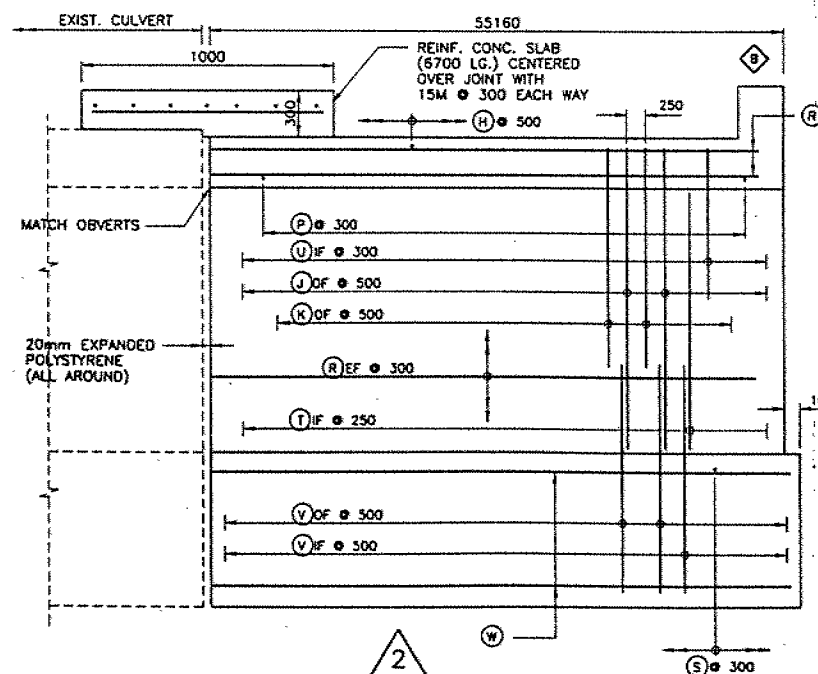
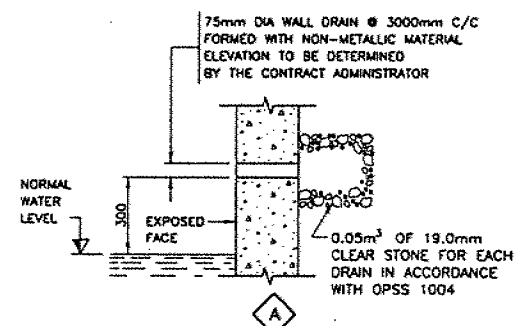
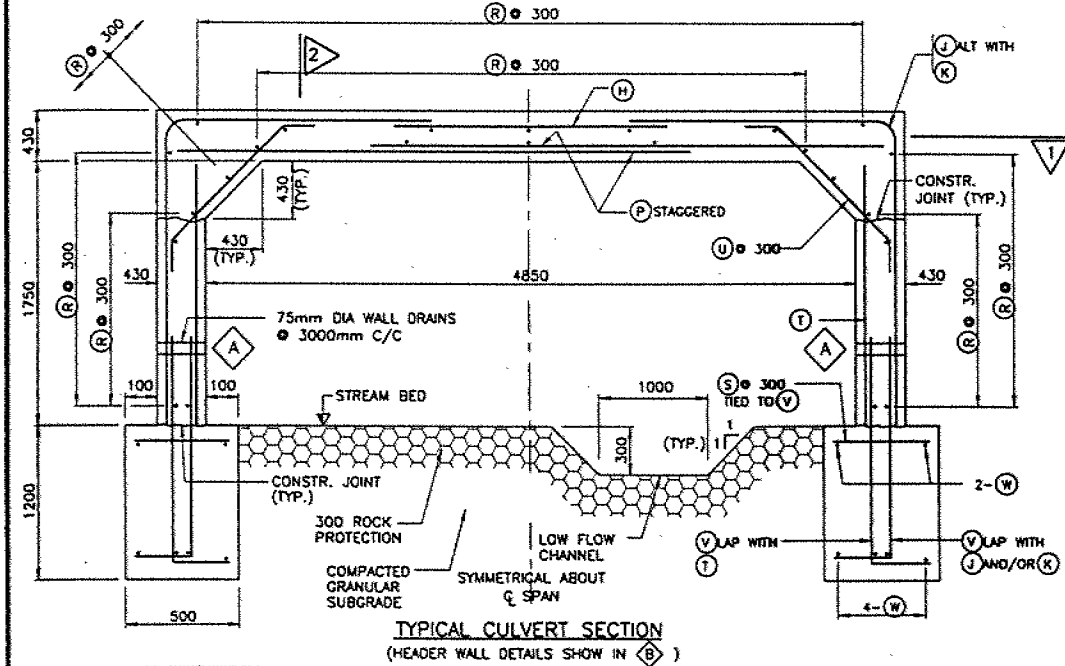
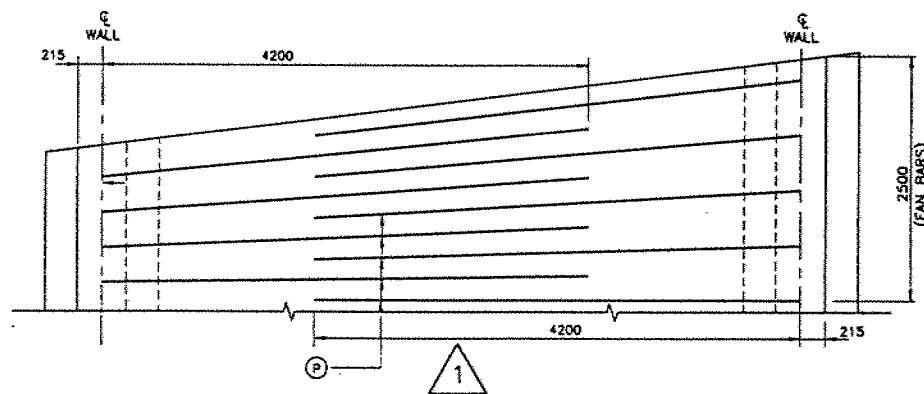
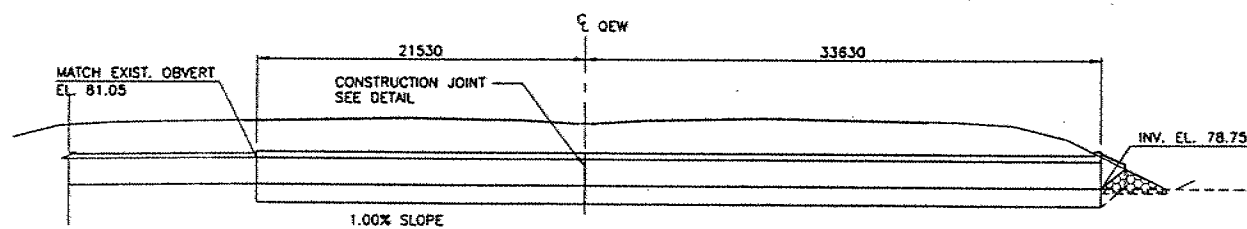
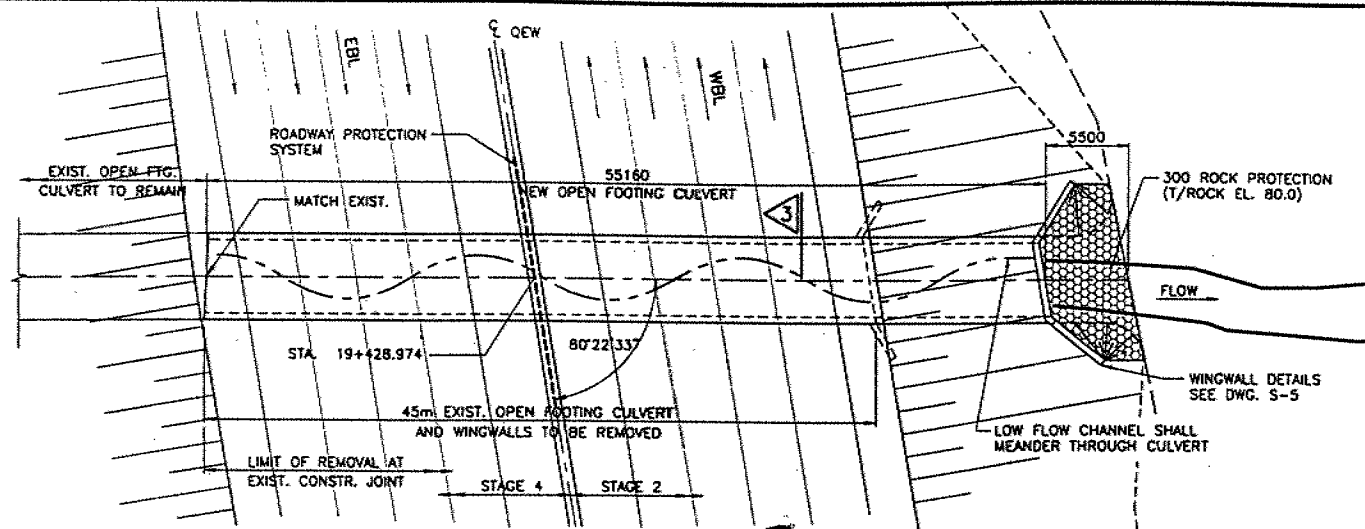
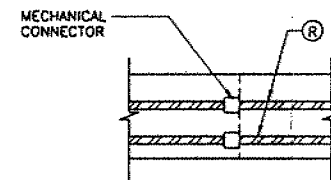
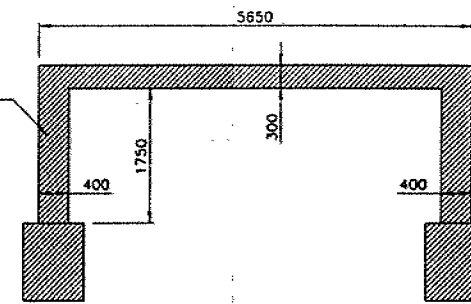


G.I.-30 SEPT. 1976

GEOCRES No. 30M3-208DIST. CR REGION W.P. No. 335-89-00 ACONT. No. W. O. No. STR. SITE No. HWY. No. Q. E. W.LOCATION Q. E. W. Widening at
Victoria AveNo of PAGES - 2 Cabinet Extensions=====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

REMOVE COMPLETE EXIST.
CULVERT WHERE NOTED

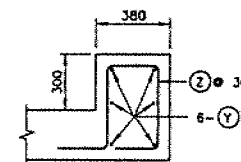
QUANTITIES				
ITEM	WALLS & SLABS	FOOTINGS	WINGWALLS	TOTAL
VOLUME OF CONCRETE cubic metres	231	93	9	333

STANDARD DRAWING
MARCH 1997

MODIFIED

SS114-1

RIGID FRAME OPEN FOOTING CULVERT



HEADER WALL

APPLICABLE STANDARD DRAWINGS
OPSD-4601.000 LOCATION OF SITE NUMBER
AND DATE FIGURESDRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWINGMETRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWNCONT No.
WP No. 335-89-00QEW WIDENING
AT VICTORIA AVE. INTERCHANGE
CULVERT No. 4
STA 19+429SHEET
230PARKER
CONSULTANTSConsulting Professional Engineers
Hamilton · London · Vancouver

GENERAL NOTES

- 1 CLASS OF CONCRETE TO BE 30MPa
- 2 CLEAR COVER TO REINFORCING STEEL
BOTTOM OF TOP SLAB 40±10 FOR SLABS ≤ 300 THICK
50±10 FOR SLABS > 300 THICK
BOTTOM OF FOOTINGS 100±25
REMAINDER 70±20 UNLESS OTHERWISE NOTED
- 3 REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BARS MARKED WITH PREFIX C DENOTE COATED BARS. UNLESS NOTED OTHERWISE, TENSION LAP LENGTHS SHALL BE CLASS 8. BAR HOOKS SHALL BE MINIMUM LENGTH AND STIRRUPS SHALL HAVE MINIMUM HOOKS, UNLESS INDICATED OTHERWISE.
- 4 LEGEND
ALT DENOTES ALTERNATE
IF DENOTES INSIDE FACE
OF DENOTES OUTSIDE FACE
EF DENOTES EACH FACE

CONSTRUCTION NOTES

- 1 BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF CULVERT KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 300mm.
- 2 SIDES OF FOOTING TO BE CAST AGAINST UNDISTURBED SOIL.
- 3 NO CONCRETE SHALL BE PLACED FOR ANY FOOTINGS UNTIL THE DEPTH OF THE EXCAVATION AND THE CHARACTER OF THE FOUNDATION HAVE BEEN APPROVED BY THE CONTRACT ADMINISTRATOR.
- 4 SUPPORTS FOR REINFORCING STEEL SHALL BE AS PER OPSD-3922.000 AND OPSD-3923.000 ON FORMED SURFACES ON NON-FORMED SURFACES, CONCRETE BLOCKS (MIN. 20MPa) SHALL BE USED.
- 5 SITE No. AND DATE FIGURES SUPPLIED BY MTO.
- 6 THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS OF THE EXISTING WORK AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR.
- 7 THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING CREEK FLOW THROUGH THE WORK AREA.

MARK	BAR SIZE	C/C	DETAILS	REMARKS
(H)	15M	500	STRAIGHT	TOP OF TOP SLAB
(J)	15M	500	1780 1590 R=215	J BARS ALTERNATE WITH K BARS
(K)	15M	500	800 1590 R=215	K BARS ALTERNATE WITH J BARS
(P)	15M	300	STRAIGHT	BOTTOM OF TOP SLAB STAGGERED
(R)	15M	300	STRAIGHT	LONGITUDINAL MIN. LAP SPLICE = 500
(S)	15M	300	STRAIGHT	TOP OF FOOTING
(T)	20M	250	STRAIGHT	INSIDE FACE OF WALLS
(U)	15M	300	880 1590 R=215	HAUNCH
(V)	20M	500	1720 220	FOOTING DOWELS
(W)	20M		STRAIGHT	LONGITUDINAL IN FOOTING MIN. LAP SPLICE = 500
(Y)	25M		STRAIGHT	HEADER WALL
(Z)	15M	300	225 610 190 230	HEADER WALL

NOTES: - All dimensions shown to centre line of bar
- * represents vertical dimension
- c/c spacing given at midspan

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	M.L.T.	CHK J.C.L.	CODE OHBDC-91/LOAD OHBD/DATE OCT. 1997
DRAWN	A.H.	CHK M.L.T.	SITE STRUCT SCHEME DWG. S-4

CONT No.
WP No. 335-89-00

QEW WIDENING
AT VICTORIA AVE. INTERCHANGE
CULVERT No. 3
STA 19+160

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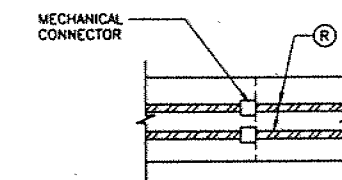
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229

GENERAL NOTES

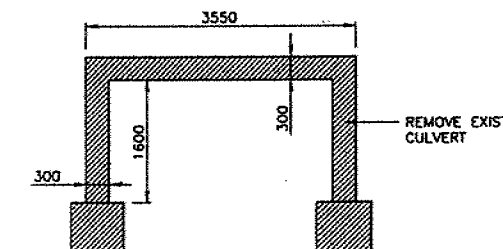
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50±10 FOR SLABS > 300 THICK
BOTTOM OF FOOTINGS 100±25
REMAINDER 70±20 UNLESS OTHERWISE NOTED
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- 4 LEGEND
ALT DENOTES ALTERNATE
IF DENOTES INSIDE FACE
OF DENOTES OUTSIDE FACE
EF DENOTES EACH FACE

CONSTRUCTION NOTES

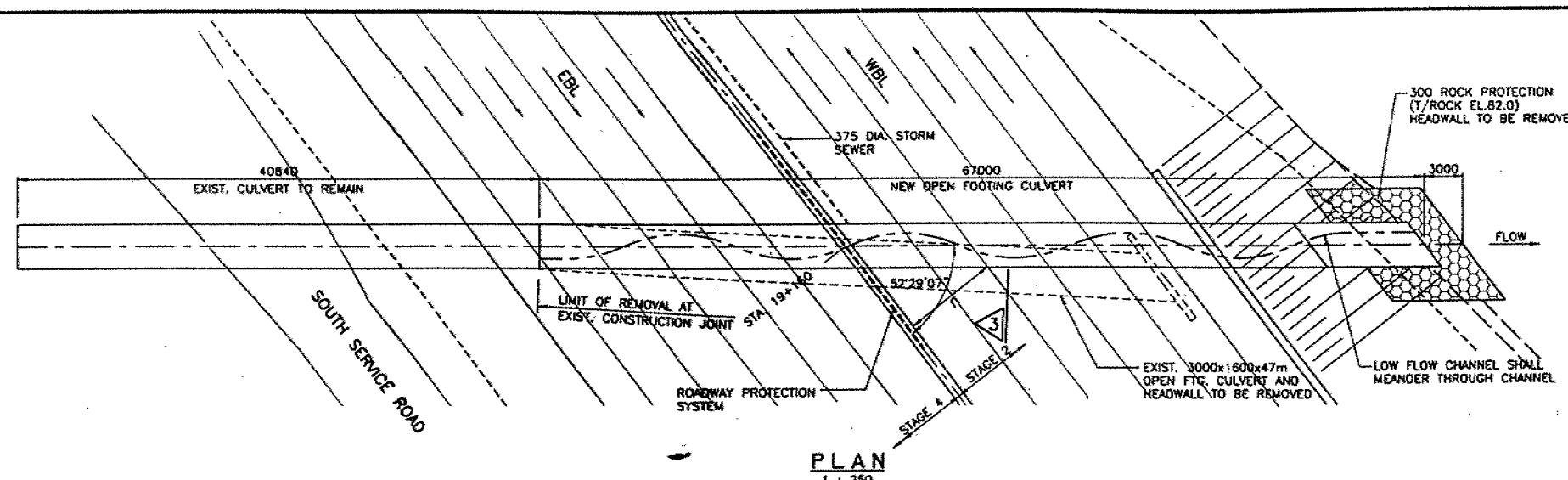
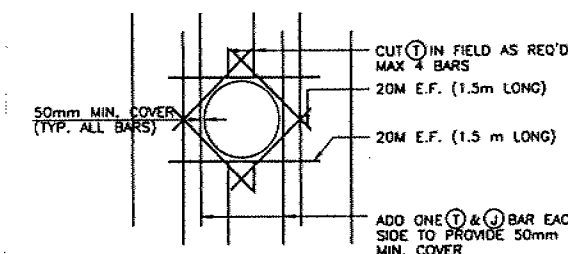
- 1 BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF CULVERT KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
- 2 SIDES OF FOOTING TO BE CAST AGAINST UNDISTURBED SOIL.
- 3 NO CONCRETE SHALL BE PLACED FOR ANY FOOTINGS UNTIL THE DEPTH OF THE EXCAVATION AND THE CHARACTER OF THE FOUNDATION HAVE BEEN APPROVED BY THE CONTRACT ADMINISTRATOR.
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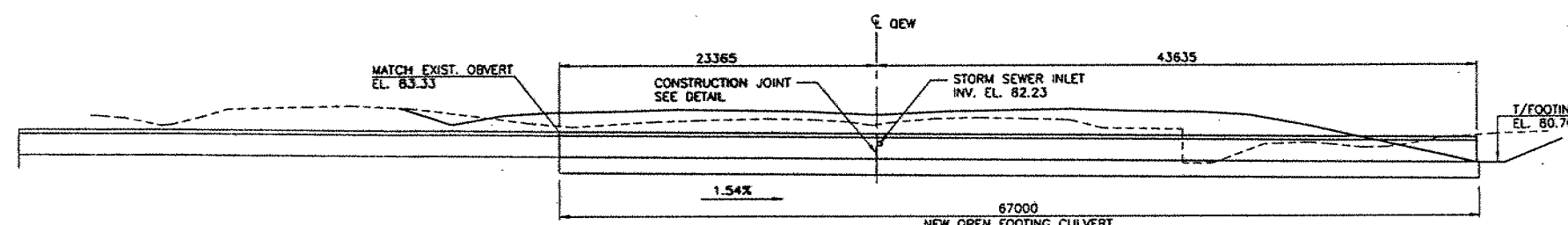
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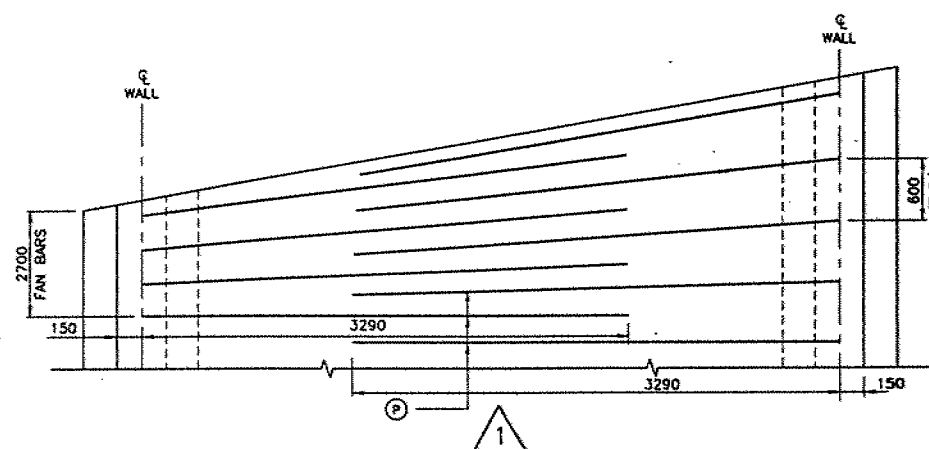
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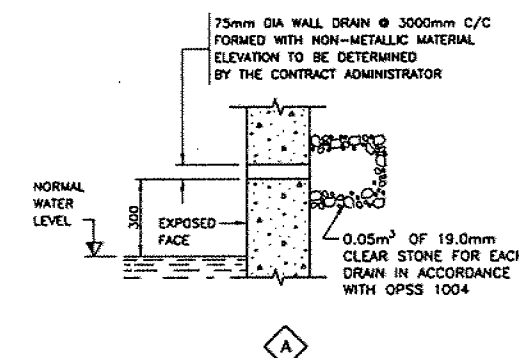
PLAN
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SECTION THRU CULVERT
1 : 250



1

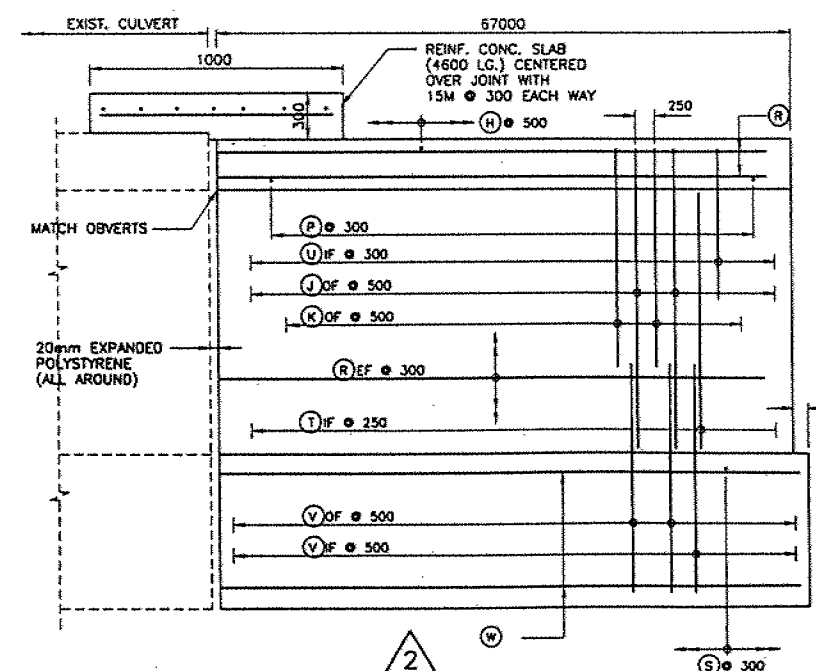


A

QUANTITIES				
ITEM	WALLS & SLABS	FOOTINGS	RETAINING WALL	TOTAL
VOLUME OF CONCRETE cubic metres	138	101	-	239

STANDARD DRAWING
JUNE 1993
SS114-1
RIGID FRAME OPEN FOOTING CULVERT

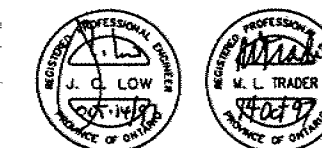
APPLICABLE STANDARD DRAWINGS
OPSD-4601.000 LOCATION OF SITE NUMBER AND DATE FIGURES



2

MARK	BAR SIZE	C/C	DETAILS	REMARKS
(H)	15M	500	STRAIGHT	TOP OF TOP SLAB
(J)	15M	500	1760 1590 R=215	J BARS ALTERNATE WITH K BARS
(K)	15M	500	800 1590 R=215	K BARS ALTERNATE WITH J BARS
(P)	15M	300	STRAIGHT	BOTTOM OF TOP SLAB STAGGERED
(R)	15M	300	STRAIGHT	LONGITUDINAL MIN. LAP SPLICE = 500
(S)	15M	300	STRAIGHT	TOP OF FOOTING
(T)	20M	250	STRAIGHT	INSIDE FACE OF WALLS
(U)	15M	300	860 1590 R=215	HAUNCH
(V)	20M	500	1720 220	FOOTING DOWELS
(W)	20M		STRAIGHT	LONGITUDINAL IN FOOTING MIN. LAP SPLICE = 500
(Y)			STRAIGHT	HEADER WALL
(Z)	15M	300	225 190 230	HEADER WALL

NOTES: - All dimensions shown to centre line of bar
- represents vertical dimension
- c/c spacing given at midspan



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN M.L.T./CHK J.C.L. CODE OHB0C-91/LOAD OHB0/DATE OCT. 1997
DRAWN A.H./CHK M.L.T. SITE/STRUCT./SCHEME/DWG. S-3

FILE COPY



Ministry
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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

**ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION**

WP 335-89-00A REGION Central
HWY QEW STR SITE

Proposed Culvert Extensions
QEW Widening at Victoria Avenue Interchange

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GEOCRES 30M3-208

DATE AUG 26 1996

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FOUNDATION INVESTIGATION REPORT
FOR
Proposed Culvert Extensions
QEW Widening at Victoria Avenue Interchange
WP 335-89-00A
Central Region

1.0 INTRODUCTION

This report summarizes the results of a foundation investigation conducted at two proposed culvert extension site locations along the QEW immediately west of Victoria Avenue. The investigation was carried out at the request of the Central Region Structural Section. The culvert extensions are part and parcel of the widening at the QEW-Victoria Avenue interchange. This report is applicable to the limits of the two culvert extension sites located north of the existing QEW and the immediate approaches (up to 25 metres) beyond the culvert structures.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 Site Descriptions

The two sites are situated approximately 200m (Site #1) and 400m(Site #2) west of Victoria Avenue within the northern limits of the QEW corridor. The sites are located within the Town of Lincoln, Regional Municipality of Niagara. The land in the general area is primarily agricultural. Individual specific site descriptions are given in this section of the report.

Site #1 - 200 m west of Victoria Avenue

The proposed 12 metre culvert extension at Site #1 is situated at the outlet of an existing rigid frame open footing type concrete culvert. The existing culvert is approximately 1.75 metres in height and has a span of approximately 4.85 metres. The concrete walls are approximately 0.4 metres in thickness and the roof thickness is approximately 0.3 metres. The culvert invert is at approximately Elevation 78.8 metres. The existing culvert, approximately 38 metres in length, transmits the northerly flowing water beneath the QEW towards Lake Ontario.

The existing culvert and adjoining wing walls at the culvert outlet show no signs of structural distress. Approximately 2 metres of fill material has been placed on top of the culvert roof. The fill material constructed at 2H:1V is superimposed on the native ground. There is no evidence of pavement settlement above the existing culvert.

The creek transmitting the water at the culvert outlet is within a valley of approximately 4 metres width. The depth of water at the time of investigation was approximately 0.4 metres. The elevation of the creek surface was approximately 79.1 m. Existing slopes of the valley are approximately 1H:1V. The native ground slopes gently to the valley from both the west and east. Within the culvert extension area beyond the valley, the land is covered with grasses.

The creek meanders beyond the MTO right-of-way beneath an existing chain link fence north of the site. Tall deciduous trees and short coniferous trees are present within the area immediately north

of the MTO right-of-way.

Site #2 - 400 m west of Victoria Avenue

The proposed 22.3 metre culvert extension at Site #2 is situated at the outlet of an existing rigid frame open footing type concrete culvert. The existing culvert is approximately 1.60 metres in height and has a span of approximately 2.95 metres. The concrete walls are approximately 0.3 metres in thickness and the roof thickness is also approximately 0.3 metres. The culvert invert is at approximately Elevation 80.8 metres. The existing culvert, approximately 70 metres in length, transmits the northerly flowing water beneath the QEW towards Lake Ontario.

The existing culvert and adjoining wing walls at the culvert outlet show no signs of structural distress. Approximately 2 metres of fill material has been placed on top of the culvert roof. The fill material constructed at 2H:1V is superimposed on the native ground. There is no evidence of pavement settlement above the existing culvert.

The creek transmitting the water at the culvert outlet is within a valley of approximately 3 metres width. The depth of water at the time of investigation was approximately 0.3 metres. The elevation of the creek surface was approximately 81.1 m. Existing slopes of the valley are approximately 1H:1V. The native ground slopes gently to the valley from both the west and east. Within the culvert extension area beyond the valley, the land is covered with grasses.

The creek meanders within the proposed culvert extension area and also beyond the MTO right-of-way beneath an existing chain link fence north of the site. Tall deciduous trees and short coniferous trees are present within the area immediately north of the MTO right-of-way.

2.2 Site Geology

Physiographically, the sites are located within the region known as the "Iroquois Plain". The Iroquois Plain is the product of the advance and retreat of the Wisconsin ice sheet which covered the area during the Pleistocene Epoch (over 12,000 years ago). The lowland bordering Lake Ontario, was inundated by the glacial lake called Lake Iroquois when the last glacier was receding at the site.

Conditions in the old lake plain vary greatly within the Iroquois Plain. At the site location, the Iroquois Plain is characterized by glacial till deposits comprised of clays, silts, sands, gravels underlain by shale bedrock with interbedded siltstone of the Queenston Formation.

3.0 INVESTIGATION PROCEDURE

3.1 General

The subsurface conditions at the site were determined by conducting a field investigation and a laboratory testing program. Details of the field investigation and laboratory testing program are discussed in this section of the report.

3.2 Field Investigation

The field investigation, which consisted of a total of 4 boreholes, was carried out on April 29, 1996 and April 30, 1996. Two boreholes were advanced at each culvert extension site.

The boreholes were advanced using a track mounted CME 55 diesel drilling unit to depths ranging from 5.5 metres to 9.9 metres. Hollow stem and solid stem augers were used to advance the boreholes through the overburden. Conventional rock coring techniques employing NW casing and a NX core barrel was used to retrieve rock core samples up to 1.6 metres in depth.

Subsoil samples were generally retrieved at 0.76 metre intervals in accordance with the Standard Penetration Test (ASTM D1586). All subsoil samples were identified and then sealed in plastic containers in the field to preserve natural moisture contents. The samples were then transported to the laboratory where additional visual classifications and pertinent laboratory tests were conducted.

Rock core samples were also identified in the field and physical index properties were determined by visual examination and also by measurement of rock quality designations (RQD's) and rock core recoveries. All rock core were placed in standard rock core boxes and carefully transported to the laboratory for detailed rock core logging by our resident geologist.

Groundwater levels were obtained by measuring the levels in the open boreholes throughout the duration of the field investigations. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and the ground surface elevation of the boreholes was provided by the Central Region Surveys and Plans following borehole advancement.

3.3 Laboratory Analyses

All subsoil samples were carefully examined in accordance with the procedures outlined in the Visual Method described in Chapter 2 of the MTO Soil Classification Manual. Laboratory testing on selected representative subsoil samples consisted of routine physical property testing. This testing consisted of natural moisture content determination, Atterberg Limit Testing, Particle Size Analyses and unit weight determination. Laboratory test results are shown on the individual borehole logs and figures in the Appendix

All rock cores were carefully examined and rock core descriptions that include grain size, bedding thicknesses, jointing characteristics, strength and colour have been summarized in a Rock Core Description Report attached in the Appendix of this report. Rock core recoveries and rock quality designations are also summarized in the Rock Core Description Report and also on the individual borehole logs.

4.0 SUBSURFACE CONDITIONS

4.1 General

The ground surface elevation at the boreholes advanced at the site range from 80.2 m to 83.1 m at Site #1 and from 82.1 m to 82.4 m at Site #2. At site #1, one borehole was advanced on the shoulder of the QEW and up to 4.2 metres of fill material was encountered. This fill material consisted of a

thickness of approximately 0.8 metres of sand and gravel underlain by approximately 3.4 metres of a cohesive irregular mixture of clayey silt, sand and gravel. At site #2, approximately 1.5 metres of the cohesive irregular mixture of clayey silt, sand and gravel was encountered at one borehole location. However, based on a roadway elevation of 83.9 obtained at site #2, it is expected that an additional 1.5 metres (83.9 m - 82.4 m) of fill material perhaps comprised of sand and gravel overlying the irregular mixture of clayey silt, sand and gravel exists at this site similar to site #1.

Underlying the fill material and present surficially across both sites is a cohesionless deposit of glacial till origin comprised of a Heterogenous Mixture of Silt, Sand and Gravel. This deposit has a thickness ranging from approximately 3 metres to 5.8 metres extending to an elevation of 74.4 to 74.8 at Site #1 and to an elevation of 77.3 to 77.9 at Site #2.

The overburden at the site is underlain by shale bedrock with interbedded siltstone of the Queenston Formation. This rock is characteristically greyish red to greenish grey in colour, weathered for the surficial 1 to 1.5 metres or so, and very weak to weak.

Groundwater elevations were approximately 79.1 m at site #1 and 81.1 at site #2 at the time of the investigation.

A plan of the two sites illustrating the locations and elevations of the boreholes is shown on Dwg No. 3358900A-A. Stratigraphical sections illustrating the subsurface conditions at the site are also provided on Dwg 3358900A-A. The boundaries between the various soil types, in situ and

laboratory test results and groundwater levels established at the time of the investigation are shown on the stratigraphical sections and also on the individual record of borehole sheets.

4.2 Sand and Gravel (Fill Material)

A brown, compact sand and gravel with traces of silt was encountered at Borehole #2 advanced on the shoulder of the QEW at Site #1. The thickness of this fill material used as a roadway base was approximately 0.8 metres. It is expected that the sand and gravel roadway base is present along the QEW at both sites.

4.3 Irregular Mixture of Clayey Silt, Sand and Gravel(Fill Material)

An irregular mixture of clayey silt, sand and gravel appears to have been placed as fill material above and adjacent to the existing culverts at both sites. This fill material which also contains traces of organics was explored to depths up to 3.5 metres. The fill material was generally brown or grey.

A grain size distribution envelope produced by mechanical sieve and hydrometer analysis for the fill material is illustrated in Figure 1 in the Appendix. The envelope reveals a broadly graded material with particle sizes ranging from gravels to clays. The clay fraction ranges from 15 to 23%. Silt percentages range from 38 to 56%. The combined silt and clay percentages range from 53% to 79%. In the MTO soil classification system, soils which have a fine grained portion exceeding 50% are categorized according to their plasticity and behaviour as discussed below.

Atterberg Limit Tests were carried out on the fine grained portion of the fill material (material less than 75 micrometres) to define the behaviour and plasticity of the material. The results are plotted on the Plasticity Chart illustrated in Figure 2 in the Appendix and summarized in Table 1 below. Natural moisture contents and bulk unit weights are also summarized below.

Table 1 - Irregular Mixture of Clayey Silt, Sand and Gravel(Fill Material)

Physical Property	Range	# of Tests
Natural Moisture Content(w %)	17-23	4
Liquid Limit(w_L %)	24-31	4
Plastic Limit(w_p %)	15-19	4
Plasticity Index(I_p %)	9-12	4
Bulk Unit Weight (kN/m ³)	20.3-21.3	4

The test results reveal that the fine grained portion of the fill material is of low plasticity and hence is categorized as a clayey silt. Natural moisture contents are lower than the plastic limit of the soil indicating that the soil is in a plastic to semi-solid state.

Standard Penetration Tests (SPT) carried out within the fill material revealed 'N' values ranging from 2 blows/0.3 m to 10 blows/0.3m. In general, 'N' values are within the 2 to 5 blows/0.3 m range revealing a fill material of soft to firm consistency.

4.4 Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)

The predominant native soil at both sites either underlying the fill material or present surficially at an Elevation ranging from approximately 78.8 m to 80.2 m at Site #1 and approximately 80.9 m to 82.1 m at Site #2 is a Heterogeneous Mixture of Silt, Sand and Gravel of glacial till origin. The thickness of this deposit ranges from approximately 3.1 metres to 5.8 metres extending to an elevation of 74.4 to 74.7 at Site #1 and to an elevation of 77.2 to 77.8 at Site #2.

The deposit has been oxidized for the surficial 1.5 m to 3 m and is brown in colour within the zone. Beneath the brown zone, the material is red in colour.

This glacial till deposit is characteristically unsorted and unstratified. A Grain Size Distribution Envelope for this deposit as produced by mechanical sieve and hydrometer analysis is shown in Figure 3 in the Appendix. The envelope illustrates a gradation containing primarily silt percentages ranging from 60% to 81%, with sand percentages ranging from as little as 1% to as much as 26%, clay fractions ranging from 9% to 18% and traces of gravel up to 5%.

Atterberg Limit Tests were carried out on some selected samples to determine if the fine grained portion of the deposit exhibited any plasticity. These test results are shown on the individual Record of Borehole Logs. Although there are some random zones within the deposit that exhibit a plasticity within the CL - ML transition zone based on liquid limits ranging from 20% to 22% and plasticity indices ranging from 4% to 6%, most of the samples behaved as plastic silts(ML) to non plastic silts.

Standard Penetration Tests carried out in this deposit revealed 'N' values ranging from 47 blows/0.3m to 100/0.15m with most of 'N' values being within the upper limit of this range. This indicates that the deposit is in a very dense state of denseness.

4.5 Bedrock

The Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) at the site is underlain by Shale bedrock with interbedded Siltstone of the Queenston Shale Formation. The bedrock was both augered(up to approximately 0.6 metres at some locations) and also cored. Bedrock core was retrieved in NX size for a depth of approximately 1.6 metres.

Detailed rock core descriptions are given in a "Rock Core Description Report" included in the Appendix to this report. The shale bedrock is generally greyish red with randomly interbedded greenish grey siltstone layers. The rock is an extremely friable material and could be penetrated with the conventional augering techniques as mentioned above. The rock has been moderately weathered for the surficial 0.5 metre to 1.4 metres, below which the rock is unweathered to slightly weathered.

The rock is horizontally bedded and contains close to extremely close spaced fractures that are generally flat to near vertical, planar to undulating and smooth to rough.

Core recoveries and Rock Quality Designations (RQD's) were determined in situ to evaluate the competence and integrity of the rock. Core recoveries ranged from 92% to 95% and RQD's ranged from 7% to 70%. This data reveals that the bedrock quality ranges from very poor to fair.

Based on index strength property identification, the rock strength is described as very weak to weak.

5.0 GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes throughout the duration of the field investigation. Groundwater levels were not obtained in the boreholes that were cored (BH's 2 and 4) because the water levels were not representative due to the water that was used to facilitate the coring process.

The groundwater level at Site #1 was approximately 78.2 m at the time of the investigation. The water level in the creek at the time of the investigation was 79.1 m measured adjacent to BH 2.

The groundwater level at Site #2 was approximately 80.6 m at the time of the investigation. The water level in the creek at the time of the investigation was 81.1 m measured adjacent to BH 4.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

6.0 DISCUSSION AND RECOMMENDATIONS

Two concrete culvert extensions have been proposed to facilitate the QEW widening immediately west of the Victoria Avenue interchange. One culvert located approximately 200 m west of the Victoria Avenue bridge at designated Site #1 is to be lengthened by 12 metres collinear with the existing culvert alignment at the culvert outlet situated north of the QEW. The second culvert to be lengthened is situated approximately 400 west of the Victoria Avenue Bridge at designated Site #2. The culvert is to be lengthened by 22.3 metres again collinear with the existing culvert alignment at the culvert outlet situated north of the QEW. The culvert extensions will support the new NSR - QEW W ramp that is to be constructed as part of the QEW - Victoria Avenue interchange revamping.

Both culvert extension structures are to be of the same size and geometry as the existing respective structures. At Site #1, a 4.85m span by 1.75m rise structure has been proposed. At Site #2, a 2.95m span by 1.6 m rise structure has been proposed. The elevation of the top of the roof of the culvert at Site #1 is 80.9 m. At Site #2, the elevation of the top of the roof of the culvert is 82.7 m.

The proposed profile grades of the new NSR - QEW W ramp and the QEW WB and EB lanes are approximately 83 metres at Site #1 and 85 metres at Site #2. Therefore, approximately up to 3 metres of approach fill material from the ground surface will be required at Site #1 and up to 4 metres of approach fill material above the native ground surface will be required at Site #2. This is equivalent to a culvert roof fill cover of approximately 2.2 metres at Site #1 and 2.3 metres at Site #2.

A plan illustrating the two site locations is shown on Drawing 3358900A-A in the Appendix. A stratigraphical section produced at each site location is also shown on Drawing 3358900A-A.

Recommendations pertaining to the following foundation and geotechnical considerations are included in the purview of this report.

1. Structure Foundations
2. Backfill to Structure
3. Approach Embankments
- and 4. Construction Considerations

6.1 STRUCTURE FOUNDATIONS

6.1.1 General

The existing culverts at both sites are open type box culverts. Although the spread footing founding elevations are not known, it is expected that the individual footing founding levels are perhaps situated at a depth equivalent to the thickness of the footings beneath the culvert inverts. Assuming a footing thickness of approximately 0.6 metres, it is expected that the founding footing elevations are approximately 78.2 m \pm at Site #1 and approximately 80.2 m \pm at Site #2.

6.1.2 Foundation Design

The native Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) is a very competent soil and

hence suitable for the support of conventional shallow foundations at either site. Consequently, the culvert extensions can be founded on either conventional open type spread footings or a closed type slab on grade box type spread footing. The footings can be founded at an elevation equivalent to a depth beneath the culvert invert elevation that satisfies the frost protection cover requirement of 1.2 metres. It is expected that the culvert inverts will be similar to the existing culverts and at an elevation of approximately 78.8m at Site #1 and an invert elevation of approximately 80.8m at Site #2. Based on these assumed values, the culverts can be founded at or below Elevation 77.6 m at Site #1 and at or below Elevation 79.7 m at Site #2.

Shallow Foundations shall be designed in accordance with Section 6-8 of the 3rd Edition of the O.H.B.D.C. For purposes of the O.H.B.D.C., the bearing resistances tabulated in Table 2 can be used in the design of the shallow foundations. These bearing resistances are based on a minimum footing width (B) of 1 metre. Settlements developed as a result of the applied pressures tabulated in Table 2 are expected to be within 25 mm and because the deformations will be recompression in nature should occur immediately during construction. It is recommended that the culvert extensions be articulated from the existing culverts with an "isolation joint" to accommodate any differential settlements between the existing and the new culverts.

Table 2 - Spread Footing Bearing Capacity

Limit States Design	Bearing Resistance(kPa)
Factored Resistance at U.L.S.	1000
Bearing Resistance at S.L.S.	500

The bearing resistances tabulated in Table 2 shall be reduced to account for the effects of inclined

loadings. Reduction factors shall be computed in accordance with Section 6 - 8.4.2 of the O.H.B.D.C.

For open type shallow foundations, the horizontal resistance of the footing is also a design consideration. The horizontal resistance of an open type spread footing can be computed using an angle of friction of $35^{\circ}(\delta)$ between the base of the concrete footing and the founding soil. The horizontal resistance of the shallow foundation shall be computed in accordance with Section 6 - 8.4.3 of the OHBDC.

The culvert foundations shall be protected from the scouring forces of the creek water and hence shall be a design consideration. The design of the scour protection shall consider the applicable hydrological parameters and the native subsoil conditions at the site. Scour protection at the culvert outlet can be achieved by aprons and rip rap.

6.1.3 Foundation Construction

All softened and/or organic material encountered at the founding elevation beneath the plan limits of the footing shall be removed and replaced with mass concrete.

Foundation excavation and construction adjacent to the existing culvert foundations shall be carried out such that undermining of the existing foundations are avoided.

During the construction of the culvert foundations, it is recommended that a concrete working slab

be placed to protect the founding soil from disturbance that can be caused by weathering and/or construction related activities. The concrete working slab shall be placed within 4 hours of exposure.

6.2 BACKFILL TO STRUCTURE

6.2.1 Material

It is recommended that Granular 'A' or Granular 'B' (conforming to Special Provision SP109F03) material be placed behind the culvert walls as illustrated in the applicable OPSD 803 drawings. The use of a granular material combined with weep holes in the culvert walls or pipe subdrains to drain any accumulation of water in the backfill will prevent hydrostatic pressure build-up.

Design parameters of the soil are given in Table 3 below. Computations of lateral earth pressure shall be in accordance with Section 6-7 of the O.H.B.D.C.

Table 3 - Structure Backfill Properties

Backfill Property	Granular 'A'	Granular 'B'
Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m ³)	22.8	21.2
*Coefficient of Active Earth Pressure (K_a)	0.27	0.33
*Coefficient of Earth Pressure at Rest (K_o)	0.43	0.5

- * These earth pressure coefficients apply to horizontal backfill surfaces only. The appropriate consideration shall be given to account for sloping backfill. The coefficient of earth pressure at rest shall be applied for rigid and unyielding walls. The active condition applies for flexible walls where sufficient movement is permitted to mobilize the active pressure. Figure C6-7.1 and Table C6-7.1 in the O.H.B.D.C. commentary depict movements required to achieve the active state.

The compaction surcharge shall be calculated in accordance with Section 6-7.4.3 of the O.H.B.D.C. The calculated lateral pressure is a function of the mass and type of compaction equipment and the material being compacted. A minimum compaction surcharge pressure of 16 kPa should be used for a vibratory compactor with a mass of approximately 400 kg.

6.2.2 Backfilling and Compaction

The backfill shall be placed in 300 mm lifts in accordance with OPSS 902 series and compacted to achieve 100 percent of the target maximum dry density as outlined in OPSS 501 series. The backfill shall be placed simultaneously and evenly on both sides of the culverts such that the maximum difference in the fill placement height at the culvert walls does not exceed 600mm.

Heavy vibratory equipment is not permitted in the backfill construction adjacent to the structure to minimize deflection or possible damage of the wall. Vibratory equipment exceeding 6000 kg operating weight should be kept outside of a 1.5 vertical to 1 horizontal line extending upward from the base of the culvert wall footing. Hand compaction equipment shall be used within these limits.

6.3 APPROACH EMBANKMENTS

6.3.1 General

Transverse embankment fill slopes will have to be constructed at the approaches to the culverts. There are two major factors that must be considered in the design of approach embankments:

- (1) Stability

and (2) Settlement

The stability and settlement of the approach embankments with fill heights up to approximately 3m at Site #1 to 4m at Site #2 are discussed below.

6.3.2 Stability

In view of the competent nature of the native subsoils at the sites and the proposed fill heights, there are no deep seated or global (external) slope instabilities expected for the transverse slopes constructed at 2H:1V. In addition, for the proposed slopes of up to 4 metres and less than 8m in height, the 2H:1V geometry slopes will also be adequate to avoid surficial slope instabilities provided that an effective erosion control protection scheme such as conventional seeding and mulching or sod be applied with a surface runoff drainage system at the toe of the slope. To ensure the internal stability within the embankment fill, it is recommended that the new fills be "benched" into the existing approach embankments in accordance with OPSD 208.01.

6.3.3 Settlement

Settlements induced as a result of the applied embankment loading will be the result of the elastic compression of the native subsoil and as a result of settlements within the fill material itself. It is anticipated that approximately 25mm of settlement attributable to the elastic compression of the native subsoil will be realized. These settlements will be elastic in nature and hence will occur almost immediately.

Settlements within the fill itself can amount to approximately 20 mm due to its self weight. These

settlements will be immediate in nature if a granular fill material is used. For fill materials that are cohesive, settlements will be more time dependent, but should be realized within a 3 month period following the fill placement.

6.3.4 Embankment Construction

Embankment fills shall be placed and compacted as specified in OPSS 206.07.07 and OPSS 501 series. As mentioned previously, new fills constructed adjacent to existing fills shall be benched in accordance with OPSD 208.01.

6.4 CONSTRUCTION CONSIDERATIONS

6.4.1 Temporary River Diversion and Dewatering

A temporary creek diversion using an impervious earth dike and/or corrugated steel pipes can be used to facilitate the construction of the culvert foundations adjacent to the existing river. Environmental restrictions shall be addressed for any temporary diversion.

Once the temporary creek diversion has been constructed, a gravity drainage scheme within an oversized excavation with perimeter ditches connected to a sump pump discharge system can then employed to facilitate the culvert foundation construction. The Contractor shall be advised to assess the groundwater conditions in advance of construction to determine any impact on the construction procedure. Disposal of water shall conform to OPSS 518.

6.4.2 Temporary Slopes

Any temporary excavation slopes within the irregular mixture of clayey silt, sand and gravel (Fill Material) or the Heterogenous Mixture of Silt, Sand and Gravel(Glacial Till) to facilitate the construction of the culvert shall not be steeper than 1.5H:1V.

6.4.3 Temporary Shoring

General

Should the required temporary excavation slopes recommended in Section 6.4.2 interfere with the QEW, temporary shoring walls may be required in order to facilitate the construction of the culvert extensions while maintaining traffic on the QEW WB lanes . One viable shoring scheme that can be used at the site is a soldier pile-timber lagging wall as described below.

The protection scheme at the site shall be designed and constructed by the Contractor to satisfy the performance requirements specified in OPSS 941. A Level 2 performance level is recommended at the site. The parameters to facilitate the design in accordance with OPSS 941 are given below. Additional information regarding the design of the temporary shoring is also included in this report for MTO internal purposes only. Design parameters and information only as specified in OPSS 941 shall be included in the Contract Documents and on the Contract Drawings.

Shoring Design

The design of the shoring system shall include the appropriate earth pressures computed using an acceptable method specific to the site conditions and in accordance with Section 6-7 of the

O.H.B.D.C. Loadings induced by any surcharge traffic shall be incorporated in the design . Lateral earth pressures can be computed using the soil design parameters tabulated in Table 4. The active earth pressure coefficient can be used in the design of the shoring wall.

Table 4 - Shoring Design Parameters

Site	Soil	Elevation (m)	Angle of Internal Friction (ϕ)	Unconfined Compressive Strength (kPa)	*Bulk Unit Weight (γ) (kN/m ³)
#1	Irregular Mixture of Silt, Sand and Gravel (Fill Material)	83.1 - 79	30		20
	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)	79-74.5	35		23
	Shale Bedrock(Weathered)	74.5-73		1000	21
	Shale Bedrock(Unweathered)	< 73		10000	23
#2	Irregular Mixture of Silt, Sand and Gravel (Fill Material)	84-81	30		20
	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)	81-77.5	35		23
	Shale Bedrock(Weathered)	77.5-76		1000	21
	Shale Bedrock(Unweathered)	< 76		10000	23

* Buoyant unit weights (γ') are to be used below the groundwater table.

The shoring system must be designed to satisfy earth pressure equilibrium using an appropriate restraining system. At the site, this can be achieved by either a cantilever wall, raker supported wall, or an anchored wall. An appropriate triangular, rectangular or trapezoidal stress envelope shall be chosen to accurately represent the retained soils and the restraining system.

The shoring system method that proves to be the most practical and economical shall be selected. Although the three options are described in this report, the cantilever wall appears to be the most suitable at the sites.

Cantilever Wall

In the design of a cantilever wall, the depth of embedment shall be sufficient to ensure that the wall does not overturn. The active pressures exerted on the wall must be resisted by the passive pressures below the dredge line. Triangular earth pressure distributions can be used in the calculation of the active and passive earth pressures.

Raker Supported Wall

Should the cantilever wall embedment depth be considered excessive, rakers propped against the wall can be used. Raker footings can be founded within the native Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) deposit below the frost penetration depth using the bearing capacities tabulated in Table 2. Raker foundations can be founded at Elevation 77.6 m at Site #1 and at Elevation 79.7 at Site #2.

All organic and deleterious native soils and any fill material shall be removed prior to the construction of the raker foundations.

Anchored Wall

Alternatively, the shoring wall can be supported by rock anchors installed with the bond zone within the unweathered shale bedrock. Rock anchors within the shale bedrock can be designed with an

allowable grout/rock bond stress of 300 kPa. Rock anchors can be either monobar or multistrand steel anchors installed in predrilled holes.

The soldier piles can be designed with tip elevations situated within the Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till) or the Shale Bedrock.

Shoring Construction

In view of the denseness of the native Heterogeneous Mixture of Silt, Sand and Gravel at the site and also to avoid excessive vibration caused by driving and the detrimental impact that this may have on the existing structure foundations, it is recommended that the soldier piles be installed in pre-augered holes. Vibrating or driving liners to facilitate the pre-augering is not considered acceptable at the site.

The Contractor shall maintain the stability of the pre-augered holes throughout the excavation and installation of the soldier piles. An NSSP covering the requirements of soldier pile construction shall be included in the contract documents. A copy of this NSSP can be obtained from our office. Within this NSSP, the Contractor shall be alerted that the cohesionless Heterogeneous Mixture of Silts, Sands and Gravels (Glacial Till) submerged below the groundwater table may slough into the hole during augering as a result of unbalanced hydrostatic conditions. In addition, the Contractor shall be advised that boulders and cobbles are characteristic components of glacial till deposits and hence can exist at the site.

Should rock anchors be used, it is recommended that a NSSP be included in the Contract documents

that specifies materials, installation and proof testings of the anchors. This NSSP can be obtained from our office.

Rakers shall be installed while an earth berm remains in front of the pile. Slots should be cut into this berm to install the rakers before the supporting berm is removed.

7.0 MISCELLANEOUS

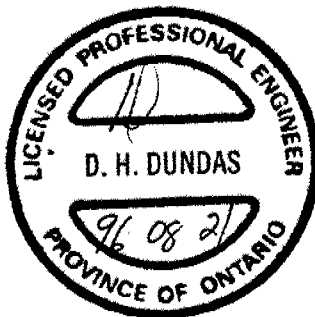
The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, utilizing equipment owned and operated by Malones Soil Samples.

The report was prepared by T. Sangiuliano and reviewed by D. Dundas, Senior Foundation Engineer.



A handwritten signature in black ink, appearing to read "T. Sangiuliano".

T. Sangiuliano, P. Eng.
Foundation Engineer

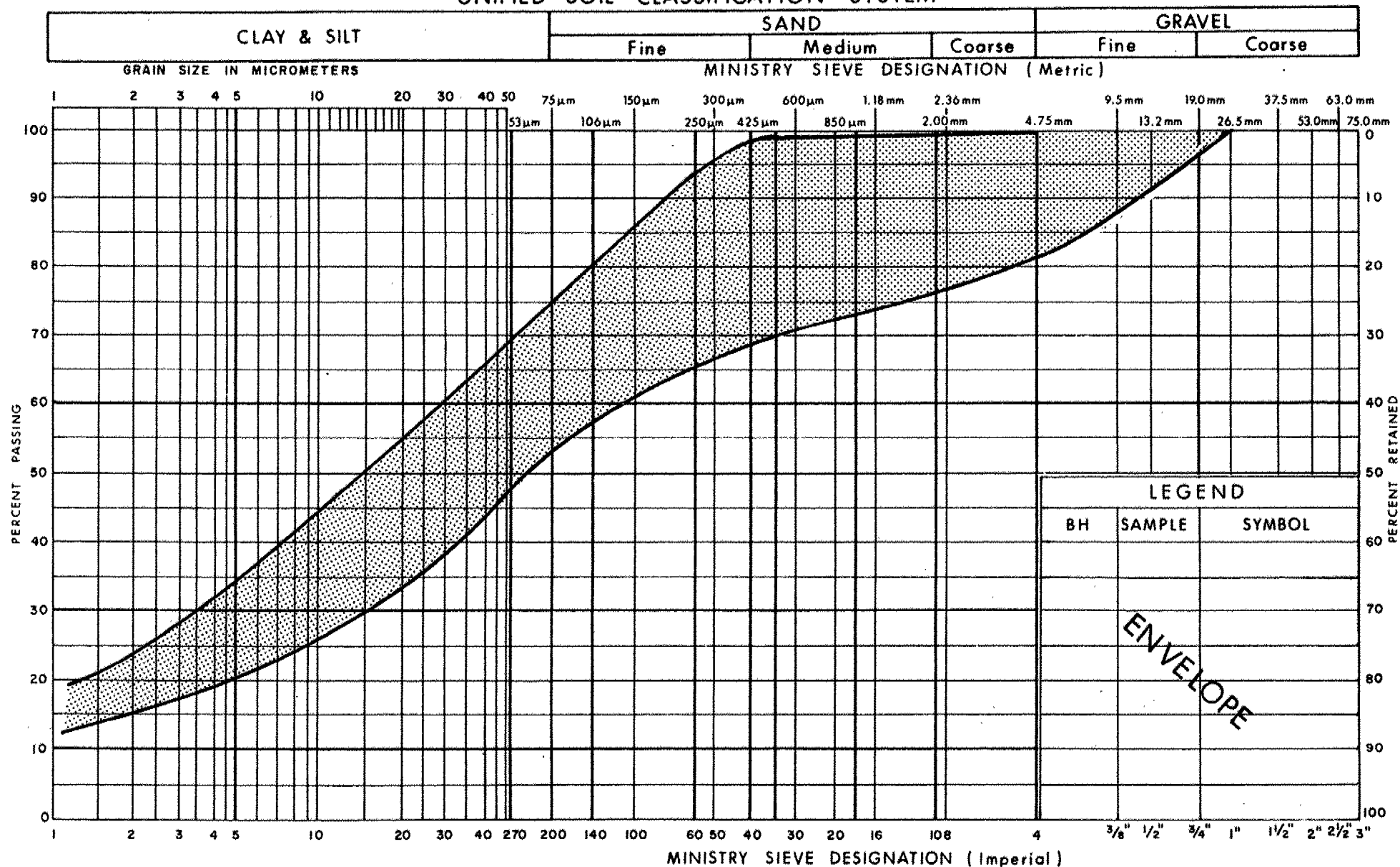


A handwritten signature in black ink, appearing to read "D. Dundas".

D. Dundas, P. Eng.
Senior Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

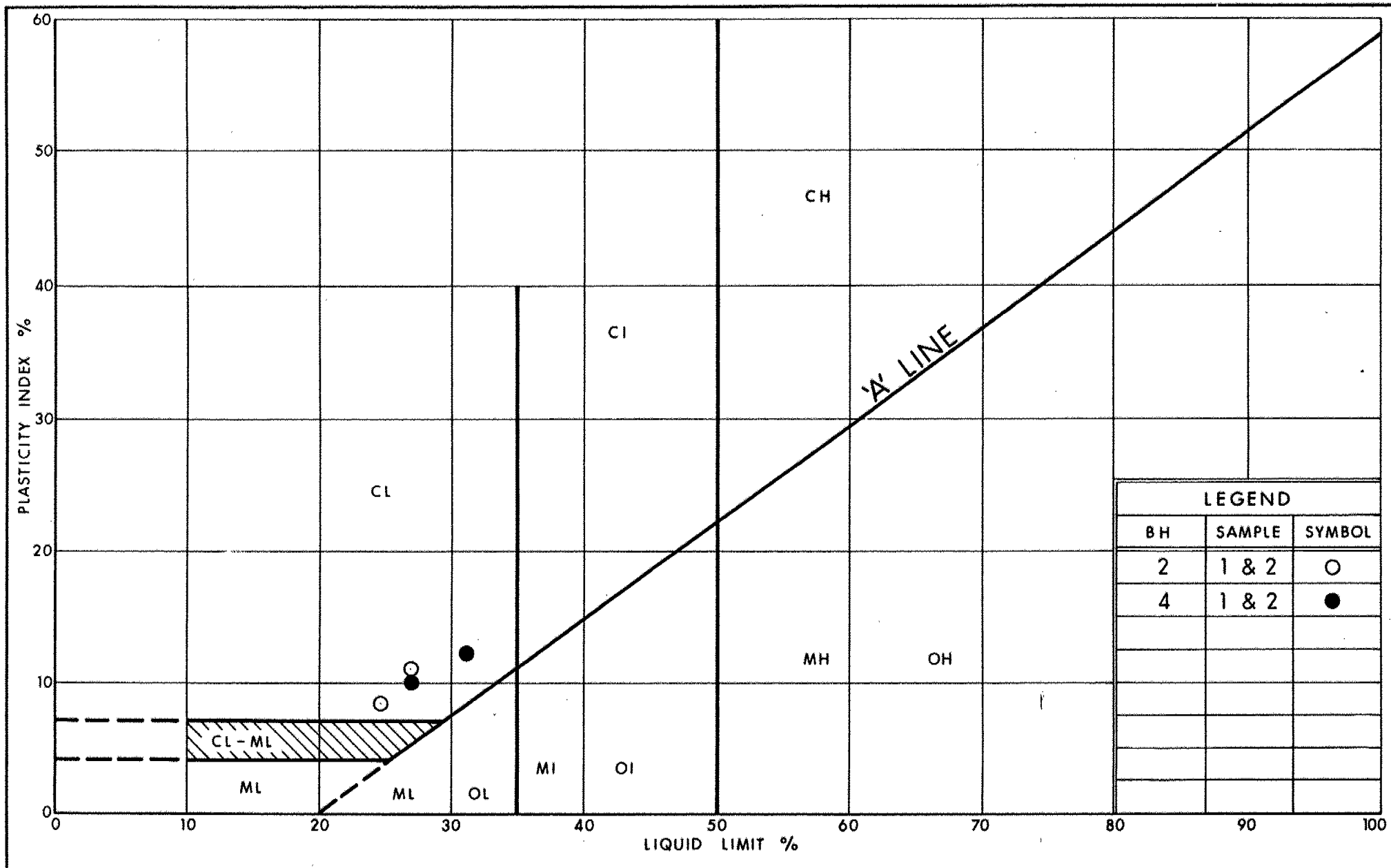


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
IRREGULAR MIXTURE OF
CLAYEY SILT, SAND & GRAVEL (FILL MATERIAL)

FIG No 1

W P 335-89-00A



Ministry of
Transportation

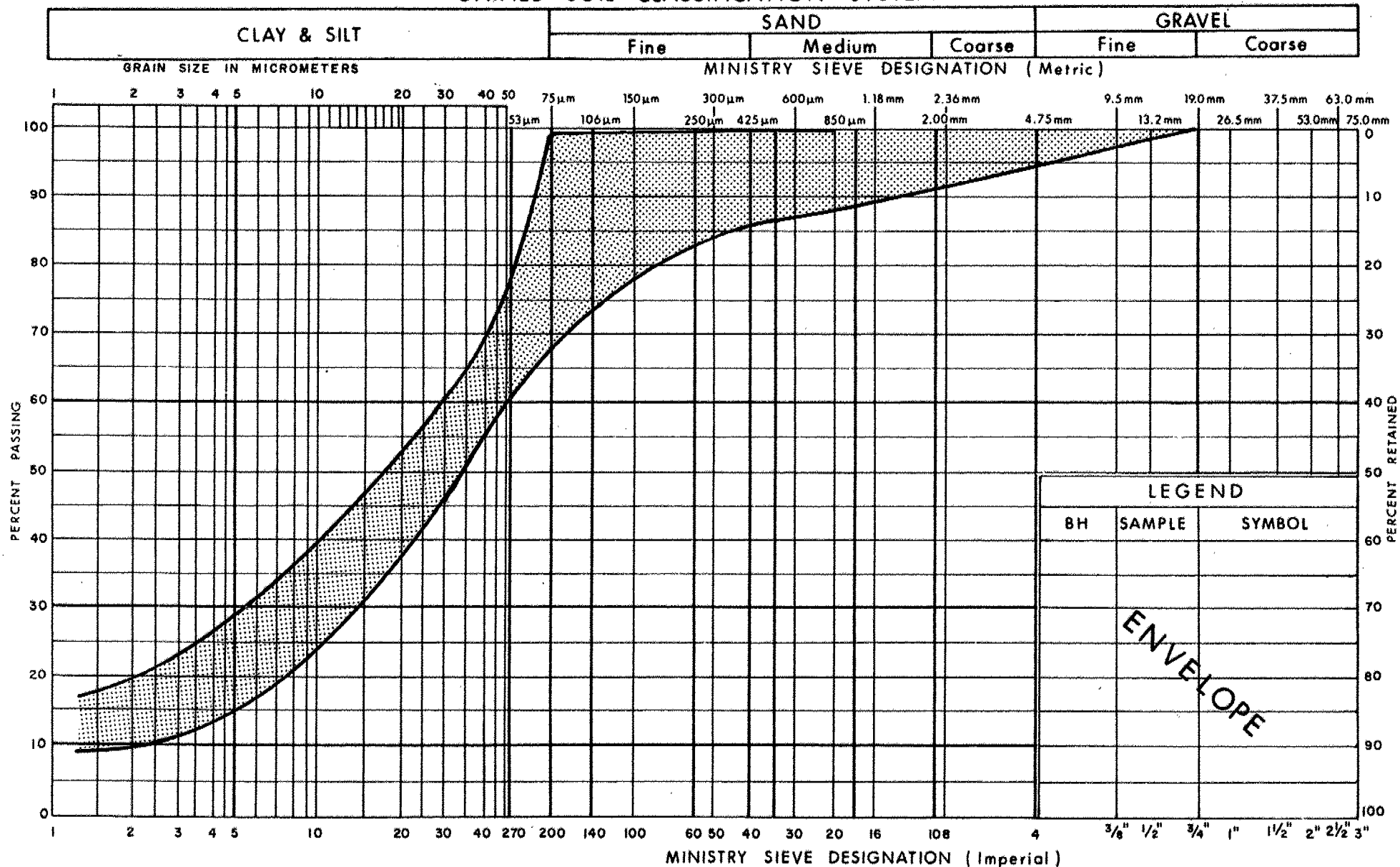
Ontario

PLASTICITY CHART
IRREGULAR MIXTURE OF
CLAYEY SILT, SAND & GRAVEL (FILL MATERIAL)

FIG No 2

W P 335-89-00A

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
 HETEROGENEOUS MIXTURE OF
 SILT, SAND & GRAVEL (Glacial Till)

FIG No 3

W P 335-89-00A

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 335-89-00A LOCATION Co-ords: N 4 782 777.1 E 313 153.1 ORIGINATED BY TS
 DIST CR HWY QEW BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 96 04 29 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
80.2	Ground Surface																
0.0	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		1	AS	-		80										
	Brown		2	SS	100	/15cm	79										
	Red		3	SS	110		78						○	H		24.4	0 9 78 13
	Very Dense		4	SS	55		77										
	Shale fragments		5	SS	95		76						○	H		23.2	0 4 82 14
			6	SS	100	/15cm	75										
74.4			7	SS	100		74						○	H			
5.8	Shale Bedrock with interbedded Siltstone		8	SS	100	/8cm											
	Greyish Red to Greenish Grey Slightly Weathered to Weathered Very Weak to Weak		9	SS	100	/5cm											
73.3																	
6.9	End of Borehole																
	* 96 04 30																

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 335-89-00A LOCATION Co-ords: N 4 782 764.1 E 313 161.4 ORIGINATED BY TS
DIST CR HWY QEW BOREHOLE TYPE SS Auger, NW Casing, NX Core COMPILED BY TS
DATUM Geodetic DATE 96 04 29 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
83.1	Ground Surface(Shoulder)																
0.0	Sand and Gravel (Fill Material)					*											
82.3	Brown, Compact																
0.8	Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)																
	trace Organics		1	SS	4											20.9	3 18 56 23
	Soft																
	Brown																
	Grey		2	SS	3											20.3	0 26 54 20
78.8																	
4.3	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		3	SS	70												
	Red, Very Dense																
			4	SS	60	/8cm											
			5	SS	100												
74.7			6	SS	60	/5cm											
8.4	Shale Bedrock with interbedded Siltstone																
	Weathered																
	Slightly Weathered to Unweathered		7	RC	REC = 96%												RQD = 7%
73.1	Greyish Red to Greenish Grey Very Weak to Weak																
10.0	End of Borehole																
	* GWL not established																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 335-89-00A LOCATION Co-ords: N 4 782 792 E 312 908.7 ORIGINATED BY TS
 DIST CR HWY QEW BOREHOLE TYPE SS Auger COMPILED BY TS
 DATUM Geodetic DATE 96 04 29 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _P	W	W _L		
82.1	Ground Surface															
0.0	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)															
	Very Dense	1	SS	47												
	Brown	2	SS	110	/20cm										23.7	5 26 60 9
	Red	3	SS	104												
		4	SS	90												
77.2		5	SS	92	/18cm										22.8	0 1 81 18
4.9	Shale, Bedrock with interbedded Siltstone															
76.6	Greyish Red to Greenish Grey Weathered	6	SS	100	/15cm											
5.5	End of Borehole															
	* 96 04 30															

RECORD OF BOREHOLE No 4

1 OF 1 METRIC

W.P. 335-89-00A LOCATION Co-ords: N 4 782 777.9 E 312 903.8 ORIGINATED BY TS
 DIST CR HWY QEW BOREHOLE TYPE SS Auger, NW Casing, NX Core COMPILED BY TS
 DATUM Geodetic DATE 96 04 30 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT UNIT W _p	NATURAL MOISTURE CONTENT UNIT W	LIQUID LIMIT UNIT W _L	WATER CONTENT (%) W	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						
82.4	Ground Surface																	
0.0	Irregular Mixture of Clayey Silt, Sand and Gravel (Fill Material)		1	SS	2	*	82										21.3	2 25 53 20
	Trace Organics		2	SS	10												21.1	18 29 38 15
80.9	Brown, Soft						81											
1.5	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		3	SS	55													
	Red, Very Dense		4	SS	90		80										21.4	1 24 63 12
	Shale Fragments		5	SS	100		79											
			6	SS	100	/18cm	78											
77.8							77											
4.6	Shale Bedrock with interbedded Siltstone Greyish Red to Greenish Grey		7	SS	120													
	Weathered Slightly Weathered to Unweathered		8	RC	REC	= 92%	76											ROD = 70%
75.8	Very Weak to Weak																	
6.6	End of Borehole * GWL not established																	

ROCK CORE DESCRIPTION **WP 335-89-00A**

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
2	7	8.43-9.96	95	7	8.43-9.96	SHALE , greyish red, with 3% interbedded greenish grey SILTSTONE and 1% gypsum occurring as interbeds up to 1 mm thick and nodules up to 5 cm in diameter; very fine grained; very weak to weak; unweathered to slightly weathered (moderately weathered, 8.43-9.02 m); fractures close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.
4	8	5.03-6.55	92	70	5.03-6.55	SHALE , greyish red, with 15% interbedded greenish grey SILTSTONE and 1% gypsum occurring as interbeds up to 1 mm thick and nodules up to 5 cm in diameter; very fine grained; very weak to weak; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%
 Logged by: DAW, Soils and Aggregates Section

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_r	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

METRIC

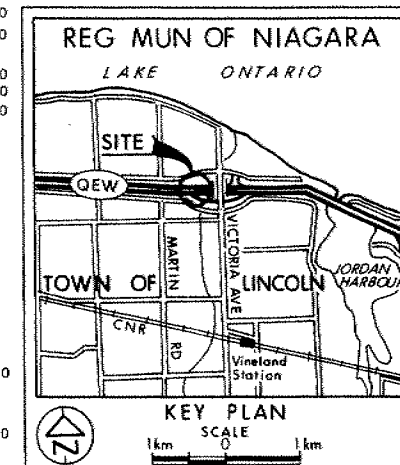
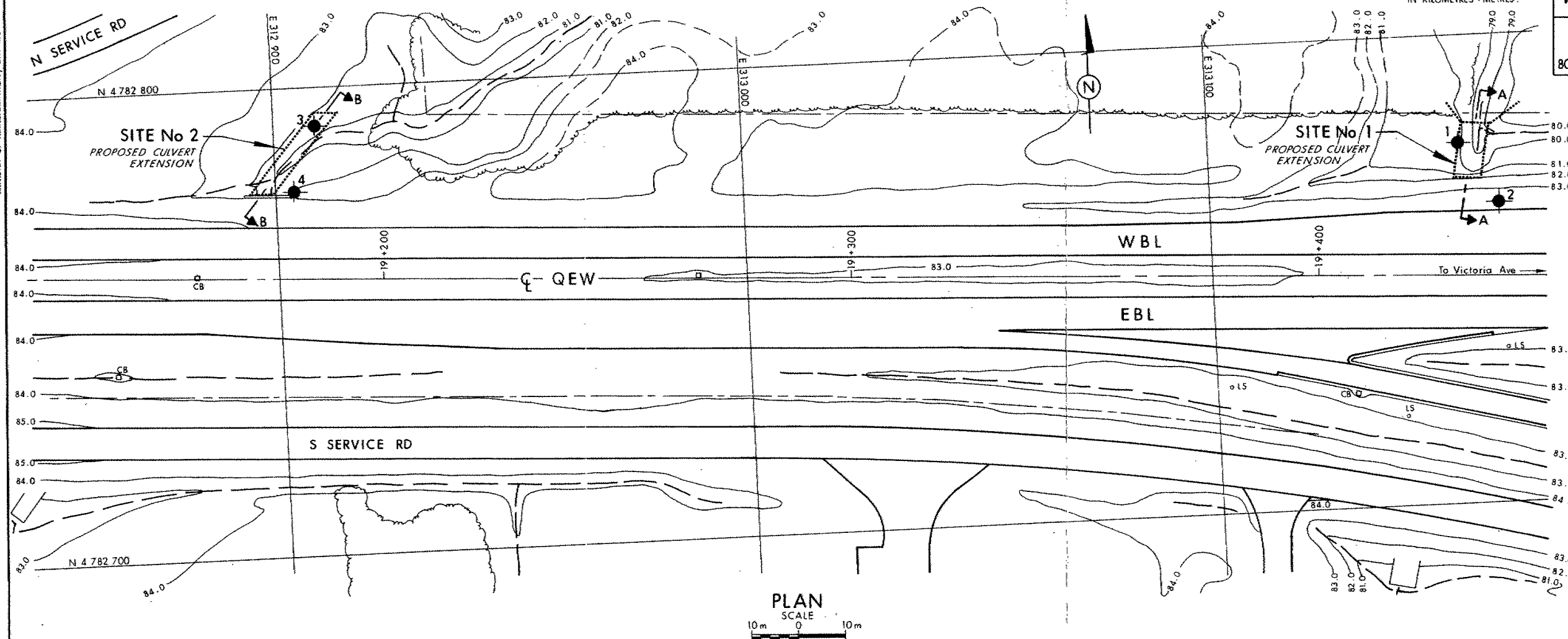
DIMENSIONS ARE IN METRES
AND / OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 335-89-00A



PROP CULVERT EXTENSIONS
VICTORIA AVE INTERCHANGE
BORE HOLE LOCATIONS & SOIL STRATA

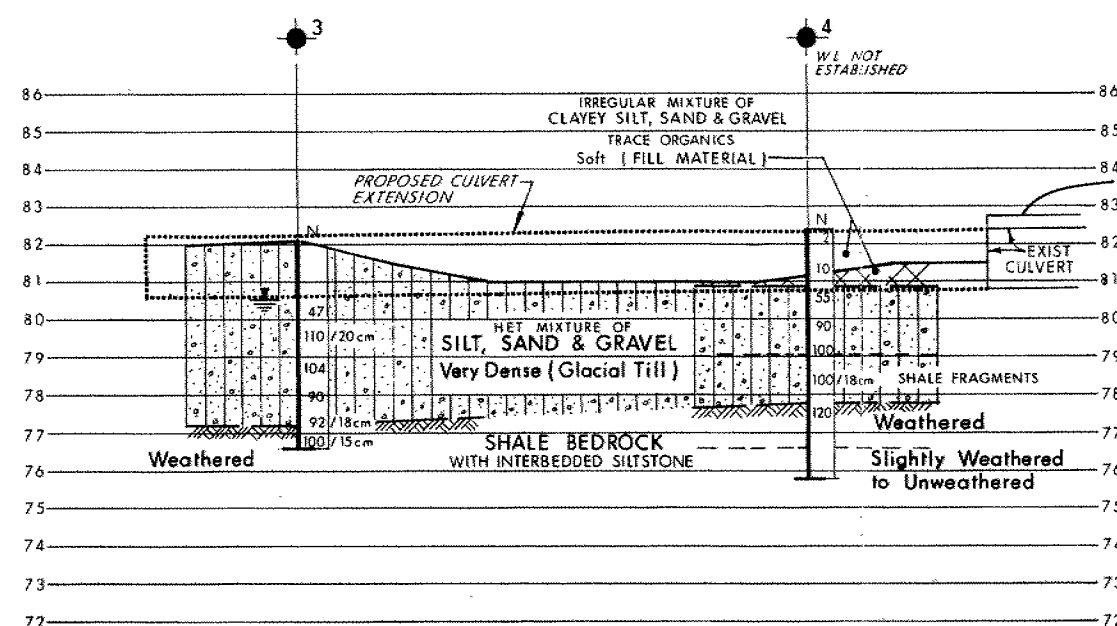
SHEET



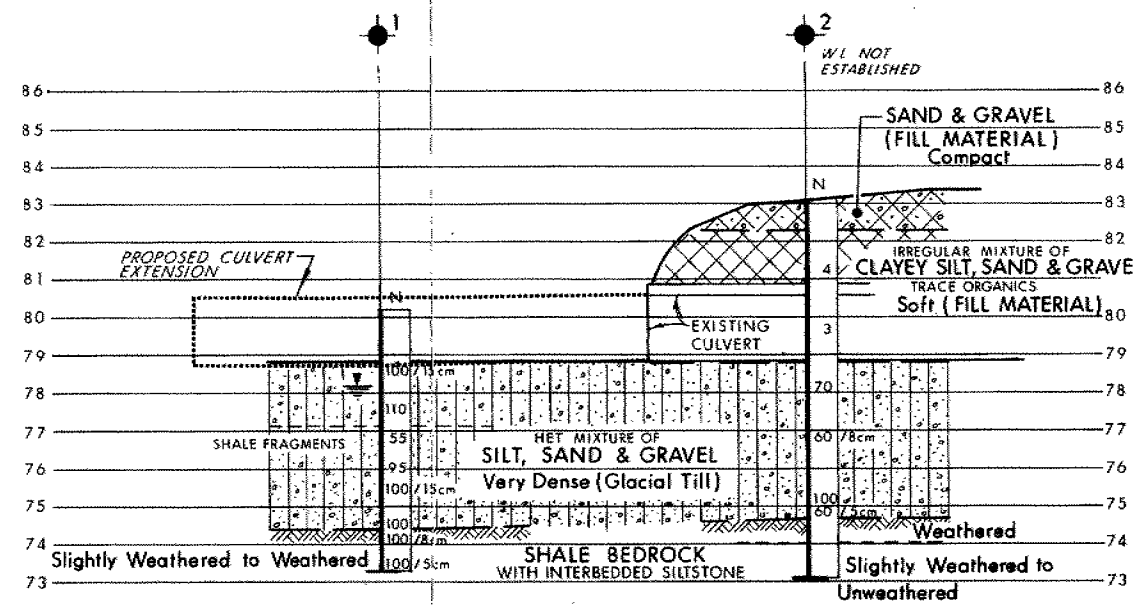
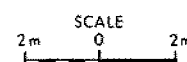
LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1996 04

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	80.2	4 782 777.1	313 153.1
2	83.1	4 782 764.1	313 161.4
3	82.1	4 782 792.0	312 908.7
4	82.4	4 782 777.9	312 903.8



SECTION B-B (SITE No 2)



SECTION A-A (SITE No 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.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REV.	DATE	BY	DESCRIPTION
1			
2			
3			
4			

Geocres No 30M3-208

HWY No QEW	DIST CR
SUBWD T5	CHECKED/5
DATE 1996 08 12	SITE
DRAWN RS	CHECKED/5
APPROVED	DWG 3358900A-A