

**FOUNDATION INVESTIGATION AND
DESIGN REPORTS
PROPOSED BATTEAUX RIVER BRIDGE
WBL, HIGHWAY 26,
NEAR COLLINGWOOD, ONTARIO.
G.W.P # 630-91-00
AGREEMENT # 2006-E-0002**

Delcan Corporation Geocres No. 41A-208

Project: SPT 1232

October 15, 2009

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Delcan Corporation
625 Cochrane Drive, Suite 500
Markham, Ontario
L3R 9R9

Attention: Mr. Sam Dinatolo, P.Eng.

Dear Sirs:

**RE: Final Foundation Investigation and Design Report, Proposed Batteaux River bridge WBL,
Highway 26, near Collingwood, Ontario**

Please find attached the results of our final geotechnical investigation and report relating to the above noted site.

If you have any comments or enquiries please contact the undersigned.

For and on behalf of Coffey Geotechnics Inc.



Ramon Miranda, P.Eng.
Manager, Transportation Division

Attachment A: Attachments

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**FOUNDATION INVESTIGATION REPORT
BATTEAUX RIVER BRIDGE, WBL, HIGHWAY 26
NEAR COLLINGWOOD, ONTARIO
W.P. # 630-91-00; Agreement # 2006-E0002**

1 INTRODUCTION

A new bridge is planned to be constructed to carry the proposed westbound lane (WBL) of the Highway 26 realignment over the Batteaux River at Station 22+600 near Collingwood, Ontario. Coffey Geotechnics Inc. (Coffey) was retained by Delcan Corporation (Delcan) to carry out a foundation investigation at the site of the proposed bridge.

An existing bridge was newly constructed which will carry the future eastbound traffic of the proposed Highway 26 realignment. The proposed WBL twin bridge will be constructed at about 13 m (clear distance) north of the existing EBL bridge.

The purpose of the investigation was to obtain information about the subsurface conditions at the site of the proposed WBL structure by means of boreholes, and to determine the engineering characteristics of the subsurface soils by means of field and laboratory tests.

The findings of the investigation are presented in this report.

2 SITE DESCRIPTION AND PHYSIOGRAPHY

Highway 26, in the area of the project, crosses the western extremity of the Nottawasaga Basin. According to the Physiography of Southern Ontario by L.J. Chapman and D.F. Putnam, 1984, the basin is located within the Physiographic Region known as the Simcoe Lowlands. The area contains some rolling and some broad flatlands such as the Minesing Flats. The area is drained by the Nottawasaga River and its tributaries.

The Nottawasaga Basin was covered by the Georgian Bay Lobe of the Laurentide Ice Sheet which formed the Edenvale Moraine east of the project area and the Cornhill Moraine south of the project area. This ice sheet deposited sandy, silty ground moraine till over most of the basin. Sandy, silty tills with boulders and cobbles were laid down south of the project area on the slope of the Niagara Escarpment as well as within the project area. During the occupation of the area by lake waters, sandy and gravelly beaches were formed along the shorelines and on hillsides. On the Niagara Escarpment slope, shore cliffs were formed by wave action of lake waters. The Nottawasaga River deposited a large sandy delta as it entered Glacial Lake Nipissing and the current Georgian Bay. Sand with some gravel and silt were deposited along the shore forming the current Wasaga Beach.

The project area is underlain by the Collingwood member of the Middle Ordovician Lindsay Formation, consisting of interbedded, black, organic-rich limestone and highly calcareous and fossiliferous black shale. Southwest of the project area, at the lower part of the Niagara Escarpment, a blue-grey, non-calcareous, fissile shale of the late Ordovician Blue Mountain Formation is found, which is overlain by the Georgian Bay Formation blue-grey shale with light grey to cream coloured limestone and dolostone. The deposition of

these formations occurred within an approximate time period between 550 and 500 million years before the present. During the wave erosion process of the Niagara Escarpment, rock from these formations contributed clay, boulders and cobbles to the till deposit of the project site.

The western and central part of the project area is underlain by a sandy, silty till with cobbles and boulders of mainly carbonate rocks, except near the present lakeshore, where sand and gravel beaches dominate.

3 FIELD AND LABORATORY WORK

The fieldwork for the proposed bridge was performed on November 3, 4, 5 and 6, 2008 and this consisted of drilling and sampling of eight boreholes (Boreholes B1 through B8) at the locations shown on the Boreholes Location Plan, Drawing No.1. The following table summarizes the borehole locations and drilling depths.

Table 3.1: Borehole Locations and Drilling Depths

Borehole No.	Location (Station)	Depth of Borehole Below Existing Ground Surface (m)
B1	22+592 (West Abutment)	4.7
B2	22+590 (West Abutment)	5.2
B3	22+605 (Centre Pier)	4.8
B4	22+605 (Centre Pier)	4.7
B5	22+628 (East Abutment)	4.9
B6	22+629 (East Abutment)	4.9
B7	22+578 (West Approach)	1.2
B8	22+639 (East Approach)	0.8

Eastern Soil investigations of Courtice, Ontario carried out the drilling, testing and sampling work, under the direction and supervision of a Professional Engineer from Coffey. The boreholes were advanced using track mounted drilling rig, outfitted with tools and equipment for soil sampling and testing. The boreholes were advanced using two different methods (i.e. continuous flight solid-stem augers and HQ rock coring) depending on the ground conditions.

Samples in the boreholes were taken at frequent intervals of depth by the Standard Penetration Test method (SPT), in general accordance with ASTM D1586. This test consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm O.D. split barrel (SS – split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the N-value of the soil which is indicative of the compactness condition of cohesionless granular soils (gravels, sands and silts) or the consistency of cohesive soils (clays and clayey soils).

Groundwater conditions in the boreholes were observed during drilling and upon completion in the open boreholes. The deep boreholes were grouted upon their completion using a cement/bentonite mixture as per MTO procedures.

The borehole locations were established in the field by Coffey engineering staff, in relation to the existing features. The locations were then tied in and the geodetic elevations of the ground at the borehole locations were determined by the client's surveyors. This survey information was provided to us.

The soil and rock samples were transported to our geotechnical laboratory in Toronto for further examination and classification. A laboratory testing programme, consisting of natural moisture content, grain size analyses, was performed on selected representative soil samples and unconfined compression tests was performed on selected rock cores. The results of the laboratory tests are presented on the appropriate Record of Borehole Sheets (Appendix A) and also in Appendix B.

4 SITE AND SUBSURFACE CONDITIONS

The subsurface conditions were explored at eight (8) boreholes (see Table 3.1 in Section 3) for this project. The plan locations of the boreholes are shown on Drawing No. 1 while a stratigraphic sections are presented on Drawing No. 2. Details of subsurface conditions encountered at each borehole location for the investigation, including the results of in-situ testing, groundwater observations and laboratory test results, are presented on the Record of Borehole Sheets in Appendix A. Detailed laboratory test results are enclosed in Appendix B.

In general, below water/topsoil and thin layer of very loose to dense silty sand till with gravel and rock fragments, the proposed bridge site is underlain by limestone bedrock.

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole Sheets in appendix A. The following paragraphs are only meant to amplify and complement these data.

4.1 Topsoil

Topsoil was encountered at the ground surface in all boreholes except for Borehole B1.

It should be pointed out that in our experience at many sites the thickness of topsoil can frequently vary in between and beyond borehole locations.

4.2 Silty Sand Till with Gravel and Rock Fragments

Beneath the topsoil in Boreholes B2, B5, B6, B7 and B8, a 0.2 to 0.8 m thick silty sand till deposit with gravel and rock fragments was encountered.

Grain-size analyses were performed on four samples from the deposit and, these indicate the following grain-size distribution, as shown in Figure B-1 in Appendix B.

Gravel	42 – 66 %
Sand	26 – 37 %
Silt & Clay	8 – 21 %

The high percentage of gravel size particles in the deposit reflect the presence of rock fragments, probably derived from the underlying bedrock.

N-values recorded in the deposit range from 2 to 40 blows/0.3 m. These results indicate a very loose to dense condition but generally loose at the top of the layer and dense near the bedrock surface.

4.3 Limestone Bedrock

Light grey to dark grey slightly weathered to fresh fine-grained fossiliferous limestone bedrock was encountered in Boreholes B1, B2, B3, B4, B5 and B6 and was proven by HQ coring as presented in Table 4.3.1 Boreholes B7 and B8 encountered auger refusal probably on bedrock surface but was not proven by coring, and these are also presented in this table:

Table 4.3.1: Bedrock elevation and condition

Borehole No.	Ground Surface Elevation (m)	Depth Below Ground Surface/Elevation of the Bedrock Surface (m)	T.C.R. (%)*	R.Q.D. (%)**
B1	190.6	0.0/190.6	100	79-95
B2	190.9	1.0/189.9	92-100	76-100
B3	190.7	0.3/190.4	97-100	83-100
B4	190.4	0.1/190.3	98-100	84-87
B5	190.8	0.5/190.3	98-100	83-100
B6	190.5	1.0/189.6	96-100	70-100
B7	191.0	1.1/189.9***		
B8	191.1	0.5/190.7***		

* T.C.R.=Total Core Recovery

**R.Q.D.=Rock Quality Designation

*** Inferred bedrock depth/elevation

The boreholes were advanced into the bedrock for a vertical distance of about 3.9 to 4.6 m by HQ coring. The percentage of recovery was 92 to 100% while the RQD values vary from 70% to 100%. These results indicate a rock quality from fair to excellent. In general, RQD increases with increasing depth. Unconfined compression tests were performed on selected rock samples as shown in Table 4.3.2 and the tests yielded unconfined compressive strength of between about 76 MPa (Borehole B4) and 131 MPa (Borehole B6). These results indicate that the rock can be classified as a strong to very strong rock.

Table 4.3.2: Bedrock unconfined compressive strength

Borehole No.	Core Number	Depth of the Sample Tested (m)	Unconfined Compressive Strength (MPa)
B1	RC1	0.8	98.5
B2	RC3	1.8	119.9
B3	RC2	1.4	122.3
B4	RC1	1.6	75.6
B5	RC2	0.6	105.6
B6	RC3	1.2	131.3

At the borehole locations the surface of the bedrock was contacted at Elevations ranging from 189.6 m (Borehole B6) to 190.6 m (Borehole B1). From these results the surface of the bedrock appears to be relatively flat in this project area.

4.4 Groundwater Conditions

Groundwater conditions were observed in the open boreholes while drilling and upon completion of each borehole. The free-standing water level in Boreholes B1, B2, B3, B4, B5 and B6 upon their completion was observed at depths of 0 to 1.2 m or El.189.6 to 190.7 m while Boreholes B7 and B8 were dry upon completion. However, in the deep boreholes, where HQ coring was used (i.e. water introduced into the boreholes) the on-completion water levels may not be reliable.

It should also be pointed out that the groundwater is subject to seasonal fluctuations and fluctuation in response to major weather events. In addition, the water table at the site will be influenced by the water level in the water course.

5. CLOSURE

The Limitations of Report, as quoted in Appendix D, is an integral part of this report.

For and on behalf of Coffey Geotechnics Inc.



Raid Khamis, P.Eng.
Geotechnical Engineer



Ramon Miranda, P.Eng.
Manager, Transportation Division



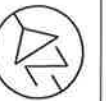
Z.S. Ozden, P.Eng.
Senior Principal



Drawings

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

HIGHWAY 26
BATTEAUX RIVER BRIDGE
BOREHOLE LOCATION PLAN AND
STRATIGRAPHY








SHEET

coffey  **geotechnics**
SPECIALISTS MANAGING THE EARTH



KEY PLAN
N.T.S.

LEGEND

- | | |
|---|--|
|  | Borehole |
|  | Blows/0.3m (Std. Pen. Test, 475 J/blow) |
|  | Water Level at Time of Investigation
(W. L. NOT STABILIZED) |
|  | Water Level in Piezometer |
|  | Piezometer |

No.	ELEVATION	STATION	OFFSET
B1	190.7	22+592	8.5m Lt Median C/L
B3	190.7	22+605	8.0m Lt Median C/L
B5	190.8	22+628	9.0m Lt Median C/L
B7	191.0	22+578	16.0m Lt Median C/L
B8	191.1	22+639	15.0m Lt Median C/L

-NOTE-

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

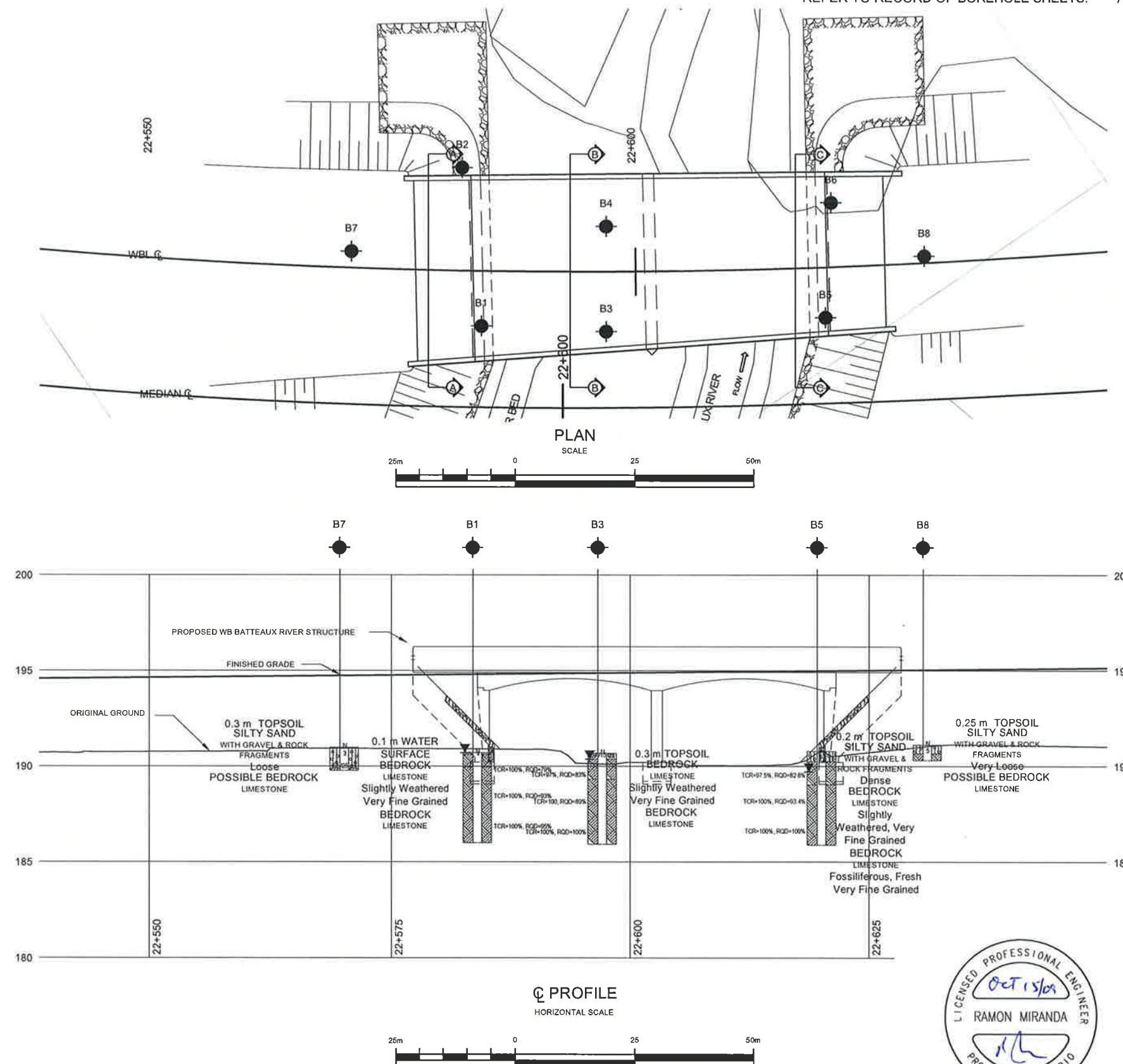
REVISIONS			
	DATE	BY	DESCRIPTION

Geocres No 41A-208

TRANETOBO1232AA				DIST	
SUBMD		CHECKED		DATE Oct. 2009	
DRAWN PHK		CHECKED RM		APPROVED ZO	
DWG				1	

NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.



METRIC

NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

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

CONT No.
GWP: 630-91-00

HIGHWAY 26
BATTEAUX RIVER BRIDGE
CROSS SECTIONS

SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



LEGEND			
	Borehole		
	Blows/0.3m (Std. Pen. Test, 475 J/blow)		
	Water Level at Time of Investigation (W. L. NOT STABILIZED)		
	Water Level in Piezometer		
	Piezometer		

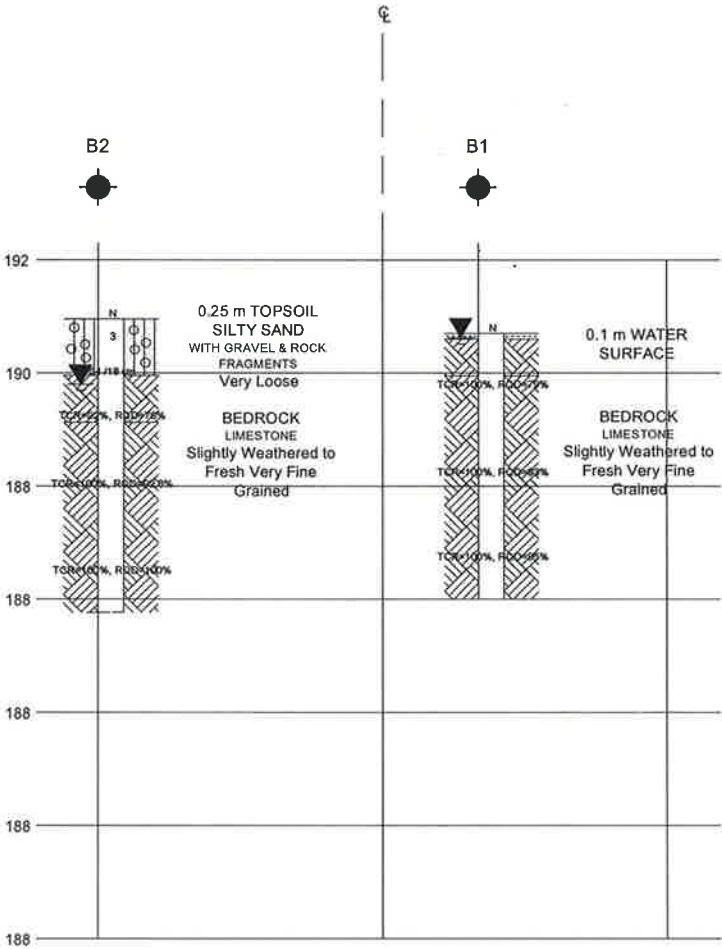
No.	ELEVATION	STATION	OFFSET
B1	190.7	22+592	8.5m Lt C/L
B2	190.9	22+590	25.0m Lt C/L
B3	190.7	22+605	8.0m Lt C/L
B4	190.4	22+605	19.0m Lt C/L
B5	190.8	22+628	9.0m Lt C/L
B6	190.5	22+629	21.0m Lt C/L

-NOTE-
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

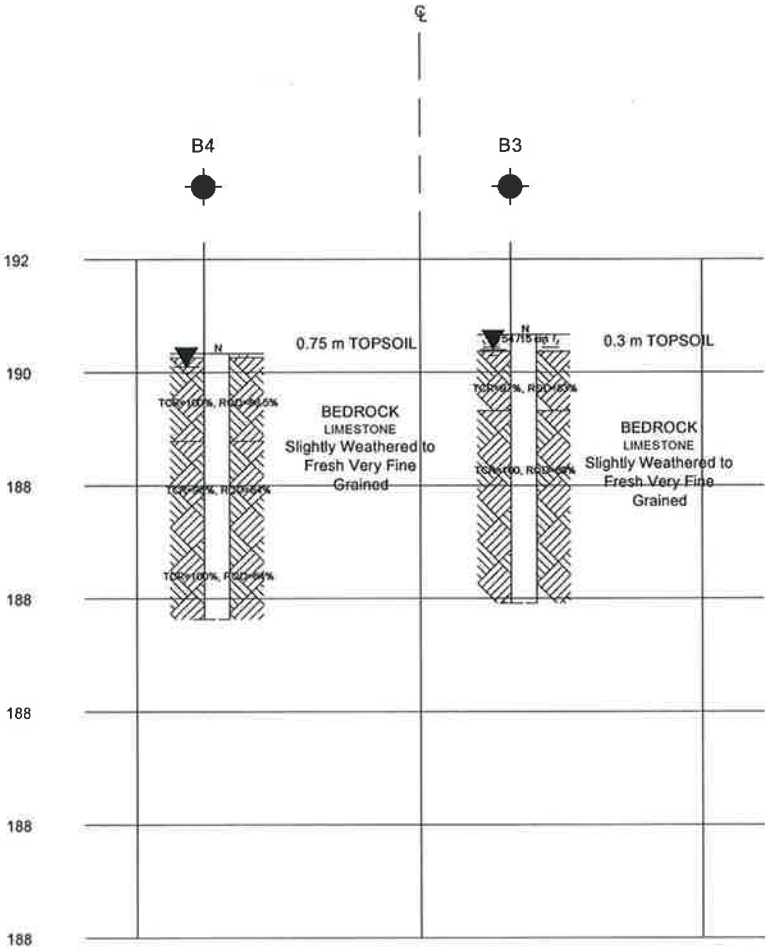
NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION

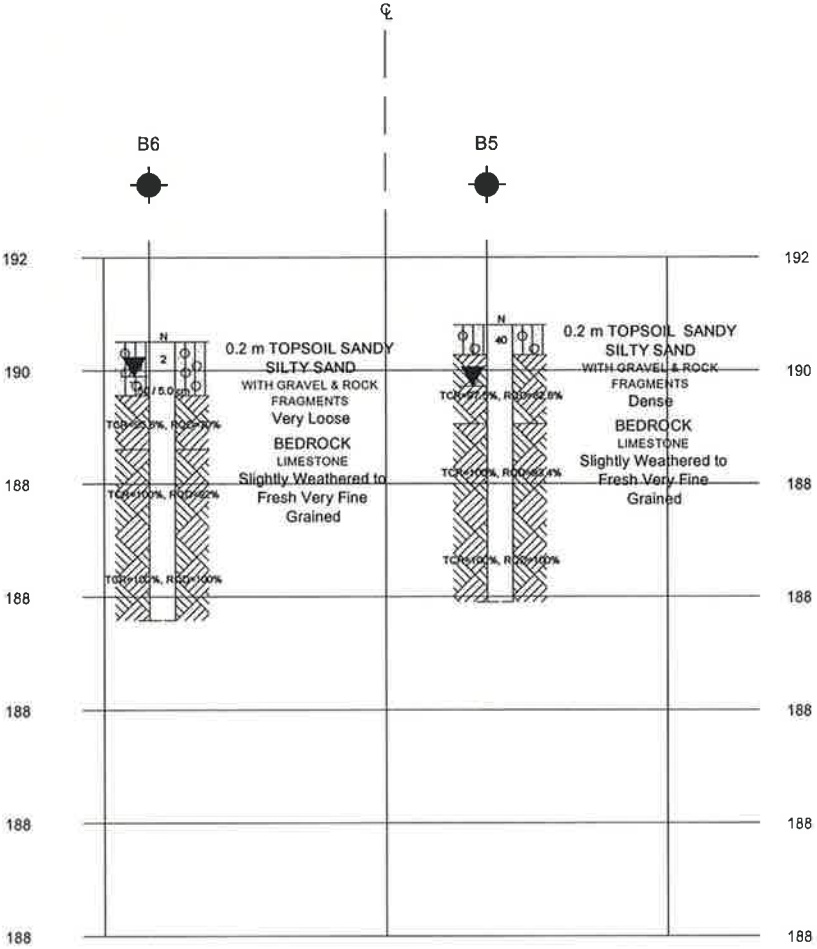
Geocres No 41A-208			
TRANETOB01232AA		DIST	
SUBMD	CHECKED	DATE	Ocl. 2009
DRAWN	PHK	CHECKED	RM
APPROVED		ZO	DWG
			2



SECTION A-A
HORIZONTAL SCALE



SECTION B-B
HORIZONTAL SCALE



SECTION C-C
HORIZONTAL SCALE



Appendix A

Borehole Logs

SPT1232 :Batteaux River Bridge

RECORD OF BOREHOLE No B1

1 OF 1

METRIC

GWP 630-91-00 LOCATION Station : 22+592, 8.5 m Lt C/L of New Hwy 26 ORIGINATED BY RK
 DIST HWY 26 BOREHOLE TYPE Solid Stem Auger/HQ Coring COMPILED BY RK
 DATUM DATE 11/4/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
190.7	WATER SURFACE							20 40 60 80 100					
190.6	0.1 m WATER							20 40 60 80 100					
190.0	LIMESTONE BEDROCK slightly weathered, very fine grained light to dark grey		1	RCTCR=100% RQD=75%			190						UCS = 98.5 MPa
0.8	LIMESTONE BEDROCK fossiliferous, fresh, very fine grained, light to dark grey		2	RCTCR=100% RQD=93%			189						
			3	RCTCR=100% RQD=95%			188						
							187						
186.0	End of borehole Water level at 0.1m(not stabilized)* above ground surface UCS = Unconfined Compressive Strength						186						
4.7													

+³, ×³ Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

SPT1232 :Batteaux River Bridge

RECORD OF BOREHOLE No B2

1 OF 1

METRIC

GWP 630-91-00 LOCATION Station : 22+590, 25.0 m Lt C/L of New Hwy26 ORIGINATED BY RK
 DIST HWY 26 BOREHOLE TYPE Solid Stem Auger/HQ Coring COMPILED BY RK
 DATUM DATE 11/4/2008 CHECKED BY RM

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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE							
190.9 0.0	GROUND SURFACE							20 40 60 80 100							
189.9 1.0	0.25 m TOPSOIL SILTY SAND TILL with gravel and rock fragments dark brown, v.loose, wet		1	SS	3		190								
189.1 1.8	LIMESTONE BEDROCK slightly weathered, very fine grained light to dark grey		2	SS	54 / 18 cm										
			3	RC	TCR=92% RQD=76%		189							UCS = 119.9 MPa	
			4	RC	TCR=100% RQD=93%		188								
			5	RC	TCR=100% RQD=100%		187								
185.8 5.2	End of borehole Water level at 1.2 m (not stabilized)* upon completion UCS = Unconfined Compressive Strength						186								

+³, ×³ : Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

SPT1232 :Batteaux River Bridge

RECORD OF BOREHOLE No B3

1 OF 1

METRIC

GWP 630-91-00 LOCATION Station : 22+605, 8.0 m Lt C/L of New Hwy26 ORIGINATED BY RK
 DIST HWY 26 BOREHOLE TYPE Solid Stem Auger/HQ Coring COMPILED BY RK
 DATUM DATE 11/4/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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	20 40 60 80 100	w _p	w	w _L		
190.7	GROUND SURFACE		1	SS	54 / 15 cm									
190.4	0.3 m TOPSOIL													
189.3	LIMESTONE BEDROCK slightly weathered, very fine grained light to dark grey		2	RC	TCR=97% RQD=83%		190							UCS = 122.3 MPa
189.3							189							
188.3	LIMESTONE BEDROCK fossiliferous fresh, very fine grained light to dark grey		3	RC	TCR=100 RQD=89%		188							
187.3			4	RC	TCR=100% RQD=100%		187							
185.9	End of borehole Water level @ 0.3 m (not stabilized)* upon completion UCS = Unconfined Compressive Strength						186							

+³, ×³: Numbers refer to
Sensitivity

20
15
10
5
(%) STRAIN AT FAILURE

SPT1232 :Batteaux River Bridge

RECORD OF BOREHOLE No B4

1 OF 1

METRIC

GWP 630-91-00 LOCATION Station : 22+605, 19.0 m Lt C/L of New Hwy 26 ORIGINATED BY RK
DIST HWY 26 BOREHOLE TYPE Solid Stem Auger/HQ Coring COMPILED BY RK
DATUM DATE 11/3/2008 CHECKED BY RM

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			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● POCKET PENETR.						
190.4 189.8 0.1	GROUND SURFACE						20	40	60	80	100					
	75 mm TOPSOIL						20	40	60	80	100					
188.8 1.6	LIMESTONE BEDROCK slightly weathered, very fine grained light to dark grey		1	RC	TCR=100% RQD=86.5%										UCS = 75.6 MPa	
	LIMESTONE BEDROCK fossiliferous, fresh, very fine grained dark grey		2	RC	TCR=98% RQD=84%											
			3	RC	TCR=100% RQD=84%											
185.7 4.7	End of borehole Water level @ 0.3 m (not stabilized)* upon completion UCS = Unconfined Compressive Strength															

+ 3 . × 3 Numbers refer to
Sensitivity

20
15 10 5 (%) STRAIN AT FAILURE

SPT1232 :Batteaux River Bridge

RECORD OF BOREHOLE No B5

1 OF 1

METRIC

GWP 630-91-00 LOCATION Station : 22+628, 9.0 m Lt C/L of New Hwy 26 ORIGINATED BY RK
 DIST HWY 26 BOREHOLE TYPE Solid Stem Auger/HQ Coring COMPILED BY RK
 DATUM DATE 11/5/2008 CHECKED BY RM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	20 40 60 80 100	W _P	W		
190.8	GROUND SURFACE												
0.0	0.2 m TOPSOIL		1	SS	40								
190.3	SILTY SAND TILL												
0.5	with gravel and rock fragments brown, dense, wet												
189.0	LIMESTONE BEDROCK		2	RC	TCR=98% RQD=83%	190							
1.8	slightly weathered, very fine grained light to dark grey												
189.0	LIMESTONE BEDROCK		3	RC	TCR=100% RQD=93%	189							
1.8	fossiliferous, fresh, very fine grained light to dark grey												
185.9	LIMESTONE BEDROCK		4	RC	TCR=100% RQD=100%	187							
4.9	End of borehole					186							
	Water level @ 1.1 m(not stabilized)* upon completion UCS = Unconfined Compressive Strength												

+³, ×³ Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE




SPT1232 :Batteaux River Bridge

RECORD OF BOREHOLE No B6

1 OF 1

METRIC

GWP 630-91-00 LOCATION Station : 22+629, 21.0 m Lt C/L of New Hwy 26 ORIGINATED BY RK
DIST HWY 26 BOREHOLE TYPE Solid Stem Auger/HQ Coring COMPILED BY RK
DATUM DATE 11/5/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● POCKET PENETR. x LAB VANE					
190.5	GROUND SURFACE						20 40 60 80 100	10 20 30					
0.0	0.2 m TOPSOIL SILTY SAND TILL with gravel & rock fragments dark brown, v.loose, wet		1	SS	2								66 26 (8)
189.6			2	SS50 / 20.0	cm								
1.0	LIMESTONE BEDROCK moderately to slightly weathered very fine grained light grey		3	RC	TCR=96% RQD=70%								UCS = 131.3 MPa
188.6			4	RC	TCR=100% RQD=92%								
1.9	LIMESTONE BEDROCK fossiliferous, fresh, very fine grained light to dark grey		5	RC	TCR=100% RQD=100%								
185.6	End of borehole Water level @ 0.9 m (not stabilized)* upon completion UCS = Unconfined Compressive Strength												
4.9													

SPT1232 :Batteaux River Bridge

RECORD OF BOREHOLE No B7

1 OF 1

METRIC

GWP 630-91-00 LOCATION Station : 22+578, 16.0 m Lt C/L of New Hwy 26 ORIGINATED BY RK
 DIST HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM DATE 11/5/2008 CHECKED BY RM

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	SHEAR STRENGTH kPa					
191.0	GROUND SURFACE												
0.0	0.3 m TOPSOIL SILTY SAND TILL with gravel and rock fragments brown, loose, moist		1	SS	3								
189.9			2	SS	58 / 25 cm	190							54 31 (15)
189.8	POSSIBLE BEDROCK												
1.2	End of borehole Borehole is dry(not stabilized) & open, upon completion Auger refusal @ 1.2 m depth												

+ 3 . x 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

SPT1232 :Batteaux River Bridge

RECORD OF BOREHOLE No B8

1 OF 1

METRIC

GWP 630-91-00 LOCATION Station : 22+639, 15.0 m Lt C/L of New Hwy 26 ORIGINATED BY RK
 DIST HWY 26 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM DATE 11/6/2008 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P	W	W _L		
191.1	GROUND SURFACE													
0.0	0.25 m TOPSOIL		1	SS	5		191							
190.7	SILTY SAND TILL													
0.5	with gravel and rock fragments													
190.3	dark brown, v.loose, moist													
0.8	POSSIBLE BEDROCK													
	End of borehole Borehole is dry (not stabilized) & open, upon completion Auger refusal @ 0.8m depth													

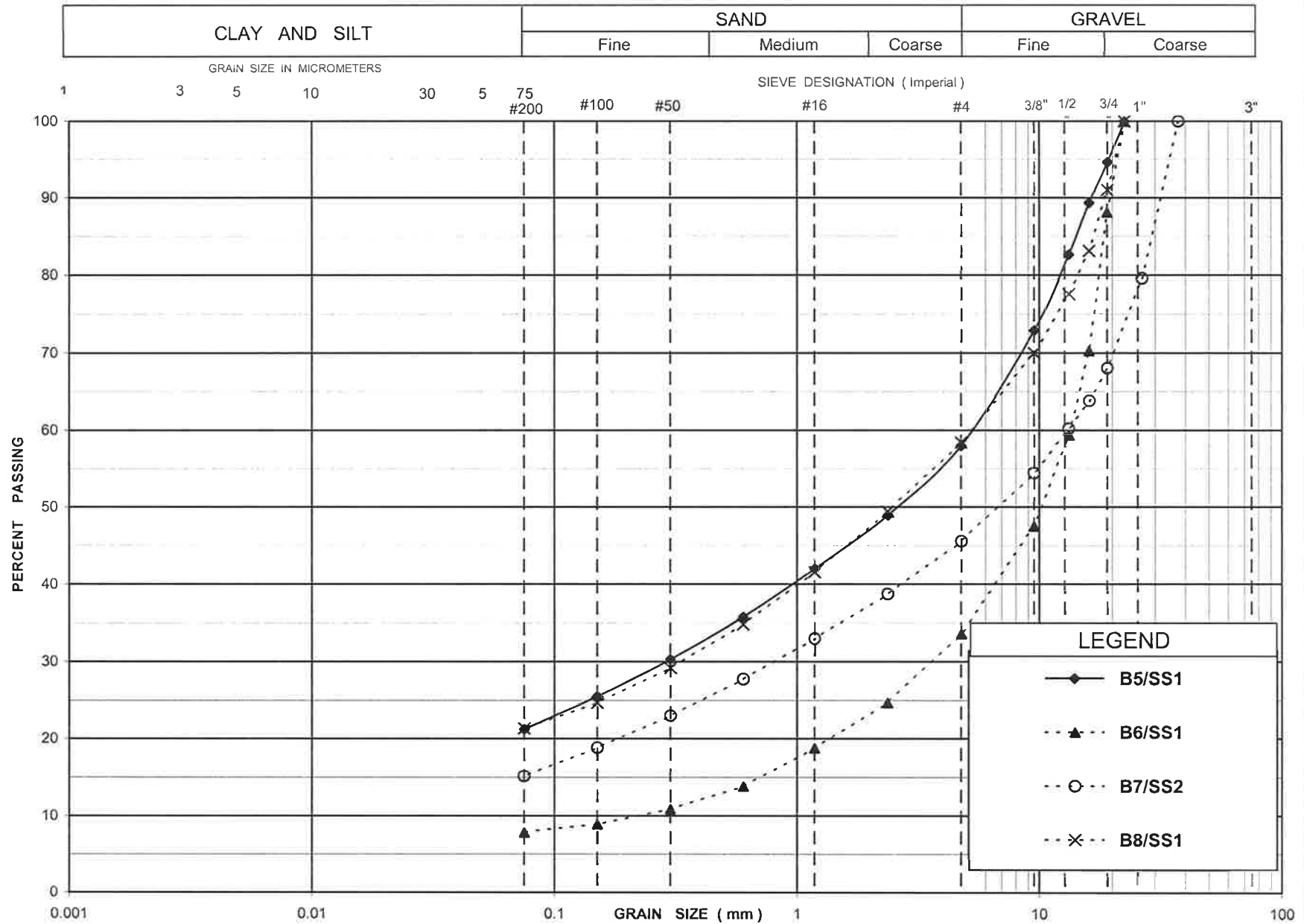
+³, x³ Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

Appendix B

Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM



UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0001	SAMPLE NUMBER	RC1
BOREHOLE NUMBER	B1	SAMPLE DEPTH, m	-

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.05

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	12.90	WATER CONTENT, (specimen) %	0.35
SAMPLE DIAMETER, cm	6.30	UNIT WEIGHT, kN/m ³	26.13
SAMPLE AREA, cm ²	31.17	DRY UNIT WT., kN/m ³	26.03
SAMPLE VOLUME, cm ³	402.13	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	1071.70	VOID RATIO	0.02
DRY WEIGHT, g	1067.96		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	98.5
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REMARKS:

DATE:

1/20/2009

Test Result (Borehole B1)

UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0001	SAMPLE NUMBER	RC3
BOREHOLE NUMBER	B2	SAMPLE DEPTH, m	-

TEST CONDITIONS

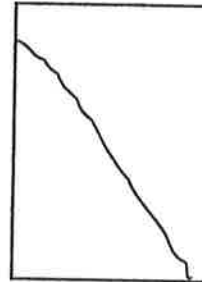
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.08

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.10	WATER CONTENT, (specimen) %	0.30
SAMPLE DIAMETER, cm	6.30	UNIT WEIGHT, kN/m ³	25.88
SAMPLE AREA, cm ²	31.17	DRY UNIT WT., kN/m ³	25.81
SAMPLE VOLUME, cm ³	408.36	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	1078.20	VOID RATIO	0.03
DRY WEIGHT, g	1074.98		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	119.9
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REMARKS:

DATE:

1/20/2009

Test Result (Borehole B2)

UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0001	SAMPLE NUMBER	RC2
BOREHOLE NUMBER	B3	SAMPLE DEPTH, m	-

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.08

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.15	WATER CONTENT, (specimen) %	0.22
SAMPLE DIAMETER, cm	6.31	UNIT WEIGHT, kN/m ³	25.80
SAMPLE AREA, cm ²	31.27	DRY UNIT WT., kN/m ³	25.74
SAMPLE VOLUME, cm ³	411.22	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	1082.20	VOID RATIO	0.03
DRY WEIGHT, g	1079.82		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	122.3
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REMARKS:

DATE:

1/20/2009

Test Result (Borehole B3)

UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0001	SAMPLE NUMBER	RC1
BOREHOLE NUMBER	B4	SAMPLE DEPTH, m	-

TEST CONDITIONS

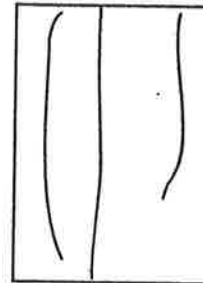
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.07

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.05	WATER CONTENT, (specimen) %	0.57
SAMPLE DIAMETER, cm	6.30	UNIT WEIGHT, kN/m ³	26.09
SAMPLE AREA, cm ²	31.17	DRY UNIT WT., kN/m ³	25.94
SAMPLE VOLUME, cm ³	406.80	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	1082.50	VOID RATIO	0.02
DRY WEIGHT, g	1076.36		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	75.6
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REMARKS:

DATE:

1/20/2009

Test Result (Borehole B4)

UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0001	SAMPLE NUMBER	RC2
BOREHOLE NUMBER	B5	SAMPLE DEPTH, m	-

TEST CONDITIONS

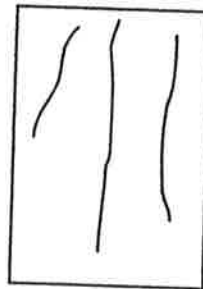
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	1.99

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	12.55	WATER CONTENT, (specimen) %	0.33
SAMPLE DIAMETER, cm	6.30	UNIT WEIGHT, kN/m ³	24.78
SAMPLE AREA, cm ²	31.17	DRY UNIT WT., kN/m ³	24.70
SAMPLE VOLUME, cm ³	391.22	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	988.90	VOID RATIO	0.07
DRY WEIGHT, g	985.65		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	105.6
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REMARKS:

DATE:

1/20/2009

Test Result (Borehole B5)

UNCONFINED COMPRESSION TEST (UC)

ASTM D 7012-04

SAMPLE IDENTIFICATION

PROJECT NUMBER	09-1116-0001	SAMPLE NUMBER	RC3
BOREHOLE NUMBER	B6	SAMPLE DEPTH, m	-

TEST CONDITIONS

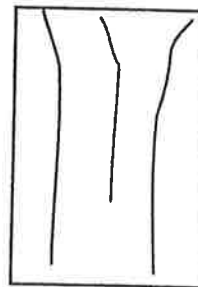
MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.08

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.10	WATER CONTENT, (specimen) %	0.30
SAMPLE DIAMETER, cm	6.30	UNIT WEIGHT, kN/m ³	25.95
SAMPLE AREA, cm ²	31.17	DRY UNIT WT., kN/m ³	25.87
SAMPLE VOLUME, cm ³	408.36	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	1080.90	VOID RATIO	0.02
DRY WEIGHT, g	1077.67		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	131.3
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REMARKS:

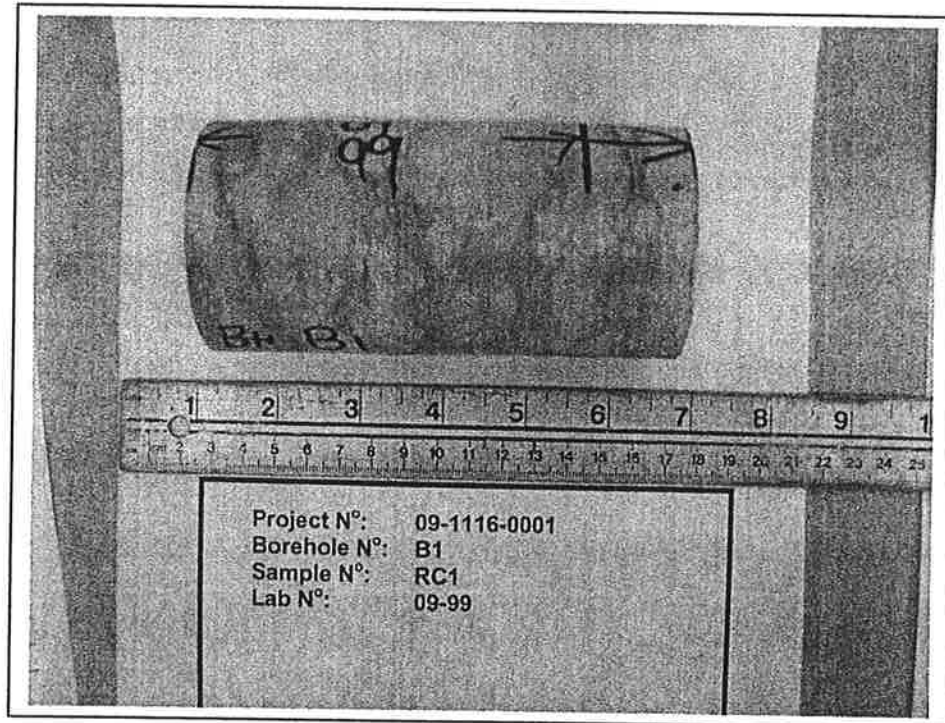
DATE:

1/20/2009

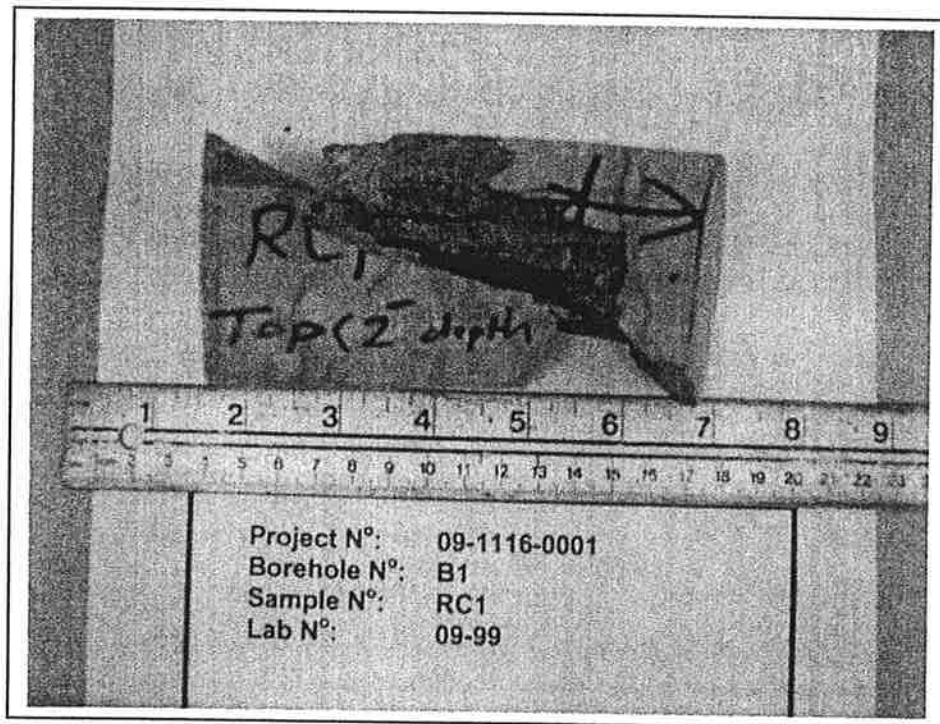
Test Result (Borehole B6)

UNCONFINED COMPRESSION TEST
ASTM D2166-98A

FIGURE



BEFORE COMPRESSION



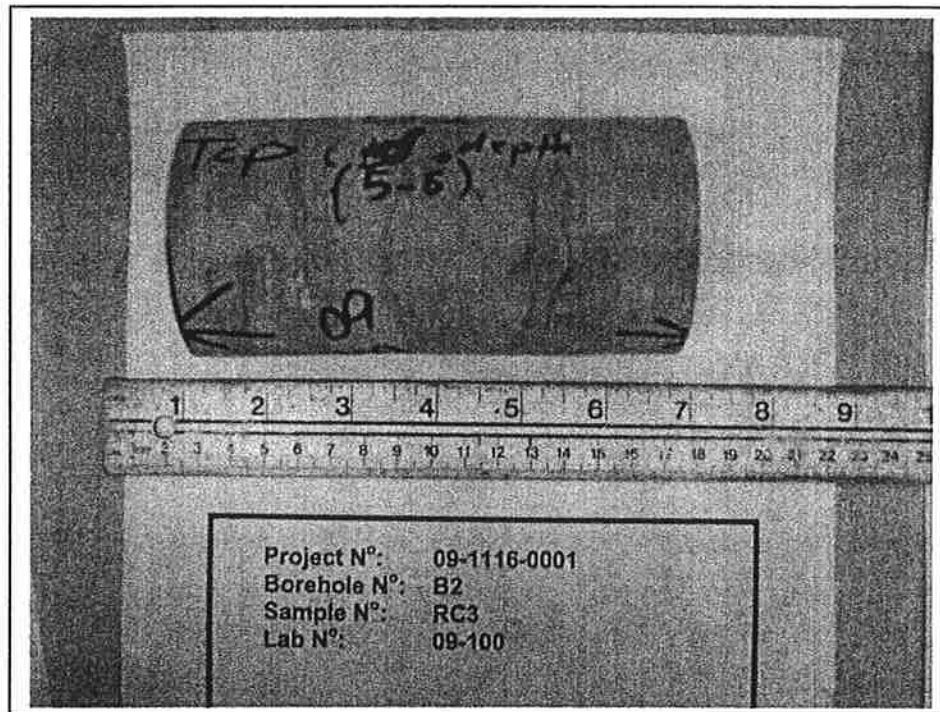
AFTER COMPRESSION

Test Specimen (Borehole B1)

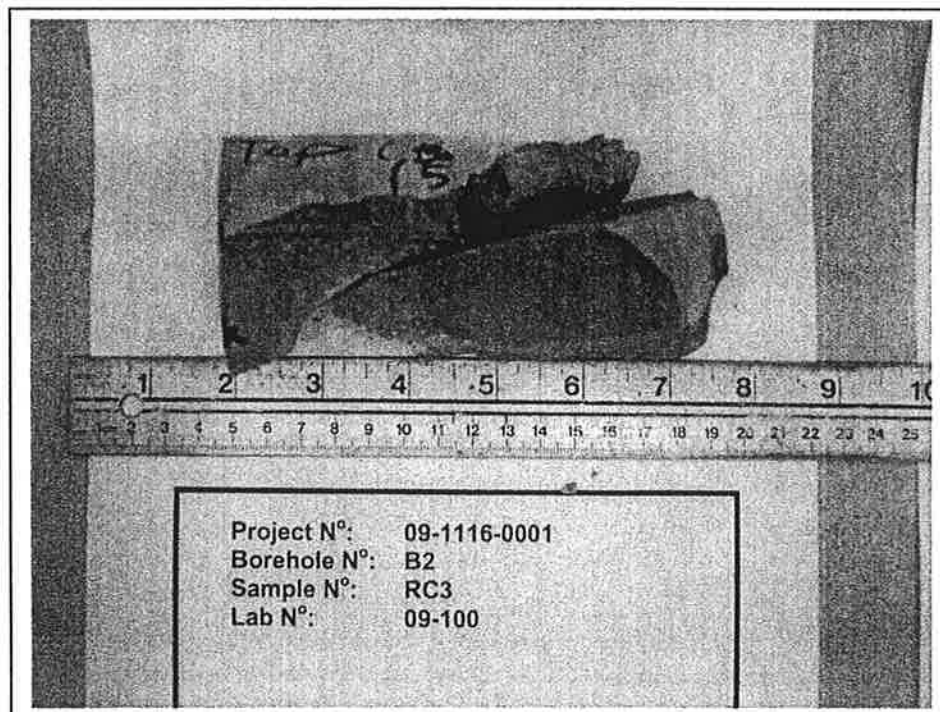
Drawn AH
Chkd. July

UNCONFINED COMPRESSION TEST
ASTM D2166-98A

FIGURE



BEFORE COMPRESSION



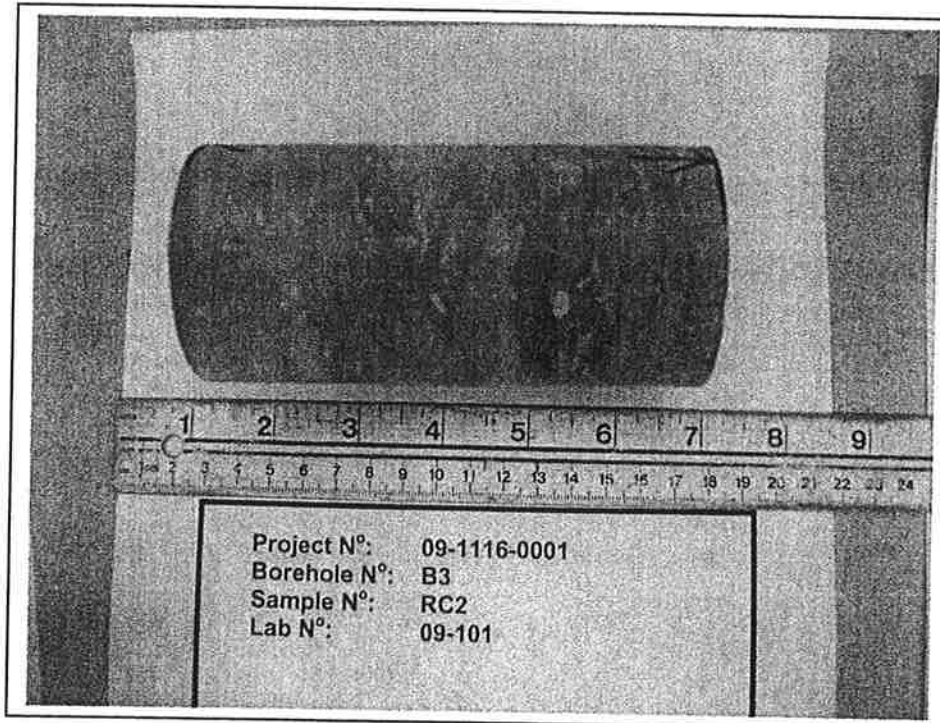
AFTER COMPRESSION

Test Specimen (Borehole B2)

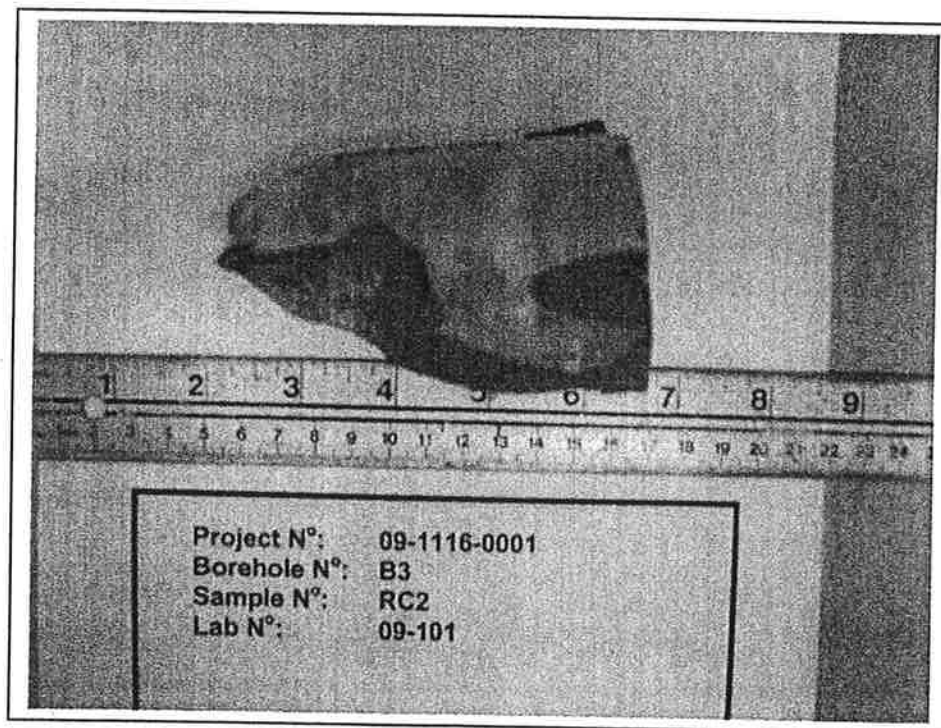
Drawn AH
Chkd. [Signature]

UNCONFINED COMPRESSION TEST
ASTM D2166-98A

FIGURE



BEFORE COMPRESSION



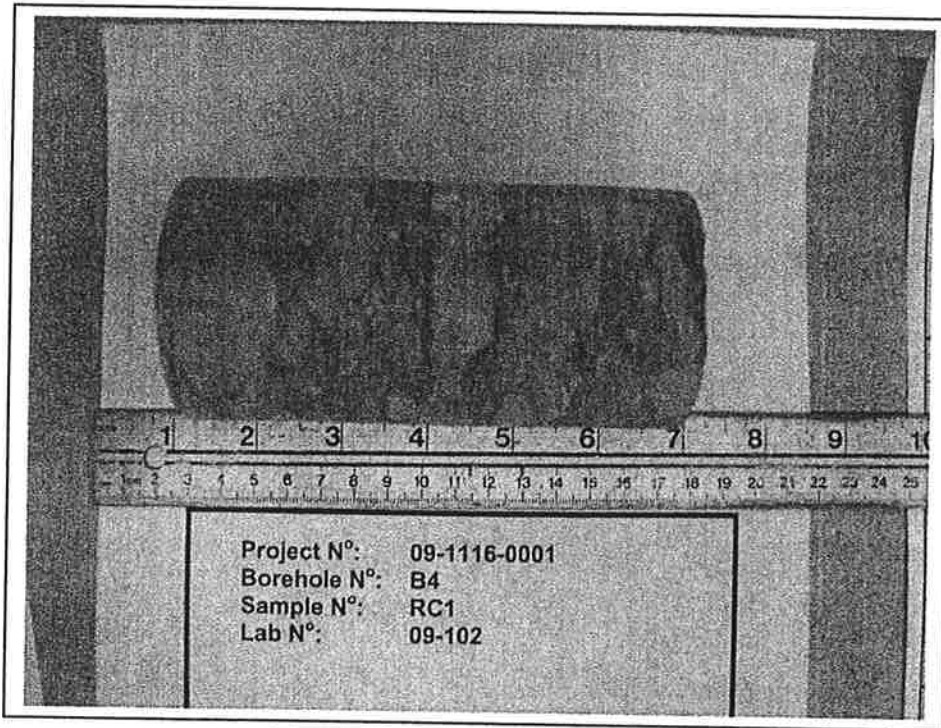
AFTER COMPRESSION

Test Specimen (Borehole B3)

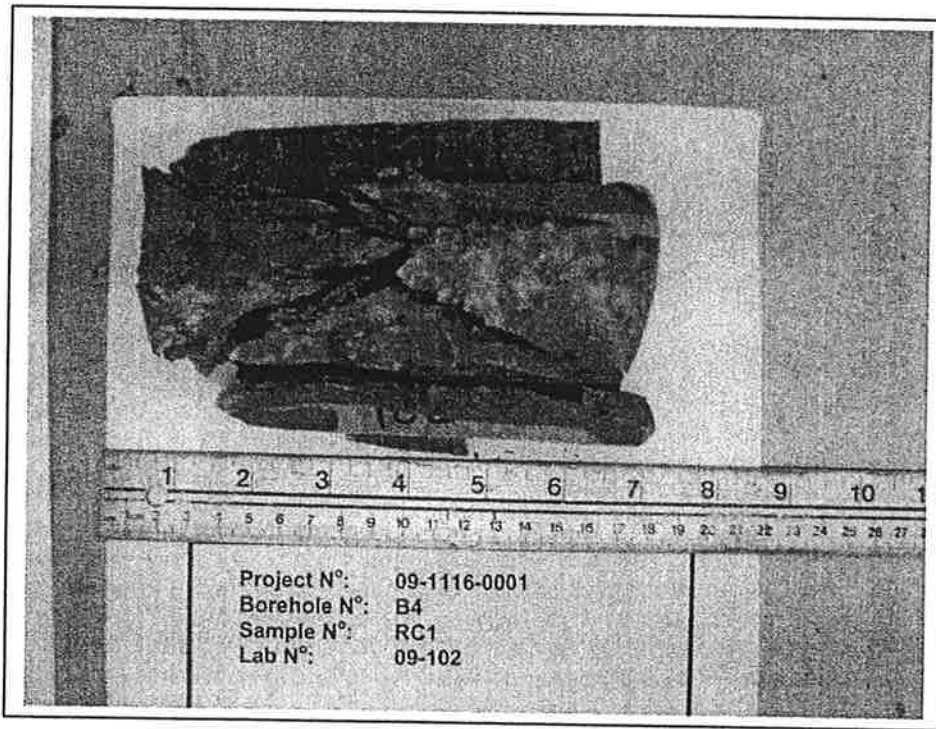
Drawn AH
Chkd. My

UNCONFINED COMPRESSION TEST
ASTM D2166-98A

FIGURE



BEFORE COMPRESSION



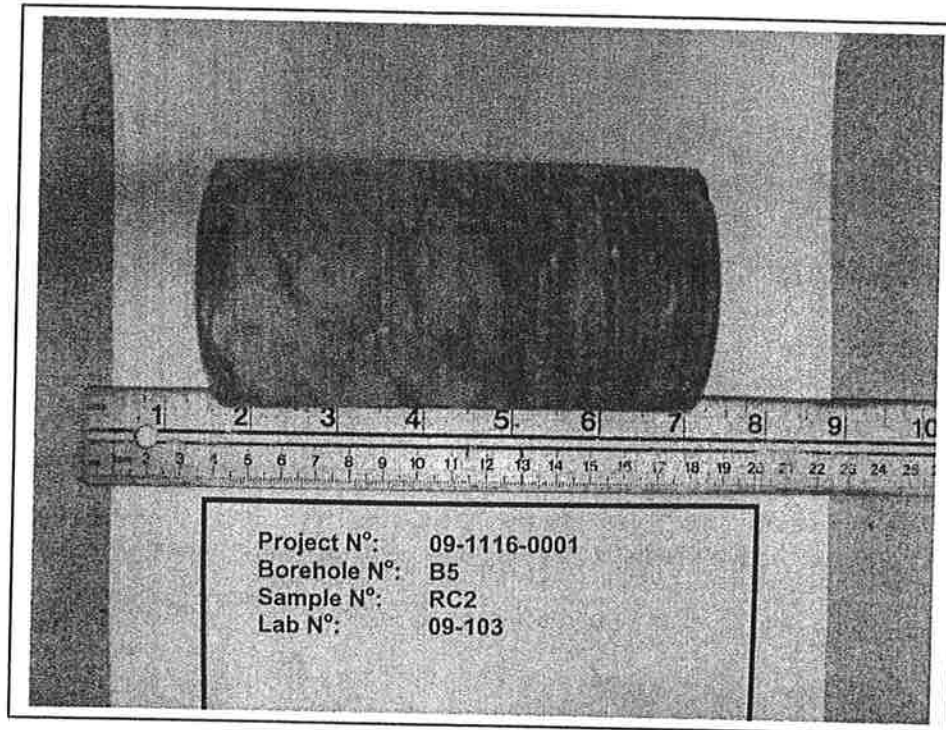
AFTER COMPRESSION

Test Specimen (Borehole B4)

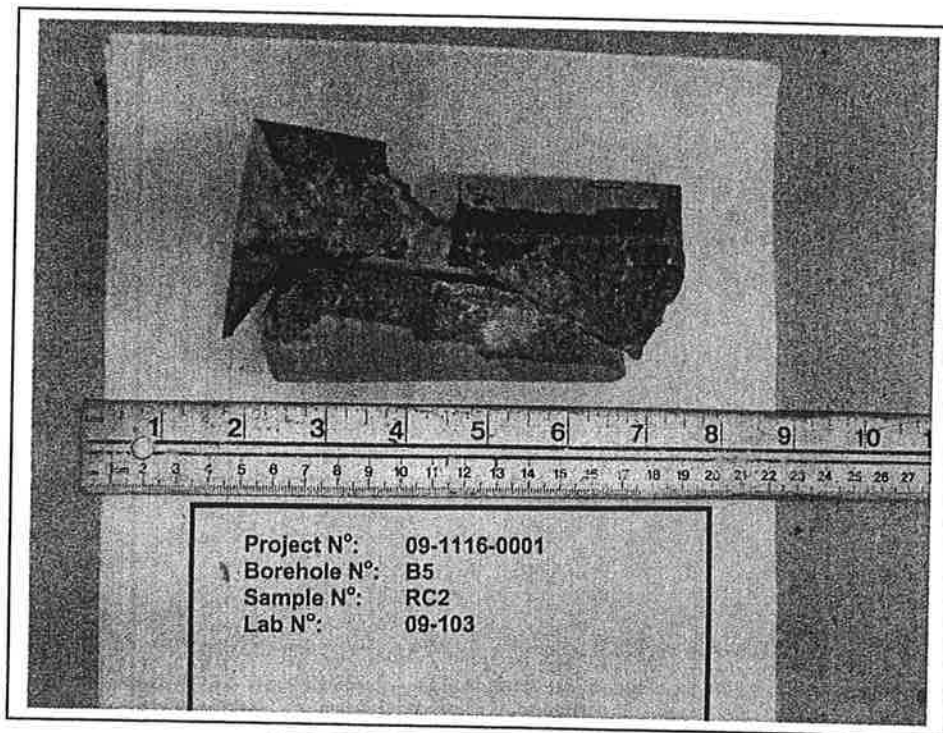
Drawn AH
Chkd. *[Signature]*

UNCONFINED COMPRESSION TEST
ASTM D2166-98A

FIGURE



BEFORE COMPRESSION



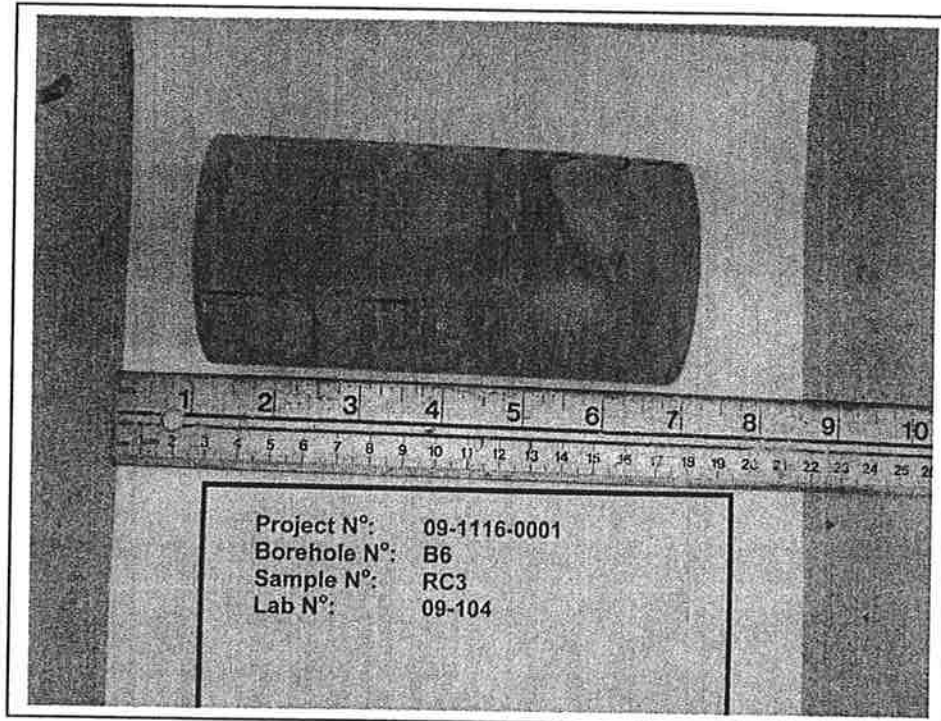
AFTER COMPRESSION

Test Specimen (Borehole B5)

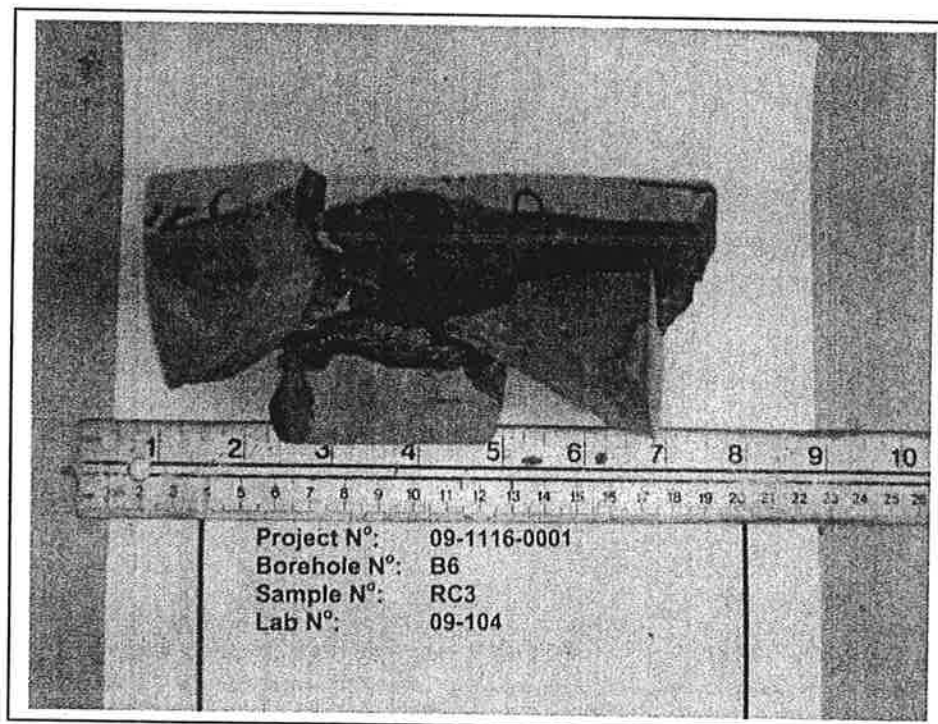
Drawn AH
Chkd. *ah*

UNCONFINED COMPRESSION TEST
ASTM D2166-98A

FIGURE



BEFORE COMPRESSION



AFTER COMPRESSION

Test Specimen (Borehole B6)

Drawn AH
Chkd. *h*

Appendix C

Site Photographs



West bank of Batteaux River, looking towards north



East bank of Batteaux River, looking towards north



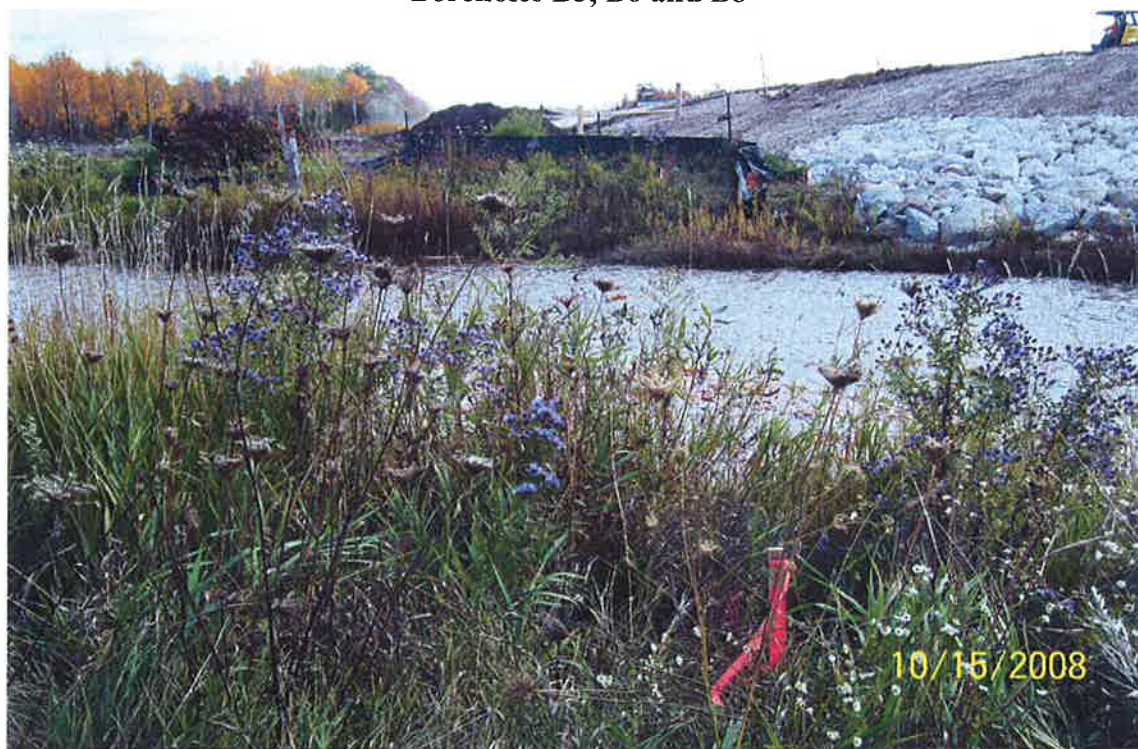
Batteaux River Bridge, looking towards east



Borehole B2 (left) and Borehole B4 (right)



Boreholes B5, B6 and B8



Borehole B3, looking towards east



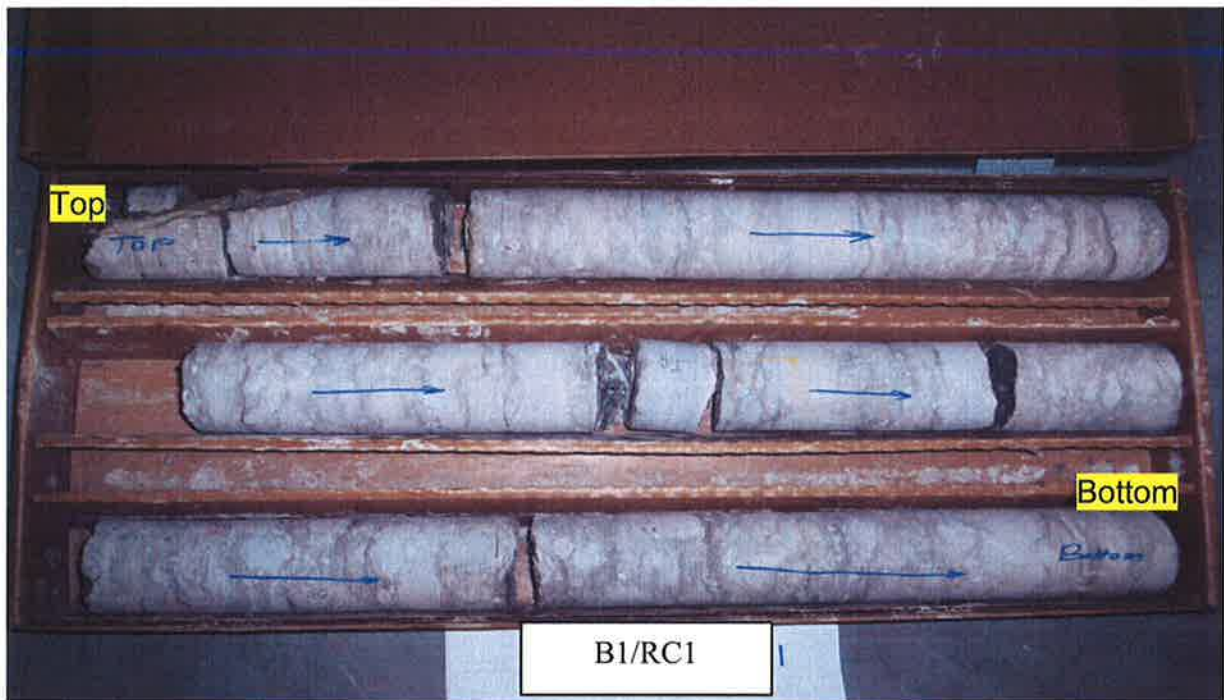
Borehole B1, looking towards north



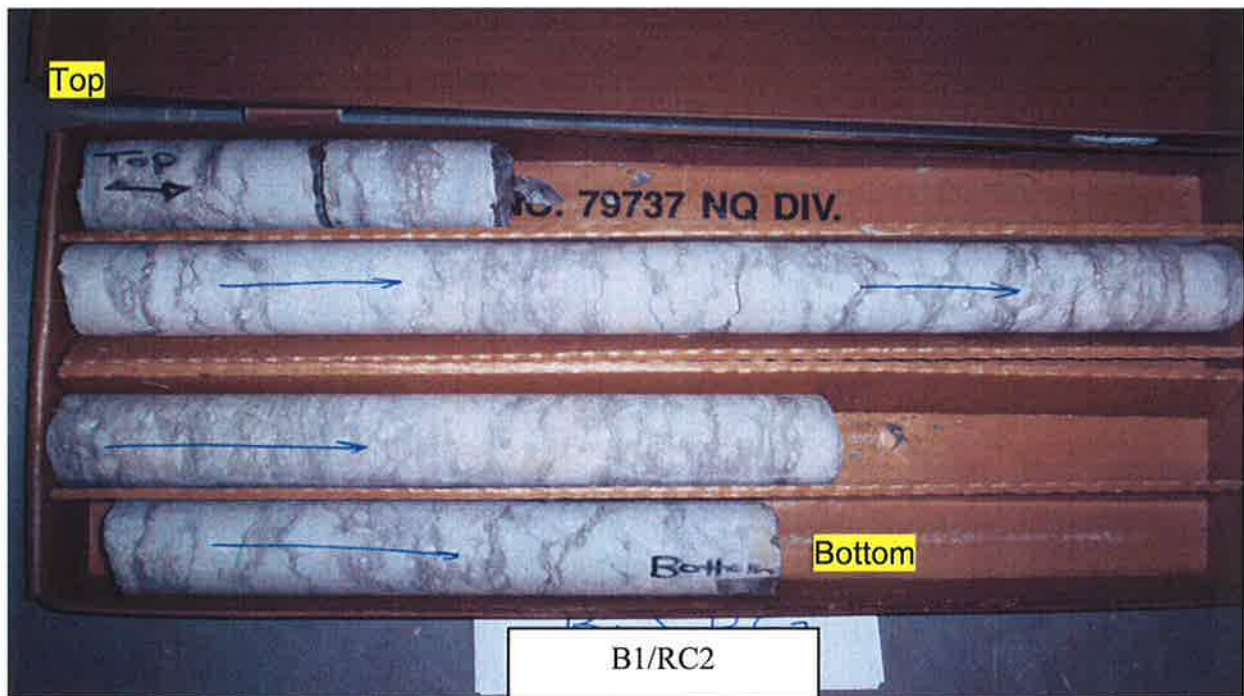
Borehole B7, looking towards west

Appendix D

Rock Core Photographs



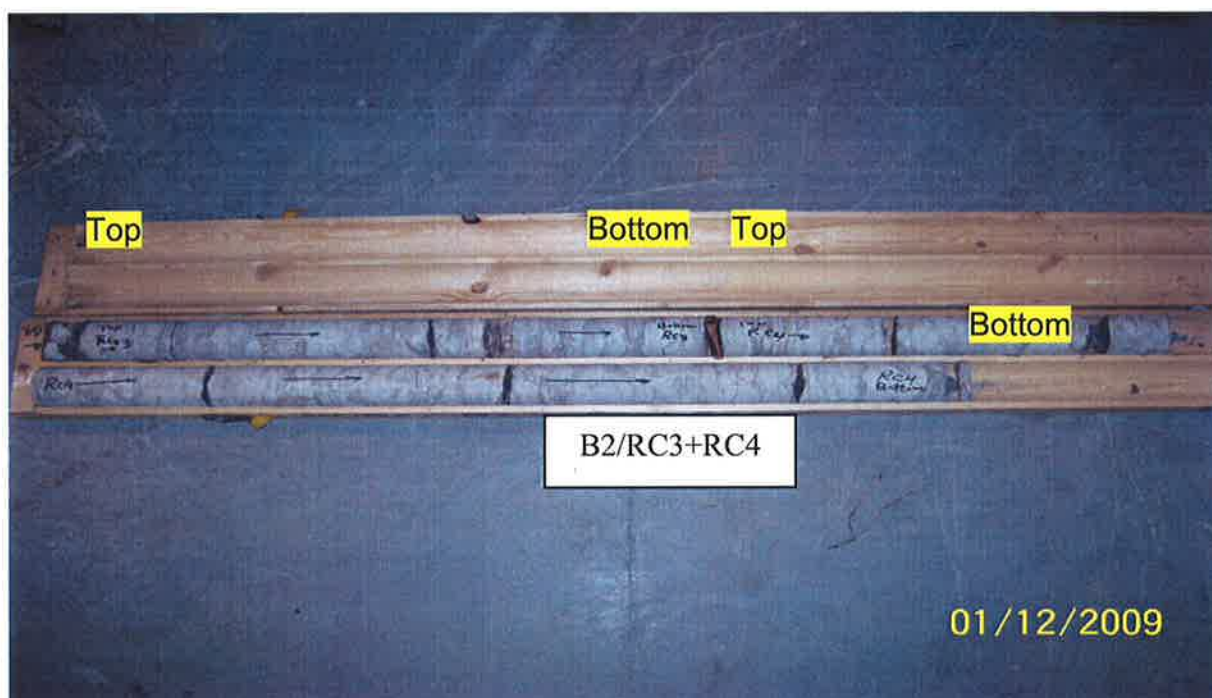
Borehole B-1/ Core # RC1



Borehole B-1/ Core # RC2



Borehole B-1/ Core # RC3



Borehole B-2/ Core # RC3 + RC4



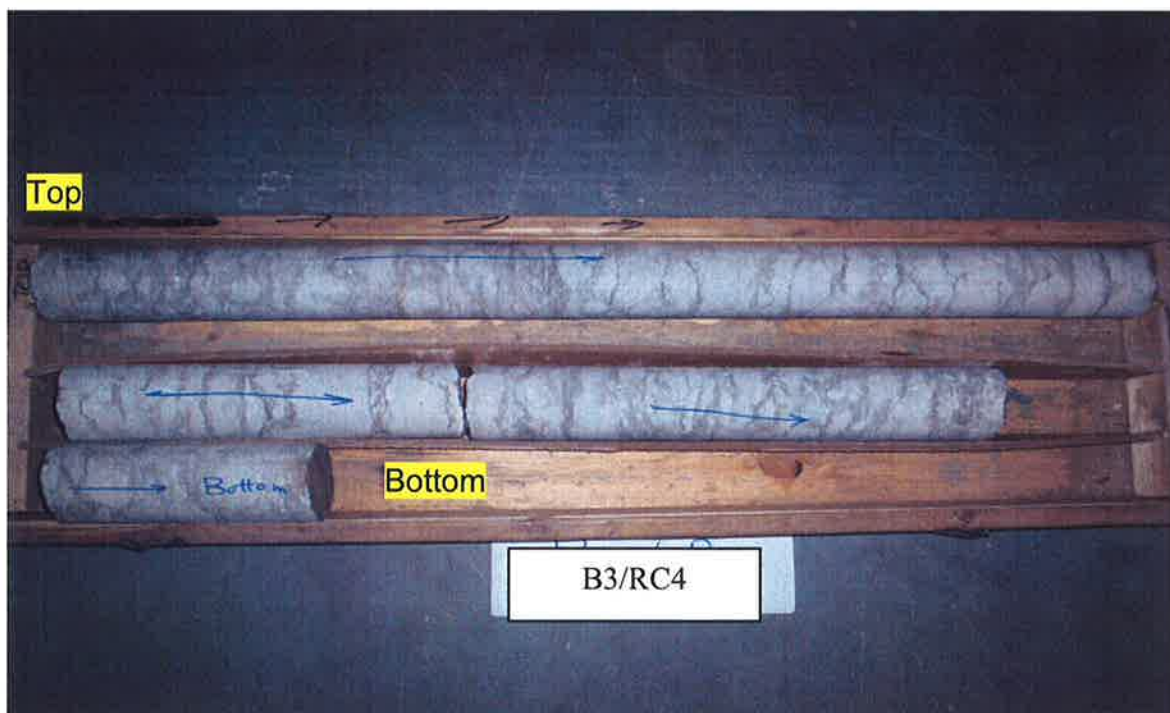
Borehole B-2/ Core # RC5



Borehole B-3/ Core # RC2



Borehole B-3/ Core # RC3



Borehole B-3/ Core # RC4



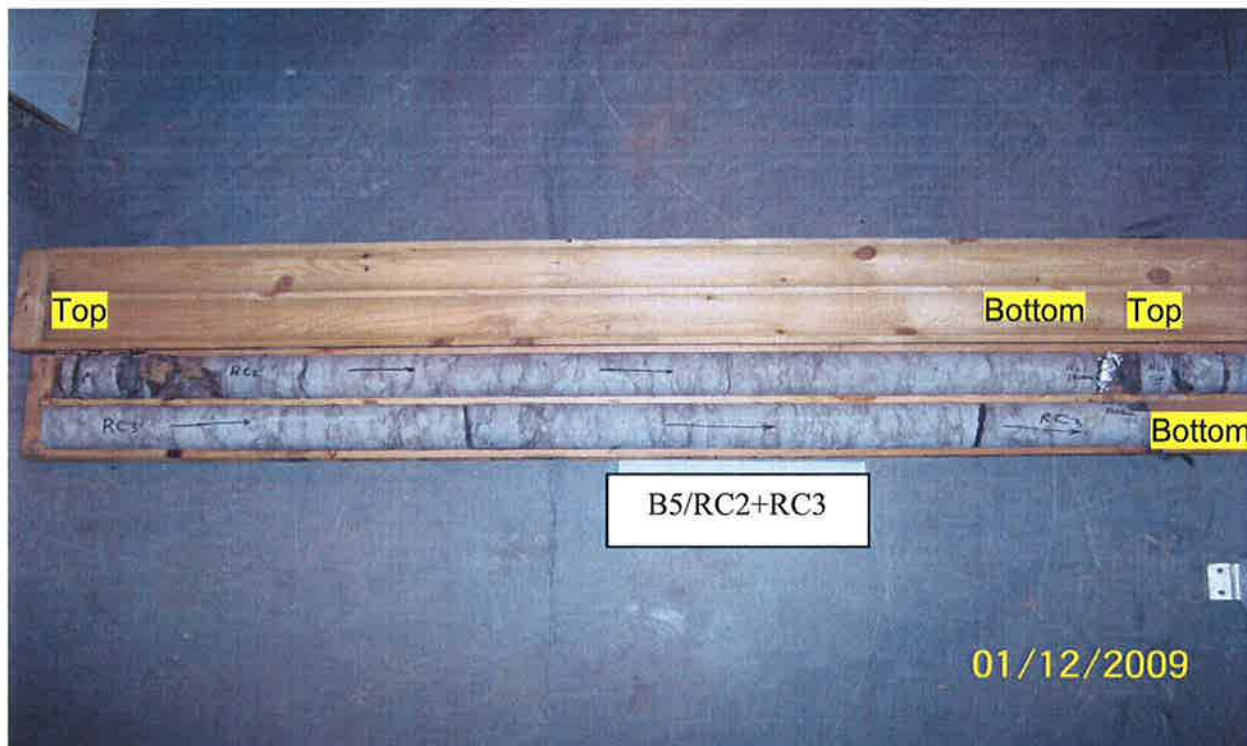
Borehole B-4/ Core # RC1



Borehole B-4/ Core # RC2



Borehole B-4/ Core # RC3



Borehole B-5/ Core # RC2+RC3



Borehole B-5/ Core # RC4



Borehole B-6/ Core # RC3



Borehole B-6/ Core # RC4+ RC5

Appendix E

Explanation of Terms Used in the Report

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

C_u (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

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

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCUTRAL 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

JOINT AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

u_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

MECHANICALL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
c_c	1	COMPRESSION INDEX
c_s	1	SWELLING INDEX
c_a	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_t	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
j_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
P_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
j_w	kN/m ³	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	N PERCENT – DIAMETER
P	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
j	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
P_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
j_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(W_L - W_p) / I_p$	v	m/s	DISCHARGE VELOCITY
P_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(W - W_p) / I_p$	i	1	HYDAULIC GRADIENT
j_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_c	1	CONSISTENCY INDEX = $(W_L - W) / 1_p$	k	m/s	HYDRAULIC CONDUCTIVITY
P'	kg/m ³	DENSITY OF SUBMERED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
j'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

**FOUNDATION DESIGN REPORT
PROPOSED BATTEAUX RIVER BRIDGE
WBL, HIGHWAY 26,
NEAR COLLINGWOOD, ONTARIO
G.W.P # 630-91-00
AGREEMENT # 2006-E-0002**

Delcan Corporation

Geocres No. 41A-208

Project: SPT1232
October 15, 2009

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Appendices

Appendix F: OPSD / OPSS

Appendix G: Limitations of Report

**FOUNDATION DESIGN REPORT
BATTEAUX RIVER BRIDGE, WBL, HIGHWAY 26
NEAR COLLINGWOOD, ONTARIO
W.P. # 630-91-00; Agreement # 2006-E0002**

5. DISCUSSION AND RECOMMENDATIONS

The proposed bridge which will carry the westbound lane (WBL) of the new proposed Highway 26 realignment over the Batteaux River will be a two-span 35 m long structure; each span will be 17.5 m. It will incorporate a central pier in the river. The proposed bridge will carry two lanes of traffic with a total bridge deck width of about 14.2 m. It is our understanding that the vertical clearance of the bridge over the existing river bed will be about 5 m.

The subsurface conditions were explored at eight (8) boreholes (see Table 3.1 in Section 3 of the foundation investigation section of this report) during this investigation. In general, below water/topsoil and thin layer of very loose to dense silty sand till with gravel and rock fragments, the proposed bridge site is underlain by limestone bedrock. The elevations of the bedrock surface in the boreholes were found to be relatively flat.

The water level at the time of investigation was contacted at elevations in between 189.6 and 190.7 m, based on the measurements of water level in open boreholes. It is our opinion that groundwater at the time of investigation was at about El. 190.5 m, similar to water level in Batteaux River. It should be pointed out that the groundwater table can expected to be subject to seasonal fluctuations and in response to major weather events. In addition, the water table at the site will be influenced by the water level in the water course.

5.1 Foundations

We understand that the proposed WBL bridge will be constructed at about 13 m (clear distance) north from the existing EBL bridge. Based on the results of this investigation, the use of normal spread footings is considered to be most suitable for both the abutment locations and the central pier location.

5.1.1 Shallow Foundations

Both the abutments and the centre pier can be founded on the limestone bedrock

The depth to the fresh strong limestone bedrock from the existing ground surface at the borehole locations varies from 1.2 to 1.9 m, as detailed in the following table.

Location	BH No.	Existing Ground El. (m)	Recommended Highest Founding Level Depth*/Elevation	ULS (kPa)
West Abutment	B1	190.7	1.2/189.5	4000
	B2	190.9	1.4/189.5	4000
Central Pier	B3	190.7	1.5/189.2	4000
	B4	190.4	1.4/189.0	4000
East Abutment	B5	190.8	1.5/189.3	4000
	B6	190.5	1.9/188.6	4000

* Below existing ground surface

Table 5.1.1: Spread Footing Foundations on bedrock

The extent of the rock excavation will depend on the actual founding level. For this purpose, all loose, fractured or weathered bedrock under the footprint of the footing should be removed and replaced with concrete. Mass concrete may be placed to raise the grade to the founding level, where necessary. When choosing the founding elevations, scour may need to be considered.

Based on the borehole results, for design purposes, the following Canadian Highway Bridge Design Code (C.H.B.D.C.) geotechnical resistances may be used.

Factored Bearing Resistance at U.L.S. = 4,000 kPa

Bearing Resistance at S.L.S. will not govern

Under the inclined loading conditions the Bearing Resistance at U.L.S. should be reduced in accordance with Clause 6.7.4 of C.H.B.D.C.

It should be noted that in between and beyond borehole locations, the bedrock surface and the depth to the suitable bedrock surface may vary considerably. Additionally, auger refusal depths may be due to refusal on cobbles or boulders within the overburden and thus the actual bedrock surface may be lower than the refusal depths in Boreholes B7 and B8.

All footing excavations and bearing surfaces must be inspected, evaluated and approved by a Geologist or Geotechnical Engineer who is familiar with the findings of this investigation. As mentioned before, all

footings should be founded on sound bedrock. For this purpose, all loose or weathered rock under the footprint of the footing should be removed to the surface of the sufficiently sound bedrock and replaced with concrete.

Sliding resistance can be provided by utilizing the sliding resistance between concrete and clean bedrock surface. For the evaluation of the sliding resistance of the foundation (C.H.B.D.C. 6.7.5) the ultimate angle of friction between the underside of the foundations and the clean, intact bedrock surface (or between concrete surfaces) can be taken as 32° . If additional horizontal resistance is required or if the rock surface is not sufficiently level, dowelling or keying-in into the bedrock can be considered. Such measures would be required if the rock surface is smooth and/or inclined. In addition, the surface of the bedrock can be chiseled (i.e. roughened), increasing the ultimate angle of friction to 35° .

If there are net uplift forces which are to be resisted by rock anchors, the factored rock/grout bond capacity at U.L.S. can be taken as 500 kPa and S.L.S. will not govern. The upper 0.6 m of the rock should, however, not be included in calculating the resistance and the minimum embedment depth should be 1.2 m into the sound rock (embedded length in the rock). The anchors should also be checked for rock wedge pull-out assuming a 60 degree apex cone/wedge and the anchor group resistance should also be checked.

5.1.2 Deep Foundations

Based on the subsurface conditions at the site, the use of deep foundations is not recommended.

5.2 Lateral Earth Pressures

Backfill behind abutments should consist of non-frost susceptible, free-draining granular materials in accordance with the Ontario Ministry of Transportation Standards and the requirements of OPSD 3101.150.

Free-draining backfill materials (i.e. Granular 'A' or Granular 'B' Type I or II, with no more than 5% passing the 0.075mm sieve) and the provision of drains pipes and weep holes, etc., should prevent hydrostatic pressure build-up. Computation of earth pressures should be in accordance with CHBDC S6-06. For design purposes, the following parameters (unfactored) can be used.

Compacted Granular 'A' and Granular 'B' Type II

Angle of Internal Friction, $\phi = 35^\circ$ (unfactored)

Unit Weight = 22 kN/m^3

Coefficient of Lateral Earth Pressure:

$K_a = 0.27$ $K_b = 0.35$

$K_o = 0.43$ $K^* = 0.45$

Compacted Granular 'B' Type I

Angle of Internal Friction, $\phi = 32^\circ$ (unfactored)

Unit Weight = 21 kN/m^3

Coefficient of Lateral Earth Pressure:

$K_a = 0.31$ $K_b = 0.41$

$K_o = 0.47$ $K^* = 0.57$

Where K_b is the 'intermediate' earth pressure coefficient for a partially restrained structure.

K^* is the earth pressure coefficient for a soil loading a fully-restrained structure, including compaction surcharge effects.

These values are based on the assumption that the backfill behind the retaining structure is free-draining and adequate drainage is provided. As well, it is assumed that the ground behind the retaining structure is level.

The earth pressure coefficient adopted will depend on whether the retaining structure is restrained or movements can be allowed such that the active state of earth pressure can develop. If the abutment is restrained and does not allow lateral yielding, then at rest pressures should be used in accordance with CHBDC S6-06. This is likely to be case for this project since support elements will rest on bedrock. The effect of compaction should also be taken into account in the selection of the appropriate earth pressure coefficients in accordance with Section 6.9 of CHBDC S6-06.

For unrestrained wing walls (if any), the intermediate earth pressure coefficient K_b may be adopted. In the determination of degree of wall displacement or rotation to mobilize the fully active earth pressure state, Section C6.9 of the CHBDC S6-06 Commentary can be consulted.

Vibratory equipment for use behind abutments and retaining walls should be restricted in size as per current MTO practice.

5.3 Approach Embankments

Based on the information provided to us by Delcan, the grade at the west and east abutment locations will be raised up to about 4 to 4.5 m over the existing grades (o.g.) to about El. 195.0 m. Embankment side slopes no steeper than 2H:1V are considered suitable for this site. All unsuitable soils should be removed within the footprint of embankment prior to construction.

The materials used for the construction of the embankment fills should consist of approved, acceptable earth fill (e.g. select subgrade materials or Granular 'B' – OPSS 1010). Fill used for construction of the embankments should be in accordance with OPSS 212 and fill placement should meet or exceed the requirements of SP 105S01 and OPSS 206. The embankment fill should be placed on the approved and properly rolled subgrade in lifts not exceeding 300 mm when loosely placed and each lift should be uniformly compacted to at least 95% of the material's Standard Proctor Maximum Dry Density.

Where the slopes are susceptible to erosion by the River (e.g. slopes along the River in the vicinity of the bridge structure), they will have to be protected from scour and erosion. This can consist of 0.5 m thick layer of rock protection consisting of 300 mm size rock, overlying a 300 mm thick layer of filter material. The rock protection should be in accordance with OPSS 511. The filter material should consist of a granular material such as Granular 'A' or equivalent. Alternatively, a suitable geotextile could be used in lieu of the granular filter. This would apply to any earth fill approach embankment slopes where they are endangered by erosion due to possible flooding. Otherwise, the side slopes of the earth fill approach embankments will be protected by applying normal proper erosion control measures which should be implemented both during the construction and permanently. This can be achieved by prompt seed and cover (OPSS 572) or sodding (OPSS 571).

Where the new embankments are to abut into the existing embankments, the existing embankment side slopes should be properly benched as per MTO standards (OPSD 208.010)

5.4 Construction Comments

All excavations, shoring and backfilling should be carried out in conformance with the Occupational Health and Safety Act (OHSA), Regulation 213/91, as well as the following specifications.

SP 105S19 – Protection Systems

SP 902S01 – Excavation and Backfilling to Structures.

The boreholes show that the excavations can be expected to extend through topsoil and silty sand till with gravel and rock fragments. These soils are underlain by bedrock. The soils can be classified as follows:

Topsoil	Type 3 soil above water level Type 4 soil below water level
Silty Sand Till with gravel and rock fragments	Type 3 soil above water level Type 4 soil below water level

The footings should be placed below possible scour depth. Temporary open cut slopes should be maintained no steeper than 1H:1V.

Excavation into the bedrock could be carried out using hardened teeth excavator, drilling and hoe ramming techniques where relatively shallow depths of cut into the bedrock are required. Line drilling and pre-shearing techniques will provide better control over the configuration of the founding surface, and this procedure would be the preferred approach where deeper excavation into the bedrock is required for footing construction.

Gravity drainage or pumping from filtered sumps located at the base of the excavations may be required to provide groundwater control during foundation excavations. Surface water runoff should be directed away from the excavations at all times.

It is recommended that the Contractor be asked to submit their dewatering scheme prior to the start of the construction to the CA for information purposes.

It is our understanding that the existing structure will be constructed approximately 13 to 15 m away from the existing bridge. We also understand that the existing bridge is supported on the limestone bedrock. No foundation settlements are therefore anticipated due to the construction activities for the construction of the new bridge structure. However, any rock excavation for the construction of the new bridge should be carried out in a manner so as not to induce excessive vibrations which could damage the foundations and the superstructure of the existing bridge or cause an instability of the side slopes of the existing embankment. For example, if rock blasting is to be implemented, this should be carried out under close supervision and vibration monitoring. In addition, if the excavations are to be extended into the side slope of the existing embankment, shoring may be required, as discussed in the following paragraphs.

Temporary support may be necessary to retain the existing embankment fills. The contractor will probably choose to slope the ground rather than shore it for the duration of the construction, where feasible. Where support is necessary, the shoring should be designed so that the lateral movement of any portion of the roadway protection system will not exceed the established criterion for the structure performance level. In this case, the Performance Level should be 2.

Table 5.4.1: Recommended Unfactored Parameters for Temporary Shoring Design

Soil Type	K_a	K_o	K_p	γ (kN/m ³)
Granular Embankment Fill *	0.32	0.49	3.1	21.0
Lower Embankment Fill *	0.33	0.50	3.0	20.5
Silty Sand Till with gravel & rock fragments	0.33	0.50	3.0	20.5
Bedrock (upper 1.0 m)	0.24	0.32	3.6	23.0
Bedrock (below 1.0 m)	0.12	0.15	5.0	24.0

* Assumed parameters - no boreholes were drilled from the top of the existing embankment.

5.5 Frost Protection

Design frost protection for the general area is 1.5 m. However, for spread footings placed on fresh limestone bedrock or mass concrete, frost protection cover is not required. It should however be ensured that any obvious crack/joints be grouted, if necessary to prevent water penetration which may cause further cracking/jointing in the founding bedrock.

5.6 Seismic Design Data

5.6.1 Site Coefficient

The subsurface conditions encountered at the site are represented by Soil Profile Type I (see Clause 4.4.6.2 of CHBDC CAN/CSA-S6-00). For seismic design, therefore, in accordance with Clause 4.4.6.1 site coefficient, S , for the site is 1.0.

5.6.2 Seismic Zone and Zonal Acceleration Ratio (A)

Table A3.1.1 of the CHBDC provides that Collingwood has a Zonal Acceleration Ratio of 0.05 and Velocity Related Seismic Zone (Z_v) of zero. As site coefficient (S) is 1.0, and the zonal acceleration is 0.05, the design zonal acceleration ratio for the site can be taken as $A=0.05$.

6. CLOSURE

The Limitations of Report, as quoted in Appendix G, are an integral part of this report.

For and on behalf of Coffey Geotechnics Inc.


Raid Khamis, P.Eng.
Geotechnical Engineer



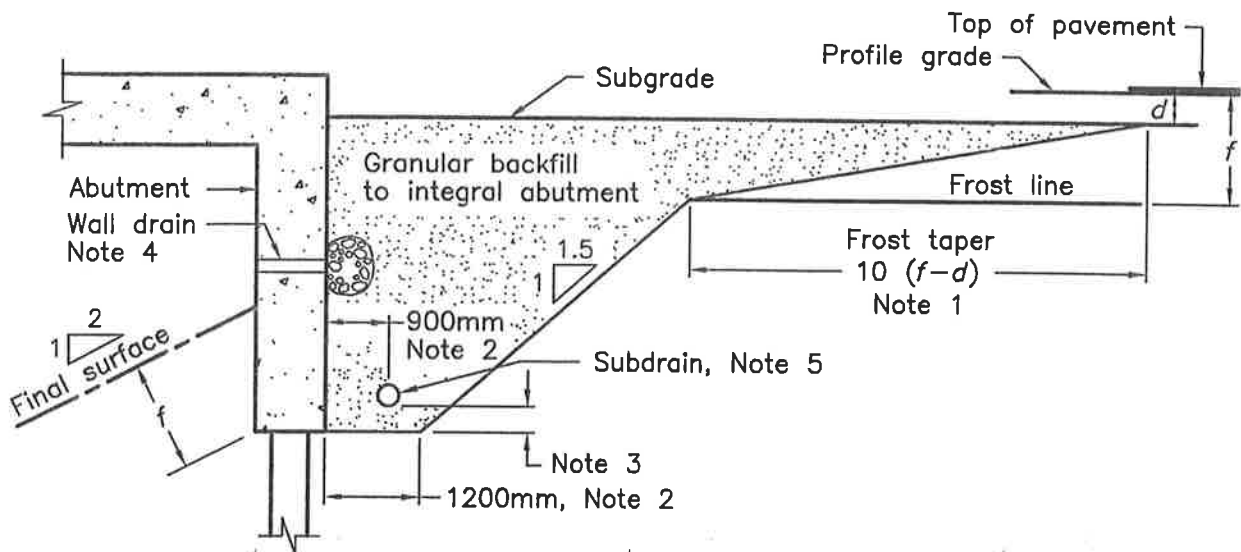

Ramon Miranda, P.Eng.
Project Manager



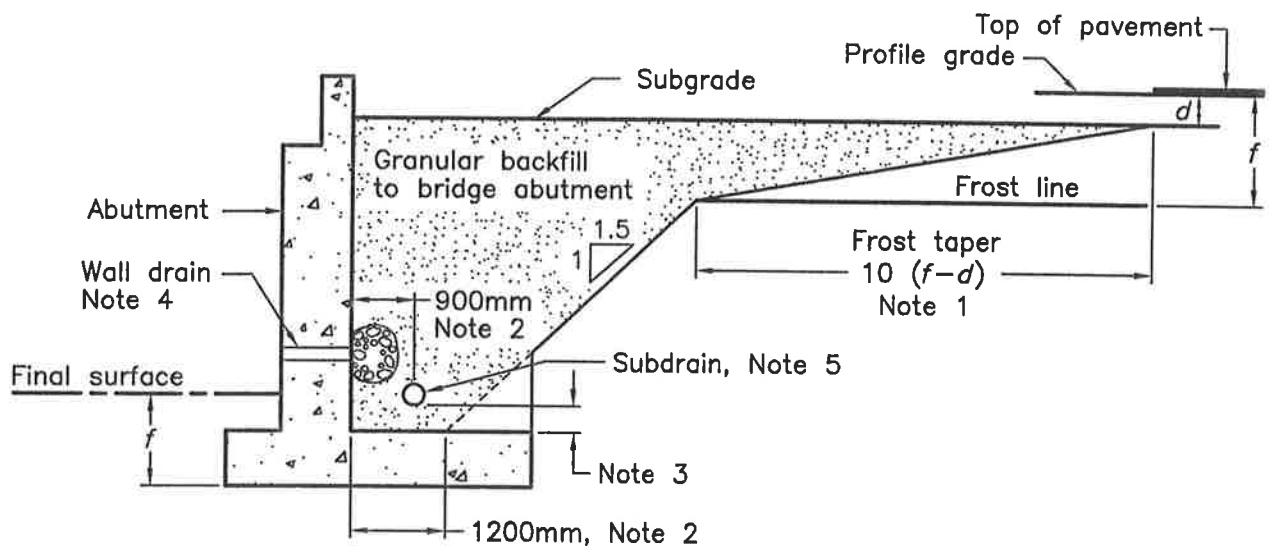

Zuhtu Ozden, P.Eng.
Senior Principal

Appendix F

OPSD / OPSS / SP



INTEGRAL ABUTMENT



ABUTMENT

NOTES:

- 1 d = depth of combined base and subbase courses.
 f = roadbed depth of frost penetration as specified.
- 2 Dimensions/perpendicular to back face of abutment.
- 3 Height to be consistent with positive drainage of subdrain as specified.
- 4 Where specified, wall drains shall be installed according to OPSD-3190.100.
- 5 150mm dia perforated pipe subdrain wrapped with geotextile.
- A Lateral limits of granular backfill to bridge abutment to be inside face to inside face of retaining wall or wingwall. Frost taper shall extend the full width of the fill unless interrupted by the retaining wall or wingwall.
- B Sections shown are parallel to centreline of roadway.
- C Subdrain to be installed with a 2% gradient behind wall.
- D All dimensions are in millimetres unless otherwise shown.

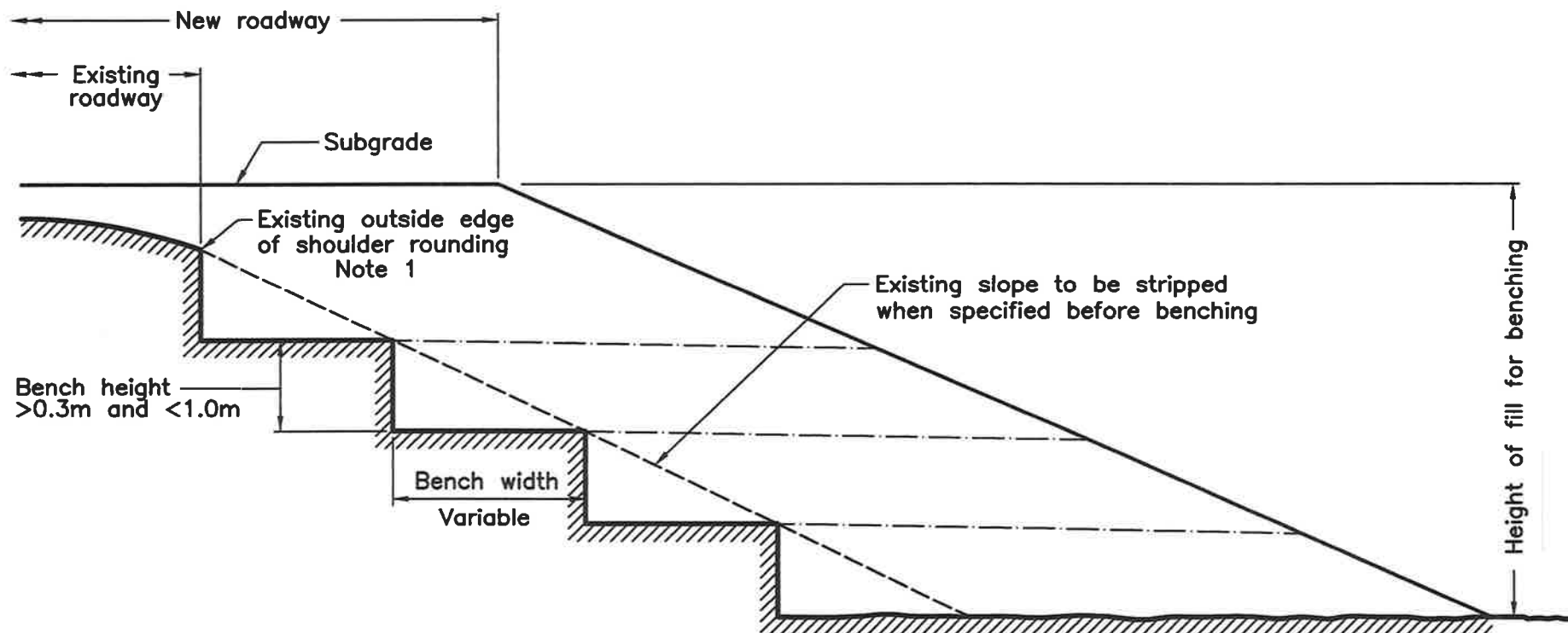
ONTARIO PROVINCIAL STANDARD DRAWING

Nov 2005 Rev 0

WALLS
ABUTMENT, BACKFILL
MINIMUM GRANULAR REQUIREMENT

OPSD - 3101.150





NOTES:

- 1 When the subgrade is below the existing outside edge of shoulder rounding, benching shall be carried out below the point where the subgrade intersects the existing slope.
- A Benching is not required on existing slopes flatter than 3:1 or where specified.

- B Benches are to be excavated one level at a time and the compacted fill brought up before the next benching level is excavated.
- C All dimensions are in millimetres or metres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

1996 02 01 Rev

BENCHING OF EARTH SLOPES

Date



OPSD - 208.010



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS 1010
November 2003**

**MATERIAL SPECIFICATION FOR
AGGREGATES - BASE, SUBBASE,
SELECT SUBGRADE, AND BACKFILL MATERIAL**

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1010.01 SCOPE

This specification covers the material requirements for aggregates for use in base, subbase, select subgrade, granular surface, shouldering, and backfill material. Procedures for QC and QA and referee testing protocols are incorporated.

1010.01.01 Significance and Use of Appendices

Appendices are not a mandatory part of this specification unless invoked by the Owner.

Appendix 1010-A is a commentary appendix to provide designers with information on the use of the specification in a Contract.

Appendix 1010-B is an additional information option that is invoked only when referenced in the Contract Documents by the Owner. This appendix contains a form for reporting fine aggregate test data, other than for LS-602 and LS-702.

Appendix 1010-C is an additional information option that is invoked only when referenced in the Contract Documents by the Owner. This appendix contains a form for reporting coarse aggregate test data, other than for LS-602.

1010.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specification, Material

OPSS 1001 Aggregates - General

Ministry of Transportation, Ontario, Publications

MTO Laboratory Testing Manual

LS-602	Sieve Analysis of Aggregates
LS-607	Percent Crushed Particles in Processed Coarse Aggregate
LS-609	Petrographic Analysis of Coarse Aggregate
LS-614	Freezing and Thawing of Coarse Aggregate
LS-616	Petrographic Analysis of Fine Aggregate
LS-617	Percent Particles with Two or More Crushed Faces and Uncrushed Particles in Processed Coarse Aggregate
LS-618	The Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-619	Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-621	Determination of Amount of Asphalt Coated Particles in Coarse Aggregate
LS-624	The Use of Control Charts for Construction Aggregates
LS-625	Sampling of Granular Materials
LS-702	Determination of Particle Size Analysis of Soils
LS-703/704	Liquid Limit, Plastic Limit and Plasticity Index of Soils
LS-709	Determination of Permeability of Granular Soils

1010.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Air-Cooled Blast-Furnace Slag means the material resulting from solidification of molten blast-furnace slag under atmospheric conditions. Subsequent cooling may be accelerated by application of water to the solidified surface.

Bench means a ledge parallel to stratigraphic bedding that in quarries forms a single level of operation above which rock is excavated from a contiguous face.

Business Day means any Day except Saturdays, Sundays, and statutory holidays.

Control Chart means a graphical chart used to monitor the central tendency and variability of a material characteristic in order to control production.

Ceramic means porcelain, china, and whiteware, e.g., sinks, toilets, and bidets made from clay and silica fired at a high temperature, excluding clay brick and tile, free of organic materials, metal, and plastic.

Deleterious Material means materials from the recycling stream other than glass, ceramic, reclaimed asphalt pavement, and reclaimed concrete materials that includes but is not limited to the following: wood, clay brick, clay tile, plastic, gypsum, gypsum plaster, and wallboard.

Free of Clay means the amount of material with a particle diameter less than 2 m shall not be greater than 1% of the total sample when tested according to LS-702.

Glass means processed glass obtained from the recycling stream that is free of organic materials, metal, and plastic.

Granular A means a set of requirements for dense graded aggregates intended for use as granular base within the pavement structure, granular shouldering, and backfill.

Granular B means a set of requirements for well-graded aggregates intended for use as granular subbase within the pavement structure and granular backfill. Granular B may be either Type I or Type II.

Granular M means a set of requirements for dense graded aggregates intended for use on unpaved road surfaces and for the maintenance of unpaved shoulders.

Granular O means a set of requirements for open graded aggregates intended only for use as a free draining granular base within the pavement structure.

Granular S means a set of requirements for dense graded aggregates intended only for use as surface dressing of low volume unpaved roads with an AADT less than 200.

Nickel Slag means the non-metallic co-product resulting from the production of nickel.

Physical Property means an inherent attribute or feature of an aggregate or soil material. Tests are carried out to determine a materials resistance to weathering or degradation or both.

Pit-Run Material means material excavated directly from an existing bank in a pit and delivered to the job site without further processing, e.g., crushing, screening, washing, and classifying.

Production Characteristic means an attribute or feature of an aggregate or soil material, including gradation, that is introduced into the material through the manufacturing process, e.g., crushing, screening, and, blending.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that materials received meet the specified requirements.

Quality Control (QC) means a system or a series of activities performed by the Contractor to ensure that materials supplied meet the specified requirements.

Random Numbers means numbers generated by chance and recorded in random number tables.

Reclaimed Asphalt Pavement (RAP) means processed hot mix asphalt material that is recovered by partial or full depth removal.

Reclaimed Concrete Material (RCM) means removed or processed old Portland cement concrete.

Referee Testing means testing by an independent laboratory selected by the Contract Administrator and acceptable to the Contractor, the results of which are used for resolving differences between QC and QA testing.

Select Subgrade Material (SSM) means a set of requirements for well-graded non-plastic aggregates used to replace poor subgrade materials and as swamp backfill.

Statistical Control means when all sources of assignable variation have been removed, that is when the variability of the process is confined to chance variation alone.

Steel Slag means the non-metallic co-product resulting from the production of steel in a basic oxygen or electric arc furnace.

1010.04 SUBMISSION and DESIGN REQUIREMENTS

1010.04.01 Submission of Test Data

The Contractor shall have test results available for the aggregates to be used in the work. At the request of the Contract Administrator, the Contractor shall make available or submit QC test results prior to the delivery of the material. Test results shall be submitted by either the stockpile/pit-run method or control chart method. All test data forms shall be legible.

Test data for each aggregate product shall be managed independently. Where more than one source is used for supplying materials, test data from each source and product shall be managed independently.

1010.05 MATERIALS

1010.05.01 General

The requirements of OPSS 1001 shall apply to this specification. Materials shall conform to this specification when tested according to the MTO Laboratory Testing Manual.

All aggregate source materials shall be clean hard durable particles free of earth, humus, and clay, e.g., coatings, lumps, and fragments. Where reclaimed materials are permitted, they shall be homogeneously blended. Where RCM is permitted, RCM shall not contain loose reinforcing materials.

Where air-cooled blast furnace slag, nickel slag, and RAP containing steel slag aggregates are used, site-specific notification shall be given by the Contractor to the Ontario Ministry of the Environment (MOE). Glass and ceramic material shall be processed to remove all deleterious organic materials.

One hundred percent of the processed glass and ceramic material shall pass the 13.2 mm sieve.

Steel slag shall not be used.

1010.05.02 Granular A, Granular M, and Granular S

Granular A, Granular M, and Granular S may be produced by crushing one or more of the following:

- a) Quarried bedrock.
- b) Naturally formed deposits of sand, gravel, and cobbles.
- c) RAP up to 30% by mass.
- d) RCM.
- e) Air-cooled blast-furnace slag or nickel slag.
- f) Glass or ceramic materials up to 15% by mass combined.

Granular A and Granular M may contain up to 100% RCM but shall not contain more than 30% by mass of asphalt coated particles and not more than a combined total of 15% by mass of glass and ceramic material. The combined amount of deleterious material shall not exceed a total of 1% by mass.

Granular A and Granular M containing RAP with steel slag aggregates shall be acceptable for unpaved gravel shoulders only.

1010.05.03 Granular B

1010.05.03.01 General

Granular B may be either Type I or Type II as described below.

1010.05.03.02 Granular B Type I

Granular B Type I may be produced from naturally formed deposits of sand, gravel, and cobbles or by crushing one or more of the following:

- a) Quarried bedrock.
- b) Air-cooled blast-furnace slag or nickel slag.
- c) RCM.
- d) RAP up to 30% by mass.
- e) Glass or ceramic materials up to 15% by mass combined.

Granular B Type I may contain up to 100% RCM but shall not contain more than 30% by mass of asphalt coated particles. Granular B Type I may not contain more than a combined total of 15% by mass of glass and ceramic material. The combined amount of deleterious material shall not exceed 1% by mass.

RAP containing steel slag aggregates shall not be allowed.

1010.05.03.03 Granular B Type II

Granular B Type II shall only be obtained from crushing quarried bedrock, air-cooled blast furnace slag, or nickel slag. Steel slag and reclaimed materials shall not be used in the production of Granular B Type II.

1010.05.03.04 Granular O

Granular O shall only be produced by crushing quarried bedrock, or by crushing cobbles or boulders retained on the 50 mm sieve.

1010.05.03.05 Select Subgrade Material

Select subgrade material shall only be non-plastic granular or sandy type soil produced from naturally formed deposits.

1010.07 Production

1010.07.01 Aggregate Processing, Handling, and Stockpiling

Aggregates that have become mixed with foreign matter of any description, or aggregates that have become mixed with each other shall not be used and shall be removed from the stockpile immediately. When a change in the character of the materials occurs or when the performance of materials that meet the requirements of this specification is found to be unsatisfactory, the use of the materials shall be discontinued until the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory.

Once a stockpile has been produced, sampled, and tested for QC under the procedure for stockpile/pit-run method, no further materials shall be added to the stockpile. Stockpiles produced, sampled, and tested under the procedure for control chart method may continue to have materials added provided that sampling and testing show that materials in the stockpile conform to this specification and that the process remains in statistical control.

1010.07.02 Quality Control

1010.07.02.01 General

The Contractor shall be responsible for all QC sampling and testing required to show conformance of the aggregates with this specification. Either the stockpile/pit-run method or control chart method shall be used. These records shall be made available to the Contract Administrator upon request.

Where the stockpile/pit-run method has been selected, test data shall be obtained from samples taken from stockpiled or pit-run material to be used in the work.

Where the control chart method has been selected, control charts shall be prepared in accordance with LS-624 or similar method. Each control chart shall contain information regarding control limits, specification limits, target values, testing frequencies, sampling locations, and time period over which the testing has taken place. Each control chart shall include individual test data of the most recent sample indicated on the chart.

1010.07.02.02 Laboratory Requirements

The Contractor shall select all QC laboratories and shall be responsible for all costs associated with the testing for QC requirements.

An acceptable laboratory conducting tests for physical properties shall be one that holds a current certificate from Canadian Council of Independent Laboratories (CCIL) as Type D for the applicable test methods and also participates in the Annual MTO Proficiency Sample Testing Program for the specific tests, except LS-616 and LS-709.

An acceptable laboratory to conduct tests for gradation according to LS-602 and percent crushed particles according to LS-607 shall be one who holds a current certificate from CCIL as Type C.

Testing shall be conducted by qualified laboratory staff that hold a valid aggregate testing certificate from CCIL.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements provided they are acceptable to the Contract Administrator.

1010.07.03 Physical Properties

1010.07.03.01 Stockpile/Pit-Run Method

Testing demonstrating conformance of the aggregates with Table 1 shall be completed for each quantity of material produced according to the following schedule:

- a) For the first 25,000 tonnes of aggregate produced.
- b) For the next 50,000 tonnes of aggregate produced.
- c) For each 100,000 tonnes of aggregate produced thereafter.

Further testing is required whenever material is produced from a new source or a new bench in a quarry or whenever a significant change in aggregate production or material occurs that may affect the quality of material.

1010.07.03.02 Control Chart Method

The Contractor shall use a Type 1 control chart as defined in LS-624 or similar method for each physical property requirement shown in Table 1. When the control chart has been established, the minimum frequency of sampling and further testing shall be as follows:

- a) Annually, i.e., obtained within the past 12 months, where the mean value of the physical property is less than 75% of the limit given in Table 1 and the Type 1 control chart demonstrates the process to be in statistical control; or
- b) Three times per year, spaced evenly throughout the aggregate production season, where the mean value of the physical property is greater than 75% of the limit given in Table 1 or the Type 1 control chart demonstrates the process to be out of statistical control.

1010.07.04 Production Characteristics

1010.07.04.01 Stockpile/Pit-Run Method

Testing demonstrating conformance of the aggregates with Table 2 shall be completed for each 1,000 tonnes of material produced.

1010.07.04.02 Control Chart Method

A Type 1 or Type 2 control chart according to LS-624 or similar method for each applicable requirement shown in Table 2 may be used.

Type 1 control charts shall cover production of at least 20,000 tonnes of material. Type 2 control charts shall cover production of at least 80,000 tonnes of material. New or revised control charts shall be required for each successive production and delivery quantity of material, as applicable.

- a) Where a Type 1 chart is used, the minimum number of test results shall be twenty ($n=20$). When this control chart has been established, the frequency of sampling and further testing shall be as follows:
 - i. When the mean value ($n=20$) of the test results is within the limit and the process is shown to be in statistical control, the frequency of sampling and testing may be decreased to meet the quantities shown in Table 3; otherwise,
 - ii. The minimum frequency shall be every 1,000 tonnes of material produced.
- b) Where a Type 2 chart is used, the minimum number of subgroups shall be twenty ($k=20$). When this control chart has been established, the frequency of sampling and further testing shall be as follows:
 - i. When the process is shown to be in statistical control, frequency of sampling and testing may be decreased to meet the quantities shown in Table 3; otherwise,
 - ii. The minimum frequency shall be every 1,000 tonnes of material produced.

1010.08 QUALITY ASSURANCE

1010.08.01 General

The Contract Administrator shall be allowed access to all sampling locations and reserves the right to take a QA sample at any time with notice to the Contractor. The Contract Administrator may elect to carry out testing at the QA laboratory to ensure that materials used in the work conform to the requirements of this specification.

Test data for each aggregate type shall be managed independently. Where more than one source is used for supplying materials, test data from each source, and product shall be managed independently.

1010.08.02 Sampling

Sampling shall be according to LS-625 taken at a time and location determined by the Contract Administrator.

Duplicate samples shall be obtained and sealed by the Contractor in the presence of the Contract Administrator. In the event that the Contractor is unavailable to take the sample, no further materials shall be placed in the work until the QA sample has been taken. Samples shall be of sufficient mass of the material to conduct the necessary gradation and physical property tests.

Each QA sample shall meet the requirements of Table 4 and shall be clearly identified both inside and outside of the container.

When materials contain blended or reclaimed aggregates or both, QA sampling shall be performed on the final blended product.

1010.08.03 QA Laboratory Requirements

The Owner will designate the QA laboratories and will be responsible for all costs associated with QA testing.

An acceptable laboratory conducting tests for physical properties shall be one that holds a current certificate from CCIL as Type D for the applicable test methods and also participates in the Annual MTO Proficiency Sample Testing Program for the specific tests, except for LS-616 and LS-709.

An acceptable laboratory to conduct tests for gradation according to LS-602 and percent crushed particles according to LS-607 shall be one that holds a current certificate from CCIL as Type C.

Testing shall be conducted by qualified laboratory staff that hold a valid aggregate testing certificate from CCIL.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements provided they are acceptable to the Contract Administrator.

1010.08.04 Acceptance

When QA testing has not been carried out, the material shall be deemed acceptable. Otherwise, QA test results or referee test results shall be used for acceptance purposes as indicated below.

When QA test results show that the materials meet the applicable requirements of Table 1 and Table 2, the material will be accepted.

When QA test results show that the material does not meet the applicable requirements of Table 1 and Table 2, the Contract Administrator shall notify the Contractor that materials represented by the test results shall not be accepted. This notification will take place in writing within 3 business days of receipt of the non-conforming data.

At the discretion of the Contract Administrator, irrespective of non-compliance with the requirements of Table 1 and Table 2, aggregates may be accepted on the basis of satisfactory field performance.

1010.08.05 Referee Testing

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that fails to meet the requirements. The Contractor shall notify the Contract Administrator of the selected option within 2 business days following notification of unacceptable material.

The Contract Administrator shall select a referee laboratory acceptable to the Contractor within 3 business days following the Contractor's notification to invoke referee testing. Referee samples shall be delivered to the referee laboratory from the QA laboratory by the Contract Administrator. The sealed sample shall be opened in the presence of the Contractor and the Contract Administrator. If referee materials are not available, the Contractor shall be responsible for obtaining and submitting new samples to the referee laboratory from a location to be decided by the Contract Administrator. The Contract Administrator shall be present to witness the sampling.

Referee testing shall be carried out in the presence of the Contract Administrator. Where applicable, the referee laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner. Comments on the nonconformity of the test methods must be made and corrected at the time of testing. If the testing cannot be corrected or if agreement on the procedure cannot be reached, the testing shall be postponed until the procedure is corrected or agreement between the parties is reached. Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the material represented by the test result, including materials in existing stockpiles or in the work shall not be accepted. The Contractor shall remove the material from the work at no cost to the Owner.

When a referee test result shows that the aggregates are in complete conformance with the requirements of this specification, the material represented by the sample shall be accepted.

The Owner will be responsible for the cost of referee testing provided that the referee test results show that the aggregates meet the applicable specifications. Otherwise, the Contractor shall be responsible for the costs.

Table 1
Physical Property Requirements

Laboratory Test	MTO Test Number	Granular O	Granular A	Granular S	Granular B Type I and Type II	Granular M	Select Subgrade Material
Coarse Aggregate Petrographic Requirement	LS-609	(Note 2)	(Note 1) (Note 2)	(Note 2)	(Note 1) (Note 2)	(Note 1) (Note 2)	(Note 2)
Freeze-Thaw Loss, % maximum	LS-614	15	N/A	N/A	N/A	N/A	N/A
Fine Aggregate Petrographic Requirement	LS-616 LS-709		(Note 3)				
Micro-Deval Abrasion Coarse Aggregate loss, % maximum	LS-618	21	25	25	30 (Note 4)	25	30 (Note 4)
Micro-Deval Abrasion Fine Aggregate loss, % maximum	LS-619	25	30	30	35	30	N/A
Plasticity Index	LS-704	0	0	0	0	0	0
Percent crushed, minimum	LS-607	100	50	50	N/A	50	N/A
2 or more crushed faces, % minimum	LS-617	85	N/A	N/A	N/A	N/A	N/A
Asphalt Coated Particles, % maximum	LS-621	N/A	30	30	(Note 5)	30	N/A

Notes:

- Granular A, B Type I, or M may contain up to 15% by mass of crushed glass and ceramic material combined.
- Granular A, B Type I, M, and S shall not contain more than 1% by mass of deleterious material. Granular O, Granular B Type II, and SSM shall not contain more than 0.1% by mass of wood. Petrographic classification of rock type need not be reported. This requirement is only to be reported when such material is present.
- Test required for materials north of the French and Mattawa Rivers only. For materials with greater than 5.0% passing the 75 μm sieve, the amount of mica passing the 150 μm sieve and retained on the 75 μm sieve, shall not exceed 10% of the material in that sieve fraction unless either testing according to LS-709 determines permeability values to be greater than 1.0×10^{-4} cm/s or field experience show satisfactory performance. Prior data demonstrating compliance with this requirement will be acceptable provided such testing has been done within the past five years and that field performance of these materials has been satisfactory.
- The coarse aggregate Micro-Deval abrasion loss test requirements will be waived if the material has more than 80% passing the 4.75 mm sieve.
- Granular B Type I may contain up to 30% asphalt coated particles. Granular B Type II shall not contain RAP or asphalt coated products.

Table 2
Gradation Requirements - Percent Passing

MTO Test Number	Sieve	Granular						Select Subgrade Material
		O	A	S	B (Note 1)		M	
					Type 1 (Note 2)	Type II		
LS-602	150 mm	N/A	N/A	N/A	100	N/A	N/A	100
	106 mm	N/A	N/A	N/A	N/A	100	N/A	N/A
	37.5 mm	100	N/A	N/A	N/A	N/A	N/A	N/A
	26.5 mm	95-100	100	100	50-100	50-100	N/A	50-100
	19.0 mm	80-95	85-100 (87-100*)	90-100	N/A	N/A	100	N/A
	13.2 mm	60-80	65-90 (75-95*)	75-100	N/A	N/A	75-95	N/A
	9.5 mm	50-70	50-73 (60-83*)	60-85	N/A	N/A	55-80	N/A
	4.75 mm	20-45	35-55 (40-60*)	40-60	20-100	20-55	35-55	20-100
	1.18 mm	0-15	15-40	20-40	10-100	10-40	15-40	10-100
	300 µm	N/A	5-22	11-25	2-65	5-22	5-22	5-95
	150 µm	N/A	N/A	N/A	N/A	N/A	N/A	2.0-65.0
	75 µm	0-5.0	2.0-8.0 (2.0-10.0**)	9.0-15.0 (9.0-17.0**)	0-8.0 (0-10.0**)	0-10.0	2.0-8.0 (2.0-10.0**)	0-25.0

Notes:

1. Where Granular B is used for granular backfill for pipe subdrains, 100% of the material shall pass the 37.5 mm sieve.

2. Where RAP is included in Granular B Type I, 100% of the RAP shall pass the 75 mm sieve. Conditions in Note 1 supersede this requirement.

* Where the aggregate is obtained from an air-cooled blast furnace slag source.

** Where the aggregate is obtained from a quarry or an air-cooled blast furnace slag or nickel slag source.

Table 3
Minimum Sampling and Testing Frequency for Control Chart Use

Material	Frequency for Type 1 Control Chart t	Frequency for Type 2 Control Chart t
Granular A, M, and S	2,500	5,000
Granular B and SSM	5,000	10,000
Granular O	2,000	4,000

Table 4
Sample Size

Material	Minimum Mass of Individual Field Samples kg
Granular A, S, M, and O	25
Granular B and SSM	50
Granular B and SSM 100% passing 26.5 mm sieve	25
Note: Each sample container shall hold no more than 25 kg of material.	

Appendix 1010-A, Commentary for OPSS 1010, November 2003

Note: This Appendix does not form part of the standard specification. It is intended to provide information to the designer on the use of this specification in a Contract.

Designer Action/Considerations

The designer should determine if the forms in Appendices 1010-B and 1010-C are to be used for submission purposes. If so, they need to be invoked by reference in the Contract Documents.

The use of steel slag aggregate is prohibited.

The designer should be aware that air-cooled blast furnace slag, nickel slag, and RAP containing steel slag aggregates may require specific placement guidelines based on local municipal and MOE requirements.

Prior to tendering, where Owner supplied or specified air-cooled blast furnace slag, nickel slag, or RAP containing steel slag aggregates are to be used, the designer should obtain site notification from MOE and ensure all environmental guidelines and requirements are met.

RAP content is determined by LS-623, percent Asphalt Coated Particles. However, this test is limited to identifying RAP content in the coarse aggregate portion only. Where RAP in fine aggregate is a concern a Petrographic Examination of the material passing the 4.75 mm sieve is recommended. (1010.05.02)

The Contract Documents should specify the QA testing to be performed in the Contract. If QA testing is not specified, the material will be deemed acceptable.

The designer may specify a higher percent crushed requirement to improve performance in higher traffic areas.

Related Ontario Provincial Standard Drawings

None.

Appendix 1010-B, Additional Information for OPSS 1010, November 2003

Note: This appendix is not a mandatory part of the standard specification. However, it is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS 1010 - FINE AGGREGATE TEST DATA
Granular A, B, M, O, S, and Select Subgrade Material (SSM)

Contract No:	Contractor:	Contract Location:
Name of Testing Laboratory:		
Telephone No:	Fax No:	Date Tested:

Material Type (check one)						
Granular						[] SSM
[] A	[] B Type I	[] B Type II	[] M	[] O	[] S	
Date Sampled (YY/MM/DD):		Sampled by (Print Name):			Material Source:	

Laboratory Test Number	Acceptance Requirements							Test Results	
	Granular						SSM	Reference Material	Sample
	A	B Type I	B Type II	M	O	S			
Petrographic Requirement, LS-616	For materials north of the French and Mattawa Rivers: maximum 10% mica (retained on the 75 µm sieve).							N/A	
Micro-Deval Abrasion Loss, % maximum, LS-619	30	35	35	30	25	30	N/A		
Plasticity Index, % maximum, LS-704	0	0	0	0	0	0	0	N/A	

Issued by Testing Laboratory Representative:

PRINT NAME	SIGNATURE	DATE
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Received By Contract Administrator Representative:

PRINT NAME	SIGNATURE	DATE
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Appendix 1010-C, Additional Information for OPSS 1010, November 2003

Note: This appendix is not a mandatory part of the standard specification. However, it is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS 1010 - COARSE AGGREGATE TEST DATA
Granular A, B, M, O, S, and Select Subgrade Material (SSM)

Contract No:	Contractor:	Contract Location:
Name of Testing Laboratory:		
Telephone No:	Fax No:	Date Tested:

Material Type (check one)						
Granular						[] SSM
[] A	[] B Type I	[] B Type II	[] M	[] O	[] S	
Date Sampled (YY/MM/DD):		Sampled By (Print Name):			Material Source:	

Laboratory Test Number	Acceptance Requirements							Test Results	
	Granular						SSM	Reference Material	Sample
	A	B Type I	B Type II	M	O	S			
Crushed Particles, % minimum, LS-607	50	N/A	100	50	100	50	N/A	N/A	
Petrographic Requirement, LS-609	(Note 1)	N/A	(Note 1)	(Note 1)	N/A	(Note 1)	N/A	N/A	
Freeze-Thaw Loss, % maximum, LS-614	N/A	N/A	N/A	N/A	15	N/A	N/A		
2 Faces Crushed, % minimum, LS-617	N/A	N/A	N/A	N/A	85	N/A	N/A	N/A	
Micro-Deval Abrasion Loss, % maximum, LS-618	25	30 (Note 2)	30	25	21	25	30 (Note 2)		
Asphalt Coated Particles, % maximum, LS-621	30	30	N/A	30	N/A	30	N/A	N/A	
Notes: 1. Maximum of 15% by mass of crushed glass or ceramic material or both, and maximum of 1% by mass of deleterious materials (wood, clay brick, clay tile, gypsum, gypsum plaster, and wallboard). 2. The coarse aggregate Micro-Deval abrasion loss test requirement will be waived if the material has more than 80% passing the 4.75 mm sieve.									

Issued by Testing Laboratory Representative:

PRINT NAME	SIGNATURE	DATE
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Received By Contract Administrator Representative:

PRINT NAME	SIGNATURE	DATE
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EARTH EXCAVATION, GRADING – Item No.
EXCAVATION FOR PAVEMENT WIDENING -Item No.
ROCK EXCAVATION, GRADING -Item No.
ROCK FACE-Item No.
ROCK EMBANKMENT -Item No.

Special Provision 206S03

January 2004

Amendment to OPSS 206, December 1993

OPSS 206, Construction Specification for Grading is deleted in its entirety and replaced with the following:

TABLE OF CONTENTS:

206.01	SCOPE
206.02	REFERENCES
206.03	DEFINITIONS
206.04	SUBMISSIONS AND DESIGN REQUIREMENTS
206.05	Not Used
206.06	EQUIPMENT
206.07	CONSTRUCTION
206.08	QUALITY ASSURANCE/QUALITY CONTROL
206.09	MEASUREMENT FOR PAYMENT
206.10	BASIS OF PAYMENT

206.01 SCOPE

This special provision covers the requirements for grading, including earth and Rock excavation and embankment construction, ditching, wall control blasting, and the management of surplus and unsuitable material.

Included in this special provision are the requirements for the construction and compaction of Rock fill embankments to minimize and control settlements within the Rock fill.

206.02 REFERENCES

This special provision refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specification, General:

OPSS 180 Management and Disposal of Excess Material

Ontario Provincial Standard Specifications, Construction:

OPSS 209 Embankment Over Swamps
OPSS 212 Borrow
OPSS 501 Compacting
OPSS 511 Rip-Rap, Rock Protection and Gravel Sheeting
OPSS 570 Topsoil
OPSS 572 Seeding and Mulching, Temporary Cover, and Erosion Control Blanket

206.03 DEFINITIONS

For the purposes of this special provision, the following definitions apply:

Angle of Repose: means the maximum angle, measured from the horizontal, at which Rock fill will remain stable.

Backslope: means the slope in a cut between the invert of the roadside ditch and the point where the slope intersects original ground.

Benching: means the keying of new fill slopes into existing earth slopes by excavating horizontal planes in the existing slopes and backfilling the benches and placing the fill simultaneously. Benching also means the stepping of cut slopes at intermediate levels in deep cuts.

Berm: means an extension of an embankment, constructed to a lower height, designed to provide road embankment stability.

Bulking Factor: means the ratio of the volume of material insitu to the expanded volume of that same material after transport and placement in embankment. The factor is determined by dividing the expanded material volume by the insitu volume.

Cushion Blasting: means a wall control blasting technique involving the placing of a single row of closely spaced holes along the excavation limits, loading them with light, well distributed charges, completely stemmed, and firing them simultaneously to remove the Rock left in place after blasting inside the cut limits.

Ditching: means the excavation in earth or in Rock for all water courses. The term shall include roadside ditches, all excavation lying beyond the end of drainage structures, and stream and watercourse diversions and corrections.

Earth: means all soils except those defined as Rock, and excludes stone masonry, concrete and other manufactured materials.

Embankment: means the limit of the materials placed within the sideslopes, below the top of Subgrade and above the original ground or excavated base as applicable, as specified in the Contract Documents. Widening, flattening or other placement of material adjacent to or on top of sideslopes beyond that specified in the Contract Documents is excluded from this definition.

Existing Rock Surface: means the Rock surface after removal of overburden.

Frontslope: means the slope in a cut section between the edge of shoulder and the invert of the roadside ditch.

Line Drilling: means a wall control blasting technique involving the placing of a single row of very closely spaced unloaded holes along the excavation limits.

Mucking: means the picking up of broken Rock prior to haulage.

Overbreak: means the portion of any Rock or broken Rock which is excavated, displaced, or loosened outside and beyond the designated excavation limits, regardless of whether it has been excavated, displaced or loosened due to the inherent character of the Rock formation or due to any other cause.

Pre-Shearing: means a wall control blasting technique involving the placing of a single row of closely spaced holes, placed along the excavation limits, lightly loading and firing them simultaneously before and independently of the main excavation blast. Preshearing is sometimes referred to as presplitting.

Roadside Ditch: means a ditch with one of its sideslopes coincident with the road frontslope.

Rock: means natural beds or massive fragments, of the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin, which may or may not be weathered, and includes boulders having a volume of 1 cubic m or greater.

Rock Face: means the vertical face between the top of the existing Rock surface and the designated Rock ditch grade line.

Scaling: means the removal of loose broken Rock fragments, from the vertical or sloped Rock cut limits, that remain in place after the Rock cut has been blasted and mucked.

Shale: means a finegrained, low strength, sedimentary Rock that undergoes rapid deterioration on exposure.

Shatter: means "in-situ" fractured Rock broken by the use of explosives.

Sideslope: means the slope in a fill between the edge of shoulder and the point where the slope intersects original ground.

Smooth Wall Blasting: means a wall control blasting technique involving the placing of a single row of closely spaced holes along the excavation limits, lightly loading and firing them along with but moments in advance of the main excavation blast.

Spall: means a small Rock fragment, chip or splinter from a Rock surface and created by weathering and/or blasting.

Stripping: means the excavation of the organic topsoil and other material specified.

Tolerance - Minus: a construction working tolerance only which:

- a. means narrower than the contract standard pertaining to horizontal dimensions as measured from centre line; and

- b. means lower in elevation than the contract standard pertaining to vertical dimensions.

Tolerance - Plus: a construction working tolerance only which:

- a. means wider than the contract standard pertaining to horizontal dimensions as measured from centre line; and
- b. means higher in elevation than the contract standard pertaining to vertical dimensions.

Wall Control Blasting: means blasting using one of the techniques of either cushion blasting, pre-shearing, smooth wall blasting, or line drilling. Wall control blasting is to produce maintenance free Rock face with a minimum of blast induced fractures; generally it is characterized by noticeable drill hole traces over the majority of the Rock face.

206.04 SUBMISSION AND DESIGN REQUIREMENTS

206.04.01 Rock Material Management Plan

Five business days prior to undertaking the work of Rock excavation or Rock embankment, the contractor shall submit to the Contract Administrator the following information;

- a) A management plan for Rock excavation corresponding to the station intervals shown in the Quantity Sheets identifying:
 - i) the solid, unblasted excavation quantity,
 - ii) the quantity of excavated Rock from the Rock excavation item to be placed in Rock embankment,
 - iii) the quantity of excavated Rock from the Rock excavation item to be processed into granular material and the crushing location,
 - iv) the quantity of excavated Rock from the Rock excavation item to be used for other purposes in completing the contract Work and the type and location of that Work,
 - v) the quantity of excavated Rock from the Rock excavation item to be disposed of or not incorporated into the contract Work, including widening and flattening of embankments, etcetera, and identifying the location and use of the material,
 - vi) any assumptions for Rock excavation overbreak quantities plus the use and location of assumed overbreak
- b) A management plan for construction of embankments identifying locations where embankment material is supplied from corresponding to the station intervals in the Quantity Sheets,
- c) the assumed various Bulking Factor(s) for Rock materials, included in the above.
- d) Additional source locations where applicable, and quantities for Rock embankment and granular materials to meet contract quantity requirements.

The contractor shall update the plan monthly to reflect changes to the plan.

The contractor shall be solely responsible for the reasonableness of the submitted plan or the contractors assumptions.

The contractor shall not be permitted to start work on Rock excavation or Rock embankment until the Rock Materials Management Plan conforming to the above requirements is submitted.

206.06 EQUIPMENT

Tractor bulldozers crawler type used for compaction of Rock fills shall have a minimum net flywheel power of 200kw.

206.07 CONSTRUCTION

206.07.01 General

206.07.01.01 Removal of Ice and Snow

All ice and snow shall be removed from any portion of the work.

206.07.01.02 Embankments

Only materials approved by the Contract Administrator shall be used. Frozen earth materials shall not be incorporated into embankments. Materials shall not be placed over either frozen earth or ice surface

Reclaimed asphalt pavement (RAP) used in embankments shall be surplus to the recycling requirements of the contract.

For the purposes of compaction, RAP and reclaimed Portland cement concrete included in the embankment shall be treated as earth or Rock corresponding to the embankment being constructed.

The Contractor shall ensure that the RAP and reclaimed Portland cement concrete are suitable for embankment construction and conform to the dimension requirements as specified in clauses 206.07.07.02, 206.07.07.03, and clause 206.07.07.04.

206.07.01.03 Compaction

Compaction of materials shall be according to OPSS 501.

206.07.01.04 Management of Surplus and/or Unsuitable Excavated Material

As much of the excavated materials as possible shall be used within the contract limits where the material is suitable for embankment construction.

Excavated materials may be used where the material is suitable for other contract Work.

Excavated material and excess material shall be managed as specified in OPSS 180.

206.07.01.05 Earth Borrow

When Earth Borrow is required to complete embankments or backfill requirements, earth borrow shall be provided according to OPSS 212.

206.07.01.06 Tolerances – General

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerances shall take precedence.

206.07.01.07 Tolerances for Earth

All earth grade surfaces shall, on completion be shaped to the specified grades and cross sections within the following tolerances, excluding swamp excavations:

- a. Vertical grading tolerances of the finished earth subgrade within the limit of the roadway:
 - + 30 mm
 - 30 mm
- b. Horizontal grading tolerances for the vertical faces of excavations to be backfilled:
 - + 100 mm
 - 0 mm
- c. Horizontal grading tolerances for the backslopes in earth cut sections:
 - + 300 mm
 - 300 mm

Backslopes beyond the plus tolerance may be accepted by the Contract Administrator where not detrimental to the work.

- d. Horizontal grading tolerances for ditching slopes in earth excluding roadside ditches in earth cut sections:
 - + 300 mm
 - 0 mm

Sideslopes beyond the plus tolerance may be accepted by the Contract Administrator where not detrimental to the work.

- e. Vertical grading tolerances for all ditching in earth:
 - + 30 mm
 - 30 mm
- f. Horizontal grading tolerances for each sideslope in earth embankment construction:
 - + 300 mm
 - 0 mm
- g. Horizontal grading tolerances for roadside ditch frontslopes:
 - + 0 mm
 - 0 mm

Irrespective of compliance with the above tolerances, the completed slopes shall present a uniform appearance.

206.07.01.08**Tolerances for Rock**

Rock grade surfaces shall, on completion, be shaped to the specified grades and cross sections within the following tolerances:

- a. Vertical grading tolerances for the finished Rock subgrade within the limits of the roadway:
 - + 30 mm
 - 100 mm

Excavation below the minus tolerance may be accepted by the Contract Administrator where it is not detrimental to the work and is brought up to grade according to clause 206.07.05.01.

- b. Horizontal grading tolerances for vertical Rock face cut limits:
 - + 0 mm
 - 300 mm

Final faces beyond the designated face, in the plus direction, may be accepted by the Contract Administrator where not detrimental to the work.

- c. Horizontal grading tolerances for sloped wall backslopes in Rock cuts:
 - + 300 mm
 - 300 mm
- d. Horizontal grading tolerances for ditching slopes in Rock, excluding roadside ditches:
 - + 300 mm
 - 0 mm

Excavation beyond the plus tolerance may be accepted by the Contract Administrator where not detrimental to the work.

- e. Vertical grading tolerances for all ditching in Rock cuts:
 - + 30 mm
 - 30 mm

Excavation below the minus tolerance may be accepted by the Contract Administrator where not detrimental to the work.

- f. Horizontal grading tolerances at the top of each sideslope of Rock embankment construction:
 - + 300 mm
 - 0 mm

The slope shall be that obtained when built in accordance with the Contract requirements.

206.07.02**Drainage**

Excavation operations shall be performed in such a manner as to avoid water saturation of embankment material and roadway foundation material, and to avoid leaving undrained pockets in excavations, by providing effective drainage during all stages of the work.

In excavations below subgrade and in stripping operations where provision for surface drainage is impracticable, backfill materials shall be placed as soon as practical following the excavation work.

Ditching required to provide for drainage of an embankment shall be completed in advance of the embankment construction. Ditches in roadway cuts shall be constructed as soon as possible to provide drainage from the cuts. Ditches located above and beyond roadway cuts shall be constructed prior to excavating adjacent cuts. Where pipe subdrainage is required in the bases of roadway cuts, such work shall be carried out at the time that the roadside ditches are being constructed.

206.07.03 Earth Excavation, Grading

206.07.03.01 General

The work to be done under the item Earth Excavation, Grading shall include excavating, hauling, handling and placing, shaping, compacting, and trimming, of earth and excess materials and the management of excess materials as specified in OPSS 180.

Suitable and non surplus earth excavated from roadway cuts, ditching and from other associated sites shall be used in embankment construction unless otherwise specified in the Contract.

206.07.03.02 Provision for Temporary Cover

Mulching for temporary cover shall be applied according to OPSS 572 to those areas specified in the Contract.

206.07.03.03 Excavation Below Subgrade

Unsuitable materials, other than material excavated from swamps, shall be removed below the subgrade to the lengths, widths and depths specified in the Contract. The resulting excavation shall be backfilled with acceptable material that shall be compacted.

206.07.03.04 Backfilling of Over-excavated Areas

Where over-excavation occurs, it shall be backfilled with acceptable material and the backfill compacted. With the exception of frontslopes and where boulders are encountered in the excavation slopes, backfilling shall not be permitted to obtain required slopes for excavations. When boulders are encountered in the excavation slopes, the boulders shall be removed when directed by the Contract Administrator and any resulting cavities shall be backfilled with acceptable material and the backfill shall be compacted.

206.07.03.05 Over-excavation of Cut Slopes

The material from over-excavations of cut slopes, where suitable and where required, shall be used in embankment construction. Where the material is surplus or is unsuitable, it shall be managed as specified in OPSS 180.

206.07.03.06 Swamp Excavation

Swamp material shall be excavated according to OPSS 209.

206.07.03.07 Stripping

Except where swamp treatment is required, the original ground under embankments of 1.2 m or less in height shall be stripped as specified in the Contract. The height of embankment for this purpose shall be measured from original ground to profile grade.

Topsoil shall be removed from the original surface over the entire width of all excavations.

206.07.03.08 Stockpiling of Topsoil

When excavating acceptable topsoil material during any grading operation, topsoil shall be stockpiled according to OPSS 570. Material removed in the stripping operation which is unsuitable for use as topsoil, or which is surplus to the amount of topsoil required for the contract, shall be managed as specified in OPSS 180.

206.07.03.09 Excavation for Widening

Excavation that is adjacent to the travelled portion of the roadway shall at no time be in advance of the backfilling operation by a distance greater than the length specified in the Contract. Any such excavation shall be backfilled with the specified material, and shall be compacted prior to closing down operations each day.

206.07.04 Excavation for Pavement Widening

The work to be done under the item Excavation for Pavement Widening shall include excavating a trench adjacent to the existing pavement, to the widths and depths specified in the Contract. Excavated material shall be spread on the adjacent shoulders and slopes.

206.07.05 Rock Excavation, Grading

206.07.05.01 General

The work to be done under the item Rock Excavation, Grading shall include drilling and blasting to obtain the required Rock excavation and shatter, mucking, and bringing to Rock grade any excavation taken below Rock grade. Hauling is only part of the work when the excavated material is not used for any contract items. Whenever a Rock face item is not included in the contract, Rock scaling and the removing of all overbreak and scaled materials shall be included in the Rock excavation item.

The contractor shall not drill or blast beyond the specified Rock face.

Where Rock is to be excavated, all overlying stumps, roots, and vegetation shall be managed as specified in OPSS 180. Where earth overlies the Rock to be excavated, the earth shall be removed. This work shall be performed sufficiently in advance of Rock excavation operations to allow Rock cross sections to be taken before blasting.

Scaling shall be done during or immediately after mucking. All Rock, boulders, and Rock fragments, either on or outside the excavated areas, and liable to slide or roll down the Rock cuts, shall be removed. Cut ditches shall be excavated at the same time as the main excavation.

Excavation below grade in Rock cuts shall be brought to grade within the specified tolerances with spalls or approved material.

Rock in roadway cuts shall be shattered to a uniform minimum depth of 0.30 m below the theoretical Rock grade for the full width of the cut, including the ditch.

206.07.05.02 Shale

The method of excavating shale shall be decided by the Contractor according to site conditions. The Rock face item shall not apply to slopes in shale. Side slopes in shale shall be as specified in the Contract. Shatter is not required in the shale subgrade

206.07.05.03 Drilling

Drilling shall not be performed outside, or extend beyond, the theoretical lines, except as noted below.

All holes shall be drilled to a vertical limit that will provide shatter as specified and provide drainage of the shatter

206.07.06 Rock Face

The work to be done under the item Rock Face shall include drilling and blasting using one or more of the wall control blasting techniques to produce the Rock face where required in the Contract, scaling, removing all overbreak and scaled Rock. Hauling is only part of the work when the excavated material is not used for any contract items. Trial sections to determine optimum explosive loads and drill and blast patterns for different Rock conditions shall be used. The contractor shall not drill or blast beyond the specified Rock face.

Holes for wall control blasting shall be a maximum diameter of 100 mm and shall be located accurately and consistently along the excavation limits.

The spacing of wall control blasting holes shall be decided by the Contractor, but shall not exceed 0.75 m centre to centre. The spacing shall be adjusted where necessary to ensure a uniform shear face between holes.

The Contractor shall accurately position and load the adjacent line of production holes, located inside the controlled blasting limits, in such a manner as to produce the required Rock face by wall control blasting. The first line of production holes, located inside cut limits, shall be drilled such that no portion of the hole is within 0.75 m of the line of the wall control blasting holes.

206.07.07 Earth Embankments

206.07.07.01 General

Embankment materials shall be deposited and spread in uniform layers for the full width of the embankment except as otherwise permitted for berms, and each layer shall be compacted before the succeeding layer is placed. For side hill or sloping sections, the lower portion shall be constructed as above until a full width surface of the specified cross section is obtained. The embankment shall be completed thereafter with full width layers or as stage construction allows.

The construction of a core through the embankment and the subsequent completion of the embankment are prohibited except where core construction is permitted in swamps as specified in OPSS 209. The use

of surplus material and the placing of material in difficult locations by side dumping, subject to the approval of the Contract Administrator, may be permitted.

Embankment berms may be constructed separately, but shall be completed before the road embankment is built to a level higher than the berm.

206.07.07.02 Layer Compaction Method

Except as provided in 206.07.07.03 and unless otherwise specified in the Contract, all earth embankments shall be built using a layer compaction method. The embankment material shall be spread in uniform full width layers not more than 0.30 m in depth prior to compaction. Each layer shall be shaped and compacted to the line and cross section specified before the succeeding layer is placed. All boulders, cobbles, fragments of Rock, RAP, and reclaimed Portland cement concrete greater than the fully compacted layer depth shall be removed.

Material in each layer shall be compacted at moisture content determined by the Contract Administrator to be suitable for obtaining the required density and be compacted according to OPSS 501.

Where the ground cannot support construction equipment using this method initially, then the first layer may be increased conforming to the modified layer compaction method.

206.07.07.03 Modified Layer Compaction Method

When it is deemed practical to construct an earth embankment or portion of an embankment in deeper lifts than specified in clause 206.07.07.02, permission may be requested to do so by supplying full details of the proposed method. Apart from the depth of material, placement of embankment material shall conform to clause 206.07.07.02 except that the maximum size of boulders, cobbles, fragments of Rock, RAP, and reclaimed Portland cement concrete shall not exceed the compacted modified layer depth or 0.30 m, whichever is less.

The Contractor shall prove that the specified compaction can be achieved throughout the layer.

The Contractor shall do all necessary excavation for establishing the compaction results throughout each compacted layer.

Boulders, cobbles, fragments of Rock, RAP, and reclaimed Portland cement concrete over 0.15 m in their maximum dimension shall not be placed within 0.30m of the surface of the earth grade.

206.07.07.04 Boulders and Fragments

Boulders, cobbles, fragments of Rock, RAP and reclaimed Portland cement concrete up to 0.5m³ may be incorporated into an embankment provided:

- (a) they are placed only in the bottom layer of the embankment;
- (b) the maximum dimension of the largest particle shall not exceed 0.80m;
- (c) they are not located within 0.3 m of the final embankment side slopes; and
- (d) they are not located within 1.0 m of the surface of the earth grade.

The work to be done under the item Rock Embankment shall include the supply, hauling, placement and compaction of broken Rock. The broken Rock material shall be supplied by the contractor from Rock material excavated on this contract or from other sources as necessary to meet the contract requirements.

Compaction of Rock materials shall conform to the method and equipment requirements of this special provision. Each Rock fill layer shall be compacted with the equipment specified. The minimum number of complete passes is six(6) and the maximum number of passes is eight(8). A complete pass is defined as 100 percent areal coverage of the layer. The maximum speed of the equipment during each pass shall be 3.2 km/h.

Construction of embankments using shale shall be carried out conforming to shale embankment requirements.

Embankments to be constructed of excavated Rock other than shale shall be constructed by placing embankment materials full width in successive, uniform layers. Layers shall not exceed 1.5 m thickness prior to compaction. Material in each layer shall be fully compacted before the succeeding layer is placed.

Materials shall be placed in final position by blading. End dumping or depositing of Rock over the end of any layer by hauling equipment is not permitted, except as otherwise noted below. Each layer shall be levelled in place and compacted to minimize voids and bridging of large Rock fragments within the embankment.

Rocks exceeding 1 metre in size shall be well distributed throughout the embankment. Rock fragments up to a maximum size of 3 metres in size may be incorporated into the embankment provided that the Rock fragments are less than two-thirds the remaining embankment height and are sufficiently spaced to allow free access of the specified equipment to compact the intervening fill. The remaining height shall be defined as the distance between the bottom of the oversized Rock fragment at point of placement to the top of the Rock fill embankment.

Placement in layers and compaction is not required for Rock to be placed under water. Rock placed underwater may be placed by end dumping. End dumping shall only be used to an elevation of 1.0 m above the water level after which Rock embankments shall be constructed using the equipment and method specified in this special provision. The Rock used for end dumping shall be deposited on the surface of the embankment and pushed forward by blading or dozing over the edge of the embankment. The materials shall be well distributed to form a solid embankment constructed to full width as the work progresses, or as stage construction allows.

Where Rock fill is placed in a wet area (such as swamps with full, partial or no excavation), the direction of the Rock fill placement shall be such that mud waves generated by the Rock fill placement would move away from the embankment. Mud waves shall be displaced or removed to prevent its entrapment below or within the embankment.

Voids on the top surface of the embankment shall be minimized to prevent migration of the roadway subbase and base into the Rock fill embankment by chinking the top surface with Rock fragments and spalls to form the subgrade prior to the placement of the roadway subbase.

Care shall be taken to avoid large boulders and Rock fragments protruding above the average embankment surface within a distance of 3 m beyond the edge of the shoulder for future roadside safety.

Dumping over the sides of embankments is permitted only after the Rock embankments have been completed. Dumping over the sides of embankments shall be restricted to standard offset and right of way limits unless otherwise specified in the Contract Documents. The Contractor shall receive written approval from the Contract Administrator before commencing the above operations.

206.07.08.01 Shale Embankments

Shale embankment materials shall be deposited and spread in uniform layers for the full width of the embankment. Layers shall not exceed 0.45 m in depth prior to compaction. Compaction of each layer shall be in two stages. In the first stage, a minimum of two passes shall be made with an 18-tonne static sheepsfoot, packall, padfoot, or tamping foot type roller. In the second stage, a minimum of two passes shall be made with a 9-tonne vibratory steel drum or pneumatic-tired roller. Maximum speed of rollers shall not exceed 10 km/hr. Where harder Rock types, such as limestone, are present as an integral part of the shale formation, no such pieces greater than 0.15 m measured vertical to the embankment layer, nor greater than 0.60 m measured parallel to layers shall be placed in the embankment.

206.07.09 Rock Backfill to Structure

When Rock backfill to structures is specified, the Rock shall be clean, free from contaminants, and no larger than 0.25 m in its greatest dimension.

End dumping of Rock backfill against a structure shall not be permitted. Rock backfill shall be placed in such a manner that the structure is not damaged.

206.08 QUALITY ASSURANCE / QUALITY CONTROL

206.08.01 General

The Contractor is responsible for carrying out all Quality Control (QC) grade checks required to ensure that horizontal and vertical grading tolerances are met. The Owner may conduct random Quality Assurance (QA) grade checks to verify the Contractor's ability to ensure that grading tolerances are met.

206.08.02 Quality Control

The Contractor shall provide a competent Survey Crew to carry out grade checks on all finished earth and Rock grade surfaces. QC of earth excavation grading and Rock excavation grading shall be based on horizontal and vertical grading tolerances as given in 206.07.01.07 and 206.07.01.08. The grade shall be certified at the stations and offsets shown in the Construction Grading Report. Minimum frequency requirements are given in Table GC7.02 of the MTO General Conditions.

206.08.03 Submission of Grade Checks

All Contractor grade checks relating to horizontal and vertical grading tolerances, including all non-compliances, shall be copied to the Contract Administrator within 2 business days following completion of each grade check.

Where grading templates are available, the Contractor shall sign and certify on the grading template that the component(s) of the work indicated on the grading template have been correctly constructed as to the specified line and grade tolerances. If no template is available, the Contractor shall complete, sign and submit the Form PH-CC-820 to the Contract Administrator.

206.08.04 Finished Grades Outside Specification

Where the finished grade or cross-section does not meet the acceptance criteria, the earth or Rock grade surface shall be brought to grade within the specified tolerances.

206.08.05 Quality Assurance

The Owner may conduct random QA grade checks to verify horizontal and vertical grading tolerances. Providing that the Owner's grade checks conform to those determined by the Contractor, no action will be taken. If discrepancies between QA and QC grade checks occur, the Owner may conduct additional QA grade checks.

If the finished grade or cross-section is found to be outside the specification limits allowed under 206.07.01.07 and 206.07.01.08, the Contractor shall be required to bring the earth or Rock grade surface to grade within the specified tolerances. The Contractor shall be charged \$250 per station for finished grade outside of specification limits for each QA grade check. All grading carried out by the Contractor as a result of QA grade checks to ensure minimum tolerances will be completed at no additional charge to the Owner.

206.09 MEASUREMENT FOR PAYMENT

206.09.01 Earth Excavation, Grading

206.09.01.01 Actual Measurement

Measurement shall be by volume in cubic metres measured in its original position and based on cross-sections taken prior to grubbing.

206.09.01.02 Plan Quantity Measurement

Measurement shall be by Plan Quantity as may be revised by Adjusted Plan Quantity, of the volume in cubic metres.

206.09.01.03 Overbuilding, Earth

The Contract Administrator shall be notified when the earth embankment has been completed, and before placing any surplus and unsuitable material and top soil on the embankment slopes.

The Contract Administrator may check the embankment for conformity to the requirements of clause 206.07.01.07 after notification by the Contractor that the embankment has been completed. When such checking is undertaken, the Contract Administrator shall notify the Contractor of any overbuilding.

Where the contract requires borrow, the quantity of material placed beyond the earth grading tolerance shall be deducted from the measured quantity of borrow on a cubic metre for cubic metre basis, with no correction for changes in density of the material.

206.09.02 Excavation for Pavement Widening

206.09.02.01 Plan Quantity Measurement

Measurement shall be by Plan Quantity, as may be revised by Adjusted Plan Quantity, of the horizontal length in metres along each edge of existing pavement where widening is specified.

206.09.03 Rock Excavation,Grading

206.09.03.01 General

The volume of Rock excavation shall include all shatter as specified in the Contract. The quantity of Rock shattered beyond that specified in the Contract, and as ordered by the Contract Administrator in writing, shall be included in the Rock excavation computation.

206.09.03.02 Actual Measurement

Measurement shall be by volume in cubic metres computed from field measurement of cross sections taken by the Contract Administrator of the original Rock line after earth overburden has been removed and shall be based on the theoretical Rock Face and bottom limits designated in the Contract. The theoretical bottom of the cut shall be the shatter line, which shall be 0.30 m below the Rock grade.

206.09.03.03 Plan Quantity Measurement

Measurement shall be by Plan Quantity, as may be revised by Adjusted Plan Quantity, of the volume in cubic metres below the existing Rock surface and above the theoretical bottom of cut, and within the designated faces of the cut. The theoretical bottom of the cut shall be the shatter line, which shall be 0.3 m below the Rock grade.

206.09.03.04 Rip-Rap and Rock Protection

Deductions shall not be made from the Rock excavation quantity for any material conforming to OPSS 511 and used as rip-rap or Rock protection.

206.09.03.05 Boulders

The volume of boulders classified as Rock shall be determined on the basis of 'actual Rock measurement' of the three maximum rectilinear dimensions.

206.09.04 Rock Face

206.09.04.01 Plan Quantity Measurement

Measurement shall be by Plan Quantity, as may be revised by Adjusted Plan Quantity, of the area in square metres of the Rock face.

206.09.05 Rock Embankment

206.09.05.01 Plan Quantity Measurement

Measurement shall be by Plan Quantity, as may be revised by Adjusted Plan Quantity of the volume in cubic metres of the Rock Embankment. Adjustments to the Plan Quantity shall be limited to those which are supported with topographic survey information.

For Rock Embankments in swamp, the theoretical pay line below the top of swamp line, shall be a 1:1 slope from the intersection of the Rock Embankment slope above the top of swamp line and the theoretical top of swamp, to the theoretical firm bottom or as specified.

In the event that the Rock Embankment construction required by the contract is outside the theoretical pay lines, the supply, haulage and placement of such additional rock required to fulfil the contract requirements, shall be deemed to be included in the contract price for Rock Embankment.

The Contract Administrator shall be notified when the Rock embankment has been completed, and before placing any surplus and unsuitable material on the embankment slopes.

The Contract Administrator may check the embankment for conformity to the requirements of clause 206.07.01.08 after notification by the Contractor that the embankment has been completed. When such checking is undertaken, the Contract Administrator shall notify the Contractor of any overbuilding.

206.10 BASIS OF PAYMENT

206.10.01 Earth Excavation, Grading - Item

Payment at the contract price for the above item shall be full compensation for all labour, equipment and material necessary to do the work.

Payment for earth grade checks, including provision of all labour, equipment and materials to conduct Quality Control testing, shall be included in the contract price as part of the work of earth excavation, grading.

206.10.01.01 Benching

Where benching is required to key new fills into existing slopes, materials excavated as a part of this operation shall not be included for measurement or payment.

206.10.02 Excavation for Pavement Widening - Item

Payment at the contract price for the above item shall be full compensation for all labour, equipment, and material necessary to do the work.

Where the Contract Administrator directs that material excavated under this item is to be handled other than as specified in subsection 206.07.04, then such handling shall conform to OPSS 180 and shall be treated as Extra Work.

Material used to backfill the excavation shall be paid for at the contract price for the material used.

206.10.03 Backfill for Over-excavation

Payment shall not be made for backfill for any over-excavation in excess of the specified tolerances.

206.10.04 Backfill for Subexcavation

Material used to backfill subexcavations, and transitions or grade point treatments shall be paid for at the contract price for the material used.

206.10.05 Rock Excavation, Grading – Item

Payment at the contract price for the above item shall be full compensation for all labour, equipment and material necessary to do the work.

Where excavated Rock is to be used for other contract item work, including Rock embankment, granular, rip rap, etcetera the hauling costs are deemed to be included in payment for the work associated with the appropriate pay item. Where excavated Rock is not to be used for other contract items work, the hauling costs are deemed to be included in payment for the work under the item of Rock Excavation, Grading.

Payment for Rock grade checks, including provision of all labour, equipment and materials to conduct Quality Control testing, shall be included in the contract price as part of the work of Rock excavation, grading.

Where drilling, blasting and mucking are required as a part of the work for this item, the following progress payments shall be made: 33 percent of the progress volume for drilling, and 33 percent of the progress volume for blasting.

206.10.06 Rock Face - Item

Payment at the Plan Quantity contract price for the above item shall be full compensation for all labour, equipment and material to do the work.

On completion of drilling and blasting, a progress payment of 50 percent of the above item shall be made.

On completion of mucking, a progress payment of 75 percent shall be made.

206.10.07 Rock Embankment - Item

Payment at the Contract price for the above item shall be full compensation for all labour, equipment and material to do the work.



**CONSTRUCTION SPECIFICATION FOR
RIP-RAP, ROCK PROTECTION, AND GRANULAR SHEETING**

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511.01	SCOPE
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This specification covers the requirements for the installation of rip-rap, rock protection, granular sheeting, and geotextile.

511.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

511.01.02

Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

511.02

REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1860	Geotextiles

511.05

MATERIALS

511.05.01

Rip-Rap, Rock Protection, and Granular Sheeting

Rip-rap shall be according to OPSS 1004 and as specified in the Contract Documents.

Rock protection and granular sheeting shall be according to OPSS 1004.

511.05.02

Geotextile

Geotextile shall be nonwoven, Class II according to OPSS 1860, with an FOS of 75-150 mm.

511.07 CONSTRUCTION

511.07.01 Excavation

Prior to placing any material, the area shall be excavated to the lines and dimensions specified in the Contract Documents and fine graded to a uniform even surface. Depressions shall be filled and compacted with acceptable material.

511.07.02 Placing Material

511.07.02.01 General

Material shall be placed to the lines and dimensions specified in the Contract Documents.

On slopes where rip-rap or rock protection is being placed, the rock shall commence at the toe of the slope and progress up the slope.

When geotextile is specified in the Contract Documents, rip-rap, rock protection, and granular sheeting shall be placed in a manner as not to tear or damage the geotextile.

511.07.02.02 Rip-Rap

Rip-rap shall be placed in a set and stable manner, flat on the slope with the largest dimension parallel to the slope contours. The larger pieces of rip-rap shall be placed in the bottom courses. The rip-rap shall be laid closely such that a reasonable semblance of courses is achieved. Smaller pieces of rip-rap shall be used to fill the voids.

511.07.02.03 Rock Protection

Rock protection shall be placed in a random but stable manner.

511.07.02.04 Granular Sheeting

Granular sheeting operations shall follow earth excavation operations as closely as practical and possible.

Compaction of granular sheeting material is not required.

511.07.02.05 Geotextile

Geotextile shall be free of folds, tears and wrinkles and as specified in the Contract Documents. The geotextile shall be joined so that the material laps a minimum of 500 mm and shall be pinned together. Alternatively, the geotextile shall be joined to conform to the seam requirements of OPSS 1860.

Geotextiles shall be fixed to prevent movement during installation. Geotextile shall be wrapped down into the ground a minimum 300 mm at termination points.

511.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

511.09 MEASUREMENT FOR PAYMENT

511.09.01 Actual Measurement

511.09.01.01 Rip-Rap

Measurement of rip-rap shall be by area in square metres following the contour of the ground.

511.09.01.02 Rock Protection

Measurement of rock protection shall be by volume in cubic metres. The volume is a product of the area of the rock protection, measured following the contour of the ground, by its depth.

Truck box measurement shall be used when it is not possible to take an in place measurement.

511.09.01.03 Granular Sheeting

Measurement of granular sheeting shall be by area in square metres following the contour of the ground.

511.09.01.04 Geotextile

Measurement of geotextile shall be by area in square metres following the contour of the ground, with no allowance made for overlaps.

511.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

511.10 BASIS OF PAYMENT

**511.10.01 Rip-Rap - Item
Rock Protection - Item
Granular Sheeting - Item
Geotextile - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Materials to do the work.

When there is not a separate tender item for geotextile, payment for the geotextile shall be included in the tender item for rip rap, rock protection, or granular sheeting, as appropriate.

**Appendix 511-A, November 2008
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Gradation requirements of rip-rap as per Table 5 of OPSS 1004. (511.05.01)
- Lines and dimensions for excavation of rip-rap, rock protection, or granular sheeting areas. (511.07.01)
- Lines and dimension for placement of material. (511.07.02.01)
- Geotextile locations, if required. (511.07.02.01)
- Placement requirements for geotextile. (511.07.02.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 810.010	Rip-Rap Treatment, for Sewer and Culvert Outlets
OPSD 810.020	Rip-Rap Treatment, for Ditch Inlets

212 - BORROW - OPSS 212

212.1 GENERAL

Earth or rock materials taken from selected borrow pits or quarries and hauled to the contract site for embankment construction or backfilling are designated as "Earth Borrow" and "Rock Borrow" respectively.

The need for borrow arises when the breakdown of main items indicates a substantial difference in quantities between material available and fill required. Smaller differences might be eliminated by widening backslopes in cut sections or by revising the profile grade. With certain types of projects it will be evident even in the planning stage, that insufficient fill material will be generated by the limited excavation opportunities and that a tender item for borrow will be required.

On projects where there is removal of pavement as part of earth excavation, the volume of pavement removed must be subtracted from the excavation quantity when calculating the amount of material available for fill.

212.1.1 Tender Items

Earth Borrow
Rock Borrow

212.1.2 Specifications

Information regarding these tender items is detailed in OPSS 212.

212.1.3 Special Provisions

The designer should investigate to determine whether Standard Special Provisions are required to be included in the contract.

When ministry-owned sources of supply are provided, a non-standard Special Provision is needed.

212.2 COMPUTATION

The quantity of borrow in cubic metres is found by subtracting material available from fill required.

Where stage construction is proposed, borrow quantities must be considered on a stage, rather than on a project basis, since quantities excavated at a later stage will not be available for fill in the earlier stages or quantities excavated in an earlier stage might not necessarily be available for fill at a later stage. Therefore, in order to obtain accurate borrow quantities, both calculation and quantity sheets must be prepared for each stage of the contract.

212.2.1 Source of Information

The main sources of information for the computation of the tender items "Earth Borrow" and "Rock Borrow" are the Geotechnical Report and Soils Profile. The locating of borrow materials is the responsibility of the Regional Geotechnical Section.

212.3 DOCUMENTATION

The quantity of borrow is entered in the appropriate earth or rock column provided for it on the Quantities Grading sheet.

The tender totals for each of the two possible tender items are transferred to the Tender document.

572 - SEEDING AND COVER – OPSS 572

572.1 GENERAL

The establishment of permanent vegetative growth on roadsides is an integral part of road construction and is an erosion control measure for both the short term (construction) and the long term (maintenance).

Seeding and cover is a two-stage operation where the seed and fertilizer are applied to the finished grade, followed by the application of a cover material. Seeding establishes a permanent vegetative growth for long-term erosion protection and right-of-way enhancement. The applied cover material protects the finished grade for the short term and provides a favourable environment for seed to germinate.

Seed and cover is applied to all bare earth areas within the right-of-way, earth stockpile areas, earth borrow sites, earth disposal areas and all areas where construction activities will destroy existing vegetation.

Areas excluded from seeding and cover include areas which will be protected by other means such as sodding, compost seeding, reforestation, tree and shrub planting, rip-rap, gravel sheeting or rock protection. The designer is encouraged to review these other sections of the CDED Manual for a description of the warrants for use and design requirements.

The warrants for use of seed and cover in this guide extend from flat earth areas up to and including 2:1 earth slopes. For earth slopes with gradients in excess of 2:1 it is strongly recommended that the designer employ specific design solutions for these areas rather than using a standard treatment. The specific design solution should take into account soils, degree of slope, length and height of slope, surface drainage, water table, slope orientation and other factors that may be relevant. There are a variety of design products and technologies available for extreme steep earth slope establishment that are not described herein.

The application of topsoil prior to seeding on all contracts in Southern Ontario is required. The application of topsoil on all contracts in Northern Ontario is strongly recommended.

572.2 SEEDING

There are seven seed mix options available to the designer; these are:

572.2.1 Standard Roadside Mix

The standard roadside seed mix is the time-tested standard MTO Seed Mix and is the

default selection for most seeding situations encountered across the province.

572.2.2 Crown Vetch Mix

Crown Vetch is a legume and is primarily used to re-vegetate slope areas where erosion and soil fertility may be a problem. Crown Vetch produces a mass of purple flowers in season and is a vigorous ground cover requiring minimal maintenance. Hardiness range is limited to Southern Ontario.

572.2.3 Birdsfoot Trefoil Mix

Birdsfoot Trefoil is also a legume and is also used to re-vegetate slopes where erosion and soil fertility may be a problem. Birdsfoot Trefoil is not as vigorous as Crown Vetch and produces a mass of yellow flowers in season. It is hardier in the northern parts of the province than Crown Vetch.

572.2.4 Salt Tolerant Mix

The salt tolerant mix is a mixture of several turfgrasses with a higher resistance to salt. The mix should be specified in areas such as medians, shoulder strips and shoulder ditches where salt is known to be in higher concentrations in the soil.

572.2.5 Lowland Mix

The lowland mix contains a mix of various turfgrass species and a legume that perform well in low areas and areas adjacent to waterbodies where the water table is high and there is intermittent surface water.

572.2.6 Acidic Soil Mix

As the name suggests, this seed mix is designed for use in areas of low fertility, medium to high acidity. It is suitable for low fertility soils in the northern areas of the province.

572.2.7 Old Field Mix

This mix is used to provide an accelerated successional cover to a mature field condition, and uses native species of aster and goldenrod to comprise the majority of the mix. Old Field should be selected where there will be fallow areas left alone with little or no maintenance, no mowing and the area will be self-sustaining. It is more suitable in rural areas than urban or suburban situations.

The designer should specify the Standard Roadside Mix as the default seed mix unless the MTO Regional Environmental Planner or Consultant Environmental Planner or the Consultant Landscape Architect has recommended another prescriptive mix.

572.3 COVER

After the seed and fertilizer has been applied by hydraulic seeder/mulcher, a temporary cover material is placed to; protect the earth areas from erosion until the vegetation grows and to; protect the germinating seeds from damage.

There are three types of cover materials available for selection by the designer:

572.3.1 Hydraulic Mulch or Straw Mulch

Hydraulic Mulch/Straw Mulch cover application is the default cover selection for most seeding situations where;

- the soils are not identified as highly erodable,
- seeding will not be applied during temperature extremes and
- the earth slopes vary from flat up to, and including, a 3:1 gradient.

Hydraulic mulches are processed fibres of wood, straw, cotton, cellulose pulp, or any combination of these materials and are applied to the earth areas by a hydraulic seeder/mulcher through a truck-mounted nozzle gun.

Straw mulch consists of chopped straw applied to the seeded area via a straw mulch blower and coated with a tackifier to hold it together. A straw mulch application requires several pieces of equipment and several people working and operating the equipment. While the Contractor has the option of selecting either hydraulic mulch or straw mulch, in almost all instances, the Contractor will select the hydraulic mulch because of its ease of application and cost advantages.

Hydraulic mulch, when properly applied at the specified rate, produces a thin 'skin' that adheres to the earth surfaces and provides a basic level of short-term protection for the earth surface and the germinating seeds. It is not recommended for use when seeding will be applied in temperature or weather extremes, such as summer droughts or late-season seeding when some over-winter protection will be required. In these instances an alternative cover application of Bonded Fibre Matrix or Erosion Control Blanket is suggested. Alternately, the designer may select another method of establishing vegetation such as sodding, compost seeding, turf reinforcement mats, reforestation planting or tree and shrub planting to establish control of the earth surfaces.

572.3.2 Erosion Control Blanket

For potential erosion problems based on soils/slope information, and/or earth slopes where the slope gradient is steeper than 3:1 but not steeper than 2:1, the designer may select either Erosion Control Blanket (ECB) or Bonded Fibre Matrix (BFM) as an alternative cover.

Erosion Control Blankets (ECBs) are a family of products that are supplied in rolls, they

are machine woven mats with a variety of materials sandwiched between the two woven layers. Materials can be wood, coco or cotton fibre, straw, or any combination depending upon manufacturer. ECBs are unrolled over the seeded earth area and stapled in place. ECBs also provide a superior level of erosion control and greater protection for germinating seedlings when compared to the standard hydraulic mulch cover.

OPSS 572 provides a generic description for the basic level of Erosion Control Blanket, which will suit the majority of application needs on MTO projects. If the designer needs to provide a higher level of erosion control, then a mid or high range proprietary ECB should be specified in the contract by non-standard special provision (NSSP).

572.3.3 Bonded Fibre Matrix

For potential erosion problems based on soils/slope information, and/or earth slopes where the slope gradient is steeper than 3:1 but not steeper than 2:1, the designer may select either Bonded Fibre Matrix (BFM) or Erosion Control Blanket (ECB) as an alternative cover.

Bonded Fibre Matrix is a 100% biodegradable product consisting of stranded wood fibres held together by organic or mineral bonding agents. When BFM is mixed with water, applied to earth surfaces and allowed to dry it forms a viscous material that creates a high strength, porous, and erosion-resistant uniform cohesive mat. This mat is applied at a higher product rate than hydraulic mulch and provides greater protection for the germinating seedlings and superior erosion protection than regular hydraulic mulch.

The main differences between Bonded Fibre Matrix and Erosion Control Blanket are the means by which they cover the earth area and the method of application. Cost is not normally a determining factor. In order to help the designer select the appropriate cover application, the following chart should be reviewed.

Cover Application	Cover Characteristics	Cover Application	Pros	Cons
Hydraulic Mulch	<ul style="list-style-type: none"> Exceptionally thin 'skin' applied to earth surface. Sets up when dry to form a uniform cohesive mat 	<ul style="list-style-type: none"> Applied via hydraulic seeder/mulcher 	<ul style="list-style-type: none"> Fast, efficient application for flat earth areas and gentle earth slopes Cheap 	<ul style="list-style-type: none"> Light application can compromise erosion control Remote areas can be ignored due to truck-mounted application Less successful in temp/weather extremes Less successful on erodable soils/steep slopes

Cover Application	Cover Characteristics	Cover Application	Pros	Cons
Erosion Control Blanket	<ul style="list-style-type: none"> • Rolled mats have some depth, matting and texture and are secured into the soil with staples 	<ul style="list-style-type: none"> • Area must be seeded first and then the ECBs are manually rolled and stapled in place 	<ul style="list-style-type: none"> • Consistent depth, texture and matting provides a more conducive germinating environment for seedlings • Many choices of blanket including photo and bio degradable • Longer protection than default cover • Lower chances of product failure than default cover 	<ul style="list-style-type: none"> • Improper placement or lack of fine grading can result in ‘tenting’ and possible erosion of soil beneath the ECB • Blanket needs to be anchored and dug in at top of slope • Labour intensive installation
Bonded Fibre Matrix	<ul style="list-style-type: none"> • Relatively thin ‘skin’ applied to earth surface. Sets up when dry to form a uniform cohesive mat 	<ul style="list-style-type: none"> • Applied via hydraulic seeder/mulcher 	<ul style="list-style-type: none"> • Fast, efficient application • When properly applied can resist moderate to severe weather events • Longer protection than default 	<ul style="list-style-type: none"> • Light application can compromise erosion control • Heavy application can inhibit seed germination • Remote areas can be ignored due to truck-mounted application

572.4 SPECIFICATIONS

The requirements for the application of seed and cover are described in OPSS 572. There are no applicable Ministry special provisions (MTO SPs).

Specific changes to the product selection for cover materials will require a non-standard special provision (NSSP) to override the appropriate sections of OPSS 572.

572.5 STANDARD DRAWINGS

There are no OPS or Ministry standard drawings applicable to this work.

572.6 TENDER ITEMS

As there are so many possible combinations from seven seed mixes and three cover types, it was decided to restrict the number of tender items for this work to three.

The cover type determines the tender item to be used. There are three tender items associated with this work:

572.6.1 Seed and Mulch

This item includes surface preparation, seeding and fertilizer application and the appropriate cover application of hydraulic mulch or straw mulch, at the Contractor's discretion.

572.6.2 Seed and Erosion Control Blanket

This item includes surface preparation, seeding and fertilizer application and the appropriate cover application of erosion control blanket.

572.6.3 Seed and Bonded Fibre Matrix

This item includes surface preparation, seeding and fertilizer application and the appropriate cover application of bonded fibre matrix.

572.7 COMPUTATION

All of these tender items are Plan Quantity Payment (PQP) items and are measured in square metres from the design cross sections or scaled from the contract drawings for each different specified type of permanent seed mix and each type of specified cover material. The area measure is determined by the slope measure and the distance of all earth areas covered, plus the required 300mm overlap application.

The designer should not be overly restrictive when calculating earth areas that require seeding and cover treatment after construction. Construction activities usually exceed the planned 'area of construction' and most contracts usually require fairly extensive seeding of areas outside the theoretical limits of construction.

572.8 SOURCES OF INFORMATION

The main sources of information are the design cross sections, field investigations, the Geotechnical Engineer, Environmental Planner and/or Landscape Architect. Specific recommendations for alternative seed mixes and/or alternative cover materials should be obtained from professionals with training and experience in the fields of erosion and sediment control, civil engineering, biology, horticulture and/or landscape architecture.

572.9 DOCUMENTATION

All seeding and cover applications should be detailed by station to station location and offset position on a Miscellaneous 1 Quantity Sheet in a separate column for each different seed mix type and each different cover application type.

As the tender item is determined by the type of cover material, each column with the same cover material application is sub-totalled independently and then all of the column sub-totals with the same cover material application are added together to give a total tender quantity for that item in square metres. This total is then transferred to the tender document against the appropriate tender item.

In addition to the Quantity Sheet documentation, it is recommended that if various seed mix and cover type combinations are used on one contract, the designer should delineate the various seed mix and cover application types on the contract drawings by using symbols and a supplemental legend.

Stations and quantity entries are recorded to the nearest whole number in metres. Station offsets are recorded in 0.1 of a metre.

Appendix G

Limitations of Report

LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Coffey Geotechnics Inc. (Coffey) at the time of preparation. Unless otherwise agreed in writing by Coffey, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Coffey accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.