Jacques Whitford

Engineering,
Scientific,
Planning and
Management
Consultants

2781 Lancaster Road
Suite 200
Ottawa Ontario
Canada K1B 1A7

Bus 613 738 0708
Fax 613 738 0721

www.jacqueswhitford.com

FINAL REPORT

FOUNDATION INVESTIGATION
W.P. 5768-04-00
HIGHWAY 60 –
LONG LAKE CREEK
CULVERT REPLACEMENT
SITE NO. 40-121

Harmer Podolak Engineering

PROJECT NO. 1004574
GEOCRES NO. 31E-241

PROJECT NO. 1004574

FINAL REPORT –
FOUNDATION INVESTIGATION

TO

Harmer Podolak Engineering
221 – 39 Robertson Road
Ottawa, ON K2H 8R2

ON

W.P. 5768-04-00

Highway 60 –
Long Lake Creek
Culvert Replacement
Site No. 40-121

Geographic Township of McClintock

District 52, Huntsville

Ministry of Transportation Ontario

Geocres No. 31E-241

March 10, 2006

Jacques Whitford
2781 Lancaster Road
Suite 200
Ottawa, Ontario
K1B 1A7

Phone: 613-738-0708
Fax: 613-738-0721
www.jacqueswhitford.com

Jacques Whitford

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FOUNDATION INVESTIGATION REPORT

for

W.P. 5768-04-00
Highway 60 – Long Lake Creek Culvert
Site No. 40-121
Geographic Township of McClintock
District 52, Huntsville

1.0 INTRODUCTION

This report was prepared in conjunction with the Detailed Design Study for Highway 60; Long Lake Culvert, W.P. 5768-04-00.

This report presents the results of a foundation investigation carried out for the proposed replacement of the existing Long Lake Creek Culvert on Highway 60, approximately 16 km east of the junction of Highways 60 and 35.

The foundation investigation was carried out in general accordance with our proposal number 1002289 dated July 12, 2005. Authorization to proceed was provided by the Ministry of Transportation of Ontario (MTO) under Agreement Number 5005-E-0007 with Harmer Podolak Engineering Consultants Inc. (Harmer Podolak), the Prime Consultant for this project.

This report has been prepared specifically and solely for the project described herein. It contains factual information pertaining to the subsurface conditions which was obtained as part of this investigation.

2.0 SITE DESCRIPTION AND GEOLOGY

The subject site is within the limits of MTO project W.P. 5768-04-00 (Highway 60). The site location is shown on the Key Plan inset to Drawing No. 1004574-1 provided in Appendix A. Photographs of the site are provided in Appendix C. It is noted that for project orientation purposes, Highway 60 will be assumed to run east-west with chainage increasing from west to east.

Physiographically, the site is located within the Algonquin Highlands. This region is characterized by rough rounded knobs and ridges with frequent outcrops of bare rock. The bedrock is generally shallow, however, the depth to bedrock varies greatly over short distances. Many of the valleys are floored with outwash sand and gravel. There are frequent swamps and bogs.

Long Lake Creek flows from south to north and is less than 5 m in width upstream of the highway. Water depths in the culvert vary significantly. Virtually no water was present during a site visit in September 2005. At the time of the drilling in November 2005 water levels had risen to higher than 700 mm. Water levels are influenced by a beaver dam upstream of the site. The surveyed water level at the inlet at the time of the investigation was 405.6 m Geodetic.

The existing roadway embankments are approximately 6 m high at the culvert. The highway embankment is approximately 20 m in total width and consists of the existing paved roadway on the north half and an abandonned alignment to the south. A shallow ditch separates the existing and abandonned alignments. Rockfill is exposed on the northern embankment slope which is sloped at approximately 1.25H:1V. Sand and gravel fill with frequent cobbles and boulders is present on the south embankment slope which is sloped at approximately 1.5H:1V. The ground surface off the embankment, within the highway right-of-way is vegetated with grass. Mature trees are present beyond the edges of the cleared right-of-way. Drainage in the area consisted of overland flow directed towards the creek. A low lying swampy area is present around the creek, north of the embankment.

Bedrock outcrops to the south and east of the culvert consist of massive to intact horneblende gneiss. Similar bedrock outcrops are present in roadway cuts to the east and west of the site.

The north half of the existing culvert consists of a, concrete open box culvert (open footing), 4.88 m wide and 1.8 m high. It is understood that the elevation of the top of the existing footing is 404.8 m Geodetic. The south half of the existing culvert is a 3.6 m by 2.3 m structural plate pipe arch with a grouted corrugated steel pipe liner. It is understood that the elevation of the stream bed at the inlet is 405.1 m Geodetic.

A plan view and cross sections are shown on Drawing No. 1004574-1 provided in Appendix A.

3.0 PROCEDURE

3.1 Field Investigation

The site soil conditions were investigated with a borehole drilling investigation and laboratory testing program. The drilling was carried out using a combination of a truck-mounted CME-55 drill rig and a portable drill rig between November 5 and 18, 2005.

Drills were supplied and operated by Colbar Resources and OGS Drilling Limited under the supervision of E. Hamilton, B.Sc. of Jacques Whitford.

Dean Flanagan of Jacques Whitford carried out a quality control inspection of the site early in the drilling operations.

A total of ten (10) boreholes were put down during the field investigation. Boreholes 05-3, 05-4 and 05-7 were not drilled due to access restrictions.

All boreholes were advanced using casing. The subsurface conditions were identified in the field by Jacques Whitford Limited (JW) personnel from samples obtained while carrying out Standard Penetration Tests (SPT) (ASTM D1586) at regular intervals (760 mm at shallow depths to 3 m at depths greater than 15 m). Boreholes along the length of the culvert were advanced into bedrock using NQ sized coring equipment. Boreholes along the northern toe of the embankment terminated at SPT refusal. Standpipes were installed in Boreholes 05-10 and 05-12. The recovered soil samples were stored in moisture proof containers and returned to our laboratory. The subsurface conditions encountered are described in detail in the Borehole Records presented in Appendix B.

Prior to completing the investigation, the boreholes were backfilled with a bentonite mixture and auger cuttings.

3.2 Survey

Borehole locations were established in the field by Jacques Whitford personnel by measuring relative to existing site features such as the existing culvert. The ground surface elevations at the borehole locations were surveyed relative to a MTO benchmark identified as PBM 748393, located to the south of Highway 60. The location of the benchmark is indicated on Drawing 1004574-1 in Appendix A. It is understood that the Benchmark has an elevation of 411.523 m Geodetic.

3.3 Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual classification by a geotechnical engineer. Routine testing, consisting of moisture content testing, and grain size distribution analysis was carried out on representative samples. Two representative soil samples were submitted for pH, sulphate and resistivity testing to assess the potential for corrosion of buried steel and the potential for sulphate attack on buried concrete.

Advanced geotechnical testing was deemed not to be necessary based on the soil conditions.

All soil samples will be stored for a period of one year after issuance of the final version of the preliminary foundation investigation report. Unless otherwise directed, the stored samples will be disposed of after this period.

4.0 SUBSURFACE CONDITIONS

4.1 Subsurface Profile

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided. In general, the subsurface profile consists of granular fill over rockfill over native glacial till over bedrock.

Borehole location plans and stratigraphic sections of the soils encountered within the boreholes are provided on Drawing 1004574-1 in Appendix A.

4.1.1 Fill: Gravel, with Sand

Granular fill was encountered at ground surface in both of the boreholes located on the existing Highway 60 embankment (05-1 and 05-2). The fill consisted of gravel with sand and is part of the roadway pavement structure. The thickness of the granular fill, where present, was 0.6 m. The underside of the granular fill was observed to range from elevation 410.0 m to 410.9 m.

4.1.2 Rock Fill

A rock fill was observed beneath the granular fill in Boreholes 05-1 and 05-2. The rock fill consisted of cobble and boulder sized material. The rock fill exposed on the north embankment side slope includes boulders as large as 2 m in size. The rock fill extended to depths of 7.6 m and 7.0 m in Boreholes 05-1 and 05-2 (elevations 403.9 m and 403.6 m) respectively. The boreholes could only be advanced by coring through the rock fill. No core was recovered in the rock fill however our interpretation is that the rock fill is probably well graded. . The materials exposed on the slopes consists of gneiss similar to the bedrock which is described below.

4.1.3 Organic Material

An appreciable organic layer was observed at only two borehole locations. A peat material was encountered in Borehole 05-09 (0.3 m thick) and 05-12 (0.6 m thick).

4.1.4 Silty Sand to Gravelly Sand

A layer of silty sand to gravelly sand was observed in Boreholes 05-5, 05-6 and 05-8 through 05-13. This native material exhibited local lenses of coarser material (05-08 and 05-12) and finer material (05-09). The thickness of this deposit, where fully penetrated, ranged from 0.3 m to 3.7 m. Where full penetration was confirmed, the base of the unit varied from elevation 401.9 m to 403.9 m. Practical refusal to SPT driving was also encountered at significantly higher elevations ranging from 404.5 m to 412.0 m within or possibly at the base of this unit. SPT 'N' values ranged from 2 to 40 and average 17, suggesting a generally compact state. The moisture content of the 8 samples tested ranged from 7% to 33% with an average of 15%. Grain size analysis of seven samples (five full sieves and two wash tests) indicated that the samples contained 12% to 32% gravel, 56% to 77% sand and 8% to 21% silt and clay sized particles. The results of the grain size distribution tests are shown on Figure 1 in Appendix B. This material ranges from an SM to SP-SM to SW-SM soil using the MTO Soil Classification System.

4.1.5 Bedrock

Bedrock was proven by coring in Boreholes 05-1, 05-2, 05-5, 05-6 and 05-8. The bedrock was observed to consist of siliceous metasediment, generally horneblende gneiss. Banding is common with quartz rich and mica rich layers contrasting with the more massive gneissic matrix. A consistent joint set was observed at approximately 70° from the axis of the cores. This set was observed to be synchronous with mica or quartz banding. A second, less prevalent joint set was observed to have an orientation of approximately 10° from the axis of the core. This joint set was observed to have openings of as much as 3 mm filled with black shale particularly near the upper bedrock surface. Some rusting was also present. The joint surfaces were generally smooth with a sandy texture. Core recoveries ranged from 81% to 100% and averaged 93%.

RQD values on the recovered cores ranged from 0% to 83% and averaged 48%. This indicates a poor quality or severely fractured bedrock. Unconfined compressive strength testing was carried out on three samples with strength results ranging from 132 MPa to 149 MPa. The bedrock elevations encountered at the borehole locations are provided in the following table:

Table 4.1: Proven Bedrock Elevations

Borehole	Bedrock Elevation, Geodetic
05-1	403.9 m
05-2	403.6 m
05-5	401.9 m
05-6	403.8 m
05-8	403.9 m

4.2 Groundwater

Groundwater levels were measured in the standpipes on November 18, 2005. Away from the culvert, groundwater levels ranged from 0.5 m to 0.6 m below ground surface. The water level in Long Lake Creek on November 10, 2005, was surveyed to be at elevation 405.6 m and 404.9 m at the inlet and outlet of the culvert respectively. The groundwater level in the vicinity of the culvert is anticipated to be close to the creek water level.

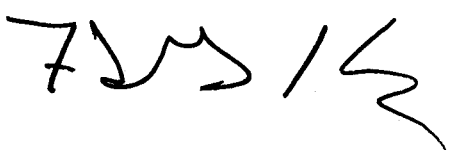
Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

5.0 CLOSURE

A subsurface investigation is a limited sampling of a site. The subsurface conditions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Yours very truly,

JACQUES WHITFORD LIMITED



Fred J. Griffiths, Ph.D., P.Eng.
Designated Principal MTO Foundation Contact

J.G.A. Raymond Haché, M.Sc., P.Eng., PMP
Designated Principal MTO Foundation Contact

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APPENDIX A

Borehole Location Plan and Profile Plot

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

CONT No
WP No 5768-04-00

LONG LAKE CULVERT REPLACEMENT
STA 21+177.25 TO STA 21+300
BORE HOLE LOCATIONS & SOIL STRATA

SHEET 1

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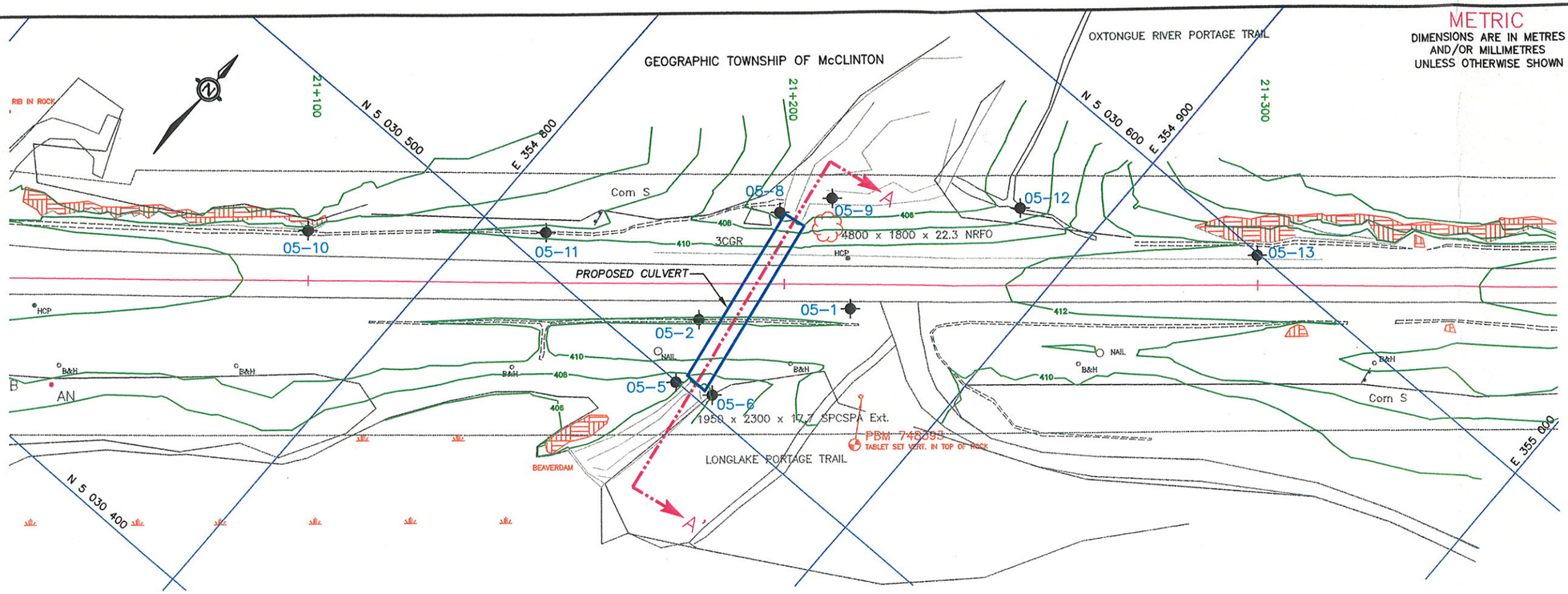
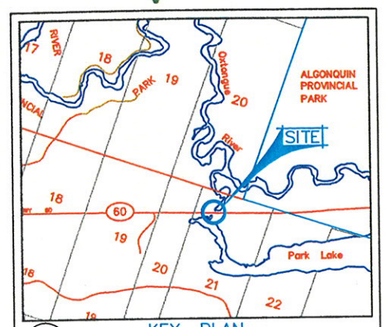
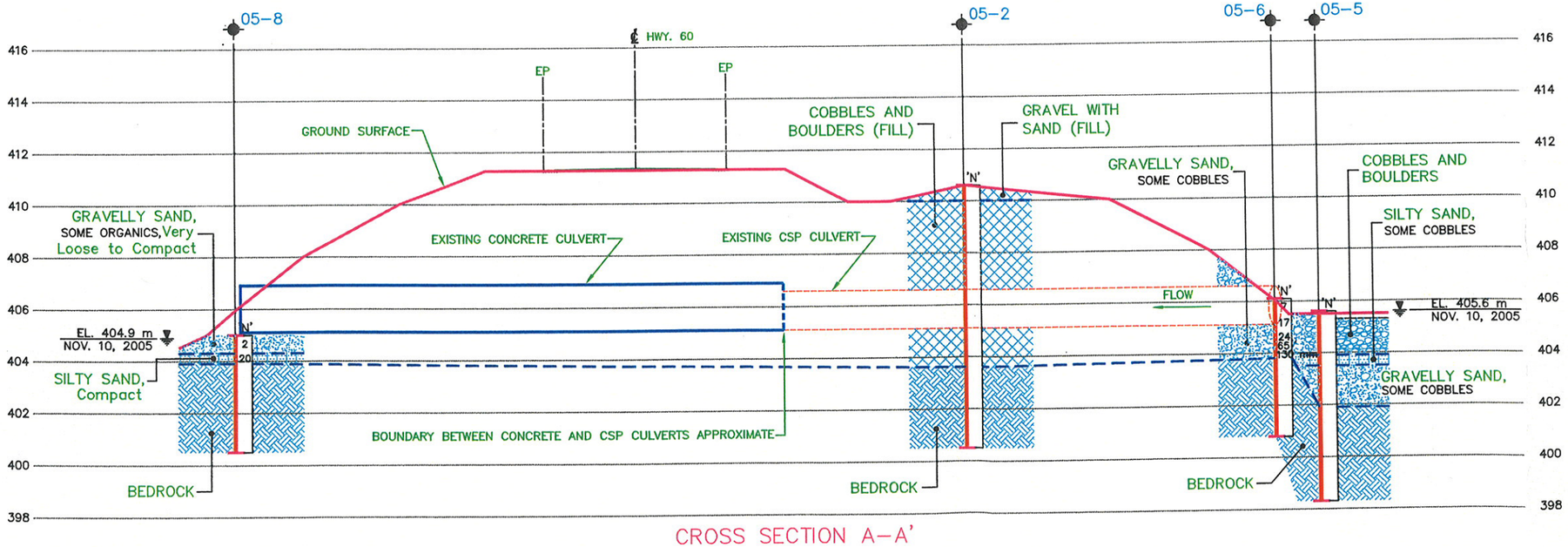


PLAN
SCALE
10m 0 10 20m



NOTE: THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION ONLY. THE PROPOSED STRUCTURE LOCATION AND FEATURES ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT BE CONSISTENT WITH THE FINAL DESIGN CONFIGURATION AS SHOWN ELSEWHERE IN THE CONTRACT DOCUMENTS.



CROSS SECTION A-A'
SCALE
2m 0 2 4m

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)
- WL at time of investigation
- WL in Piezometer
- Piezometer
- BEDROCK OUTCROP

No	ELEVATION	COORDINATES NORTH	EAST
05-1	411.5	5 030 535.5	354 871.0
05-2	410.6	5 030 512.9	354 848.2
05-5	405.6	5 030 499.9	354 853.0
05-6	406.1	5 030 502.8	354 860.6
05-8	405.0	5 030 541.1	354 846.6
05-9	404.6	5 030 550.5	354 853.1
05-10	411.0	5 030 473.7	354 773.9
05-11	409.8	5 303 506.0	354 812.1
05-12	407.0	5 030 574.8	354 884.9
05-13	412.2	5 030 599.6	354 929.4

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 102-2 of Form 100.

REVISIONS	DATE	BY	DESCRIPTION
	---	--	

GEOCRES No 31E-241

HWY No 60			DIST 52
SUBM'D FJG	CHECKED	DATE 2006/12/16	SITE 40-121
DRAWN GBB	CHECKED	APPROVED	DWG 1004574-1

APPENDIX B

Symbols and Terms Used on Borehole Records
Borehole Records
Grain Size Distribution Test Results

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting good vegetative growth
Peat	-	fibrous aggregate of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	>75 mm
Seam	-	2 mm to 75 mm
Parting	-	< 2 mm
Well Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Uniformly Graded	-	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the Unified Soil Classification System (USCS) (ASTM D-2488). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%

The standard terminology to describe cohesionless soils includes the compactness (formerly "relative density"), as determined by laboratory test or by the Standard Penetration Test 'N' - value.

Relative Density	'N' Value	Compactness %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

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Consistency	Undrained Shear Strength		'N' Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25-0.5	12.5-25	2-4
Firm	0.5-1.0	25-50	4-8
Stiff	1.0-2.0	50-100	8-15
Very Stiff	2.0-4.0	100-200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from in situ fractures.

RQD	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000-6000	*Very Thick*	*Very Wide*
600-2000	*Thick*	*Wide*
200-600	*Medium*	*Moderate*
60-200	*Thin*	*Close*
20-60	*Very Thin*	*Very Close*
<20	*Laminated*	*Extremely Close*
<6	*Thinly Laminated*	

Strength Classification	Uniaxial Compressive Strength (MPa)
Very Low	1-25
Low	25-50
Medium	50-100
High	100-200
Very High	>200

Terminology describing weathering:

Slight - Weathering limited to the surface of major discontinuities. Typically iron stained.

Moderate - Weathering extends throughout rock mass. Rock is not friable.

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High - Weathering extends throughout rock mass. Rock is friable.

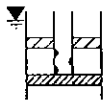
STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

WATER LEVEL MEASUREMENT

Borehole or Standpipe



Piezometer

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits.

N - VALUE

Numbers in this column are the results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75).

OTHER TESTS

S	Sieve analysis
G_s	Specific gravity of soil particles
k	Permeability (cm/sec)
	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer
H	Hydrometer analysis
γ	Unit weight
C	Consolidation
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct shear
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$; the index corrected to a reference diameter of 50 mm)

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RECORD OF BOREHOLE No BH05-01 1 OF 2 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+214 Offset 5.0 m Rt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 14.11.05 - 14.11.05 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
411.5											
0.0 / 410.9	Gravel, with sand, brown (FILL)						411				
0.6	Cobbles and Boulders (ROCK FILL)		1	NQ			410				REC = 0
							409				
			2	NQ			408				REC = 0
							407				
			3	NQ			406				
403.9							405				REC = 0
7.6	Hornblende Gneiss BEDROCK		4	NQ			404				
							403				REC = 92 RQD = 63
			5	NQ			402				
											REC = 91 RQD = 45

Continued Next Page

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity ε 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH05-01 2 OF 2 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+214 Offset 5.0 m Rt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 14.11.05 - 14.11.05 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Hornblende Gneiss BEDROCK		6	NQ			400				REC = 88 RQD = 83
399.3 12.2	End of Borehole										

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

RECORD OF BOREHOLE No BH05-02 1 OF 1 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+182 Offset 7.5 m Rt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 18.11.05 - 18.11.05 CHECKED BY FG

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
410.6	Old highway										
0.0	Gravel, with sand, brown (FILL)										
410.0							410				
0.6	Cobbles and Boulders (ROCK FILL)		1	NQ			409				REC = 0
			2	NQ			408				REC = 0
			3	NQ			407				REC = 0
			4	NQ			406				REC = 0
403.6							405				
7.0	Sound Hornblende Gneiss BEDROCK		5	NQ			404				REC = 93 RQD = 71
			6	NQ			403				REC = 93 RQD = 71
400.6							402				
10.1	End of Borehole						401				

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity $\lesssim^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No BH05-05 1 OF 1 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+177 Offset 20.6 m Rt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 08.11.05 - 09.11.05 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
405.6 Water											
0.0 / 405.3	WATER										
0.3 / 404.0	COBBLES and BOULDERS		1	GS			405				
1.7 / 403.5	SILTY SAND, some cobbles, dark grey (SM)						404				
2.1 / 401.9	GRAVELLY SAND, some cobbles, greyish brown (SP - SM)						403				
3.7	Horneblende Gneiss BEDROCK		2	NQ			402				REC = 81 RQD = 45
							401				
			3	NQ			400				REC = 100 RQD = 50
398.3							399				
7.3	End of Borehole										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH05-06 1 OF 1 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+185 Offset 23.3 m Rt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 07.11.05 - 08.11.05 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
406.1	Cobbles, blast rock						406				
0.0	GRAVELLY SAND, some cobbles, trace silt (SP - SM)		1	SS	7						
	Becoming compact		2	SS	17		405				
			3	SS	24				○		30 62 (9)
403.8			4	SS	65/ 130 mm		404		○		32 56 (12)
2.3	Hornblende Gneiss BEDROCK		5	NQ							REC = 96 RQD = 35
			6	NQ			403				REC = 96 RQD = 42
			7	NQ			402				REC = 86 RQD = 36
400.8							401				
5.3	End of Borehole										

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

RECORD OF BOREHOLE No BH05-08 1 OF 1 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+199 Offset 15.0 m Lt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 10.11.05 - 10.11.05 CHECKED BY FG

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
405.0	Long grass, small trees, boulders										
0.0	GRAVELLY SAND, some organics, very loose, dark brown (SP - SM)		1	SS	2				○		27 65 (8)
404.4											
404.8	Gravel										
0.7	SILTY SAND, compact, dark brown to grey (SM)		2	SS	20		404		○		22 64 (14)
403.9											
1.1	Homeblende Gneiss BEDROCK		3	NQ							REC = 100 RQD = 0
			4	NQ			403				REC = 96 RQD = 51
			5	NQ			402				REC = 89 RQD = 43
			6	NQ							REC = 100 RQD = 24
			7	NQ			401				REC = 96 RQD = 45
400.5											
4.5	End of Borehole										

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

RECORD OF BOREHOLE No BH05-09 1 OF 1 METRIC

W.P. 5766-04-00 LOCATION Long Lake Culvert, Station 21+210 Offset 18.0 m Lt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 10.11.05 - 10.11.05 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
404.6	Marsh										
0.0 / 404.3	PEAT										
0.3	GRAVELLY SAND, compact, brown (SW - SM)		1	GS			404				
403.4			2	GS							
1.2 / 403.0	SILT, dense, grey (ML)		3	SS	100/150 mm		403				
1.7	End of borehole Spoon Refusal on Inferred Bedrock										

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

RECORD OF BOREHOLE No BH05-10 1 OF 1 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+100 Offset 10.5 m Lt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 07.11.05 - 07.11.05 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
411.0	Grass in ditch										
0.0	GRAVELLY SAND, very loose, brown (SW - SM)		1	SS	3	▽					14 77 (9)
410.3			2	SS	33/ 80 mm						
0.7	End of Borehole						410				
	Spoon Refusal on Inferred Bedrock										
	Standpipe Installed										

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

RECORD OF BOREHOLE No BH05-11 1 OF 1 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+150 Offset 10.5 m Lt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 07.11.05 - 07.11.05 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
409.8	Grass, bush										
0.0	GRAVELLY SAND, compact, brown to grey (SW - SM)		1	SS	26						
409.1			2	SS	33/ 100 mm				○		
0.7	End of Borehole						409				
	Spoon Refusal on Inferred Bedrock										

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

RECORD OF BOREHOLE No BH05-12 1 OF 1 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+250 Offset 16.1 m Lt ORIGINATED BY EH

DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 08.11.05 - 10.11.05 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
407.0	Grass, boulders										
0.0 / 406.4	PEAT		1	SS	3	▽					
0.6	SILTY SAND, some cobbles, loose to dense, yellowish brown to grey (SM)		2	SS	6		406				
			3	SS	40				○		12 67 (21)
404.5			4	SS	26		405		○		17 67 (16)
2.4 / 404.1	GRAVELLY SAND, dense, grey (SW - SM)		5	SS	33/ 80 mm						
2.8	End of Borehole Spoon Refusal on Inferred Bedrock Standpipe Installed										

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

RECORD OF BOREHOLE No BH05-13 1 OF 1 METRIC

W.P. 5768-04-00 LOCATION Long Lake Culvert, Station 21+300 Offset 6.3 m Lt ORIGINATED BY EH

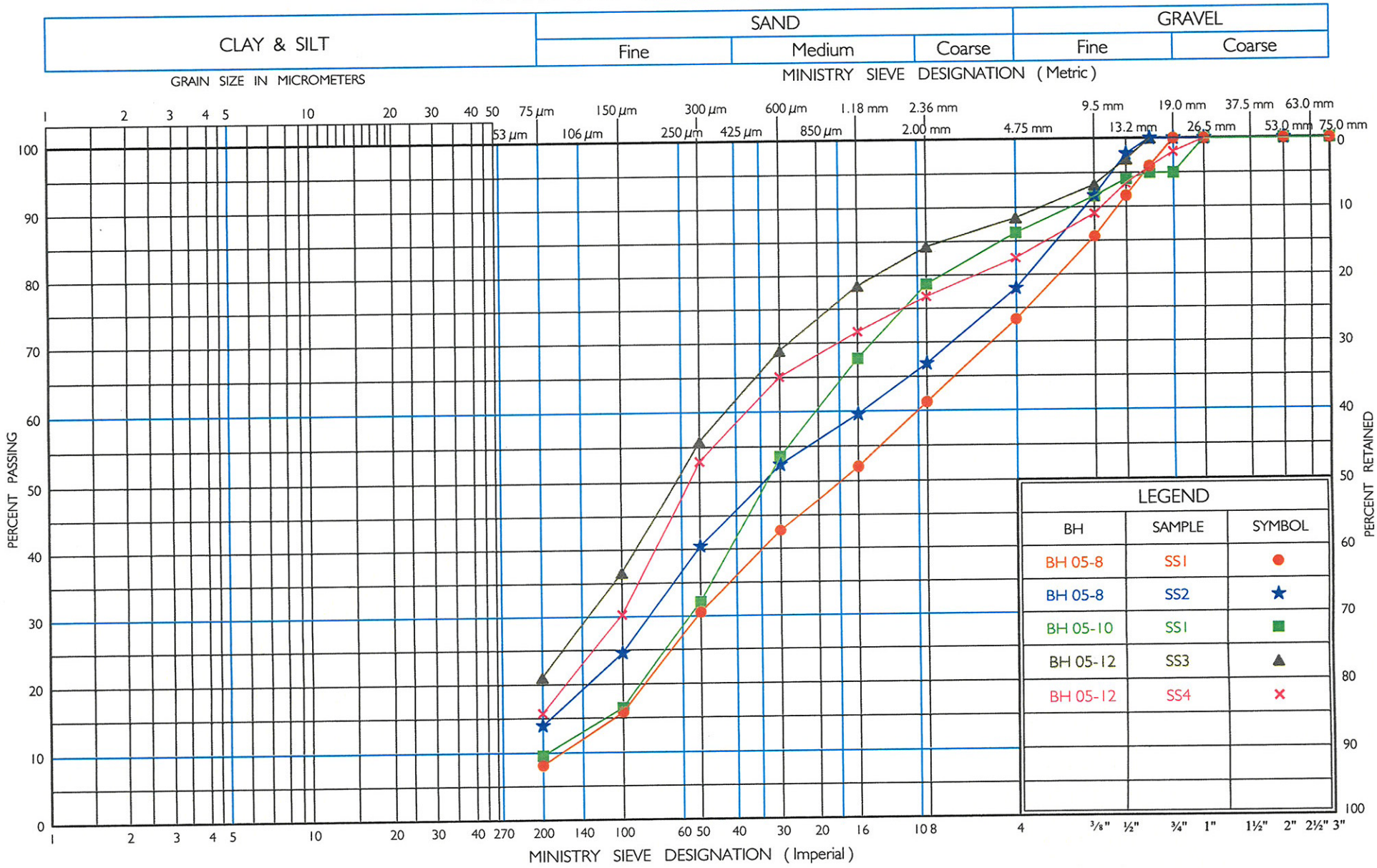
DIST 52 HWY 60 BOREHOLE TYPE Cased Split Spoons COMPILED BY EH

DATUM Geodetic DATE 09.11.05 - 09.11.05 CHECKED BY FG

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_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
412.2	Short grass										
0.0 / 412.0	GRAVELLY SAND, dense, brown (SW - SM)		1	SS	33/100 mm		412				
0.3	End of Borehole										
	Spoon Refusal on Inferred Bedrock										

$+^{3}, \times^{3}$: Numbers refer to Sensitivity ; 3% STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

GRAVELLY SAND TO SILTY SAND

FIG No 1

W P 5768-04-00

APPENDIX C

Site Photos

Photo 1: Culvert Inlet

Photo 2: Culvert Outlet

Photo 3: Site Looking West

Photo 4: Site Looking East