

G.I.-30 SEPT. 1976

GEOCRES No. 31C-151

DIST. 10 REGION

W.P. No. 253-87-01

CONT. No.

W. O. No.

STR. SITE No. 26-12

HWY. No. 504

LOCATION Hwy 504 & Miner Creek

No of PAGES - 1

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

memorandum



To: Mr. E.C.Lane
Head of Structural Section
Eastern Region
Attention : Mr. H.S. Kleywegt

Date: 91 11 29

From : Foundation Design Section
Room 315, Central Building

Re : Highway 504
Mink Creek Bridge Structure Replacement
W.P.253-87-01, Site 26-12
District 10, Bancroft

We refer to your memorandum dated 91 11 01. The design dimensions of the culvert given therein are noted.

Regarding your concerns on the anticipated high cost of constructing a sheetpile cofferdam for the purpose of the subexcavation and backfilling recommended in our memorandum report dated 91 10 16, we have reviewed the project again and have the following comments and recommendations.

A sheetpile cofferdam can serve the dual purpose of shoring and water cut-off. It allows construction works be carried out in generally 'dry' conditions. The risk involved in causing distress to adjacent ground and structures is negligible. However, as you have pointed out in your memorandum, this alternative is relatively expensive to implement for a project of this size.

Due to granular nature of the subsoil and the close proximity of the proposed structure to the existing one, unwatering the site cannot be carried out by methods such as well-points, temporary creek diversion or sump pumping in pilot trenches. If a cofferdam is not to be built, subexcavation and backfilling will have to be carried out under water.

Instead of taking the entire excavation down to elevation 305.0 m, it is recommended to step the excavation with a view to remove the organic material, yet keeping excavation to a minimum especially at the west end which is closest to the existing structure. The estimated excavation elevations are as follows :

<u>Proposed Structure</u>	<u>Estimated Bottom of Excavation Elevation (m)</u>
West End	306.5
Centre	305.5
East End	305.0

The excavation should then be filled with Granular A material to 308.5 m, about 1 m above the proposed culvert invert elevation (307.3 m). No dewatering is required and the lifts above prevailing groundwater elevation should be compacted in accordance with MTO Standards. Then the fill should be re-excavated to the elevation of the culvert base. It is noted from the E-plan that the High Water Mark at the site in Spring 1991 was at elevation 310.71 m. During the field investigation carried out in Summer 1991, the water level was down to about 307.50 m. It is therefore recommended that the construction works be programmed to be carried out in the dry season of the year.

Temporary slopes will be stable at 1H:1V gradient above water and 1.5H:1V gradient below water. Without dewatering, the base of the culvert will be below water. It is recommended to construct prefabricated culvert panels and lift them in place. The founding base should be lined with fabrics to prevent loss of fines at joint locations. The joints should also be properly sealed.

With a nominal slab thickness of 400 mm, the bottom elevation of the culvert will be at 306.9 m. The final thickness of the granular pad would be more than 1 m over most of the culvert length except the west end of it, where the thickness would only be 0.4 m.

The bearing capacities recommended as per the O.H.B.D.C. for this method of construction are as follows :

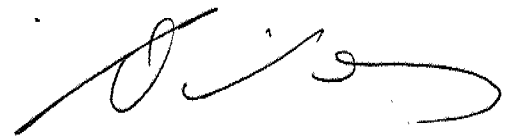
Factored Bearing Capacity at U.L.S. = 375 kPa
Bearing Capacity at S.L.S. Type II = 150 kPa

The northwest corner of the proposed structure is less than 1 m from the existing structure. Excavation in this area will be up to 2.5 m, which would exceed the recommended steepness for temporary slopes. Consequently, there is a possibility that a corner of the existing footing be undermined during excavation. The foundation details of the existing structure are unknown. If it is founded on spread footings, it would be prudent to provide shoring at this location. Shoring can be in the form of sheetpiles. The same design parameters recommended in our previous report for sheetpiles can be used for the design. We strongly recommend that consideration be given to moving the proposed culvert away from the existing structure as far as possible by setting it at a skew angle to minimize the concerns with undermining the existing foundation and consequently the shoring requirements.

If it is considered that some risk of undermining the existing structure is acceptable

since it will be replaced by the new structure eventually, the excavation could be carried out without shoring. In this case, it is recommended that the highway be closed during construction and diverted to an alternate route such as Highway 620. The existing bridge should be closely monitored by survey during construction. If excessive movements occur, the excavation should be backfilled immediately and our office should be contacted for recommendations on alternative method of construction. The excavation and backfilling operations should be concurrent and constructed in strips generally perpendicular to the structure and not exceeding three (3) metres in width. Backfilling and placement of the prefabricated concrete panels should be carried out as soon as possible but definitely within four (4) hours of excavation. After reinstatement of the area, the bridge structure should be inspected by a structural engineer prior to re-opening of it to public use.

We believe that the above is sufficient for your present purposes. If you require further information, please contact our office.

A handwritten signature in black ink, appearing to be 'D. Kwok', written in a cursive style.

D. Kwok, P. Eng.
Project Foundation Engineer
for
D. Dundas, P. Eng.
Senior Foundation Engineer

memorandum



Geocres No. 31C-151

To: Mr. E. C. Lane
Head of Structural Section
Eastern Region
Attention : Mr. H. S. Kleywegt

Date: 91 10 16

From : Foundation Design Section
Room 315, Central Building

Re : Highway 504
Mink Creek Bridge Structure Replacement
W.P.253-87-01, Site 26-12
District 10, Bancroft

The field investigation for the above-noted project has been completed. This memorandum provides a summary of the subsurface conditions encountered at the site and engineering recommendations pertaining to the design and construction of the replacement structure. We understand that this Memorandum Report is sufficient for your design and contract requirements.

The site is located on Highway 504 over Mink Creek (also known as Faraday Creek), about 200 m south of Highway 620 at Glen Alda, in the District of Bancroft. It lies in the physiographical region known as Algonquin Highlands (after Chapman and Putnam, 1984) and consists mainly of bare rock ridges and shallow sandy till, and valleys floored with sand and gravel outwash. The site is located at the valley and flood plains of Mink Creek. The creek is about 6 m wide at the proposed crossing. The river generally flows straight in a westerly direction and it has a granular bed. No major river bank erosion is noticed. The bank is less than 1 m high. The flood plains are overgrown with grass and occasional shrubs.

It is proposed to realign Highway 504 at this location, and construct a replacement structure for the existing bridge about 1 m minimum clear distance to the west. The form and details of the replacement structure have not been finalized by your section. It has been assumed that a 6.0 X 4.0 m concrete open footing or box culvert would be appropriate. The proposed invert elevation of the culvert is assumed to be at 307.0 m or lower. Approach fills are anticipated to be less than 5 m high.

The field work was carried out between 91 08 12 and 91 08 14 and consisted of eight (8) sampled boreholes taken down to 3.4-8.8 m depths. A Dynamic Cone Penetration test was conducted in each of the holes to determine the strength and layering of the subsoil. The locations of the boreholes are shown in Figure 1. Some borehole locations were selected due to the terrain and to avoid the

overhead cables. The creek level was very low with only inches of water during the investigation.

Reference is made to Figure 2 for the stratigraphical profiles and to the Record of Borehole sheets for subsurface details and laboratory test results. The subsurface stratigraphy typically comprised a non-cohesive silty sand deposit overlying bedrock. Organic inclusions were found in the top 0.8 to 3.0 m of the silty sand layer. The surface of bedrock ranged from elevation 304.4 m to 300.1 m (3.3-6.9 m depths). The bedrock was a slightly weathered to unweathered medium strong Quartzite interbedded with Marble. The groundwater level was generally at the ground surface for all the boreholes.

The organic layer has been described as silty sand with organic inclusions. Based on the Standard Penetration Test 'N' values which range from 2 to 13, the material is in a very loose to compact state but typically very loose to loose. Figure 3 illustrates a typical grain size distribution for this material, based on representative samples from the entire site. This information may be pertinent for scour considerations.

Underlying the organic layer is a silty sand deposit. The thickness of the stratum varies from 2.2 to 6.6 m. Based on the 'N' values which range from 3 to over 50, the material is in a loose to very dense state but typically loose to compact. Figure 4 illustrates a typical grain size distribution for this material, based on representative samples from the entire site. This information may be pertinent for scour considerations.

Based on the field investigation, the site is covered with a surficial alluvial deposit containing organics. Although the material is generally non-cohesive in nature, the organic inclusions are highly compressible. It is therefore recommended to remove the organic material and replace it by compacted granular A material. A minimum thickness of 1 m is recommended for the granular pad. This will involve excavation to elevation $305.5 \pm$ m on the left side of the centerline, and slopes down from 305.5 m to $305.0 \pm$ m at the right end of the proposed structure. For construction simplicity, it may be preferable to subexcavate to 305.0 m for the entire site. The depth of the excavation ranges from 2 to 3 m approximately. The pad should extend to the silty sand stratum, and a minimum of 1.0 m beyond the plan limits of the footing, from where it should slope down at 1H:1V or flatter.

To allow compaction of the granular pad and placement of concrete to be carried out in 'dry', the site has to be dewatered below the bottom of the pad (i.e. 305.5 m) prior to excavation. It is the contractor's responsibility to design and construct

a dewatering system to ensure construction be carried out in dry without disturbance to the existing bridge and the foundation soil. The contractor should be alerted that the subsoil is susceptible to disturbance under unbalanced hydrostatic pressures and his proposal should take this into account. The contractor should submit his proposal to this office at least two weeks in advance for review. An NSSP should be included in the contract document to reveal the above requirements. Our office should review the SPs in order to ensure consistency with our recommendations.

Although dewatering is the responsibility of the contractor, we have provided the following comments for consideration. Due to the granular nature of the material and the close proximity of the proposed structure to the existing one, unwatering the site area for backfilling and concreting cannot be conveniently carried out by well-points, temporary diversion of the creek, or sump pumping in pilot trenches. One way of doing it is to construct a cofferdam. Sheetpiles driven to bedrock or sufficient depths can serve the purposes of shoring and water cut-off. Dewatering inside the cofferdam can be carried out by conventional sump pumping. The use of vibratory hammers should be avoided especially at the northwest corner where the proposed structure is only about 1 m from the existing structure which will remain in use during construction. The foundation details of the existing structure are unknown. However, it is envisaged that the foundation is a spread footing founded on the sand stratum as the overburden is about 7 m thick as revealed in the closest borehole (BH 2). For dewatering purposes, the sheetpiles should be driven to bedrock or a minimum depth of twice the excavation depth. The following soil parameters should be adopted for the design of the cofferdam. Cross bracing may be required for supports.

$$\phi = 30^\circ, C = 0, \text{ Bulk unit weight} = 20 \text{ kN/m}^3$$

(assuming that the groundwater table is at ground surface)

The contractor should be alerted through a NSSP in the contract document that there are surficial boulder obstructions especially near the existing structure.

Footings for the structure can be placed on the granular pad. A box culvert is preferred to a concrete open footing culvert as the foundation element for this method of construction since it can distribute the load more uniformly over the granular pad and hence minimize differential settlements. The bearing capacities recommended as per the O.H.B.D.C. are as follows :

Factored Bearing Capacity at U.L.S. = 675 kPa
Bearing Capacity at S.L.S. Type II = 250 kPa

The minimum earth cover required for frost protection is 1.8 m, unless if the culvert is structurally designed to withstand frost pressures.

Backfill to the culvert may consist of rockfill or granular material. Reference is made to OPSD 803 standards for details. Only relatively free draining granular material should be used below the groundwater table. If rockfill is used as backfill to the culvert, consideration should be given to specifying a 500 mm cushion around the culvert consisting of well graded rockfill with particle sizes less than 300 mm.

Backfill to wingwalls should consist of rockfill or granular material in accordance with MTO Standard Special Provision #121 (83 10). Computation of earth pressures should be in accordance with Section 6.6.1.2 of the O.H.B.D.C. For design purposes, the following properties for backfill are recommended :

<u>Material</u>	<u>ϕ</u>	<u>γ</u>	<u>K_o</u>	<u>K_a</u>
Granular 'A'	35°	22.8kN/m ³	0.43	0.27
Granular 'B'	30°	21.2kN/m ³	0.50	0.33
Rockfill	35°	18.0kN/m ³	0.43	0.27

For footings on the granular pad, active condition (K_a) would govern the earth pressure design. However, if there are any rigidly connected headwalls, at-rest condition (K_o) should be used.

Sliding resistance between concrete and foundation soil should be calculated in accordance with the O.H.B.D.C. assuming an unfactored ϕ value of 30°.

Earth fill slopes up to 5 m high will be stable at 2H:1V or flatter. Rock fill slopes up to 5 m high will be stable at 1.25H:1V or flatter. They should blend smoothly with the existing slopes through a transition zone.

For culvert protection, there are two treatment zones to be considered. They are the embankment and the channel. For rockfill, protection is only required for the channel. The culvert outlet should be protected with 0.6 m rock protection as per OPSD 810.01 Type 'A'. The treatment should extend for 10 m along the channel

to prevent undercutting of the bed. For earthfill, protection of the channel is required as described above. In addition, protection is needed for the embankment. A seal of cohesive material with a minimum thickness of 0.6 m should be constructed at the culvert inlet. The material can either be a CI-CH clay or an artificial mixture of bentonite and granular material produced as per OPSS 1205.05.03. The intent of the clay seal is to protect the granular backfill. The seal should extend a minimum of 1 m beyond each side of the channel at culvert inlet, and from the high water level down to 1 m below the base of the culvert or 5 m along the creek bottom as a cutoff. The culvert inlet should be protected with 0.6 m of rock protection extending a minimum of 1 m beyond the clay seal. The embankment at the culvert outlet should also be protected with 0.6 m rock protection in the same manner. Clay seal is not required at the outlet. In critical conditions where large or rapid flow is anticipated, it is recommended to install a 0.6 m thick granular blanket as a filter between rock protection and earth embankment to avoid excessive loss of fines.

We believe the above is sufficient for your present purposes. If you require further information, please contact our office.

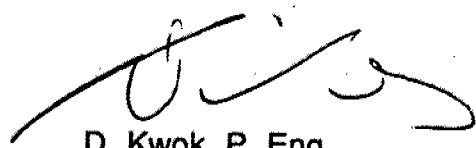
MISCELLANEOUS

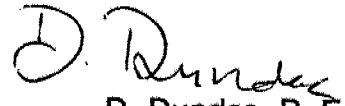
The report was prepared by D. Kwok, Project Foundation Engineer, reviewed by D. Dundas, Sr. Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.

cc:

E.C. Lane (2)
S. Cheng
D.J. Kimmett (2)
D. Hogg (2)
K.G. Bassi
S.J. Dunham
E.A. Joseph
T.A. Hickey (Cover Only)
F. Bacchus (Cover Only)
File Copy




D. Kwok, P. Eng.
Project Foundation Engineer


D. Dundas, P. Eng.
Senior Foundation Engineer

Attach.

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 253-87-01

LOCATION Sta 35+09.3 Lt 5.0 m

ORIGINATED BY CD

DIST 10 HWY 504

BOREHOLE TYPE Hollow Stem Auger, BX Rock Coring, Cone

COMPILED BY DK

DATUM Geodetic

DATE 91 08 12

CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 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					
307.5	Ground Surface												
0.0	Silty Sand, With Organic Inclusions, Some Gravel Dark Brown and Grey, Loose		1	SS	11								22 68 6 4
306.7													
0.8	Silty Sand		2	SS	3								0 34 61 5
	Trace Clay												
	Grey, Loose		3	SS	8								
	becoming Dense		4	SS	30								5 44 45 6
304.2	Coarse Sand with Gravel		5	SS	30								
3.3	Bedrock, Slightly Weathered to Unweathered Medium Grained, Grey Strong, Grey, Moderately Close to Close Spaced Joints, (Quartzite)		6	RC	REC 100%								RQD 100%
303.5			7	RC	REC 89%								RQD 73%
4.0	Bedrock, Slightly Weathered to Fresh, Medium Grained, Grey Medium Strong, Moderately Close to Wide Spaced Joints (Marble)		8	RC	REC 98%								RQD 88%
300.9			9	RC	REC 100%								RQD 100%
8.6	End of Borehole • 91 08 12 •• Gravel at tip												

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 253-87-01 LOCATION Sta 35+100 Lt 3.4 m ORIGINATED BY CD
 DIST 10 HWY 504 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK
 DATUM Ceodetic DATE 91 08 14 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
308.0	Ground Surface													
0.0	Silty Sand With Organic Inclusions Scattered Wood Fibres Very Loose to Loose Brown to Dark Brown		1	SS	4									6 75 14 5
306.4			2	SS	6									
1.5			3	SS	5									
	Silty Sand		4	SS	6									0 45 51 4
	Trace Clay		5	SS	3									
	Very Loose to Loose													
	Grey		6	SS	3									
	becoming Compact		7	SS	23									
301.1														
6.9	End of Borehole Probable Bedrock													
	* 91 08 14													

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 253-87-01

LOCATION Sta 35+106 Lt 0.5 m

ORIGINATED BY CD

DIST 10 HWY 504

BOREHOLE TYPE Hollow Stem Auger, Cone

COMPILED BY DK

DATUM Geodetic

DATE 91 08 14

CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE 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	W _p	W	W _L		
308.2	Ground Surface																
0.0	Silty Sand With Organic Inclusions, Some Rootlets Very Loose, Dark Brown		1	SS	3												
306.7			2	SS	3												
1.5	Silty Sand Trace Clay Very Loose to Loose		3	SS	3												
			4	SS	9												
			5	SS	8												
	Grey becoming Compact		6	SS	11												
			7	SS	10												
300.1	Sandy Silt, Trace Clay and Gravel, Very Dense		8	SS	50	/18cm											
8.1	End of Borehole Probable Bedrock																
	• 91 08 14																

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 253-87-01 LOCATION Sta 35+097 Centreline ORIGINATED BY CD
 DIST 10 HWY 504 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 08 13 CHECKED BY DD

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	W _p W W _L	WATER CONTENT (%) 10 20 30				
307.8	Ground Surface													
0.0	Silty Fine to Coarse Sand with Organic Inclusions Very Loose to Compact Dark Brown		1	SS	13									8 76 14 2
			2	SS	3									
			3	SS	3									
305.5														
2.3	Silty Sand Trace Clay Grey Very Loose to Loose		4	SS	3									
			5	SS	6									
302.6	Silt, Trace Clay and Sand Grey, Very Dense		6	SS	50									0 6 86 8
5.2	End of Borehole Probable Bedrock													
	* 91 08 13													

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 253-87-01

LOCATION Sta 35+094 Rt 0.5 m

ORIGINATED BY CD

DIST 10 HWY 504

BOREHOLE TYPE Hollow Stem Auger, Cone

COMPILED BY DK

DATUM Geodetic

DATE 91 08 13

CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
308.1	Ground Surface																	
0.0	Silty Sand with Organic Inclusions and Gravel Scattered Rootlets Brown to Dark Brown Very Loose to Compact		1	SS	2									15 76 8 1				
306.5			2	SS	11													
1.5	Trace Organics Dark Brown to Grey Grey		3	SS	4													
	Silty Sand Trace Clay Compact to Very Dense		4	SS	14									0 41 56 3				
304.7			5	SS	63	/16cm												
3.4 304.4	End of Borehole																	
3.7	End of Cone Test Probable Bedrock																	
	• 91 08 13																	

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 253-87-01 LOCATION Sta 35+098 Rt 5.0 m ORIGINATED BY CD
 DIST 10 HWY 504 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK
 DATUM Geodetic DATE 91 08 13 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER # CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 10 20 30 40 50	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									
307.7	Ground Surface												
0.0	Silty Fine to Coarse Sand with Organics, Dark Brown Very Loose to Loose		1	SS	2								
306.5			2	SS	6								
1.2	Silty Sand		3	SS	5								
	Trace Clay and Gravel, Grey		4	SS	8								1 42 55 2
	Very Loose to Loose		5	SS	3								
302.6	Silt, Trace Clay and Gravel Compact		6	SS	15								13 5 77 5
5.2	End of Borehole Probable Bedrock												
	91 08 13												

RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 253-87-01

LOCATION Sta 35+095 Rt 11 m

ORIGINATED BY CD

DIST 10 HWY 504

BOREHOLE TYPE Hollow Stem Augers, Cone

COMPILED BY DK

DATUM Geodetic

DATE 91 08 13

CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)		
308.5	Ground Surface													
0.0	Silty Sand With Organic Inclusions Some Rootlets and Wood Fibres Dark Brown to Grey, Very Loose		1	SS	3		308							1 78 17 4
			2	SS	2		307							
			3	SS	3		306							
305.5			4	SS	3		305							
3.0	Silty Sand Trace Clay Grey, Very Loose		5	SS	2		304							1 20 76 3
			6	SS	3		303							
302.4														
6.1	End of Borehole Probable Bedrock													
	• 91 08 13													

+3, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.P. 253-87-01

LOCATION Ste 35+103 Rt 10 m

ORIGINATED BY CD

DIST 10 HWY 504

BOREHOLE TYPE Hollow Stem Auger, BX casing, Cone

COMPILED BY DK

DATUM Geodetic

DATE 91 08 14

CHECKED BY QD

SOIL PROFILE			SAMPLES			GROUND WATER + CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
307.7	Ground Surface													
0.0	Silty Fine to Coarse Sand with Organic Inclusions Brown and Dark Brown Very Loose to Loose		1	SS	2									
			2	SS	2									
			3	SS	5									
304.9			4	SS	7									1 50 46 3
2.7	Silty Sand Very Loose to Compact Grey		5	SS	4									
	Sandy Silt, Trace Clay Compact		6	SS	15									0 15 82 3
302.1														
5.6	Bedrock, Slightly Weathered to Unweathered, Medium Strong Fine to Medium Grained, Grey Wide to Close Spaced Joints (Quartzite)		7	RC	REC 76%									RQD 71%
			8	RC	REC 98%									RQD 93%
			9	RC	REC 100%									RQD 86%
298.9														
8.8	End of Borehole • 91 08 14													

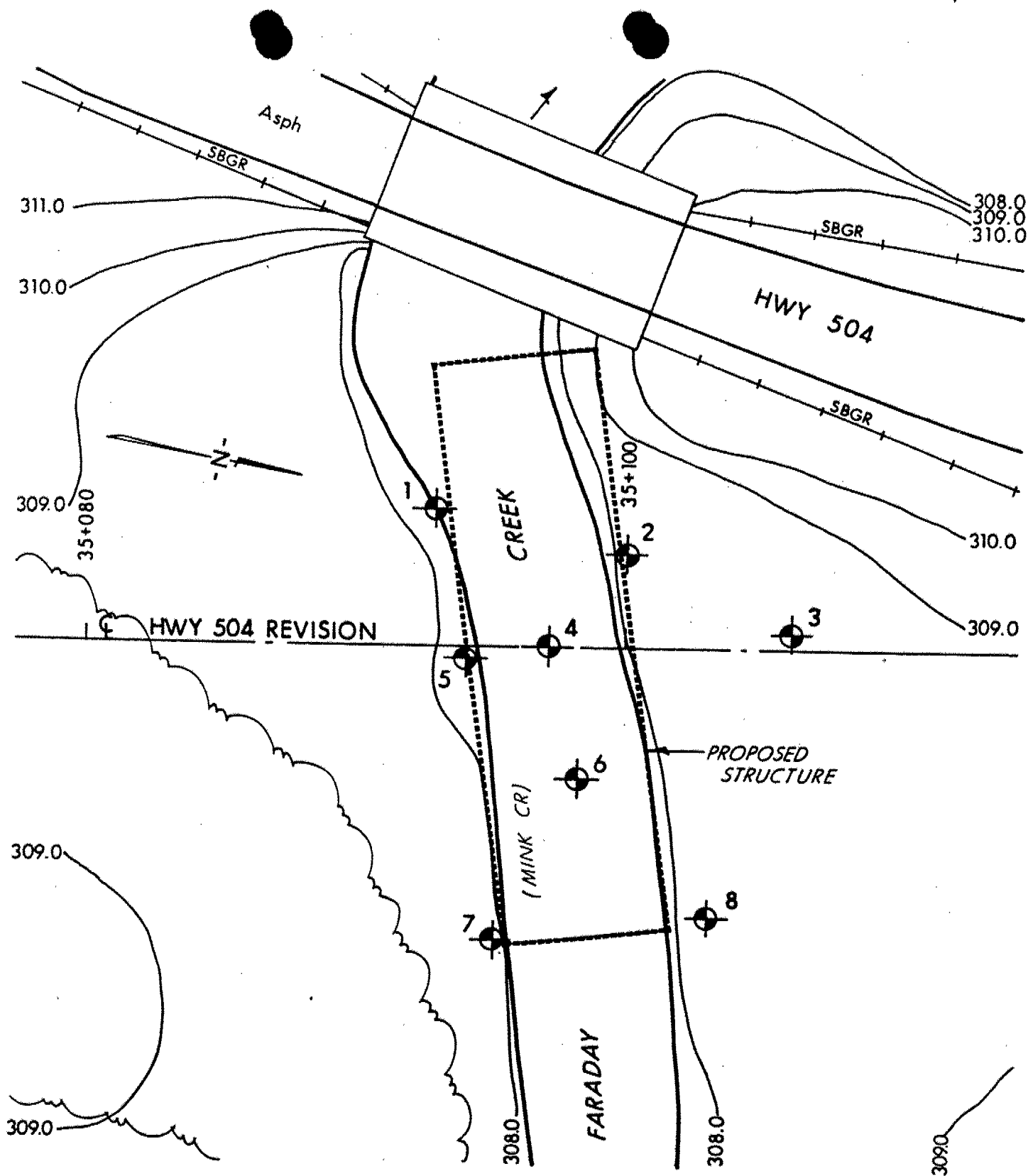


FIG 1

WP 253-87-01 HWY 504
DIST 10 GEOCRE5 NO 31C-151

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

memorandum

235-3696



To: M.S. Devata
Chief Foundation Engineer
Foundation Design Section
Central Building, Room 315

Date: 91 08 21

Attn: D. Kwok

From: Soils and Aggregates Section
Engineering Materials Office
Central Building, Room 311

File No: 3162-2-4-113

Re: **Borehole Core Descriptions**
Highway 504/Highway 620, Wollaston Township
W.P. 253-87-01

As requested by your section, core from two (2) boreholes was logged, and a description is appended. Bedrock is interlayered **QUARTZITE** and **MARBLE** of the Grenville Province. Depth to bedrock and depth to unweathered to slightly weathered bedrock in each borehole are tabulated below:

Borehole Number	Depth to bedrock in metres below ground surface	Depth to unweathered to slightly weathered bedrock in metres below ground surface
1	3.1	3.3
8	5.3	5.6

If you have any questions, please contact me.

D.A. Williams

David A. Williams,
Petrographer.

DAW/jlp
Attachment

ROCK CORE DESCRIPTION

WP 253-87-01

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	6	3.28-3.53	100	100	3.28-4.04	QUARTZITE (calcareous, biotite-hornblende-bearing, tourmaline-bearing at 3.73 m), light grey to medium dark grey; fine to medium grained; strong; unweathered to slightly weathered; fractures moderately close to close spaced, flat to near vertical, undulating, smooth.
	7	3.53-4.42	89	73		
	8	4.42-5.94	98	98		
	9	5.94-6.62	100	100		
					4.04-6.62	MARBLE (phlogopite-bearing), medium light grey to greenish grey to brownish black; medium grained; medium strong; unweathered to slightly weathered; fractures wide to moderately close spaced, dipping, undulating to planar, smooth to rough.
8	7	5.56-6.17	77	71	5.56-8.81	QUARTZITE (calcareous, biotite-hornblende-bearing), light grey to dark grey; fine to medium grained; strong; unweathered to slightly weathered; fractures wide to close spaced, flat, undulating, smooth to rough.
	8	6.17-7.44	97	93		
	9	7.44-8.81	100	87		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section





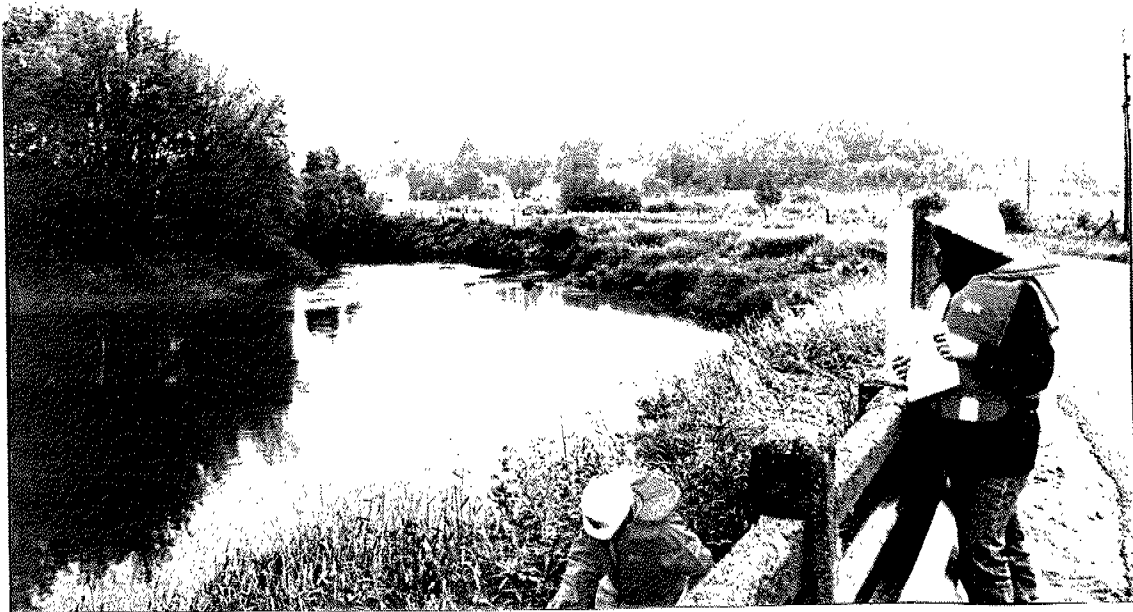


Hwy. 504



Mink
creek →

2A - Main structure (26-12) looking South-East.



Crowe
River →

3A - Main structure (26-12) looking North-west.

Hwy. 504



← Mink
Creek

FA - Main structure (26-12) looking North-East.



Mink →
creek

IA - Main structure (26-12) looking due East.