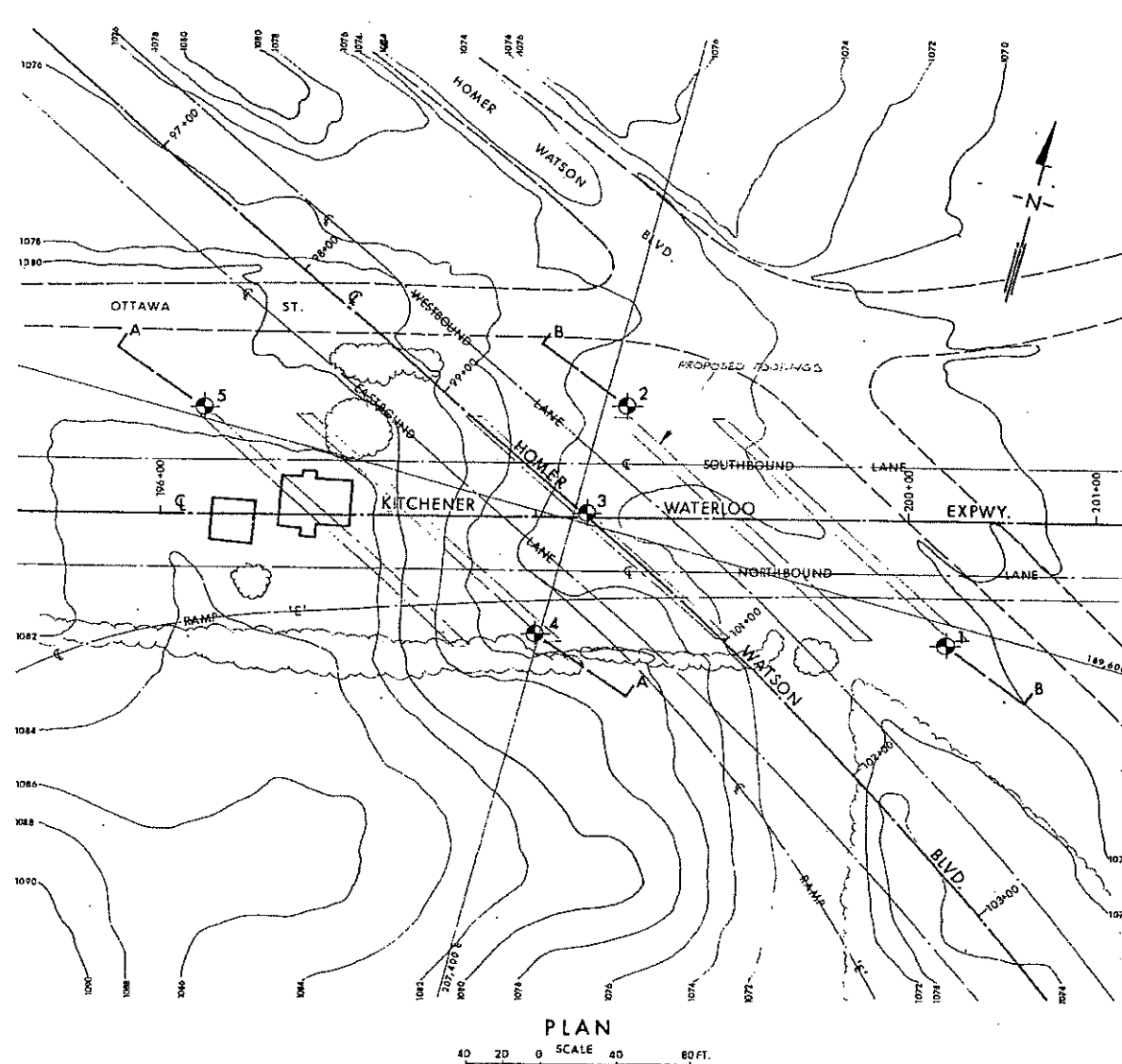
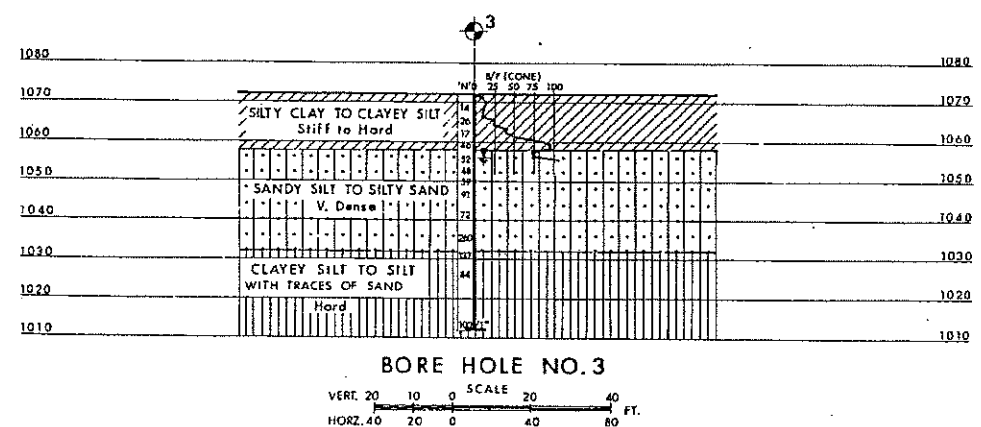
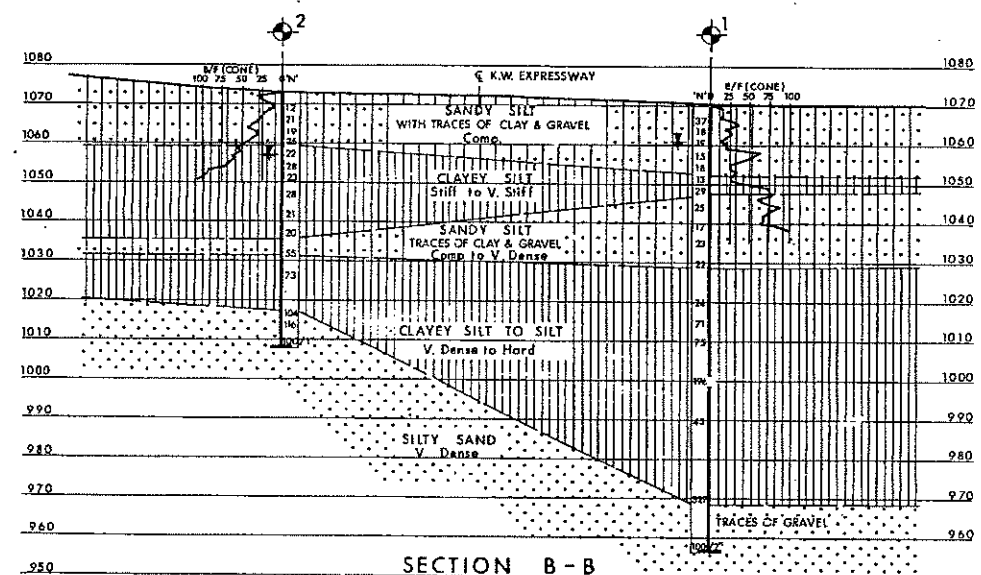
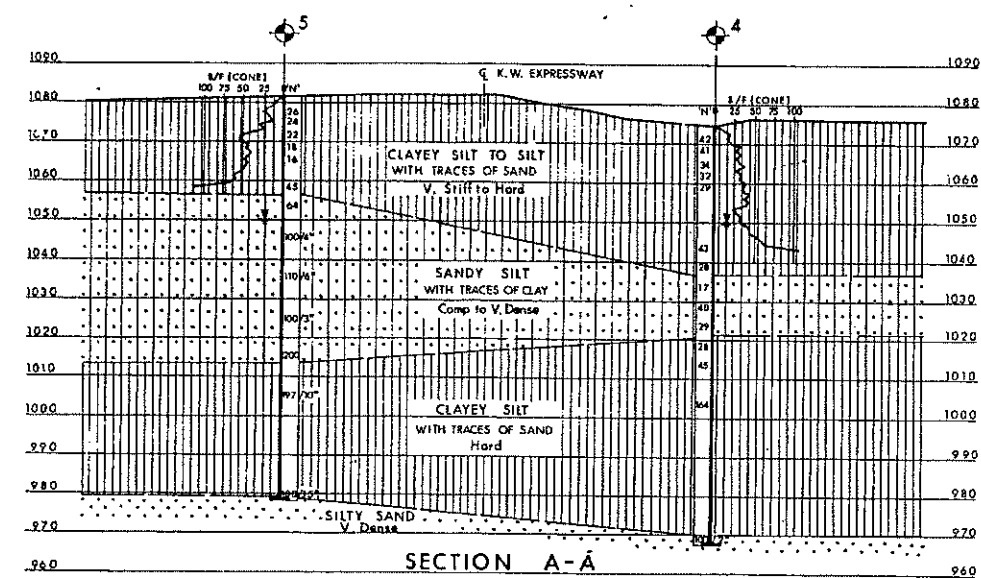
GrOSa0  
S184C116

W.L.  
1050'


GrOSa21  
S167C112

GrOSa46  
S143C111


Gr1Sa15  
S164C120




**LEGEND**




Bore Hole



Cone Penetration Hole



Bore & Cone Penetration Hole



Water Levels established at time  
of field investigation, JULY & AUG 1962

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	1070.4	189,587	207,610
2	1072.7	189,665	207,410
3	1072.3	189,603	207,400
4	1074.6	189,553	207,350
5	1081.5	189,603	207,190

- NOTE -

The boundaries between soil strata have been established only of Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

HOMER WATSON BOULEVARD

KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPWY. DIST. NO. 4  
CO. WATERLOO CITY OF KITCHENER  
TWP. \_\_\_\_\_ LOT \_\_\_\_\_ CON. \_\_\_\_\_

## BORE HOLE LOCATIONS &amp; SOIL STRATA

SUBMIT V.K.	CHECKED <i>Li</i>	W.P. NO. 627-64	M.B.T. DRAWING NO.
DRAWN S.O.	CHECKED <i>He</i>	JOB NO. 66-F-70	66-F-70 A
DATE 31 AUG. 1966	SITE NO	BRIDGE DRAWING NO.	
APPROVED <i>A.B. Thomas</i>	CONT. NO.		

[illegible]

**Appendix G**  
**Geotechnical Resistances and Founding Elevations**  
**Ottawa Street (South) Overpass WBL and EBL**



**COMPARISON OF FOUNDATION ALTERNATIVES**  
**OTTAWA STREET (SOUTH) OVERPASS (WBL AND EBL)**

Foundation Element	Driven Steel H-Piles	Driven Tube (Pipe) Piles	Spread Footings	Augered Caissons (Drilled Shafts)
<b>East and West Abutments</b>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively high geotechnical resistance is available for end-bearing piles.</li> <li>ii. Minimal excavation required for foundation construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Compatible with the existing foundations and relatively high geotechnical resistance.</li> <li>ii. Minimal excavation required for foundation construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction at the piers.</li> <li>ii. Likely the most cost effective alternative for the piers.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Larger geotechnical resistance than other deep foundation types is available for comparable founding depths.</li> </ul>
<b>East and West Piers</b>	<ul style="list-style-type: none"> <li>iii. Commonly used deep foundation type.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Vibration and potential adverse effects on the existing foundations must be addressed during design and construction.</li> <li>ii. Feasibility for use at the piers is doubtful due to relatively short pile lengths.</li> </ul>	<p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively uncommon pile type nowadays that may include concrete filling.</li> <li>ii. Lesser geotechnical resistance than H-piles of comparable size and driven depth.</li> <li>iii. Large displacement piles that could have more severe adverse effects on the existing foundations. Vibration effects must also be addressed during design and construction.</li> <li>iv. Feasibility for use at the piers is doubtful due to relatively short pile lengths.</li> </ul>	<p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Impractical for use at the abutments if perched abutments similar to the existing structures are used.</li> </ul>	<p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Specific requirements during installation through water-bearing cohesionless soils, including the use of temporary liners, drilling fluids and tremie concrete.</li> <li>ii. Caisson equipment must be equipped to handle obstructions, boulders and cobbles etc.</li> <li>iii. May require manual cleaning and inspection of the caisson base.</li> </ul>





### ANTICIPATED GEOTECHNICAL RESISTANCES AND FOUNDING ELEVATIONS

#### Ottawa Street (South) Overpass WBL

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS (kN)	SLS (kN)
<b>West Abutment</b>					
324.3 or below	450	300	324.0 or below	1,500	1,000
<b>West Pier</b>					
324.3 or below	450	300	324.0 or below	1,500	1,000
<b>East Pier</b>					
324.3 or below	450	300	324.0 or below	1,500	1,000
<b>East Abutment</b>					
324.3 or below	450	300	324.0 or below	1,500	1,000

#### Ottawa Street (South) Overpass EBL

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS (kN)	SLS (kN)
<b>West Abutment</b>					
324.3 or below	450	300	324.0 or below	1,500	1,000
<b>West Pier</b>					
324.3 or below	450	300	324.0 or below	1,500	1,000
<b>East Pier</b>					
324.3 or below	450	300	324.0 or below	1,500	1,000
<b>East Abutment</b>					
324.3 or below	450	300	324.0 or below	1,500	1,000

Concrete filled, 12¾" O.D. steel tube (pipe) piles driven to the above elevations may be designed for factored geotechnical resistance at ULS of 900 kN per pile, and geotechnical resistance at SLS of 600 kN per pile.



**Records of Boreholes**

**Plans and Profiles**



### FOUNDATION SECTION

CHECKED BY K.G.S.

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	BLOWS / FOOT		SHEAR STRENGTH P.S.F.	WATER CONTENT % 5 10 15		
1077.7	Groundlevel									
C	Fine Sandy Silt		1	SS	55	1070				
	To Silty Fine To		2	SS	74					
	Medium Sand With		3	SS	108					
	Trace Of Gravel		4	SS	201		10"			
			5	SS	142		1060			
	Very Dense		6	SS	130		5 1/2"			
			7	SS	100		6"			
			8	SS	116		6"	1050		
1047.7			9	SS	114	6"				
30.0	Sandy Silt					1040				
To Silt With	10		SS	100	5"					
Trace Of Gravel										
1036.2	Very Dense		11	SS	100	4 1/2"				
41.5	End Of Borehole					1030				



FOUNDATION SECTION

ORIGINATED BY A.M.S.

COMPILED BY A.H.S.

CHECKED BY                     

Gr16Sa65  
S1C1.19  
W.L.  
1047.8

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

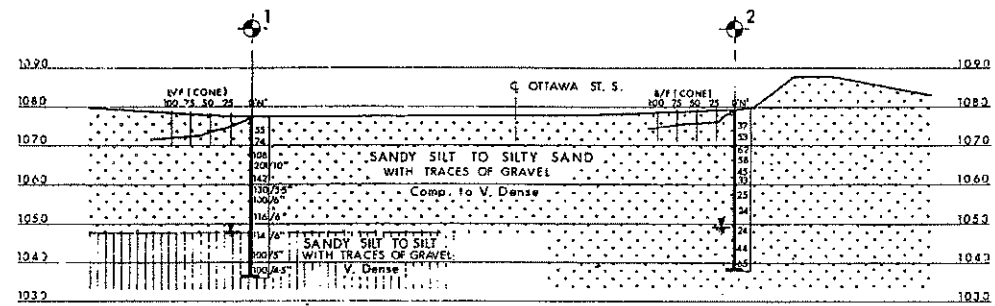
RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

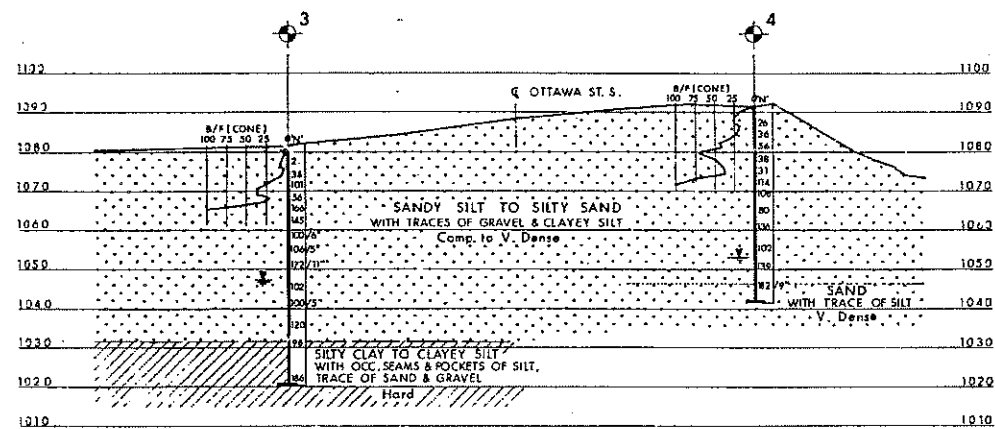
JOB 66-E-69 LOCATION Co-Ord's: N-189,784.0; E-208,303.4 ORIGINATED BY A.M.S.  
W.P. 626-64 BORING DATE August 4 & 5/66 COMPILED BY A.M.S.  
DATUM Geodetic BOREHOLE TYPE Washboring & BX Casing CHECKED BY HR

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	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					WATER CONTENT %				
							20	40	60	80	100	wp	w	wL		
SHEAR STRENGTH P.S.F.																

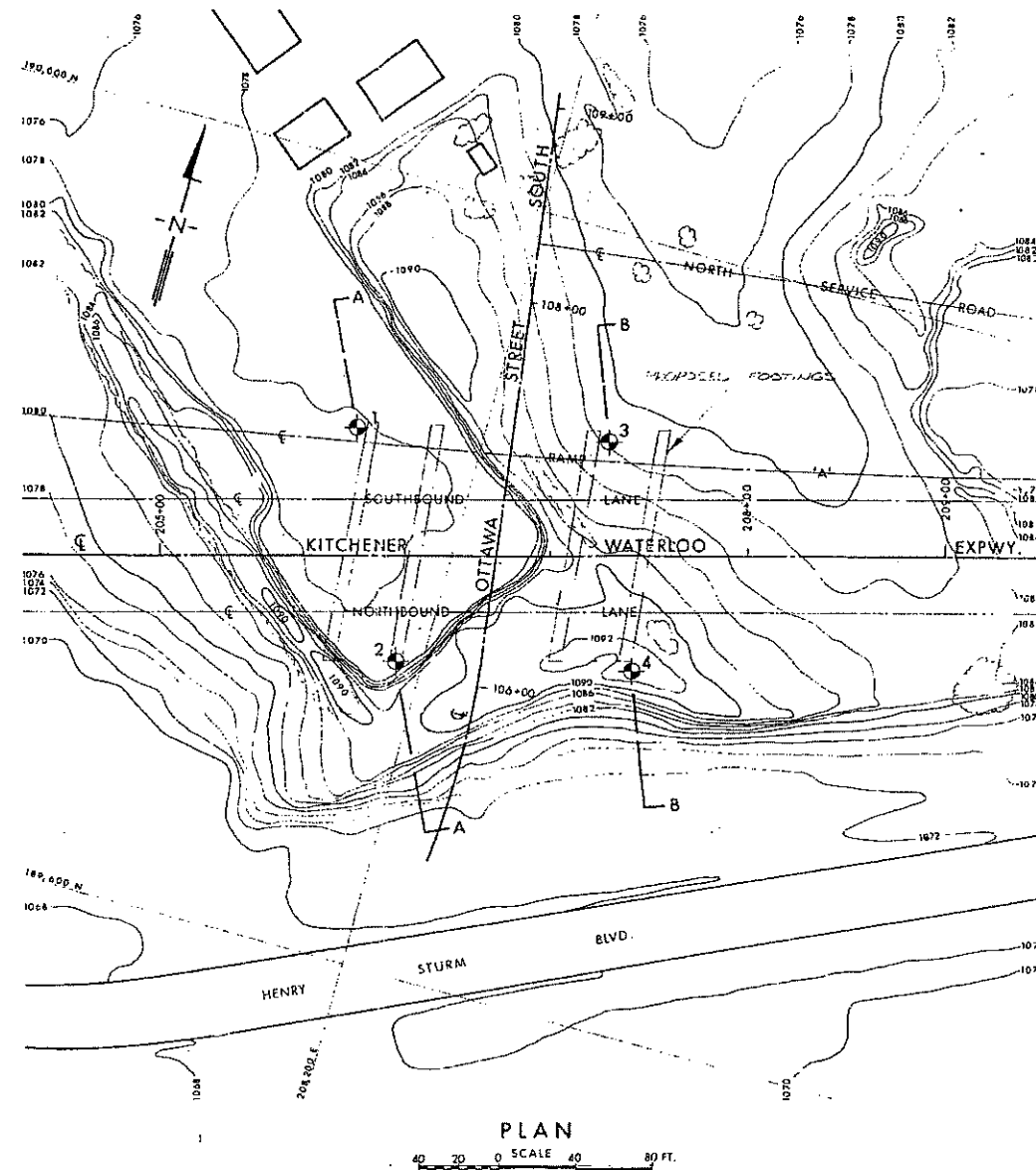
1091.1	Ground Level					1090											
	Sandy Silt To Silty Sand With Traces Of Gravel And Clayey Silt Compact To Very Dense		1	SS	26												GrOsa50 S1C150
			2	SS	36												
			3	SS	56	1080											
			4	SS	38												
			5	SS	31												
			6	SS	114	1070											
			7	SS	106												
			8	SS	80												
			9	SS	136	1060											
			10	SS	102												
			11	SS	139	1050											
1046.1				12	SS	182/9"											
45.0	Fine To Medium Sand With Traces of Silt																
1041.1	Very Dense																
50.0	End Of Borehole					1040											W.L. 1053.0 GrOsa95 S1C15



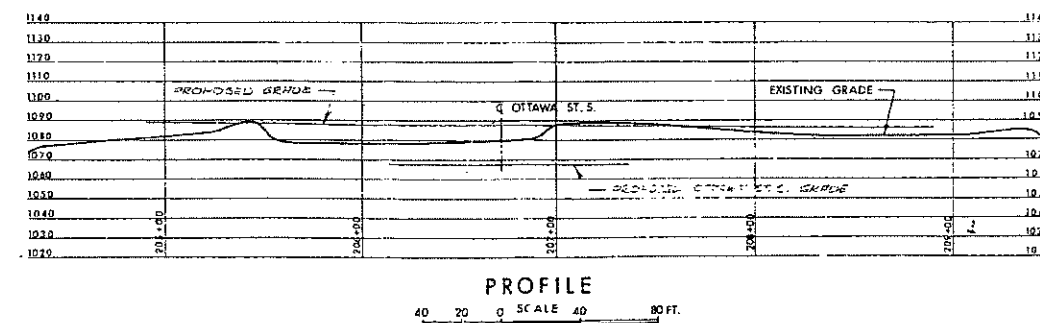
SECTION A-A



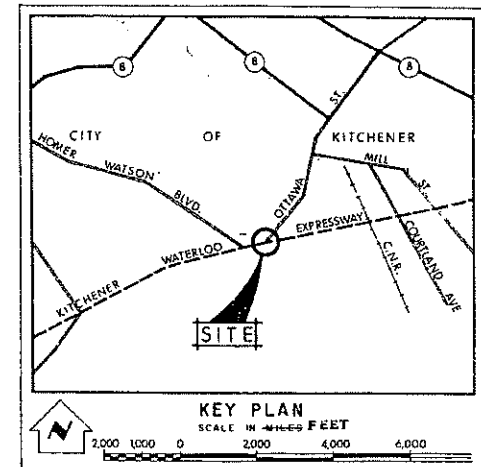
SECTION B-B



## PLAN







## PROFILE



KEY PLAN

LEGEND

-  Bore Hole  
 Cone Penetration Hole  
 Bore & Cone Penetration Hole  
 Water Levels established at time of field investigation, JULY & AUG. 1966

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	1077.7	189,867	208,135
2	1079.5	189,757	208,186
3	1081.7	189,894	208,261
4	1091.1	189,784	208,363

- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

OTTAWA STREET SOUTH

KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPWY. DIST. NO. 4  
CO. WATERLOO CITY OF KITCHENER  
TWP. \_\_\_\_\_ LOT \_\_\_\_\_ CON. \_\_\_\_\_

## BORE HOLE LOCATIONS &amp; SOIL STRATA

SUBMD A.5.	CHECKED <i>AS</i>	W.P. NO. 626-64	N.B.T. DRAWING NO.
DRAWN S.O.	CHECKED <i>W</i>	JOB NO. 66-F-69	66-F-69A
DATE 26 AUG. 1966	SITE NO	BRIDGE DRAWING NO.	
APPROVED <i>A. J. Thomas</i>	CONT. NO.		

[illegible]

\_\_\_\_\_



DEPARTMENT OF HIGHWAYS - ONTARIO			RECORD OF BOREHOLE NO. 2				FOUNDATION SECTION					
MATERIALS & TESTING DIVISION			JOB 66-F-70				LOCATION Kitchener-Waterloo Expy. - Homer Watson Blvd.					
W.P. 627-64			BORING DATE August 3/66				ORIGINATED BY V.K.					
DATUM Geodetic			BOREHOLE TYPE Washboring, No casing; Cone				COMPILED BY W.T.E.					
							CHECKED BY A.R. <i>HR</i>					
SOIL PROFILE		STRAT. PLOT	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	20 40 60 80 100	10 20 30			
1072.7	Groundlevel											
0.0	Sandy Silt		1	SS	12	1070						Gr2Sa33
	Traces of Sand		2	SS	21							Si58C17
	And Gravel		3	SS	19							Gr0Sa20
1059.8	Compact		4	SS	25	1060						Si170C1.10
13.2	Clayey Silt		5	SS	22							W.L. 1057'
	To Silt		5A	TW	PM/12"							
	Very Stiff		6	SS	28							
			7	SS	23	1050						
			8	SS	28							
			9	SS	21	1040						
1035.5			10	SS	30							
37.5	Sandy Silt		10A	TW	PM/12"							
1031.8	Very Dense		11	SS	55	1030						Gr0Sa17
41.2	Clayey Silt		12A	TW	PM/12"							Si170C1.11
	To Silt		12	SS	73							
	Hard					1020						
1017.0			13	SS	104							
56.0	Silty Sand		14	SS	116	1010						Gr9Sa57
	Very Dense											Si125C19
1007.9			15	SS	100/1"							
65.1	End Of Borehole					1000						

FOUNDATION SECTION

CHECKED BY           A.D.          

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT ——— W <sub>L</sub>	PLASTIC LIMIT ——— W <sub>P</sub>	WATER CONTENT ——— W	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	W <sub>P</sub>	W	W <sub>L</sub>		
							20 40 60 80 100					
							SHEAR STRENGTH P.S.F.	WATER CONTENT % 10 20 30				
1072.3	Ground Level					1070						Gr08a2 S147C151
1057.8	Silty Clay To Clayey Silt Stiff To Hard		1	SS	14	1060						Gr18a11 S163C125 W.L. 1056 Gr08a19 S178C13  Gr08a63 S134C13   Gr08a8 S181C1.11
			2	SS	26							
			3	SS	17							
			4	SS	46							
14.5	Sandy Silt To Silty Sand Very Dense		5	SS	52	1050						
			6	SS	48							
			7	SS	59							
			8	SS	91							
			9	SS	72							
			10	SS	269							
1032.3						1040						
40.0	Clayey Silt To Silt With Traces Of Sand Hard		11	SS	137	1030						
			12	SS	84							
1011.7						1020						
60.6	End Of Borehole					1010						

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

FOUNDATION SECTION

JOB 66-F-70 LOCATION K-W Expy. - Homer Watson Blvd. ORIGINATED BY V.K.  
W.P. 627-64 BORING DATE August 10, 1963 COMPILED BY V.K.  
DATUM Geodetic BOREHOLE TYPE Drive Casing & Wash CHECKED BY A.B. HR

[illegible]

## RECORD OF BOREHOLE NO. 5

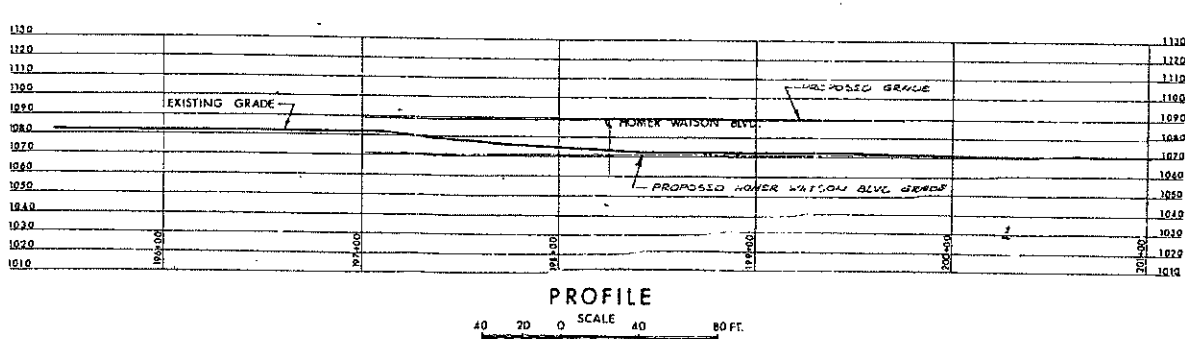
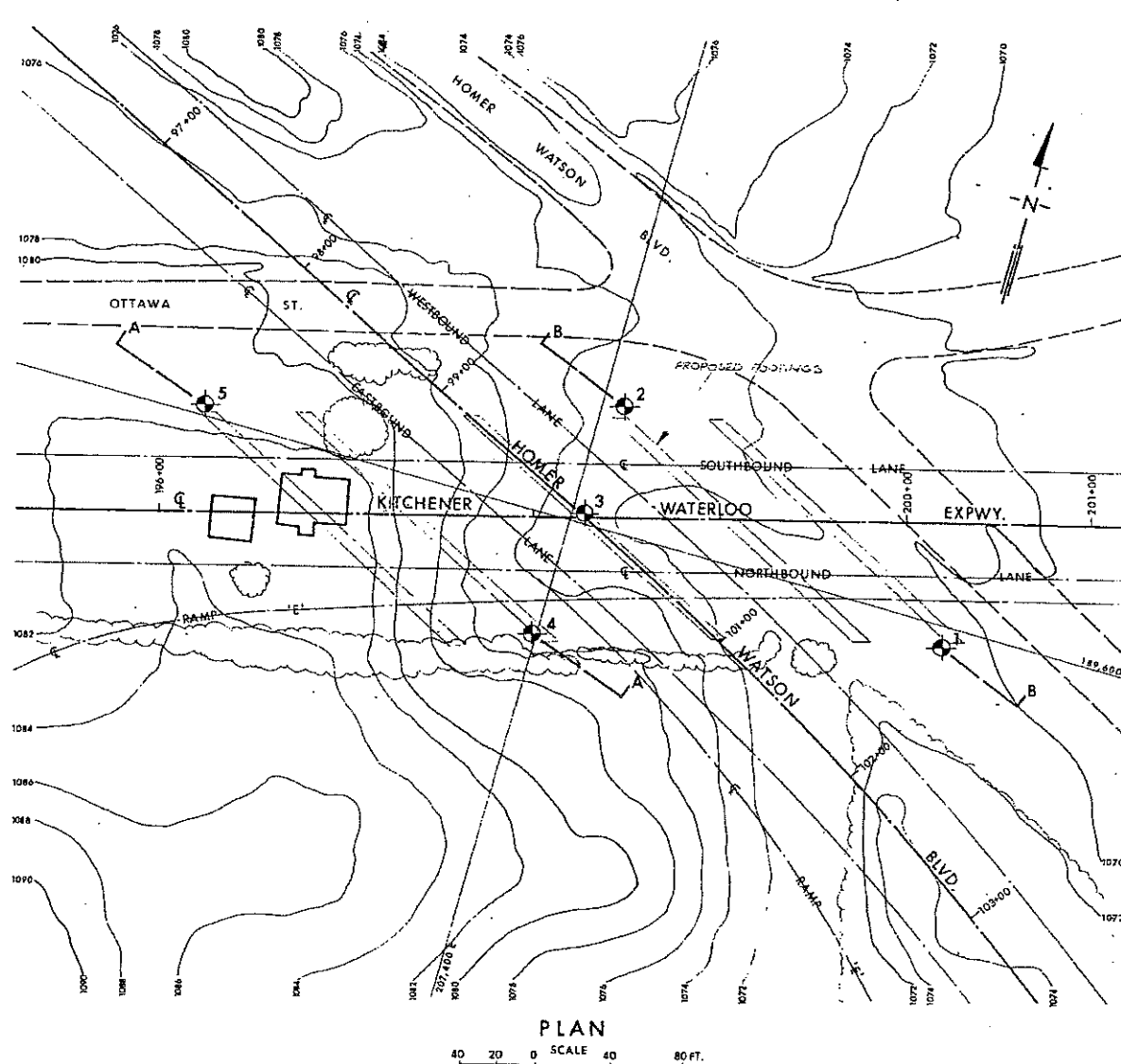
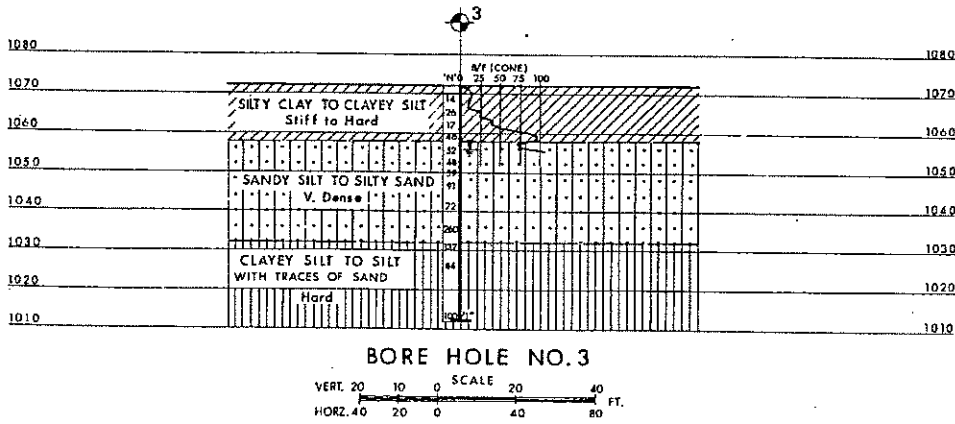
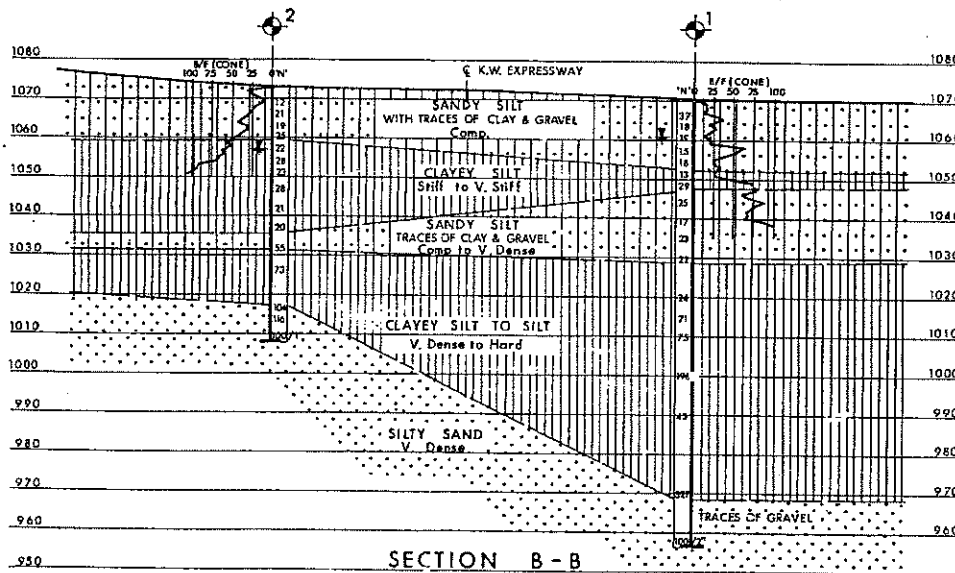
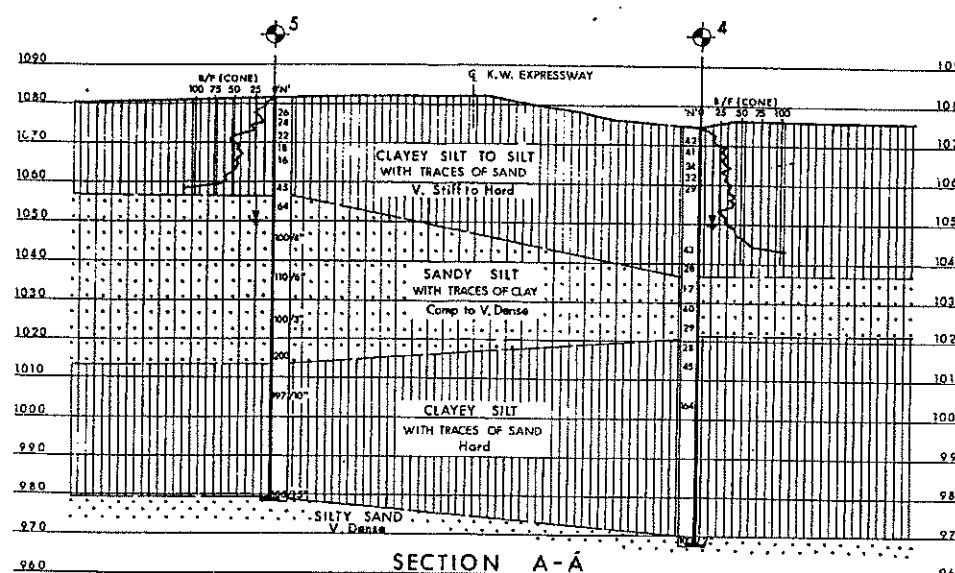
FOUNDATION SECTION

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION





JOB 66-F-70 LOCATION K-1 Empry. - Homer Watson Blvd.  
W.P. 527-64 BORING DATE August 15, 1966  
DATUM Geodetic BOREHOLE TYPE Drive Casing and Wash

ORIGINATED BY V.K.  
COMPILED BY V.K.  
CHECKED BY A.B. *AB*

[illegible]



**LEGEND**

 Bare Hole  
 Cone Penetration Hole  
 Bore & Cone Penetration Hole  
 Water Levels established at time of field investigation. JULY & AUG 1966

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	1070.4	189,587	207,610
2	1072.7	189,645	207,410
3	1072.3	189,603	207,405
4	1074.6	189,553	207,355
5	1081.5	189,603	207,193

- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

HOMER WATSON BOULEVARD

KING'S HIGHWAY NO. KITCHENER-WATERLOO EXPWY. DIST. NO. 4  
CO. WATERLOO CITY OF KITCHENER  
TWP. LOT CON

BORE HOLE LOCATIONS & SOIL STRATA

SUBNO. V.K.	CHECKED <i>LL</i>	W.P. NO. 627-64	M.S.T. DRAWING NO.
DRAWN S.O.	CHECKED <i>LL</i>	JOB NO. 66-F-70	66-F-70 A
DATE 31 AUG. 1966		SITE NO.	BRIDGE DRAWING NO.
APPROVED <i>A. J. Stearns</i>		CONT. NO.	

[illegible]

**Appendix H**  
**Geotechnical Resistances and Founding Elevations**  
**CNR Overpass WBL and EBL**



**COMPARISON OF FOUNDATION ALTERNATIVES  
CNR OVERPASS (WBL AND EBL)**

Foundation Element	Driven Steel H-Piles	Driven Tube (Pipe) Piles	Spread Footings	Augered Caissons (Drilled Shafts)
East and West Abutments	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively high geotechnical resistance is available for end-bearing piles.</li> <li>ii. Minimal excavation required for foundation construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Compatible with the existing foundations and relatively high geotechnical resistance.</li> <li>ii. Minimal excavation required for foundation construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction.</li> <li>ii. Likely the most cost effective alternative for the retaining walls.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Larger geotechnical resistance than other deep foundation types is available for comparable founding depths.</li> </ul>
	<p>iii. Commonly used deep foundation type.</p> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Vibration and potential adverse effects on the existing foundations must be addressed during design and construction.</li> <li>ii. Cost ineffective for use at the retaining walls due to relatively small foundation loads.</li> </ul>	<p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively uncommon pile type nowadays that may include concrete filling.</li> <li>ii. Lesser geotechnical resistance than H-piles of comparable size and driven depth.</li> <li>iii. Large displacement piles that could have more severe adverse effects on the existing foundations. Vibration effects must also be considered during design and construction.</li> <li>iv. Cost ineffective for use at the retaining walls due to relatively small foundation loads.</li> </ul>	<p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Settlements due to foundation compression (anticipated to be complete by end of construction) must be taken into account during design.</li> </ul>	<p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Potentially incompatible with existing rigid frame design (requires larger cap).</li> <li>ii. Specific requirements during installation through water-bearing cohesionless soils, including the use of temporary liners, drilling fluids and tremie concrete.</li> <li>iii. Caisson equipment must be equipped to handle obstructions, boulders and cobbles etc.</li> <li>iv. May require manual cleaning and inspection of the caisson base.</li> </ul>



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**CNR Overhead WBL**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS <sub>r</sub> (kN)	SLS (kN)
<b>West Abutment</b>					
Below 317.0	300	200	305.0 or below	1,500	1,000
<b>East Abutment</b>					
Below 315.0	300	200	300.0 or below	1,500	1,000
<b>Retaining Walls (west of bridge)</b>					
317 to 323 (west to east)	450	300	-	-	-
<b>Retaining Walls (east of bridge)</b>					
316.3 to 313.3 (east to west)	300	200	-	-	-

**CNR Overhead EBL**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS <sub>r</sub> (kN)	SLS (kN)
<b>West Abutment</b>					
Below 317.0	300	200	305.0 or below	1,500	1,000
<b>East Abutment</b>					
Below 315.0	300	200	300.0 or below	1,500	1,000
<b>Retaining Walls (west of bridge)</b>					
317 to 323 (west to east)	450	300	-	-	-
<b>Retaining Walls (east of bridge)</b>					
316.3 to 313.3 (east to west)	300	200	-	-	-

Concrete filled, 12¾" O.D. steel tube (pipe) piles driven to the above elevations may be designed for factored geotechnical resistance at ULS of 900 kN per pile, and geotechnical resistance at SLS of 600 kN per pile.





**Records of Boreholes**

**Plans and Profiles**



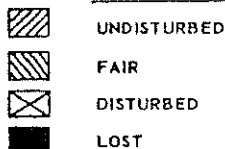


**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

BOREHOLE LOG

Job Name Kitchener - Waterloo Area Expressway System, Heavy Storm Job No. 64225 Borehole No. 2  
Client Dept. of Highways. Casing 4-1/2" Auger and 4" Boring Date Sept. 17 - 18, 1964.  
Elevation 1042.7 Compiled By A. A. M. Checked By sb

**SAMPLE CONDITION**



**SAMPLE TYPE**

A.S. AUGER SAMPLE  
 C.S. CASING SAMPLE  
 S.S. 2" STANDARD SPLIT TUBE SAMPLE  
 S.L. SPLIT BARREL WITH LINERS  
 S.T. THIN-WALLED SHELBY TUBE SAMPLE  
 W.S. WASH SAMPLE  
 R.C. ROCK CORE

**ABBREVIATIONS**

V.T. IN SITU VANE SHEAR TEST  
 M. MOIST  
 W.L. WATER LEVEL IN CASING  
 W.T. GROUND WATER TABLE IN SOIL  
 W.T.P.L. WETTER THAN PLASTIC LIMIT  
 D.T.P.L. DRIER THAN PLASTIC LIMIT  
 A.P.L. ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Moisture Content	WATER LEVELS & REMARKS
Ground surface			0'0"						Cone Probe
Fill (sand, gravel, organic sandy silt loam)	Lt. brown to dark brown				1	AS			Moist
Fill (silty sand with some pebbles)	Brown	Loose			2	SS	10	10.3	Quite moist.
		Very stiff	5'8"		3	SS	16		
Clayey silt with sand seams.	Brown				4	SS	17	13.8	About P.L. and Quite moist.
Clayey silt	Mottled brown	Very stiff							Slightly D.T.P.L.
		Stiff	10'8"		5	SS	10	15.2	W.T.P.L.
Clayey silt interlayered with sandy silt	Buff grey					3"SL			Saturated.
						3"SL			
Clayey silt					6	2"ST			
			20'0"						
Sandy silt with clayey silt layers	Ditto	Compact			7	SS	18	18.7	Saturated and W.T.P.L.
					8	2"ST			Probe hole terminated at 22 ft.
As above, Silty clay seams	Grey-brown	Ditto			9	SS	15	17.5	Wet and W.T.P.L.
					10	2"ST			
			30'0"						
Clayey silt and some sandy silt seams	Ditto	Very stiff			11	SS	26	16.7	W.T.P.L. Saturated.
Clayey silt with Silty fine sand layers	Ditto	Ditto			12	SS	20	18.1	Slight water seepage at 35 ft. W.T.P.L. and Saturated.
									Water seepage at 38'
			40'0"						

Clayey silt with Silty fine sand layers	Ditto	Ditto		12	SS	20	18.1	Water seepage at 35 ft. W.T.P.L. and Saturated.
								Water seepage at 38'
As above	Ditto	Ditto	40'0"	13	SS	25	17.2	W.T.P.L. & saturated
Silty clay with silt and fine sand seams	Ditto	Ditto		14	SS	20	33.1	W.T.P.L.
			42'0"					
Silty fine sand	Ditto			15	SS	40	17.2	Plows too high Saturated.
As above	Ditto	Compact		16	SS	23	20.9	Saturated.
								Hardens at 58'
Silty fine sand	Grey-brown	Very dense	60'0"	17	SS	78	15.4	Saturated
Silty clay, some grits and pebbles	Ditto	Very stiff	65'8"	18	SS	27	18.3	W.T.P.L.
			70'0"					
Clayey silt with grits and pebbles	Grey	Hard		19	SS	42	18.8	Slightly W.T.P.L.
As above	Ditto	Ditto		20	SS	39	21.3	Slightly W.T.P.L.
Silty clay with grits and pebbles.	Ditto	Ditto	81'6"	21	SS	43		W.T.P.L.
Test Hole Terminated at 81'6"								

## BOREHOLE LOG

Borehole No. 3  
Boring Date Sept. 25, 1964.  
Checked By sh.

SAMPLE TYPE

### ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT.
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

SAMPLE CONDITION



UNDISTURBED

 FAIR

☒ DISTURBED

**LOST**

SAMPLE TYPE

A.S. AUGER SAMPLE

C.S. CASING SAMPLE

### 5.5. 2" STANDARD SPLIT TUBE SAMPLE

S.L. SPLIT BARREL WITH LINERS

S.T. THIN-WALLED SHELBY TUBE SAMPLE

W.S. WASH SAMPLE

R.C. ROCK CORE

### ABBREVIATIONS

### Y.T. IN SITU VANE SHEAR TEST

M MOIST

W.L. MOIST WATER LEVEL IN CASING





W.T. GROUND WATER TABLE IN SOIL

W.T.P.L. WETTER THAN PLASTIC LIMIT

D.T.P.L. DRIER THAN PLASTIC LIMIT

A.P.L ABOUT PLASTIC LIMIT

[illegible]

SAMPLE CONDITION		SAMPLE TYPE			ABBREVIATIONS				
	UNDISTURBED	A.S.	AUGER SAMPLE	V.T.	IN SITU VANE SHEAR TEST				
	FAIR	C.S.	CASING SAMPLE	M.	MOIST				
	DISTURBED	S.S.	2" STANDARD SPLIT TUBESAMPLE	W.L.	WATER LEVEL IN CASING				
	LOST	S.L.	SPLIT BARREL WITH LINERS	W.T.	GROUND WATER TABLE IN SOIL				
		S.T.	THIN-WALLED SHELBY TUBE SAMPLE	W.T.P.L.	WETTER THAN PLASTIC LIMIT				
		W.S.	WASH SAMPLE	D.T.P.L.	DRIER THAN PLASTIC LIMIT				
		R.C.	ROCK CORE	A.P.L.	ABOUT PLASTIC LIMIT				

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS & REMARKS
Ground surface			0'0"					Cone Probe
7" sandy clayey topsoil	Dark grey-brown		0'7"					A
Sandy clay	Mottled brown	Stiff	3'3"		1	SS	12	About P.L.
Silty fine sand	Light brown		4'6"					
Silty clay	Mottled brown	Very stiff	6'12"		2	SS	17	W.T.P.L.
Silty fine sand	Light brown		8'10"					
Silty clay; rusty lenses some grits	Brown (Reddish spots)				3	SS	17	W.T.P.L.
			10'8"					
					4	3"ST		
Very silty clay	Grey	Stiff			5	SS	10	W.T.P.L.
					6	3"ST		
As above, seams of silty fine sand	Ditto	Ditto			7	SS	11	W.T.P.L.
			22'0"		8	3"ST		
Sandy silt, some grits	Ditto	Compact			9	SS	20	Saturated
Sandy, clay silt fine sand seams	Ditto	Compact			10	SS	14	Softens at 26'6" W.T.P.L. and Saturated.
			29'0"					
Silty fine sand			31'0"			3"ST		Strong water seepage
		Loose	31'7"		11	SS	10	
								Clayey silt seam 31'0" to 31'7" (W.T.P.L.)
Silty fine sand	Ditto	Compact			12	SS	16	Saturated.
Very silty fine sand	Ditto	Ditto			13	SS	27	Saturated.
Silty fine sand, clay pockets	Ditto	Dense	46'2"		14	SS	36	Wet Clayey silt seam 46'2" to 47'0" (W.T.P.L.)
			47'0"					
Very silty fine sand pockets of silty clay	Grey	Ditto	51'6"		15	SS	38	Wet and W.T.P.L.
								Test Hole Terminated at 51'6"





## BOREHOLE LOG

6A  
Borehole No. ....  
Boring Date Sept. 25, 1964.  
Checked By sb .....

**SAMPLE TYPE**

## ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

# BOREHOLE LOG

Borehole No. 6B  
 Boring Date October 5, 1964  
 Checked By sb

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Moisture Content (adopt)	WATER LEVELS & REMARKS
Ground surface			0'0"						
									Augered down to 20 ft. no sampling
No sampling to 20 ft.									
			20'0"						
Very silty fine sand with clayey silt pockets	Buff-grey	Compact	27'0"	1	SS	17	15.9		Saturated and W.T.P.L.
As above	Ditto	Ditto	31'8"	2	SS	29	21.6		Start using wash water at 30 ft. Saturated and W.T.P.L.
Silty fine sand									
9" clayey silt seam at 35'6". Silty sand	Grey	Ditto	35'6" 36'2" 38'0"	3	SS	23	18.4		Wet and W.T.P.L. Saturated
Clayey silt, with thin seam of sandy silt and fine sand	Ditto	Very stiff	44'0"	4	SS	32	18.6		W.T.P.L.
Very clayey silt	Ditto	Ditto		5	SS	20	18.8		W.T.P.L.
Clayey silt with some thin sandy silt seams	Ditto	Ditto	51'6"	6	SS	21	23.3		W.T.P.L.
									Test Hole Terminated at 51'6".

## BOREHOLE LOG

Borehole No. 9  
Boring Date Sept. 24, 1964  
Checked By rm

SAMPLE TYPE

### ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBESAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

Y. T.	IN SITU VANE SHEAR TEST
M.	MOIST
W. L.	WATER LEVEL IN CASING
W. T.	GROUND WATER TABLE IN SOIL
W. T. P. L.	WETTER THAN PLASTIC LIMIT
D. T. P. L.	DRIER THAN PLASTIC LIMIT
A. P. L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Natural Moisture Content	WATER LEVELS & REMARKS
Ground Surface			0'0"						
3" Sandy topsoil: fine sand			1'6"						
Fine sand	Light Brown	Compact	3'5"	1	X	S. S.	21		Quite Moist
Sandy silt	Brown								Moist
		Compact	6'0"	2	X	S. S.	23	1.8	Moist
Coarse to med. Sand	Light Brown			3	X	S. S.	27	1.2	Moist
Fine gravel									
As above	Ditto	Ditto							
Coarse sand & fine gravel	Ditto	Ditto		4	X	S. S.	27	2.4	Moist
As above	Brown	Ditto		5	X	S. S.	23	9.6	Wet from 12.5
Coarse to fine sand & fine gravel	Ditto	Loose		6	X	S. S.	7	10.6	
Med. to fine sand, some pebbles	Ditto	Ditto		7	X	S. S.	9	16.6	Saturated
Fine sand	Ditto	Compact	21'5"	8	X	S. S.	24	10.6	Wet to Saturated
Clayey silt & silty clay	Grey Brown		23'0"						Wet to Saturated
Clayey silt with sandy streaks	Grey	Hard	26'6"	9	X	S. S.	60	15.4	D.T.E. 12.0 to 15.4
		Teat hole Terminated	at 26'6"						

## BOREHOLE LOG

Borehole No. 10  
Boring Date Sept. 24, 1964  
Checked By rm

### ABBREVIATIONS

V.T.	IN SITU YANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Borehole No. 11

Boring Date Sept. 23, 1961.....

Checked By END

SAMPLE TYPE

## ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]



# BOREHOLE LOG

Borehole No. 12  
Boring Date Sept. 21, 1964  
Checked By rjn

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Natural Moisture Content	WATER LEVELS & REMARKS
Ground Surface			0'0"						
Organic silty topsoil	Dark Brown		0'5"						Quite Moist
Fine sand	Brown								
Silty clay with sand pockets, pebbles	Mottled Brown	Stiff	2'5"		1 X	S.S.	13	18.2	W.T.P.L.
			4'6"						
Very silty clay with grits & pebbles	Grey some Brown spots	Stiff			2 X	S.S.	15	12.9	Slightly W.T.P.L.
As above, sand seams	Grey to brown	Very stiff	7'6"		3 X	S.S.	27	16.4	W.T.P.L.
Clayey silt, odd pebble	Brown		8'0"						Quite Moist
Sandy, clayey silt with grits & pebbles	Brown	Dense			4 X	S.S.	39	19.9	Quite Moist
			11'2"						
Fine sand layer	Brown	Dense	12'1"		5 X	S.S.	40	13.2	Saturated
Sandy silt	Grey		14'0"						Quite Moist
Coarse to fine sand some pebbles	Brown	Compact			6 X	S.S.	21	12.9	Wet to saturated
Coarse sand & fine gravel	Brown	Ditto			7 X	S.S.	21	15.6	Saturated
			21'6"						
		Testhole Terminated at 21'6"							





# BOREHOLE LOG

Borehole No. 13

Boring Date Sept. 28, 1964

Checked By 111

### ABBREVIATIONS

	UNDISTURBED	A.S. AUGER SAMPLE
	FAIR	C.S. CASING SAMPLE
	DISTURBED	S.S. 2" STANDARD SPLIT TUBE SAMPLE
	LOST	S.L. SPLIT BARREL WITH LINERS
		S.T. THIN-WALLED SHELBY TUBE SAMPLE
		W.S. WASH SAMPLE
		R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Moisture Content (%)	WATER LEVELS & REMARKS
Ground Surface Elev.	0+3.0		0'0"						Cone Probe
4" Sandy topsoil	Dark Brown								
Fine sand & sandy silt	Lt. Brown	Compact			1 X	S.S.	19	7.9	Moist
Sandy Silt, grits,	Dark Grey								
Cinder pieces (Fill)									
Silty clay	Mottled Brown	Soft	5'9"		2 X	S.S.	4	18.3	W.T.P.L.
with silty sand seams									Wet from 5'9"
Silty clay with sandy silt seams	Brown Buff-Grey	Medium	7'10"		3 X	S.S.	7	17.6	W.T.P.L.
					4 X	"S.T."			
Clayey silt and sandy silt interlayered	Buff-Grey	Compact			5 X	S.S.	11	16.7	Saturated
Silty fine sand & sandy silt	Ditto	Ditto			6 X	S.S.	11	21.1	Saturated
					7 X	"S.T."			
Sandy silt with silty clay layers	Buff	Ditto			8 X	S.S.	12	19.6	Wet & W.T.P.L.
					9 X	S.S.	16	13.2	Stiffens at 19'6"
Sandy Clayey Silt	Ditto	Ditto							Wet & W.T.P.L.
Aa Above	Ditto	Ditto			10 X	S.S.	21	13.4	Quite Moist & About B.C.Y.
Silty clay with fine sand seams	Buff, Brown	Very Stiff	31'5"		11 X	S.S.	19	18.3	W.T.P.L. & Wet
		Testhole Terminated at 31'5"							

# BOREHOLE LOG

Borehole No. 14  
Boring Date Sept. 10, 1964  
Checked By RM

SAMPLE TYPE





## ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRYER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]



SAMPLE CONDITION		SAMPLE TYPE		ABBREVIATIONS	
	UNDISTURBED	A.S.	AUGER SAMPLE	V.T.	IN SITU VANE SHEAR TEST
	FAIR	C.S.	CASING SAMPLE	M.	MOIST
	DISTURBED	S.S.	2" STANDARD SPLIT TUBE SAMPLE	W.L.	WATER LEVEL IN CASING
	LOST	S.L.	SPLIT BARREL WITH LINERS	W.T.	GROUND WATER TABLE IN SOIL
		S.T.	THIN-WALLED SHELBY TUBE SAMPLE	W.T.P.L.	WETTER THAN PLASTIC LIMIT
		W.S.	WASH SAMPLE	D.T.P.L.	DRIER THAN PLASTIC LIMIT
		R.C.	ROCK CORE	A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Moisture Content	WATER LEVELS & REMARKS
Ground surface			0'0"						Comp. Prob.
Sand and gravel	Brown		1'3"						Moist
Sandy, clayey silt with grits and pebbles	Brown	Very stiff			1	SS	17	10.4	Wet
Coarse to medium sand, some gravel.	Brown	Dense	5'3"		2	SS	38	9.9	Wet
Silty fine to coarse sand and gravel	Brown	Dense			3	SS	35	11.4	Saturated from 8'
As above then clayey silt seams & silty sand	Brown	Hard	10'8"		4	SS	63	17.2	Saturated Wet
Sand and gravel	Buff grey	Very dense	11'8"		5	SS	52	11.1	Saturated
Very clayey silt with silt pockets	Grey	Hard	13'10"		6	SS	56	14.9	Quite moist
Clayey silt	Drab	Stiff	21'6"		7	SS	53	13.8	Quite moist
Test Hole Terminated at 21'6"									

## BOREHOLE LOG

SAMPLE CONDITION

SAMPLE TYPE

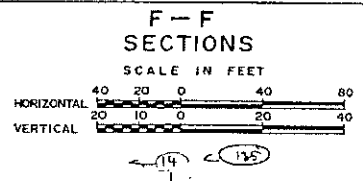
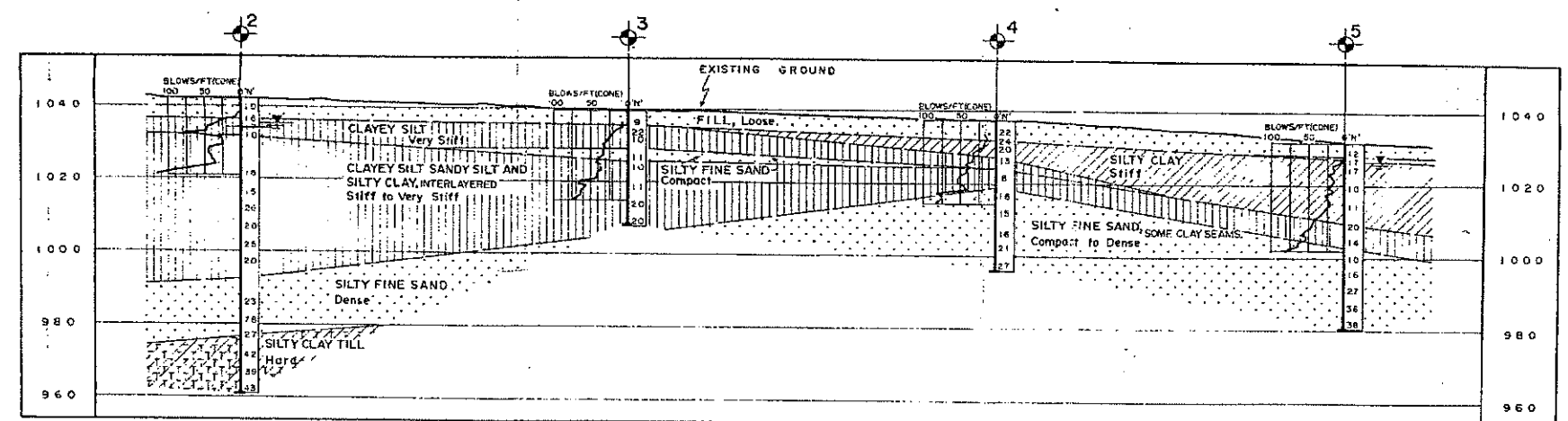
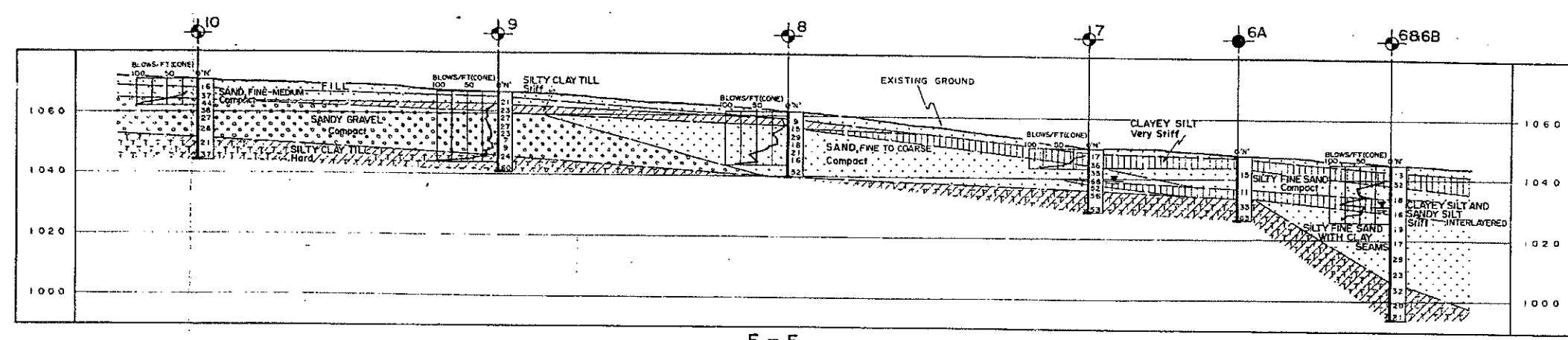
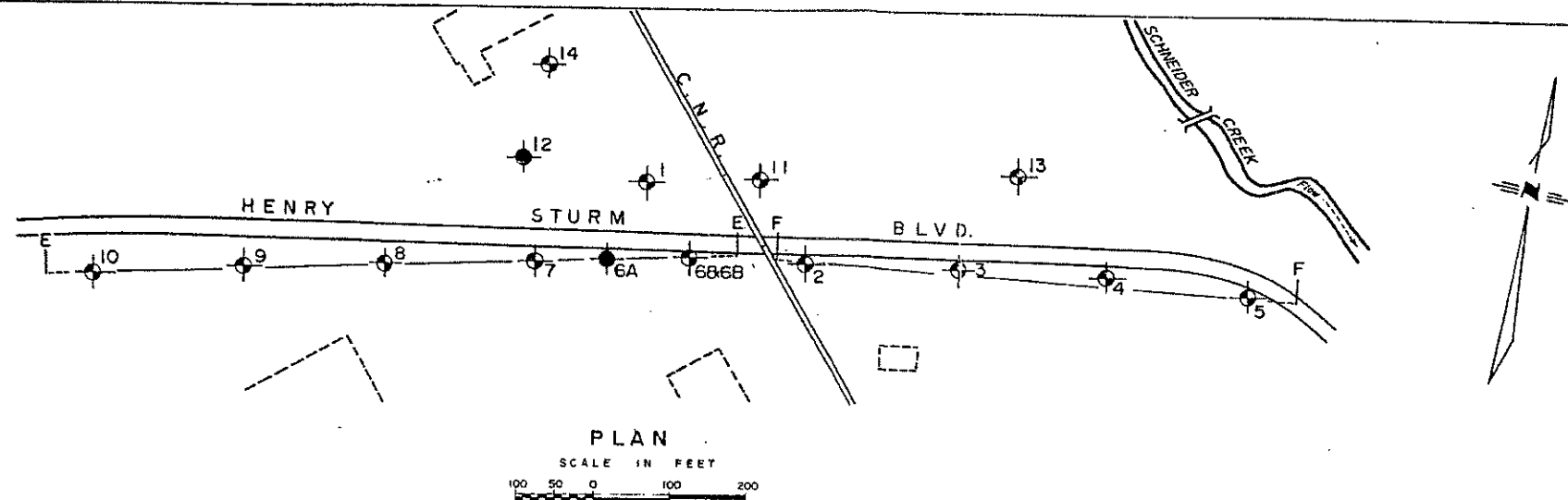
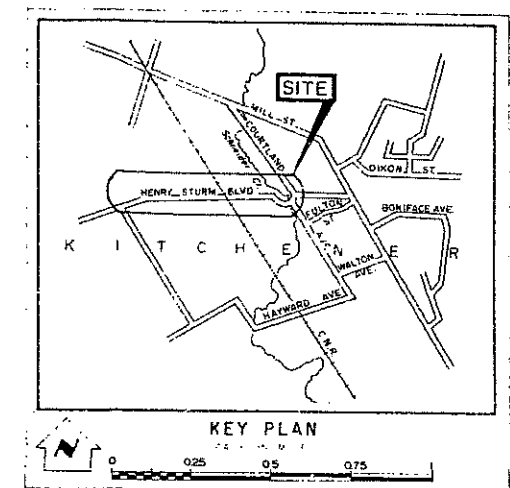
### ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T. IN SITU VANE SHEAR TEST  
M. MOIST  
W.L. WATER LEVEL IN CASING  
W.T. GROUND WATER TABLE IN SOIL  
W.T.P.L. WETTER THAN PLASTIC LIMIT  
D.T.P.L. DRIER THAN PLASTIC LIMIT  
A.P.L. ABOUT PLASTIC LIMIT

[illegible]

542000E  
1208300N 17 4288V



LEGEND			
●	Bore Hole		
○	Core Penetration Line		
○	Bore or Core Penetration Hole		
—	Water Levels established at time of field investigation (OCT. 1964)		

NO.	ELEVATION	STATION	OFFSET
1	1045.17	190 367.31210	151.1
2	1042.71	190 306.91210	374.9
3	1039.88	190 345.11210	580.1
4	1037.88	190 377.61210	775.0
5	1032.12	190 392.41210	964.6
6B6B	1045.07	190 281.41210	226.9
6A	1047.88	190 255.21210	123.3
7	1050.14	190 242.21210	030.8
8	1061.40	190 184.71209	837.0
9	1067.19	190 140.31209	654.4
10	1070.84	190 087.71209	464.1
11	1038.81	190 401.21210	296.1
12	1049.61	190 365.01209	987.3
13	1032.68	190 483.91210	595.5
14	1043.94	190 452.21209	992.6

NOTE  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS	DATE	BY	REVISION

E. M. PETO ASSOCIATES LTD.  
DEPARTMENT OF HIGHWAYS - ONTARIO  
WATERLOO & RESEARCH DIVISION, FOUNDATION SECTION

KITCHENER-WATERLOO EXPRESSWAY  
HENRY STURM BLVD. & C.N.R.

KING'S HIGHWAY NO. \_\_\_\_\_ DIST NO. 4  
CO. WATERLOO  
TWP. WATERLOO LOT \_\_\_\_\_ CON. \_\_\_\_\_

BORE HOLE LOCATIONS & SOIL STRATA

SUBSD. B.L.	CHECKED	WP NO. 625-64	DRAWING NO.
CRAWN C.K.	CHECKED	JOB NO. 64225	2
DATE JANUARY 1965	SITE NO.	BRIDGE DRAWING NO.	
APPROVED	DESIGNED	CONT. NO.	

NOTES  
(A) PLAN HAS BEEN EXTRACTED FROM THE FUNCTIONAL REPORT AND IS NOT BASED ON A SITE SURVEY. ACCORDINGLY, IT SHOULD BE REGARDED AS DIAGNOSTIC.  
(B) THE TESTHOLES AND PROBES HAVE BEEN LOCATED IN ACCORDANCE WITH CO-ORDINATES GIVEN IN THE TABLE, WHICH HAS BEEN SUPPLIED BY THE DEPARTMENT.

PRINT RECORD		
NO	FOR	DATE

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 95-94-00

LOCATION CO - ORDS: N 4 812 081.3; E 227 052.3

ORIGINATED BY M.V.

DIST 31 HWY 7

BOREHOLE TYPE HOLLOW STEM AUGER & CONE TEST

COMPILED BY M.V.

DATUM GEODETIC

DATE 94 07 29

CHECKED BY T.C.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
318.7	Ground Surface												
0.0	Topsoil												
316.8	CLAYEY SILT, Occasional Silt Layers, Stiff to Very Stiff		1	SS	13								
1.9			2	SS	29								
	SANDY GRAVEL Trace of Silt, Dense		3	SS	34								
			4	SS	36								
314.5			5	SS	45								
4.2			6	SS	50								
			7	SS	64								
	Some Gravel		8	SS	71								
	SILT TO SANDY SILT, Occasional Clayey Silt and Sand Seams, Very Dense		9	SS	123								
			10	SS	121								
308.6													
10.1	SILTY CLAY, Occasional Gravel, Hard		11	SS	71								
306.1			12	SS	57								
12.6	End of Borehole												
	Note: Formerly BH # 2 of W. P. 102 - 94 - 01												

+3, x5, Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

## METRIC

ORIGINATED BY VTS&CF

COMPILED BY M V

CHECKED BY T. C. K.

+3, x5: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 95 - 94 - 00

LOCATION CO - ORDS: N 4 B12 091.6; E 227 040.9

ORIGINATED BY VTS&CFE

DIST 31 HWY 7

BOREHOLE TYPE WASHBORING & CONE TEST

COMPILED BY M V

DATUM GEODETIC

DATE 65 06 12

CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
326.1	Ground Surface												
0.0	Compact		1	SS	20								
			2	SS	30								
			3	SS	45								
			4	SS	60								
			5	SS	77								
			6	SS	98								
319.9			7	SS	30								
6.2	SILT, Occasional Clayey Silt and Sand Layers, Dense to Very Dense		8	SS	133								
316.6			9	SS	48								
9.5	SANDY GRAVEL, Trace of Silt, Dense		10	SS	97								
315.5			11	SS	175	/18cm							
10.6	SILTY CLAY, Occasional Sand and Silt Layers, Hard		12	SS	200	/17cm							
310.7			13	SS	235	/22cm							
15.4	End of Borehole												
	Note: Formerly BH # 6 of W. P. 631 - 64												

# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 95 - 94 - 00

LOCATION CO - ORDS: N 4 B12 087; E 227 087.8

ORIGINATED BY VTS&CF

DIST 31 HWY 7

BOREHOLE TYPE WASHBORING & CONE TEST

COMPILED BY N V

DATUM GEODETIC

DATE 65 06 23 & 24

CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%) 20 40 60	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
326.3	Asphalt Surface											
0.0	Asphalt - - - - -		1	SS	19							
	SILTY SAND TO SAND, Pockets of Clay Boils, Loose to Very loose ( Fill )		2	SS	7							
			3	SS	4							
			4	SS	3							
			5	SS	3							
			6	SS	3							
			7	SS	3							
318.8	CLAYEY SILT, Occasional Silty Sand Layers, Hard		8	SS	1							
7.5			9	SS	20							
			10	SS	90							
315.2	Silty Sand - - - - -		11	SS	50							
11.1	End of Borehole											
	Note: Formerly BH # 7 of W. P. 631 - 64											

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 95 - 94 - 00 LOCATION CO - ORDS: N 4 812 099.1; E 227 055.7 ORIGINATED BY VTS&CFT  
 DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V  
 DATUM GEODETIC DATE 85 06 24 CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa • UNCONFINED + FIELD VANE • QUICK TRIAXIAL * LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES										
326.1	Asphalt Surface														
0.0	Asphalt - SILTY SAND, Trace of Organics, Compact ( Fill )		1	SS	28										
324.4			2	SS	24										
1.7			3	SS	28										
			4	SS	29										
			5	SS	41										
			6	SS	39										
319.3	SAND, Trace of Silt, Compact to Dense		7	SS	26										
6.8			8	SS	66										
316.5	CLAYEY SILT, Occasional Silt Layers, Hard		9	SS	57										
9.6	End of Borehole														
	* Note: Formerly BH # 8 of W. P. 631 - 64														

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 95-94-00

LOCATION CO - ORDS: N 4 812 290; E 226 910

ORIGINATED BY PETO

DIST 31 HWY 7

BOREHOLE TYPE CONTINUOUS FLIGHT SOLID STEM AUGER

COMPILED BY M V

DATUM GEODETIC

DATE 64 10 13

CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
324.6	Ground Surface												
0.0	Topsoil		1	SS	22		324						
	SAND, Trace of Silt, Compact to Dense		2	SS	10		322						
			3	SS	33		320						
318.6			4	SS	56		318						
6.0	CLAYEY SILT to SILTY CLAY, Occasional Sand Seams, Hard		5	SS	49								
316.5													
8.1	End of Borehole												
	Note: Formerly BH # D - 4 of W. P. 618 - 64												

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

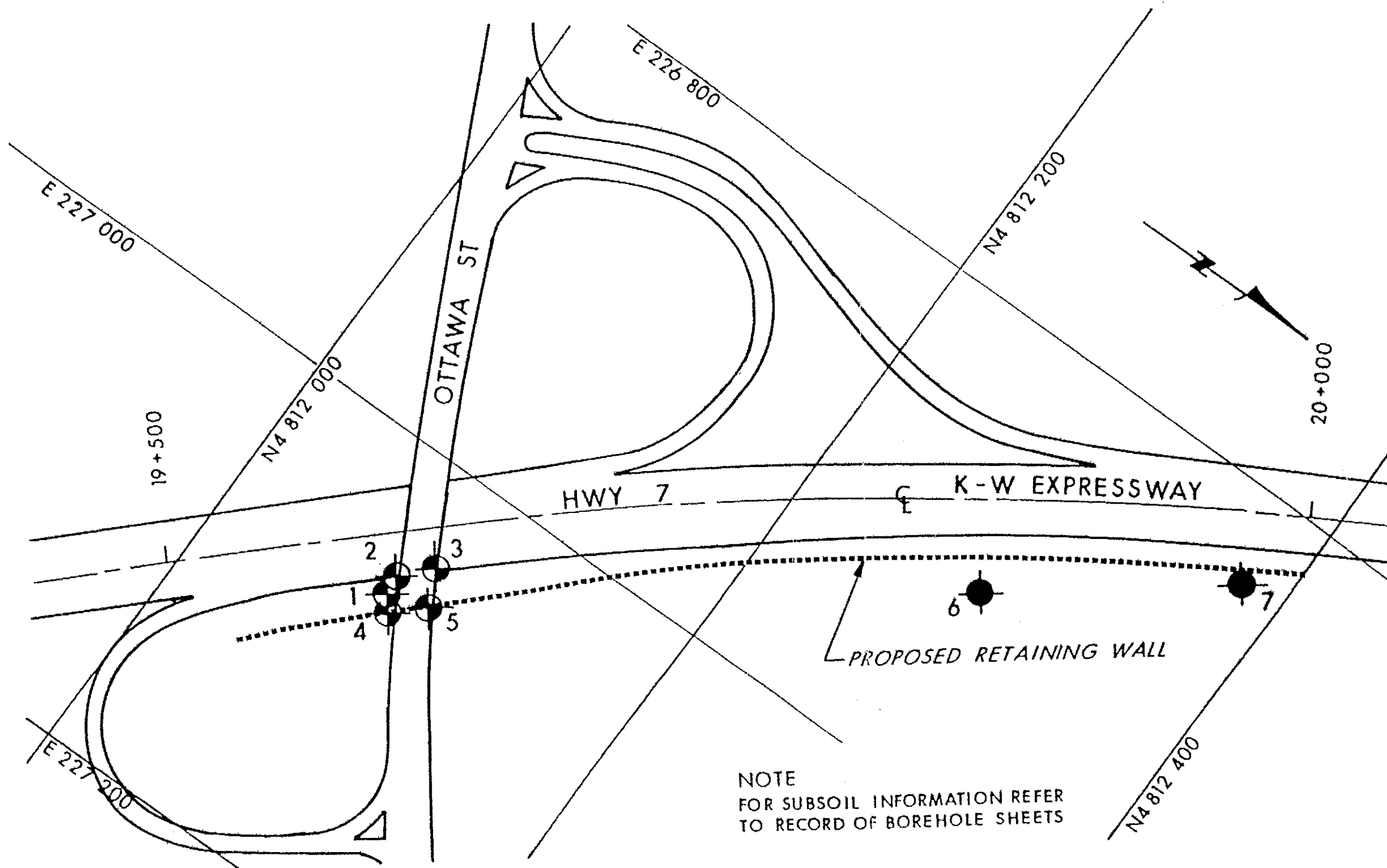
RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 95 - 94 - 00 LOCATION CO - ORDS: N 4 812 380; E 226 B40 ORIGINATED BY PETO  
 DIST 31 HWY 7 BOREHOLE TYPE CONTINUOUS FLIGHT SOLID STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 64 10 13 CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
324.2	Ground Surface																
0.0	Topsoil																
			1	SS	19												
	SAND, Trace of Silt, Compact		2	SS	21												
			3	SS	48												
	Sandy Silt		4	SS	55												
316.3			5	SS	75												
7.9	End of Borehole																
	Note: Formerly BH # D - 6 of W. P. 618 - 64																



LEGEND

- Bore Hole
- ⊙ Bore Hole & Cone

PLAN  
SCALE  
20m 0 20m

RETAINING WALL Along Hwy 7 EBL

HWY 7, WP 95-94-00, DIST 31

DWG 959400-A Geocres No 40P8-114

**Appendix I**

**Geotechnical Resistances and Founding Elevations**

**Courtland Avenue Overpass WBL and EBL**



**COMPARISON OF FOUNDATION ALTERNATIVES**  
**COURTLAND AVENUE OVERPASS (WBL AND EBL)**

Foundation Element	Driven Steel H-Piles	Driven Tube (Pipe) Piles	Spread Footings	Augered Caissons (Drilled Shafts)
<b>East and West Abutments</b>  <b>East, Centre and West Piers</b>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively high geotechnical resistance is available for end-bearing piles.</li> <li>ii. Minimal excavation required for foundation construction.</li> <li>iii. Commonly used deep foundation type.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Potential vibration and adverse effects on the existing foundations must be addressed during design and construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Compatible with the existing foundations and relatively high geotechnical resistance.</li> <li>ii. Minimal excavation required for foundation construction.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Relatively uncommon pile type nowadays that may include concrete filling.</li> <li>ii. Lesser geotechnical resistance than H-piles of comparable size and driven depth.</li> <li>iii. Large displacement piles that could have more severe adverse effects on the existing foundations. Vibration effects must also be addressed during design and construction.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Relative ease of foundation construction at the approaches.</li> <li>ii. Compatible with existing foundations at the approaches.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Depending on the structural layout, it may be impractical to use at the piers due to reasons such as space restriction.</li> <li>ii. Requires larger excavation than pile cap construction.</li> <li>iii. Settlements due to foundation compression (anticipated to be complete by end of construction) must be taken into account during design.</li> </ul>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Larger geotechnical resistance than other deep foundation types is available for comparable founding depths.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Specific requirements during installation through water-bearing cohesionless soils, including the use of temporary liners, drilling fluids and tremie concrete.</li> <li>ii. Caisson equipment must be equipped to handle obstructions, boulders and cobbles etc.</li> <li>iii. May require manual cleaning and inspection of the caisson base.</li> </ul>



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**Courtland Avenue Overpass WBL**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS (kN)	SLS (kN)
<b>West Abutment and West Pier</b>					
311.0	375	250	300 or below	1,500	1,000
<b>Centre Pier</b>					
311.0	375	250	300 or below	1,500	1,000
<b>East Abutment and East Pier</b>					
311.5	375	250	300 or below	1,500	1,000

**Courtland Avenue Overpass EBL**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS (kN)	SLS (kN)
<b>West Abutment and West Pier</b>					
311.0	375	250	300 or below	1,500	1,000
<b>Centre Pier</b>					
311.0	375	250	300 or below	1,500	1,000
<b>East Abutment and East Pier</b>					
311.5	375	250	300 or below	1,500	1,000

Concrete filled, 12¾" O.D. steel tube (pipe) piles driven to the above elevations may be designed for factored geotechnical resistance at ULS of 900 kN per pile, and geotechnical resistance at SLS of 600 kN per pile.







**Records of Boreholes**

**Plans and Profiles**



WP 624-64  
Job Name Kitchener-Waterloo Expressway Job No. 64226 Borehole No. 1  
Client System Department of Highways Ont. Casing 4" & B.X. Boring Date Sept. 28-29, 1964  
Elevation 1033.7 Compiled By A. A. M. Checked By rm

SAMPLE CONDITION

	UNDISTURBED
	FAIR
	DISTURBED
	LOST

**SAMPLE TYPE**

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

### ABBREVIATIONS

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Notes	WATER LEVELS & REMARKS
Ground surface			0'0"						Cone Probe
Fill (fine to med. sand, asphalt pieces etc.)	Mixed grey				1	C.S.			Dry
Sandy silt, root remains pebbles	Brown	Loose	2'1"		2	S.S.	7	17.3	Moist
			5'0"						
Layers of fine sand, sandy clay and organic clayey silt	Brown and dark grey	Very loose and very soft	7'9"		3	S.S.	2	15.1	Wet
Fine sand	Grey	Compact			4	S.S.	11	16.8	W.T.P.L.
								56.5	Wet (org. silt)
Sandy, clayey silt	Grey	Compact	10'2"		5	S.S.	18		Saturated
					6	3" S.T.		19.2	
As above	As above	As Above	16'10"		7	S.S.	13		Saturated & W.T.P.L.
					8	3" S.T.		16.5	
Clayey silt till	Grey	Dense			9	S.S.	44	11.4	Moist
As above	As above	very dense			10	S.S.	51	9.7	Moist
As above with sand pockets	As above	As above			11	S.S.	49	18.8	Wet (sand)
								12.8	Moist
Sandy silt till, sand pockets	Grey	As above	31'6"		12	S.S.	71	10.9	Wet
Fine sand, some gravel								21.0	Saturated
Sandy gravel	As above	Dense			13	S.S.	40	10.0	Saturated
Some fine sand layers	As above								
Sandy gravel		Very dense			14	S.S.	63	6.4	Saturated
			45'0"						
Sandy silt till	As above	Extremely dense	46'8"		15	S.S.	165	6.3	Quite moist
Fine sand, grits & pebbles									
Coarse to med. sand, silt seams	As above	Very dense	51'6"		16	S.S.	69	12.3	Saturated
		Testhole terminated at 51'6"							



# BOREHOLE LOG

Borehole No. 2  
Boring Date Sept. 30, 1964  
Checked By RFR

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of blows per ft.	Moisture Content	WATER LEVELS & REMARKS	
			6.0"							Cone Probe
Ground Surface					1	C. S.			Moist	15
Fill (silty sand, pebbles stones)	Brown				2	S. S.	21	11.3	Moist	19
Fill (silty sand, stones sandy clay with pebbles, interlayered with organic silt)	Dark grey	Compact	5.0"		3	S. S.	5	44.4	W. T. P. L.	2
Organic silt	As above	Soft	5.9"		4	S. S.	30	20.5	Wet to Saturated	5
Silty fine sand	Grey		7.0"							17
As above	As above	Dense						26.1	Wet	25
Sand with pebbles, stones	Brown		9.8"							37
Sandy silt or silty fine sand	Grey					3" S. T.				46
Silty fine sand and Clayey Silt interlayered	As above	Compact	14.0"		5	S. S.	20	19.2	Saturated	40
					6	3" S. T.		21.1	W. T. P. L.	38
					7	S. S.	8	16.9	W. T. P. L.	50
Clayey silt with grits and pebbles	As above	Firm	19.8"		8	S. S.	19	13.1	About P. L. & Quite Moist	69
Sandy to clayey silt	As above	Very stiff								
As above	As above	hard	26.6"		9	S. S.	50	12.3	Moist	
		Testhole Terminated at 26.6"								

## BOREHOLE LOG







Borehole No. 2A  
Boring Date January 18th, 1965  
Checked By /dc

**SAMPLE TYPE**

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

ABBREVIATIONS:

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Initial Moisture Content	WATER LEVELS & REMARKS
									No sampling down to 25'
			10'0"						
			20'0"						
Sandy silt till	Grey	Compact			1	SS	22	10.0	Moist
Ditto	Ditto	Ditto			2	SS	26	12.0	Moist
Fine to coarse sand	Grey	Dense	34'6"		3	SS	42	13.0	Saturated
Sandy silt till	Grey		35'2"						Moist
Ditto	Ditto	Dense	40'0"		4	SS	39	15.0	Saturated
Fine to medium sand, odd stones	Ditto				5	SS	30	18.0	Saturated
			46'6"						TESTHOLE TERMINATED AT 46'6"

# BOREHOLE LOG





Borehole No. 3  
Boring Date Oct. 1, 1964  
Checked By FFA

**SAMPLE TYPE**

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

A.S. ROGER SAMPLE  
C.S. CASING SAMPLE  
7" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALL TUBE SHEET BY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

	UNDISTURBED
	FAIR
	DISTURBED
	LOST





[illegible]

# BOREHOLE LOG

Job Name Kitchener-Waterloo Expressway Job No. 64226  
System  
Client Department of Highways, Ontario Casing 4 & 3 1/2" Anger  
Elevation 1033.4 Compiled By A. A. M.

Borehole No. 4  
Boring Date Oct. 5 - 6, 1964  
Checked By rm

### ABBREVIATIONS

	UNDISTURBED
	FAIR
	DISTURBED
	LOST

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.L. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Barcode No. 4A

Boring Date January 17th, 1965

Checked By       /dc      

## ABBREVIATIONS

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

TESTHOLE TERMINATED AT	55'6"
------------------------	-------

## BOREHOLE LOG

Checked By rrn

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
O.T.P.L.	DRYER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

Testhole terminated at 58'6"
------------------------------



## BOREHOLE LOG

Borehole No. 6  
Boring Date Oct. 5, 1964  
Checked By rm

SAMPLE TYPE

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Checked By rm

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Mutual Moisture Content	WATER LEVELS & REMARKS
Ground surface			0'0"						Cone Probe 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Soil stratification as in B.H. # 6.			10'		1	3" S.T.			
			20'		2	3" S.T.			
Clayey silt, sand pockets	Grey	Compact	28'0"		3	S.S.	19	17.8	W.T.P.L. & Sat'd.
Silty fine sand odd clayey silt pockets	Buff-Grey	Compact			4	S.S.	19	15.3	Saturated
As above	Ditto	As above	36'6"		5	S.S.	20	18.1	Saturated
									Testhole terminated at 36'6"



## BOREHOLE LOG

Borehole No. 7  
Boring Date Oct. 6, 1964  
Checked By rni

SAMPLE TYPE

### ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Form No. \_\_\_\_\_

Boring Date Oct. 7 &amp; 8, 1944

Checked By \_\_\_\_\_ V. M.

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRYER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Layer	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Moisture % (by weight)	WATER LEVELS & REMARKS	Cone Penetration
Ground Surface			0'0"							
4" Sandy topsoil	Dark brown		0'4"		1	A.S.			Moist	7
Medium sand	Light brown	Very loose to loose			2	SS	6	2.6	Moist	8
					3	AS				9
Medium to fine sand	Ditto	Compact			4	SS	15	3.5	Moist	10
As above and silt pockets	Ditto	Ditto			5	SS	14	5.6	Moist	11
			10'0"						Wet below 9'	12
Medium to fine sand	Brown	Loose to compact			6	SS	9	5.6	Wet to saturated	13
					7	AS				14
					8	2"ST				15
Silty fine to medium sand	Ditto	Compact			9	SS	16	10.5	Saturated	16
			10'6"							17
Silty very fine sand or sandy silt; odd clayey seams; medium sand layer	Ditto	Ditto			10	SS	14	16.5	Saturated	18
Silty very fine sand with clayey seams	Ditto	Ditto	23'2"		11	SS	17*	17.6	* Spoon was full Saturated	19
			26'0"							20
Clayey silt	Grey		27'6"		12	3"ST			W.T.P.L.	21
Silty very fine sand interlayered with clayey silt	Buff-grey	Very loose to loose			13	SS	4	22.8	Spoon went down 3" by itself Saturated	22
			35'0"		14	2"ST				23
Silty very fine sand	Ditto	Very loose Loose to compact	38'0"		15	SS	11	21.3	Saturated	24
		TESTHOLE TERMINATED AT				38'				25

# BORFHOLE LOG

Borehole No. 9

Boring Date Oct. 23/64

Checked By V.M.

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.P.L.	DRIER THAN PLASTIC LIMIT
	ABOUT PLASTIC LIMIT

[illegible]

**C. M. POW ASSOCIATES LTD.**  
**SOIL ENGINEERING SERVICE - TORONTO, ONTARIO**  
**BOREHOLE LOG**

Job Name K.W. Expressway System Job No. 64226 Borehole No. 10  
 Client D.H.O. Casing 4" & BX Boring Date Oct. 23-24, 1964  
 Elevation 1064.6 Compiled By A.A.M. Checked By V.M.

**SAMPLE CONDITION**

**SAMPLE TYPE**

**ABBREVIATIONS**

- ☒ UNDISTURBED  
☒ FAIR  
☒ DISTURBED  
☒ LOST

- A.S. AUGER SAMPLE  
 C.S. CASING SAMPLE  
 S.S. 2" STANDARD SPLIT TUBE SAMPLE  
 S.L. SPLIT BARREL WITH LINERS  
 S.T. THIN-WALLED SHELBY TUBE SAMPLE  
 W.S. WASH SAMPLE  
 R.C. ROCK CORE

- V.T. IN SITU VANE SHEAR TEST  
 M. MOIST  
 W.L. WATER LEVEL IN CASING  
 W.T. GROUND WATER TABLE IN SOIL  
 W.T.P.L. WETTER THAN PLASTIC LIMIT  
 D.T.P.L. DRIER THAN PLASTIC LIMIT  
 A.P.L. ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Ground Water Content	WATER LEVELS & REMARKS
									Cone
Ground Surface			0'0"						Prob
Medium sand, odd stones									2
									6
Medium sand	Brown	Very loose to loose			1	SS	5	3.9	Moist 10
					2	CS			12
Fine to medium sand	Light brown	Compact			3	SS	15	4.1	Moist 20
									18
Medium sand	Brown	Compact			4	SS	17	7.7	Moist 17
					5	CS			18
As above	Brown	Compact to dense			6	SS	32	15.7	Quite moist 19
									18
Coarse to medium sand	Ditto	Compact			7	SS	13	16.2	Saturated 30
									16
As above	Ditto	Ditto	16'0"		8	SS	19	16.6	Saturated 18
									13
									25
									31
									41
									40
As above	Ditto	Compact to dense			9	SS	31	22.2	Saturated 37
									43
									40
			24'2"						39
Silty clay seams									50
Sandy silt or silty very fine sand interlayered with silty clay	Brown	Ditto			10	SS	29	19.7	W.T.P.L. 55
								20.2	Saturated 42
									42
									56
Silty very fine sand and clayey silt interlayered	Grey-brown	Dense	31'6"		11	SS	39	22.0	Saturated 123
									Prob
									at 31 ft.
									TESTHOLE TERMINATED AT 31'6"

# BOREHOLE LOG

Borehole No. 11  
Boring Date Oct. 29, 1964  
Checked By V. M.

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Job No. 64226  
4" & DX  
Casing  
Compiled By A. A. M.

Borehole No. 12  
Oct. 26-27, 1964  
Boring Date  
Checked By V.M.

**SAMPLE TYPE**

### ABBREVIATIONS





A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE









V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

**C. M. Peto Associates Ltd.**  
**SOIL ENGINEERING SERVICE - TORONTO, ONTARIO**  
**BOREHOLE LOG**

Job Name K. W. Expressway System Job No. 64226 Borehole No. 13  
 Client D. H. O. Casing 4" & BX Boring Date Oct. 26, 1964  
 Elevation 1051.2 Compiled By A. A. M. Checked By V. M.

SAMPLE CONDITION		SAMPLE TYPE		ABBREVIATIONS	
	UNDISTURBED	A.S. AUGER SAMPLE	V.T. IN SITU VANE SHEAR TEST		
	FAIR	C.S. CASING SAMPLE	M. MOIST		
	DISTURBED	S.S. 2" STANDARD SPLIT TUBE SAMPLE	W.L. WATER LEVEL IN CASING		
	LOST	S.L. SPLIT BARREL WITH LINERS	W.T. GROUND WATER TABLE IN SOIL		
		S.T. THIN-WALLED SHELBY TUBE SAMPLE	W.T.P.L. WETTER THAN PLASTIC LIMIT		
		W.S. WASH SAMPLE	D.T.P.L. DRIER THAN PLASTIC LIMIT		
		R.C. ROCK CORE	A.P.L. ABOUT PLASTIC LIMIT		

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft	Moisture Content	WATER LEVELS & REMARKS	Cone Probe
Ground Surface			0'0"							
Sandy loam	Dark brown		1'5"							11
Medium to fine sand	Brown	Loose			1 	SS	7	16.7	Saturated	13
					2 	CS			Start using washwater	16
As above; seams of silty fine sand	Ditto	Loose to compact	6'6"		3 	SS	10	15.7	Saturated at 5'	28
Silty very fine sand	Ditto	Compact			4 	SS	15	24.7	Saturated	30
										22
As above	Ditto	Loose to			5 	SS	7	23.2		14
Silty fine sand interlayered with clayey silt			14'0"			2" ST				15
Very silty clay, silt pockets	Grey	Stiff			6 	SS	11	19.0	W. T. P. L.	21
Silty clay and sandy silt seams					7 	2" ST				42
Silty very fine sand inter-layered with clayey silt	Ditto	Very stiff	21'6"		8 	SS	27	19.7	Saturated	54
								20.6	W. T. P. L.	60
									Water level at 2'	65
									TESTHOLE TERMINATED AT 21'6"	69



**e. m. peto associates ltd.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

**BOREHOLE LOG**

Job Name K. W. Expressway System  
Client D. H. O.  
Elevation 1056.8

Job No. 64226  
Casing 4" & 11X  
Compiled By A. A. M.

Borehole No. 14  
Boring Date Oct. 28, 1964  
Checked By V. M.

**SAMPLE CONDITION**

- ☒ UNDISTURBED
- ☒ FAIR
- ☒ DISTURBED
- ☒ LOST

**SAMPLE TYPE**

- A.S. AUGER SAMPLE
- C.S. CASING SAMPLE
- S.S. 2" STANDARD SPLIT TUBE SAMPLE
- S.L. SPLIT BARREL WITH LINERS
- S.T. THIN-WALLED SHELLY TUBE SAMPLE
- W.S. WASH SAMPLE
- R.C. ROCK CORE

**ABBREVIATIONS**

- V.T. IN SITU VANE SHEAR TEST
- M. MOIST
- W.L. WATER LEVEL IN CASING
- W.T. GROUND WATER TABLE IN SOIL
- W.T.P.L. WETTER THAN PLASTIC LIMIT
- D.T.P.L. DRIER THAN PLASTIC LIMIT
- A.P.L. ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Texture, or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS & REMARKS
Ground Surface			0'0"					
Sandy topsoil	Dark brown		1'4"					
Silty fine sand	Brown	Compact			1	SS	16	18.5 Wet to saturated
Fine sand	Ditto	Ditto			2	SS	15	20.7 Saturated
Silty fine sand	Ditto	Ditto			3	SS	13	19.2 Sat'd. at 5'
Silty very fine sand	Ditto	Ditto			4	SS	14	21.8 Saturated
As above	Ditto	Loose to compact	14'0"		5	SS	12	Saturated
Sandy silt interlayered with silty clay	Ditto	Very stiff			6	SS	22	20.7 Saturated
								7.5 W.T.P.L.
Silty clay interlayered with sandy silt or silty fine sand	Ditto	Hard	21'6"		7	SS	38	19.0 W.T.P.L.
								18.5 Saturated
BOREHOLE TERMINATED AT 21'6"								Probably terminated at 22'6"



## BOREHOLE LOG

Borehole No. 16  
Boring Date October 29 - 30, 1964.  
Checked By S. B.

SAMPLE TYPE

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

# BOREHOLE LOG

17  
Borehole No. \_\_\_\_\_  
Boring Date   October 30 - 31, 1964.  
Checked By   \_\_\_\_\_

**SAMPLE TYPE**

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

## ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

# BOREHOLE LOG

Borehole No. 18  
Boring Date November 2, 1964.  
Checked By S.B.

SAMPLE TYPE

### ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Borehole No. 19  
Boring Date November 3, 1964  
Checked By S. B.

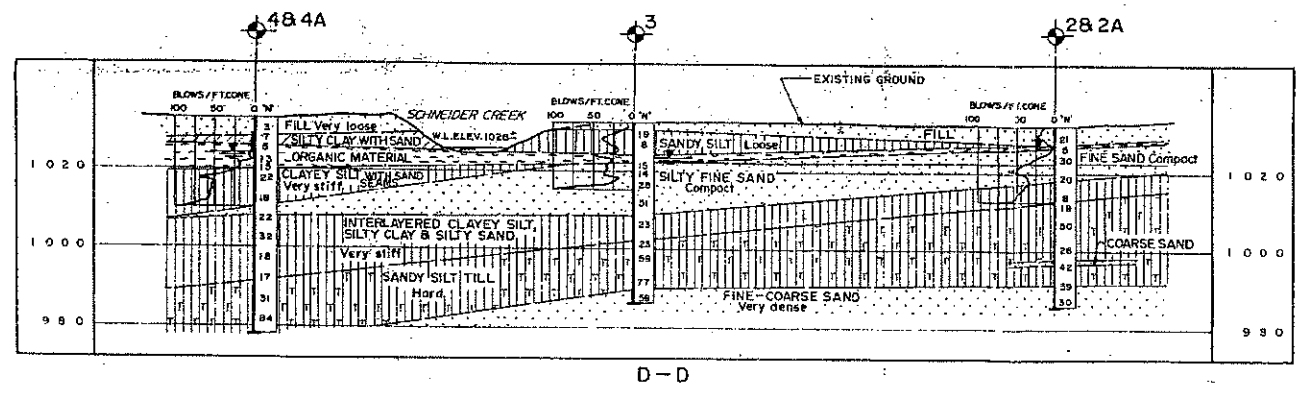
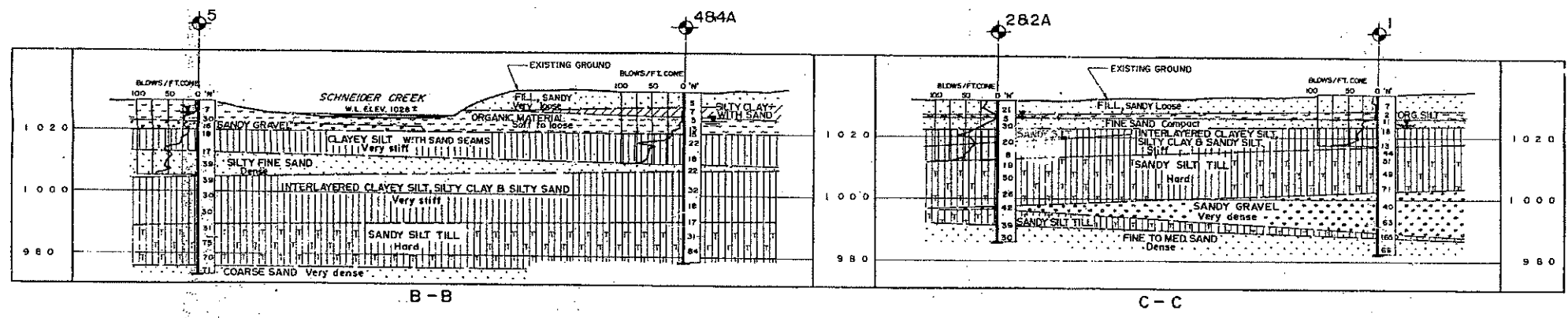
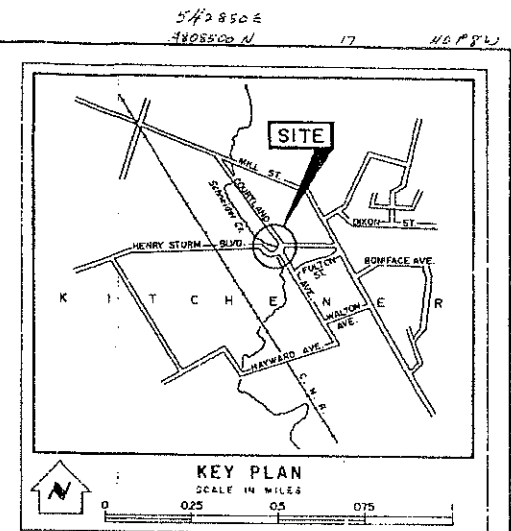
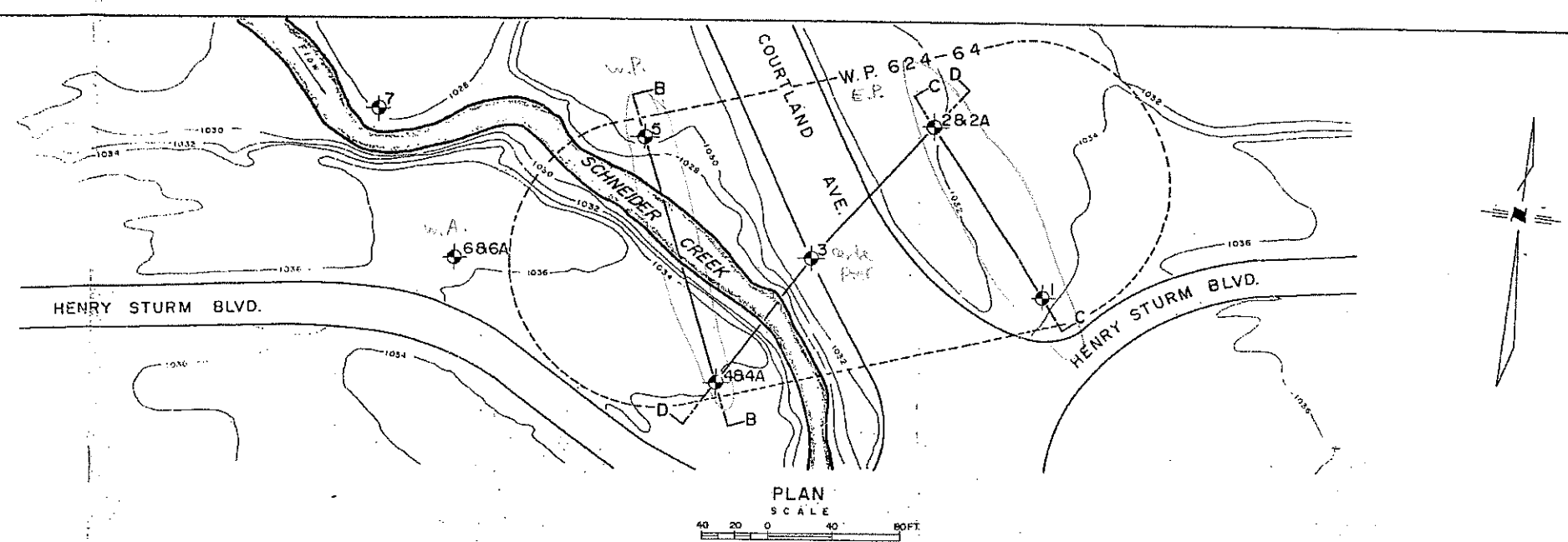
SAMPLE TYPE

### ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation (Nov. 1964)

NO.	ELEVATION	COORDINATES	
		NORTH	EAST
1	1033.68	190 491.1	211 348.7
282A	1032.00	190 585.2	211 271.2
3	1032.48	190 495.6	211 208.8
484A	1033.35	190 412.2	211 161.1
5	1029.90	190 555.6	211 098.3
686A	1036.17	190 467.8	210 996.3
7	1028.17	190 550.7	210 938.1

NOTE: The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD

NO.	FOR	DATE

NOTE: THE TESTHOLES AND PROBES HAVE BEEN LOCATED IN ACCORDANCE WITH COORDINATES GIVEN IN THE TABLE, WHICH HAS BEEN SUPPLIED BY THE DEPARTMENT.

REVISIONS

DATE	BY	DESCRIPTION

E. M. PETO ASSOCIATES LTD.

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

KITCHENER-WATERLOO EXPRESSWAY  
HENRY STURM BLVD. & COURTLAND AVE.

KING'S HIGHWAY NO. DIST NO. 4  
CO. WATERLOO  
TWP. WATERLOO LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBMIT B.L.	CHECKED <input checked="" type="checkbox"/>	W.P. NO. 624-64	DRAWING NO. 1
DRAWN G.T.	CHECKED <input checked="" type="checkbox"/>	JOB NO. 64226	
DATE JANUARY 1965	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>[Signature]</i>	CONT. NO.		







**- NOTE -**

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

E. M. PETO ASSOCIATES LTD.

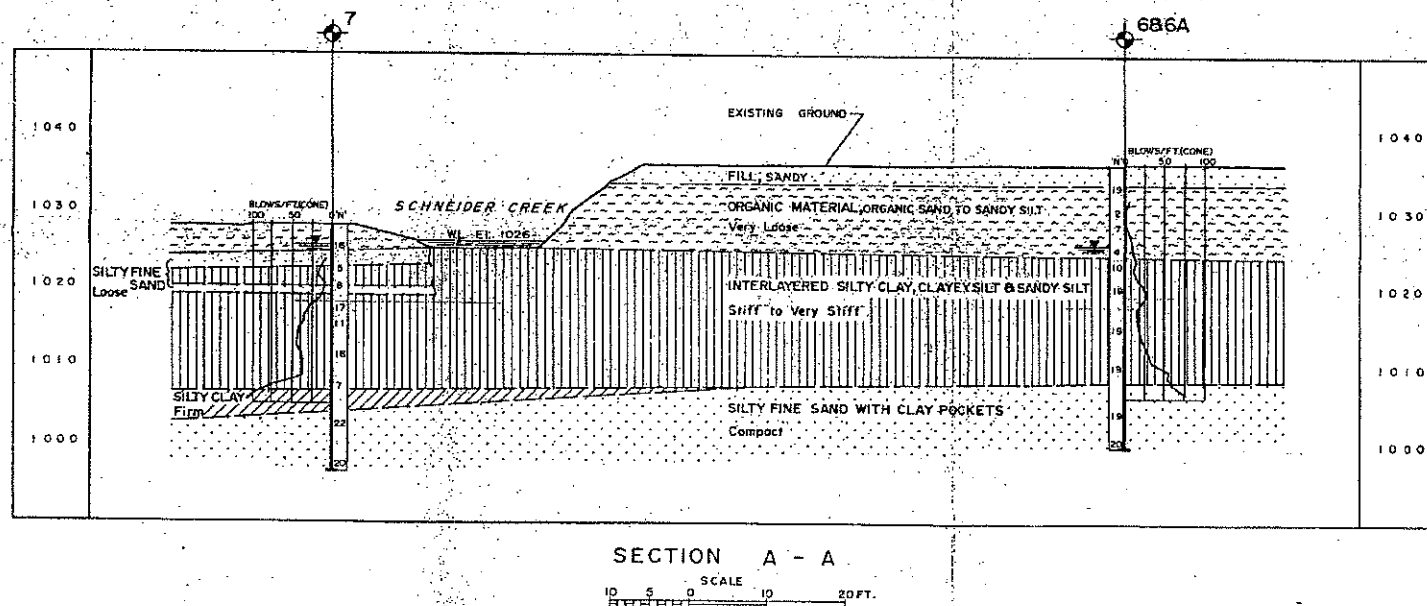
DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

KITCHENER-WATERLOO EXPRESSWAY  
HENRY STURM BLVD. & SCHNEIDER CREEK

KING'S HIGHWAY NO. \_\_\_\_\_ DIST. NO. 4  
CO. WATERLOO \_\_\_\_\_  
TWP. WATERLOO \_\_\_\_\_ LOT \_\_\_\_\_ CON. \_\_\_\_\_

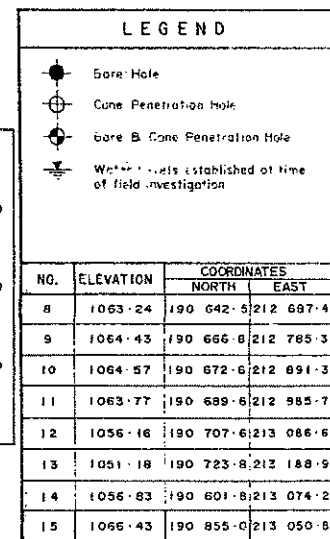
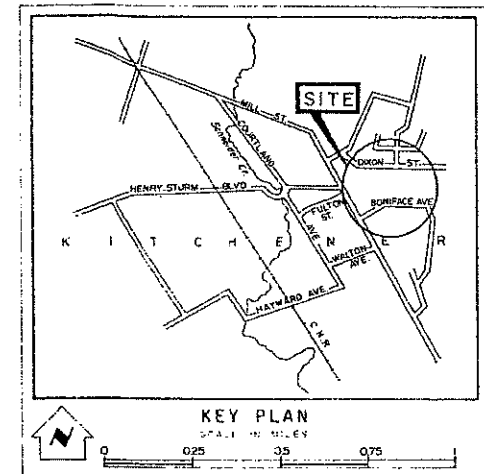
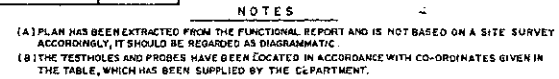
BORE HOLE LOCATIONS &amp; SOIL STRATA

SUBM'D B.L.	CHECKED <i>ES</i>	W.P. NO. 644-64	DRAWING NO.
DRAWN K.K.	CHECKED <i>ES</i>	JOB NO. 64226	2
DATE JANUARY 1965	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>A. J. Thomas</i>	FORT. NO.		

[illegible]

NOTE THE TESTHOLES AND PROBES HAVE BEEN LOCATED IN ACCORDANCE WITH COORDINATES GIVEN IN THE TABLE WHICH HAS BEEN SUPPLIED BY THE DEPARTMENT.



[illegible]

E. M. PETO ASSOCIATES LTD.			
DEPARTMENT OF HIGHWAYS - ONTARIO			
MATERIALS & RESEARCH DIVISION - HIGHWAY CONSTRUCTION			
KITCHENER-WATERLOO EXPRESSWAY			
HENRY STURM BLVD.-RETAINING WALL			
KING'S HIGHWAY NO. ....		DIST NO 4 .....	
CO. <u>WATERLOO</u>			
TWP. <u>WATERLOO</u>		LOT .....	CON. ....
BORE HOLE LOCATIONS & SOIL STRATA			
SUBD. B.L.	CHECKED <input checked="" type="checkbox"/> <u>W.P.</u>	PART OF WP. <u>618-64</u>	SECTION NO.
DRAWN C. K.	CHECKED <input checked="" type="checkbox"/> <u>W.P.</u>	JOB NO. <u>64226</u>	<b>4</b>
DATE JANUARY 1965	STF. NO.	SHEET "OF 1"	
APPROVED _____	CONT. NO.		

[illegible]



**Appendix J**  
**Geotechnical Resistances and Founding Elevations**  
**Pedestrian Bridge (east of Courtland)**



## COMPARISON OF FOUNDATION ALTERNATIVES

### PEDESTRIAN BRIDGE (EAST OF COURTLAND)

Foundation Element	Driven Steel H-Piles	Driven Tube (Pipe) Piles	Spread Footings	Augered Caissons (Drilled Shafts)
<b>Piers and North Approach</b>  <b>South Approach</b>	<b>Advantages:</b> i. Relatively high geotechnical resistance is available for end-bearing piles. ii. Minimal excavation required for foundation construction. iii. Commonly used deep foundation typed.	<b>Advantages:</b> i. Compatible with the existing foundations and relatively high geotechnical resistance. ii. Minimal excavation required for foundation construction.	<b>Advantages:</b> i. Relative ease of foundation construction. ii. A technically feasible alternative if space restriction is not an issue.	<b>Advantages:</b> i. Larger geotechnical resistance than other deep foundation types is available for comparable founding depths.
	<b>Disadvantages:</b> i. Potential vibration and adverse effects on the existing foundations must be addressed during design and construction.	<b>Disadvantages:</b> i. Relatively uncommon pile type nowadays that may include concrete filling. ii. Lesser geotechnical resistance than H-piles of comparable size and driven depth. iii. Large displacement piles that could have more severe adverse effects on the existing foundations. Vibration effects must also be addressed during design and construction.	<b>Disadvantages:</b> i. Requires larger excavation than pile cap construction. ii. Settlements due to foundation compression (anticipated to be complete by end of construction) must be taken into account during design.	<b>Disadvantages:</b> i. Specific requirements during installation through water-bearing cohesionless soils, including the use of temporary liners, drilling fluids and tremie concrete. ii. Caisson equipment must be equipped to handle obstructions, boulders and cobbles etc. iii. May require manual cleaning and inspection of the caisson base.



**ANTICIPATED GEOTECHNICAL RESISTANCES  
AND FOUNDING ELEVATIONS**

**Pedestrian Bridge (east of Courtland)**

Spread Footings			HP 310 X 110 Piles		
Elevation (m)	ULS (kPa)	SLS (kPa)	Elevation (m)	ULS <sub>r</sub> (kN)	SLS (kN)
<b>Piers and North Approach</b>					
-	-	-	315.8 to 313.3	750	500
-	-	-			
<b>South Approach</b>					
Below 321.5	225	150	312 or below	750	500

Concrete filled, 12¾" O.D. steel tube (pipe) piles driven to the above elevations may be designed for factored geotechnical resistance at ULS of 500 kN per pile, and geotechnical resistance at SLS of 350 kN per pile.



**Records of Boreholes**

**Plans and Profiles**



## Bit Lays

Job Name Kitchener-Waterloo Expressway Job No. 64226  
System  
Client Department of Highways Ont. Casing 4" & B. X.  
Elevation 1033.7 Compiled By A. A. M.

Borehole No. 1  
Boring Date Sept. 28-29, 1964.  
Checked By rml

ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Water Content (%)	WATER LEVELS & REMARKS	Cone Probe
Ground surface			0'0"							
Fill (fine to med. sand, asphalt pieces etc.)	Mixed grey				1	C.S.			Dry	6
Sandy silt, root remains pebbles	Brown	Loose	2'1"		2	S.S.	7	17.3	Moist	6
			5'0"							2
Layers of fine sand, sandy clay and organic clayey silt	Brown and dark grey	Very loose and very soft	7'9"		3	S.S.	2	15.1	Wet	3
Fine sand	Grey	Compact	7'9"		4	S.S.	11	16.8	W.T.P.L.	5
								56.5	Wet (org. silt)	24
Sandy, clayey silt	Grey	Compact	10'2"		5	S.S.	18		Saturated	24
					6	3" S.T.		19.2		31
As above	As above	As Above	16'10"		7	S.S.	13	16.5	Saturated & W.T.P.L.	45
					8	3" S.T.				66
Clayey silt till	Grey	Dense			9	S.S.	44	11.4	Moist	
As above	As above	very dense			10	S.S.	51	9.7	Moist	
As above with sand pockets	As above	As above			11	S.S.	49	18.8	Wet (sand)	
								12.8	Moist	
Sandy silt till, sand pockets	Grey	As above	31'6"		12	S.S.	71	10.9	Wet	
Fine sand, some gravel								21.0	Saturated	
Sandy gravel	As above	Dense			13	S.S.	40	10.0	Saturated	
Some fine sand layers	As above									
Sandy gravel		Very dense			14	S.S.	63	6.4	Saturated	
			45'0"							
Sandy silt till	As above	Extremely dense	46'8"		15	S.S.	165	6.3	Quite moist	
Fine sand, grits & pebbles										
Coarse to med. sand, silt seams	As above	Very dense	51'6"		16	S.S.	69	12.3	Saturated	
		Testhole terminated at 51'6"								

# BOREHOLE LOG

Borehole No. 2  
Boring Date Sept. 30, 1964  
Checked By RDR

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Moisture Content	WATER LEVELS & REMARKS	
			0-0"							Con
Ground Surface			0-0"							Probr
Fill (silty sand, pebbles stones)	Brown			1	X	C. S.			Moist	15
Fill (silty sand, stones)	Brown	Compact		2	X	S. S.	21	11.3	Moist	19
sandy clay with pebbles, interlayered with organic silt	Dark grey		5'0"							22
Organic silt	As above	Soft	5'10"	3	X	S. S.	5	44.4	W. T. P. L.	3
Silty fine sand	Grey		7'0"					20.5	Wet to Saturated	2
As above	As above	Dense		4	X	S. S.	30			5
Sand with pebbles, stones	Brown		9'8"					26.1	Wet	17
Sandy silt or silty fine sand	Grey					3" S. T.				25
Silty fine sand and Clayey Silt interlayered	As above	Compact	14'0"	5	X	S. S.	20	19.2	Saturated	37
								21.1	W. T. P. L.	46
				6	X	3" S. T.				63
Clayey silt with grits and pebbles	As above	Firm		7	X	S. S.	8	16.9	W. T. P. L.	40
			19'8"							44
Sandy to clayey silt	As above	Very stiff		8	X	S. S.	19	13.1	About P. L. & Quite Moist	50
										50
As above	As above	hard	26'6"	9	X	S. S.	50	12.3	Moist	69
		Testhole Terminated at	26'6"							

## BOREHOLE LOG

Chit 1 By \_\_\_\_\_ /dc

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Borehole No. 3

Boring Date Oct. 1, 1964

Checked By ... MM

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

LOST

[illegible]



# BOREHOLE LOG

Job Name Kitchener-Waterloo Expressway Job No. 64226  
System Department of Highways, Ontario  
Client 4 & 3 1/2" Auger  
Elevation 1033.4 Compiled By A. A. M.

Borehole No. 4  
Boring Date Oct. 5 - 6, 1964  
Checked By rm

### ABBREVIATIONS.

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

# BOREHOLE LOG

Checked By        /dc

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

# BOREHOLE LOG

Checked By rtm

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Layer	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Moisture Content	WATER LEVELS & REMARKS	Core Probe
Ground surface			0'0"							
5" of sandy topsoil	Dark brown		0'5"	1	X	C.S.			Quite Moist	
Silty sand loam				2	X	S.S.	7	27.8	Quite moist	
Silty fine sand and sandy silt interlayered, org. matter, wood remains	Brown to dark Brown	loose	4'0"						Wet to Sat'd from 4'	
Coarse to fine sand, some gravel, traces of peat, org.	Brown Black	Dense	7'0"	3	X	S.S.	30	26.4	Wet	
Sandy gravel, (matter)	Grey	Compact		4	X	S.S.	16	15.2	Saturated	
			9'5"							
Very silty clay	Grey-brown	Stiff		5	X	S.S.	18	19.8	W.T.P.L.	
				6	X	2" S.T.				
Silty clay with fine sand seams	Grey	As above	17'2"	7	X	S.S.	17	17.1	W.T.P.L. & Wet	
Silty fine sand with thin clay seams	Grey	Dense		8	X	S.S.	39	22.0	Saturated & W.T.P.L.	
Very sandy silt & silty clay interlayered	Grey	Hard		9	X	S.S.	39	22.6	Saturated & W.T.P.L.	
Sandy, clay silt	Grey	Dense		10	X	S.S.	30	23.5	Saturated	
As above	Grey	As above		11	X	S.S.	30	19.2	Saturated	
Sandy, clayey silt till	Grey	As above	40'6"	12	X	S.S.	31	11.8	Quite moist	
As above	Grey	Very dense		13	X	S.S.	75	11.3	Quite moist	
Sandy silt till	Grey-brown	As above		14	X	S.S.	70	11.1	Moist	
			54'0"							
Coarse to med. sand, fine gravel	Ditto		56'6"	15	X	S.S.	71	11.4	Saturated	
									Testhole terminated at 56'6"	





## BOREHOLE LOG

Borehole No. 7

Boring Date Oct. 6, 1964

Checked By       rm      

SAMPLE TYPE

### ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT





[illegible]



# SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

## BOREHOLE LOG

Job Name K. W. Expressway System Job No. 54226 Borehole No.             
 Client D. H. O. Casing 4" & 3-1/2" Auger Boring Date Oct. 7 & 8, 1964  
 Elevation 1063.2 Compiled By A. A. M. Checked By V. M.

SAMPLE CONDITION		SAMPLE TYPE		ABBREVIATIONS	
	UNDISTURBED	A.S.	AUGER SAMPLE	V.T.	IN SITU VANE SHEAR TEST
	FAIR	C.S.	CASING SAMPLE	M.	MOIST
	DISTURBED	S.S.	2" STANDARD SPLIT TUBE SAMPLE	W.L.	WATER LEVEL IN CASING
	LOST	S.L.	SPLIT BARREL WITH LINERS	W.T.	GROUND WATER TABLE IN SOIL
		S.T.	THIN-WALL TUBE SAMPLE	W.T.P.L.	WETTER THAN PLASTIC LIMIT
		W.S.	WASH SAMPLE	P.T.P.L.	DRYER THAN PLASTIC LIMIT
		R.C.	ROCK CORE	A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Log	Sample No. and Condition	Sample Type	No. of Blows per ft	Grain Size	WATER LEVELS & REMARKS	Cone Probe
Ground Surface			0'0"							
4" Sandy topsoil	Dark brown		0'4"		1	A.S.			Moist	7
Medium sand	Light brown	Very loose to loose			2	SS	6	2.6	Moist	8
					3	AS				
Medium to fine sand	Ditto	Compact			4	SS	15	3.5	Moist	10
As above and silt pockets	Ditto	Ditto			5	SS	14	5.6	Moist	15
			10'0"						Wet below 9'	16
Medium to fine sand	Brown	Loose to compact			6	SS	9	15.6	Wet to saturated	17
					7	AS				18
					8	2"ST				19
										20
Silty fine to medium sand	Ditto	Compact			9	SS	16	19.8	Saturated	21
										22
			18'6"							23
Silty very fine sand or sandy silt; odd clayey seams, medium sand layer	Ditto	Ditto			10	SS	14	18.5	Saturated	24
										25
Silty very fine sand with clayey seams	Ditto	Ditto	23'2"		11	SS	17*	17.6	* Spoon was full Saturated	26
										27
			26'4"							28
Clayey silt	Grey									29
			29'6"							30
					12	3"ST			W.T.P.L.	31
Silty very fine sand interlayered with clayey silt	Buff-grey	Very loose to loose			13	SS	4	22.8	Spoon went down 3" by itself Saturated	32
										33
			35'0"		14	2"ST				34
										35
Silty very fine sand	Ditto	Very loose Loose to compact	37'0"		15	SS	11	21.3	Saturated	36
										37
										38
										39
										40
										41
										42
										43
										44
										45
										46
										47
										48
										49
										50
										51
										52
										53
										54
										55
										56
										57
										58
										59
										60
										61
										62
										63
										64
										65
										66
										67
										68
										69
										70
										71
										72
										73
										74
										75
										76
										77
										78
										79
										80
										81
										82
										83
										84
										85
										86
										87
										88
										89
										90
										91
										92
										93
										94
										95
										96
										97
										98
										99
										100

TESTHOLE TERMINATED AT 38'

# BOREHOLE LOG

Borehole No. 9

Boring Date Oct. 23, 64

Checked By V.M.

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.F.	DRIER THAN PLASTIC LIMIT
	ABOUT PLASTIC LIMIT





[illegible]



**C. M. PELO ASSOCIATES INC.**  
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

**BOREHOLE LOG**

Job Name K. W. Expressway System Job No. 64226 Borehole No. 10  
Client D. H. O. Casing 4" & BX Boring Date Oct. 23-24, 1964  
Elevation 1064.6 Compiled By A. A. M Checked By V. M.

SAMPLE CONDITION		SAMPLE TYPE		ABBREVIATIONS	
	UNDISTURBED	A.S.	AUGER SAMPLE	V.T.	IN SITU VANE SHEAR TEST
	FAIR	C.S.	CASING SAMPLE	M.	MOIST
	DISTURBED	S.S.	2" STANDARD SPLIT TUBE SAMPLE	W.L.	WATER LEVEL IN CASING
	LOST	S.L.	SPLIT BARREL WITH LINERS	W.T.	GROUND WATER TABLE IN SOIL
		S.T.	THIN-WALLED SHELBY TUBE SAMPLE	W.T.P.L.	WETTER THAN PLASTIC LIMIT
		W.S.	WASH SAMPLE	D.T.P.L.	DRIER THAN PLASTIC LIMIT
		R.C.	ROCK CORE	A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Notes	WATER LEVELS & REMARKS
Ground Surface			0'0"						Cone Prob
Medium sand, odd stones									2
Medium sand	Brown	Very loose to loose			1	SS	5	3.7	Moist 10
					2	CS			12
Fine to medium sand	Light brown	Compact			3	SS	15	4.1	Moist 26
Medium sand	Brown	Compact			4	SS	17	7.7	Moist 18
					5	CS			18
As above	Brown	Compact to dense			6	SS	32	15.7	Quite moist 19
									Wet from 11'5" 18
Coarse to medium sand	Ditto	Compact			7	SS	13	16.2	Saturated 30
									16
As above	Ditto	Ditto	16'0"		8	SS	19	16.6	Saturated 18
									25
									31
									41
									46
As above	Ditto	Compact to dense			9	SS	31	22.2	Saturated 37
									43
									40
			24'2"						39
Silty clay seams									50
Sandy silt or silty very fine sand interlayered with silty clay	Brown	Ditto			10	SS	29	19.7	W. T. P. L. 53
								20.2	Saturated 42
									42
									58
Silty very fine sand and clayey silt interlayered	Grey-brown	Dense			11	SS	39	22.0	Saturated 123
			31'6"						Probehole terminated at 31 ft.
									TESTHOLE TERMINATED AT 31'6"

# BOREHOLE LOG

### SAMPLE CONDITION

**SAMPLE TYPE**

ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBE SAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Moisture Content	WATER LEVELS & REMARKS	Conc. Probe
Ground surface			0'0"						No wash water was used	17
Medium to fine sand	Brown	Loose to compact			1 X	SS	9	7.9	Quite moist	19
					2 X					19
Medium sand, silty fine sand	Brown	Ditto	5'3"		3 X	SS	10	4.5 17.5	Moist Quite moist	20 12
Silty fine sand	Light brown	Compact			4 X	SS	14	17.0	Moist	13
					7 X					17
Fine sand	Brown	Loose	10'4"		5 X	SS	8	18.9	Saturated from 10'4"	16
Silty fine sand	Ditto	Loose to compact			6 X	SS	12	19.8	Saturated	21
As above	Ditto	Ditto	14'6"		8 X	SS	12	11.0	Saturated	27
										16
										17
										17
										26
										31
										30
										32
										35
										31
										12
									Probehole terminated at 26 ft.	

BOREHOLE LOG

### SAMPLE CONDITION

**SAMPLE TYPE**

## ABBREVIATIONS

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 2" STANDARD SPLIT TUBESAMPLE  
S.L. SPLIT BARREL WITH LINERS  
S.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.S. WASH SAMPLE  
R.C. ROCK CORE

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Borehole No. 13

Boring Date Oct. 26, 1964

Checked By ..... V. M. ....

## ABBREVIATIONS

Y.T. IN SITU VANE SHEAR TEST

M. MOIST

W.L.	WATER LEVEL IN CASING
10.0	10.0
10.1	10.1
10.2	10.2
10.3	10.3
10.4	10.4
10.5	10.5
10.6	10.6
10.7	10.7
10.8	10.8
10.9	10.9
11.0	11.0
11.1	11.1
11.2	11.2
11.3	11.3
11.4	11.4
11.5	11.5
11.6	11.6
11.7	11.7
11.8	11.8
11.9	11.9
12.0	12.0
12.1	12.1
12.2	12.2
12.3	12.3
12.4	12.4
12.5	12.5
12.6	12.6
12.7	12.7
12.8	12.8
12.9	12.9
13.0	13.0
13.1	13.1
13.2	13.2
13.3	13.3
13.4	13.4
13.5	13.5
13.6	13.6
13.7	13.7
13.8	13.8
13.9	13.9
14.0	14.0
14.1	14.1
14.2	14.2
14.3	14.3
14.4	14.4
14.5	14.5
14.6	14.6
14.7	14.7
14.8	14.8
14.9	14.9
15.0	15.0
15.1	15.1
15.2	15.2
15.3	15.3
15.4	15.4
15.5	15.5
15.6	15.6
15.7	15.7
15.8	15.8
15.9	15.9
16.0	16.0
16.1	16.1
16.2	16.2
16.3	16.3
16.4	16.4
16.5	16.5
16.6	16.6
16.7	16.7
16.8	16.8
16.9	16.9
17.0	17.0
17.1	17.1
17.2	17.2
17.3	17.3
17.4	17.4
17.5	17.5
17.6	17.6
17.7	17.7
17.8	17.8
17.9	17.9
18.0	18.0
18.1	18.1
18.2	18.2
18.3	18.3
18.4	18.4
18.5	18.5
18.6	18.6
18.7	18.7
18.8	18.8
18.9	18.9
19.0	19.0
19.1	19.1
19.2	19.2
19.3	19.3
19.4	19.4
19.5	19.5
19.6	19.6
19.7	19.7
19.8	19.8
19.9	19.9
20.0	20.0
20.1	20.1
20.2	20.2
20.3	20.3
20.4	20.4
20.5	20.5
20.6	20.6
20.7	20.7
20.8	20.8
20.9	20.9
21.0	21.0
21.1	21.1
21.2	21.2
21.3	21.3
21.4	21.4
21.5	21.5
21.6	21.6
21.7	21.7
21.8	21.8
21.9	21.9
22.0	22.0
22.1	22.1
22.2	22.2
22.3	22.3
22.4	22.4
22.5	22.5
22.6	22.6
22.7	22.7
22.8	22.8
22.9	22.9
23.0	23.0
23.1	23.1
23.2	23.2
23.3	23.3
23.4	23.4
23.5	23.5
23.6	23.6
23.7	23.7
23.8	23.8
23.9	23.9
24.0	24.0
24.1	24.1
24.2	24.2
24.3	24.3
24.4	24.4
24.5	24.5
24.6	24.6
24.7	24.7
24.8	24.8
24.9	24.9

W.T. GROUND WATER TABLE IN SOIL

W.T.P.L. WETTER THAN PLASTIC LIMIT

**D.T.P.L. DRIER THAN PLASTIC LIMIT**

A.P.L. ABOUT PLASTIC LIMIT

## BOREHOLE LOG

Exhibit No. 14

Oct. 28, 1944

Checked By: V. M.

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Hardness or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Soil Moisture Value	WATER LEVEL & REMARKS	Comp. Prob.
Ground Surface			0' 0"							3
Sandy topsoil	Dark brown		1' 4"	S						3
Silty fine sand	Brown	Compact			1	X SS	16	18.5	Wet to saturated	22
Fine sand	Ditto	Ditto			2	X SS	15	20.7	Saturated	22
Silty fine sand	Ditto	Ditto			3	X SS	13	19.2	Start using washwater	22
									Sat'd. at 5'	22
Silty very fine sand	Ditto	Ditto			4	X SS	14	21.8	Saturated	22
As above	Ditto	Loose to compact	14' 0"		5	X SS	12		Saturated	22
Sandy silt interlayered with silty clay	Ditto	Very stiff			6	X SS	22	20.7	Saturated	22
								17.5	W.T.P.L.	22
Silty clay interlayered with sandy silt or silty fine sand	Ditto	Hard	21' 6"		7	X SS	39	19.0	W.T.P.L.	22
								18.5	Saturated	22
									TEST HOLE TERMINATED AT 22' 6"	22
									Probe hole terminated at 22' 6"	22

# BOREHOLE LOG

Borehole No. 16  
Boring Date October 29 - 30, 1964.  
Checked By S. B.

SAMPLE TYPE

### ABBREVIATIONS

A.5. AUGER SAMPLE  
C.5. CASING SAMPLE  
5.5. 2" STANDARD SPLIT TUBE SAMPLE  
5.L. SPLIT BARREL WITH LINERS  
5.T. THIN-WALLED SHELBY TUBE SAMPLE  
W.5. WASH SAMPLE  
R.C. ROCK CORE

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRYER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]

## BOREHOLE LOG

Borehole No. 17  
Boring Date October 30 - 31, 1964.  
Checked By .....

Test Hole Terminated at 35'0"



# BOREHOLE LOG

Borehole No. 18  
Boring Date November 2, 1964.  
Checked By S.B.

### ABBREVIATIONS

Y.T.	IN SITU VANE SHEAR TEST
M.	MOIST
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT
A.P.L.	ABOUT PLASTIC LIMIT

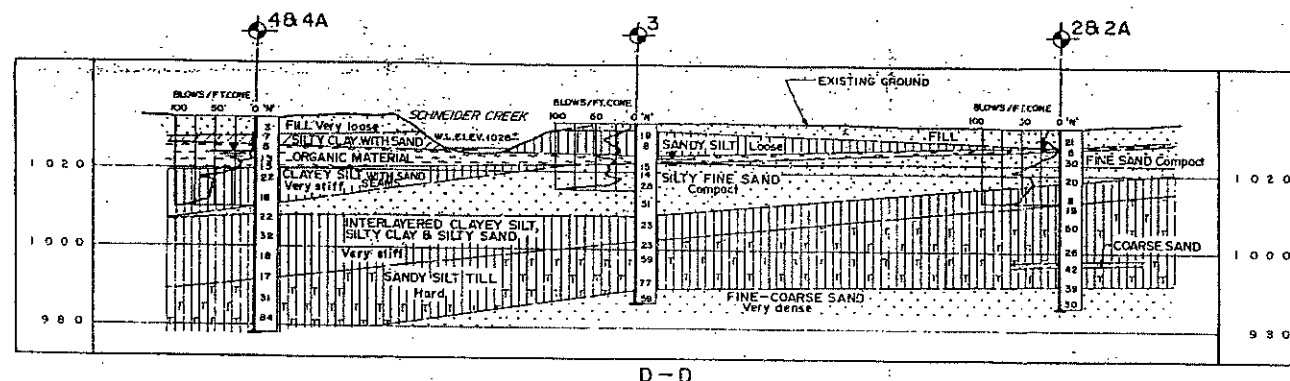
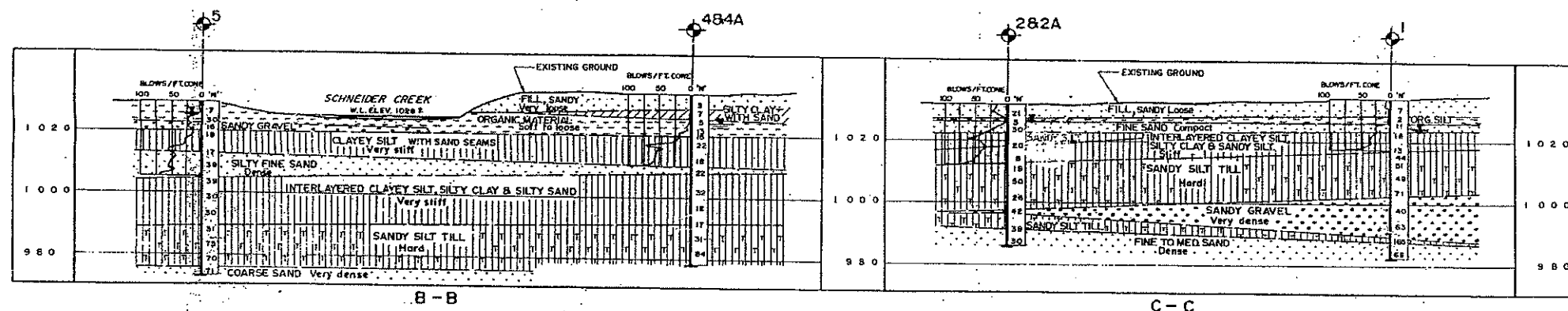
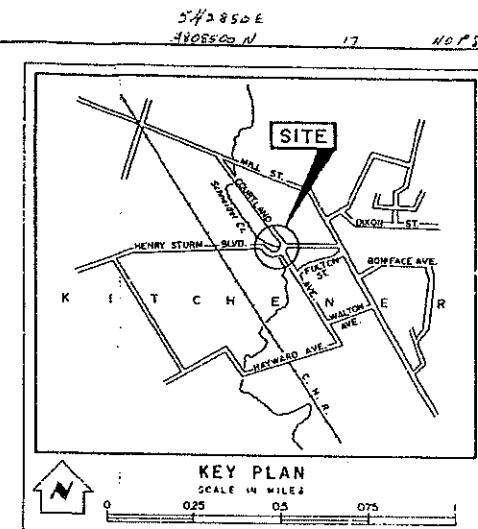
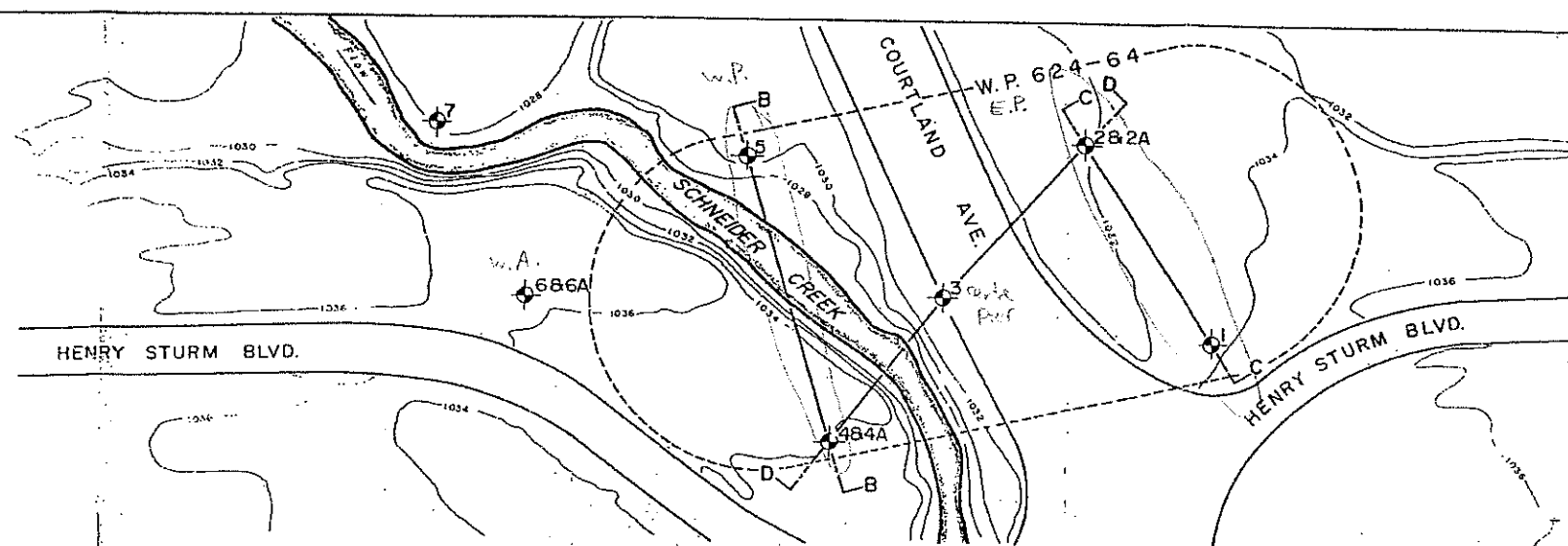
[illegible]



# BOREHOLE LOG

Borehole No. 19  
Boring Date November 3, 1964  
Checked By S. B.

[illegible]



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation (Nov. 1964)		

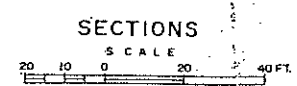
NO.	ELEVATION	COORDINATES	
		NORTH	EAST
1	1033.68	190 491.1	211 348.7
282A	1032.00	190 585.2	211 271.2
3	1032.48	190 495.0	211 208.8
484A	1033.35	190 412.2	211 161.1
5	1029.90	190 555.6	211 098.3
686A	1036.17	190 467.8	210 996.3
7	1028.17	190 550.7	210 938.1

**NOTE**  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD		
NO.	FOR	DATE

E. M. PETO ASSOCIATES LTD.	
DEPARTMENT OF HIGHWAYS - ONTARIO	
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION	
KITCHENER-WATERLOO EXPRESSWAY	
HENRY STURM BLVD. & COURTLAND AVE.	
KING'S HIGHWAY NO.	DIST NO. 4
CO. WATERLOO	
TWP. WATERLOO	LOT CON.
BORE HOLE LOCATIONS & SOIL STRATA	
SUBMITTAL CHECKED <i>[Signature]</i> WP NO. 624-64	DESIGNING NO. 1
DRAWN G.T. CHECKED <i>[Signature]</i> JOB NO. 64226	
DATE JANUARY 1965	SITE NO.
APPROVED <i>[Signature]</i> CONT. NO.	BRIDGE DRAWING NO.

**NOTE:** THE TESTHOLES AND PROBES HAVE BEEN LOCATED IN ACCORDANCE WITH COORDINATES GIVEN IN THE TABLE, WHICH HAS BEEN SUPPLIED BY THE DEPARTMENT.









**Appendix K**

**Selected Photographs Showing Existing Structures**

**Thurber Site Visit of July 8, 2005**





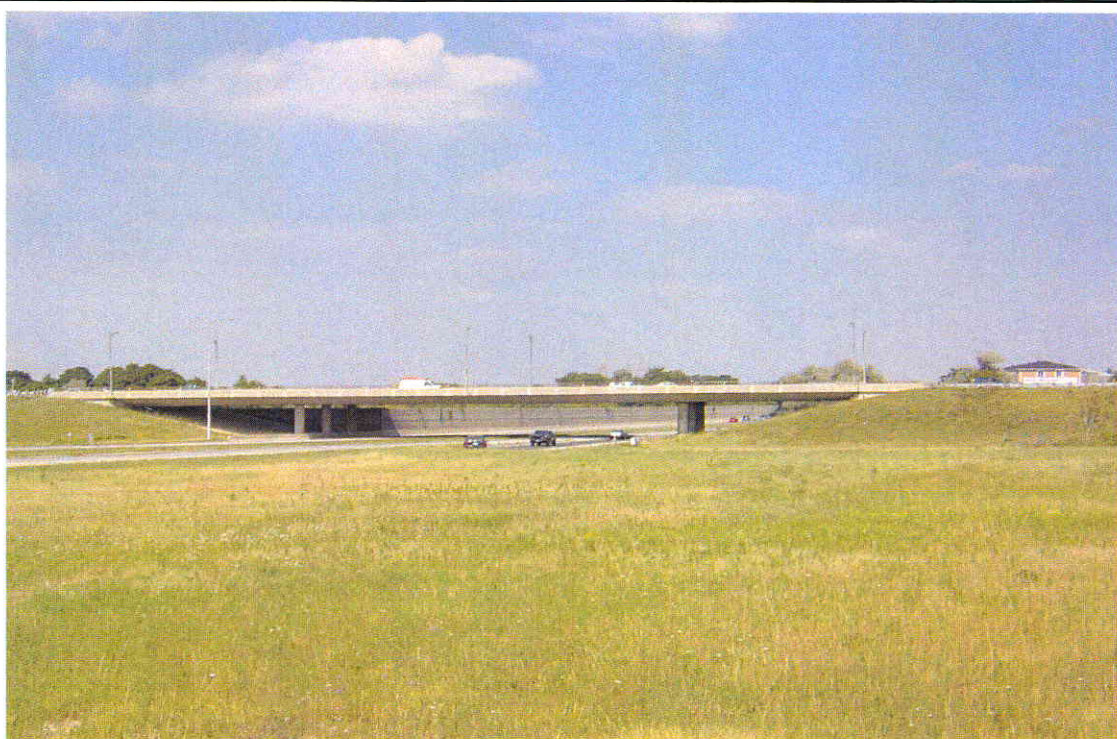


Borden Creek Under Highway 7/8



Borden Creek Under Fischer-Hallman Road





Fischer-Hallman Underpass from West



Westmount Road Overpass





Borden Creek Culvert East of Westmount Road



Homer Watson Boulevard Overpass





Ottawa Street South Overpass



CNR Overhead





Courtland Avenue Overpass



Pedestrian Overpass East of Courtland Avenue