

#56-F-210C

MONTREAL RD.

& HWY #17

24687

MCROSTIE & ASSOCIATES

CONSULTING ENGINEERS
OTTAWA 1
CANADA

393 BELL STREET
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FOUNDATION INVESTIGATION AT MONTREAL ROAD

1. FIELD WORK

Three boreholes and one probing were made at the site in the location shown on plate one. Two inch thin wall tube samples were taken to a depth of 30 feet in Holes 1 and 2, and to a lesser depth in Hole No. 3. The first two boreholes were extended to probing refusal to give an idea of the depth of the compressible soil layer. Groundwater levels were observed in all holes.

2. LABORATORY WORK

Samples from the two inch tubes were tested in unconfined compression and were classified visually. A limited number of moisture content tests were made. Representative samples were tested to obtain the consolidation properties of the significant soil layers.

3. OBSERVATIONS

Soil conditions are quite uniform at the site. Under the topsoil is a layer of firm to hard brownish gray clay which is fissured. Under this is a great depth of soft to medium soft, sensitive gray clay. At approximately 125 feet, probing refusal indicates the presence of dense material, probably sand. Local well records indicate limestone rock at 175 to 200 feet.

Groundwater levels were at or near the surface during the investigation, this is caused by thawing and the flow of melt-water through the upper fissured clays and is a temporary condition. In dry seasons it is unlikely that any groundwater would appear.

4. DESIGN RECOMMENDATIONS

4.1 Soil Bearing Capacity

The bearing capacity that can be assigned to the soil for the support of piers or abutments does not change with depth. This is due to the fact that large loaded areas stress a considerable depth of soil and the soils at depth are quite uniform.

The recommended allowable load which can be added to the soil at this site is 2200 POUNDS PER SQ. FT.

If this value results in spread footings of extreme dimensions, consideration could be given to the use of hollow box piers. The weight of soil displaced by the vertical portion of such piers may be subtracted from the loads considered to be acting at the footing bottoms. Where soils lie below the water table (temporary or permanent) only their submerged weight may be used. In this case, the unit weight of the soil is approximately 110 pounds per cubic foot and the submerged weight would therefore be approximately 50 pounds per cubic foot. This principle is outlined in the National Building Code and is more fully set out in "Soil Mechanics in Engineering Practice" by Terzaghi and Peck.

4.2 Soil Shear Strength

Stability of the slopes of the proposed embankments should be checked at some stage in the design. The circular arc theory is probably the most practical. Unit weight and shear strength of the foundation soils are required in this analysis. We would recommend the use of 110 lbs. per cubic foot as unsubmerged unit weight and a shear strength of 1200 pounds per square foot with no angle of internal friction.

4.3 Soil Consolidation

4.3.1 Loads The weight of a 20 foot embankment is the largest force acting. Due to its width (180 feet at bottom) it will raise the stress in the full 125 feet of compressible soils and cause consolidation of the entire deposit. Movement of the abutments will correspond with the movement of adjacent portions of the embankment. Loads under pier foundations were also considered. Since they have much smaller widths than the embankment, less soil will be affected and their settlement would be less.

4.3.2 Soil Properties The consolidation properties of the soil are indicated on the attached graph, Plate 6, and indicate that the soil has a "yield point" with regard to consolidation settlements. Below this yield point, which represents ancient precompression, settlements are much smaller than above the point. Fortunately the stresses due to a 20 foot embankment fall just within the pre-compressed range.

4.3.3 Settlements We have calculated the expected settlement under the centre of the embankment, and find it to be 1.3 feet. Similar calculations for the settlement under a typical pier, not embedded in the embankment, give an expected settlement of 0.3 feet. These values should not be considered precise since the present state of our knowledge requires considerable judgment to be used in the interpretation of test results.

4.3.4 Timing of Settlements Even more difficult to calculate is the length of time required for these settlements to

take place. The chief difficulty lies in estimating the degree of continuity of drainage which occurs in the deposit. This cannot be determined from a few boreholes.

The estimated time for the settlements to take place, ranges from 3 to 10 years, and the smaller area of the piers will reach maximum settlement sooner than the embankment area.

4.4 Foundation Type

All of the foregoing analysis has been based on the use of spread footings. End-bearing piles for the support of piers and abutments would need to be 100 to 120 feet long, and hence have not been considered economically feasible. The use of shorter, friction piles in the soft, sensitive clay is not feasible according to most opinions on the subject. The "successful" use of such piles on the nearby bridge would need to be confirmed by a soil study and settlement observations to check the actual design and performance.

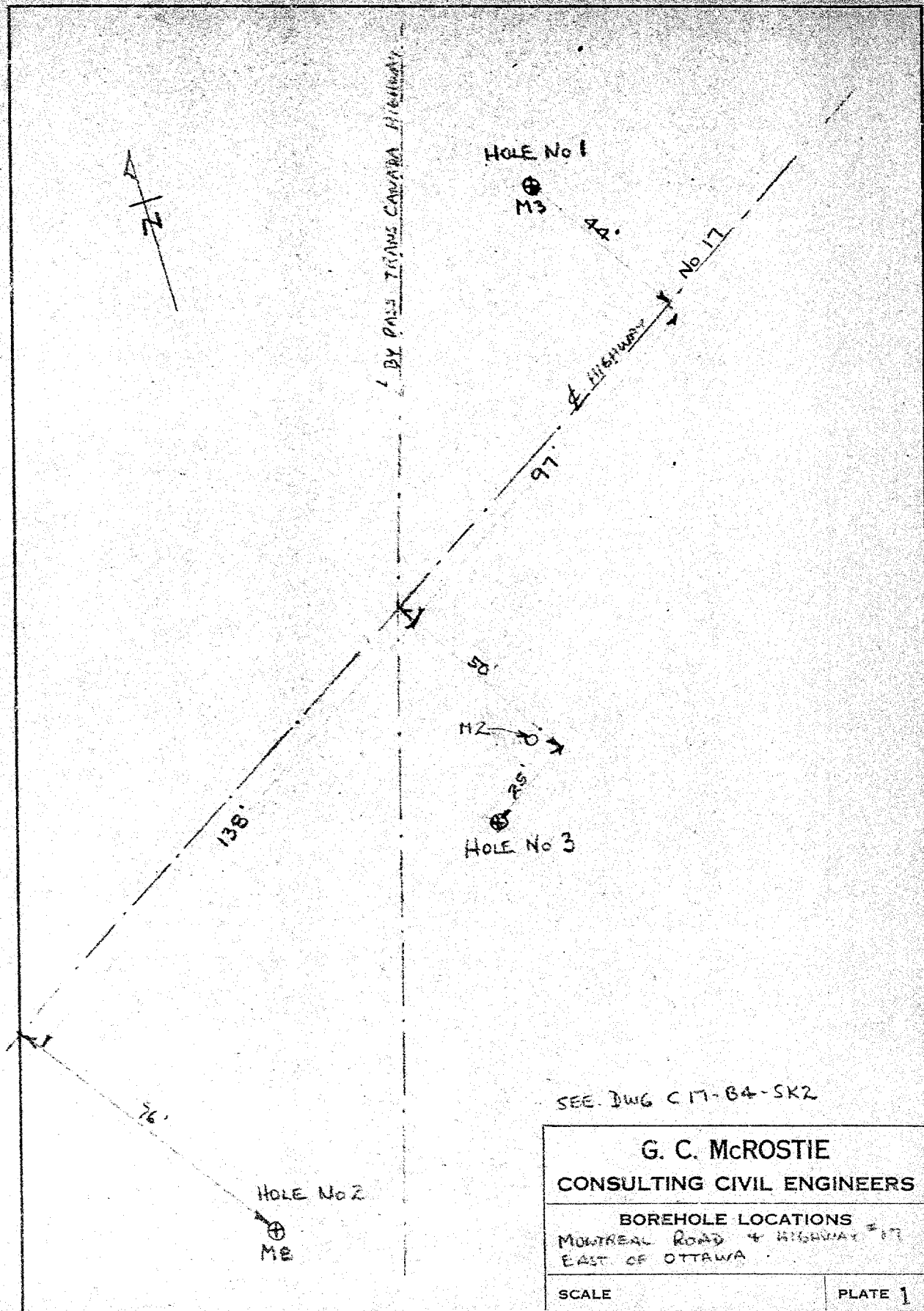
5. CONSTRUCTION FEATURES

5.1 Protection of Soil The clay soils are sensitive to disturbance during construction operations. The movement of men or construction equipment will destroy the strength of the surface layer of clay. In addition, the clay will shrink and swell with changes of moisture content. If the clay at the bottom of an excavation is allowed to dry out, it later takes up moisture under the slab and swells, tending to overstress the slab, particularly before a load is applied. For these reasons it is necessary to protect the upper surface of the clay immediately below the bottom of the footings.

This can be accomplished by excavating, by hand, a few inches below the bottom of the machine excavation and replacing this space with crushed stone or lean concrete. If crushed stone is used and if dry weather occurs, water should be added to prevent drying of the clay through the porous stone layer.

5.2 Settlement Gauges Accurate data on the amount and timing of the consolidation settlements could be obtained by the installation of settlement gauges. These should be in at least one abutment and one pier. The installation could consist of a pipe or rod driven to refusal (125 ft.) through a larger pipe sleeve cast in the concrete up to the deck level. Settlements could then be readily measured at regular intervals as the difference between the tops of inner and outer pipes.

Such factual information would be useful on many future design projects in the Ottawa and St. Lawrence Valleys.



SEE DWG C17-B4-SK2

<p>G. C. McROSTIE CONSULTING CIVIL ENGINEERS</p>	
<p>BOREHOLE LOCATIONS MONTREAL ROAD & HIGHWAY #17 EAST OF OTTAWA</p>	
SCALE	PLATE 1

G. C. McROSTIE
CONSULTING CIVIL ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY
OF LABORATORY TESTS

Trans Canada - East of Ottawa
 Montreal Road Crossing

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 183.6

REMARKS Geodetic datum

HOLE NO.

1

BORINGS BY McRostie TESTING BY McRostie DATE 9 JAN 66

UNCONFINED COMPRESSIVE STRENGTH	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION	PENETRATION TEST	
						LB. HAMMER INCH DROP	NO CASING INCH DIA. ROD
KIPS/FT ²						BLOWS PER FOOT	
			GROUND SURFACE	0	183.6		
0.17		1	Firm slightly fissured brownish grey clay 7.5	0	183.6	Groundwater at surface	
0.30		2		1			
1.75		3		2			
1.75		4		3			
1.8		5		4			
2.15		6	Medium	5			
1.94		7		6			
1.73		8		7			
1.8		9		8			
1.58		10	Soft	9			
1.73		11		10			
0.46		12		11			
1.0		13		12			
1.97		14	grey	13			
1.73		15		14			
0.02		16	clay	15	133.6		
2.59		17		16			
2.59		18		17			
2.59		19		18			
2.45		20		19			
			Soft soil -	20	83.0		
			no samples -	21			
			see penetration	22	100 - 83.6		
			tests -	23			
			Bottom of hole 123.0	24	120		
				25	130		
				26	140		
				27	150		
				28	160		
				29	170		
				30	180		
				31	190		
				32	200		
				33	210		
				34	220		
				35	230		
				36	240		
				37	250		
				38	260		
				39	270		
				40	280		
				41	290		
				42	300		
				43	310		
				44	320		
				45	330		
				46	340		
				47	350		
				48	360		
				49	370		
				50	380		
				51	390		
				52	400		
				53	410		
				54	420		
				55	430		
				56	440		
				57	450		
				58	460		
				59	470		
				60	480		
				61	490		
				62	500		
				63	510		
				64	520		
				65	530		
				66	540		
				67	550		
				68	560		
				69	570		
				70	580		
				71	590		
				72	600		
				73	610		
				74	620		
				75	630		
				76	640		
				77	650		
				78	660		
				79	670		
				80	680		
				81	690		
				82	700		
				83	710		
				84	720		
				85	730		
				86	740		
				87	750		
				88	760		
				89	770		
				90	780		
				91	790		
				92	800		
				93	810		
				94	820		
				95	830		
				96	840		
				97	850		
				98	860		
				99	870		
				100	880		
				101	890		
				102	900		
				103	910		
				104	920		
				105	930		
				106	940		
				107	950		
				108	960		
				109	970		
				110	980		
				111	990		
				112	1000		
				113	1010		
				114	1020		
				115	1030		
				116	1040		
				117	1050		
				118	1060		
				119	1070		
				120	1080		
				121	1090		
				122	1100		
				123	1110		
				124	1120		
				125	1130		
				126	1140		
				127	1150		
				128	1160		
				129	1170		
				130	1180		
				131	1190		
				132	1200		
				133	1210		
				134	1220		
				135	1230		
				136	1240		
				137	1250		
				138	1260		
				139	1270		
				140	1280		
				141	1290		
				142	1300		
				143	1310		
				144	1320		
				145	1330		
				146	1340		
				147	1350		
				148	1360		
				149	1370		
				150	1380		
				151	1390		
				152	1400		
				153	1410		
				154	1420		
				155	1430		
				156	1440		
				157	1450		
				158	1460		
				159	1470		
				160	1480		
				161	1490		
				162	1500		
				163	1510		
				164	1520		
				165	1530		
				166	1540		
				167	1550		
				168	1560		
				169	1570		
				170	1580		
				171	1590		
				172	1600		
				173	1610		
				174	1620		
				175	1630		
				176	1640		
				177	1650		
				178	1660		
				179	1670		
				180	1680		
				181	1690		
				182	1700		
				183	1710		
				184	1720		
				185	1730		
				186	1740		
				187	1750		
				188	1760		
				189	1770		
				190	1780		
				191	1790		
				192	1800		
				193	1810		
				194	1820		
				195	1830		
				196	1840		
				197	1850		
				198	1860		
				199	1870		
				200	1880		
				201	1890		
				202	1900		
				203	1910		
				204	1920		
				205	1930		
				206	1940		
				207	1950		

G. C. McROSTIE
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OTTAWA CANADA

SOIL PROFILE AND SUMMARY
OF LABORATORY TESTS

Trans-Canada - East of Ottawa -
 Montreal Road crossing

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 136.04

HOLE NO.

REMARKS Geodetic survey

BORINGS BY Mc Rostie TESTING BY Mc Rostie DATE 12 JAN 66

2

UNCONTINUED COMPRESSIVE STRENGTH	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION	PENETRATION TEST	
						LB. HAMMER INCH DROP	NO CASING INCH DIA. ROD
KIPS/FT ²			GROUND SURFACE	0		BLOWS PER FOOT	
5.18		1	Hard slightly fissured brownish grey clay	0	136.04	Ground surface as shown	
2.16		2	From slightly fissured brownish grey clay	10			
2.14		3		20			
2.45		4		30			
2.39		5		40			
2.16		6		50	136.04		
1.8		7		60			
1.94		8		70			
2.39		9		80			
2.39		10		90			
2.39		11		100	86.00		
2.16		12		110			
1.37		13		120			
2.09		14		130			
1.73		15		140			
2.16		16		150			
2.16		17		160			
1.94		18		170			
2.39		19		180			
		20		190			
		21		200			
		22		210			
		23		220			
		24		230			
		25		240			
		26		250			
		27		260			
		28		270			
		29		280			
		30		290			
		31		300			
		32		310			
		33		320			
		34		330			
		35		340			
		36		350			
		37		360			
		38		370			
		39		380			
		40		390			
		41		400			
		42		410			
		43		420			
		44		430			
		45		440			
		46		450			
		47		460			
		48		470			
		49		480			
		50		490			
		51		500			
		52		510			
		53		520			
		54		530			
		55		540			
		56		550			
		57		560			
		58		570			
		59		580			
		60		590			
		61		600			
		62		610			
		63		620			
		64		630			
		65		640			
		66		650			
		67		660			
		68		670			
		69		680			
		70		690			
		71		700			
		72		710			
		73		720			
		74		730			
		75		740			
		76		750			
		77		760			
		78		770			
		79		780			
		80		790			
		81		800			
		82		810			
		83		820			
		84		830			
		85		840			
		86		850			
		87		860			
		88		870			
		89		880			
		90		890			
		91		900			
		92		910			
		93		920			
		94		930			
		95		940			
		96		950			
		97		960			
		98		970			
		99		980			
		100		990			
		101		1000			
		102		1010			
		103		1020			
		104		1030			
		105		1040			
		106		1050			
		107		1060			
		108		1070			
		109		1080			
		110		1090			
		111		1100			
		112		1110			
		113		1120			
		114		1130			
		115		1140			
		116		1150			
		117		1160			
		118		1170			
		119		1180			
		120		1190			
		121		1200			
		122		1210			
		123		1220			
		124		1230			
		125		1240			
		126		1250			
		127		1260			
		128		1270			
		129		1280			
		130		1290			
		131		1300			
		132		1310			
		133		1320			
		134		1330			
		135		1340			
		136		1350			
		137		1360			
		138		1370			
		139		1380			
		140		1390			
		141		1400			
		142		1410			
		143		1420			
		144		1430			
		145		1440			
		146		1450			
		147		1460			
		148		1470			
		149		1480			
		150		1490			

% WATER CONTENT

PLATE

3

G. C. McROSTIE
CONSULTING CIVIL ENGINEERS
OTTAWA CANADA

SOIL PROFILE AND SUMMARY
OF LABORATORY TESTS

Tram Camp 9 - East of Ottawa
 Main Road crossing

ELEVATION OF GROUND SURFACE (ZERO DEPTH) _____

HOLE NO. _____

REMARKS PRELIMINARY PROFILE

BORINGS BY McROSTIE

TESTING BY _____

DATE 5 Jan 1966

UNCONFINED COMPRESSIVE STRENGTH KIPS/FT ²	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION	PENETRATION TEST	
						LB. HAMMER INCH DROP BLOWS PER FOOT	NO CASING INCH DIA. ROD
			GROUND SURFACE	0			
				10			
				20			
				30			
				40			
				50			
				60			
				70			
				80			
				90			
				100			
				110			
				120			
				130			
				140			
				150			
				160			
				170			
				180			
				190			
				200			
				210			
				220			
				230			
				240			
				250			
				260			
				270			
				280			
				290			
				300			
				310			
				320			
				330			
				340			
				350			
				360			
				370			
				380			
				390			
				400			
				410			
				420			
				430			
				440			
				450			
				460			
				470			
				480			
				490			
				500			
				510			
				520			
				530			
				540			
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				560			
				570			
				580			
				590			
				600			
				610			
				620			
				630			
				640			
				650			
				660			
				670			
				680			
				690			
				700			
				710			
				720			
				730			
				740			
				750			
				760			
				770			
				780			
				790			
				800			
				810			
				820			
				830			
				840			
				850			
				860			
				870			
				880			
				890			
				900			
				910			
				920			
				930			
				940			
				950			
				960			
				970			
				980			
				990			
				1000			

10 to 30 ft

blows per foot, no casing

no hammer to drop
 1/2" dia rods

% WATER CONTENT

PLATE

5

