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**DRAFT
FOUNDATION INVESTIGATION
& DESIGN REPORT,
GEOSTRUCTURAL EVALUATION,
PROPOSED HANLAN FEEDERMAIN NORTH,
HIGHWAY 401/403 CROSSING,
MISSISSAUGA, ONTARIO**

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FOUNDATION INVESTIGATION REPORT, GEOSTRUCTURAL EVALUATION, PROPOSED HANLAN FEEDERMAIN NORTH, HIGHWAY 401/403 CROSSING, MISSISSAUGA, ONTARIO

1 INTRODUCTION

The Region of Peel (The Region) is planning the construction of a 2,400 mm diameter feedermain (the Hanlan Feedermain) and a 1,500 mm diameter watermain (the MCC watermain) in the City of Mississauga. Starting from the intersection of Britannia Road and Tomken Road at the north, the Hanlan Feedermain will follow Tomken south until it reaches Eastgate Parkway, where it will turn east towards Dixie Road. The MCC watermain also starts at the same point in the north end, but when reaching Eastgate Parkway it will turn west towards Cawthra Road. On Tomken Road, both watermain will pass under the existing Highway 401/403 bridge structures. Trenchless crossing is being considered.

Coffey Geotechnics Inc. (Coffey) was retained by the MMM Group (MMM) on behalf of The Region to carry out a geotechnical investigation for the project and to prepare a Geotechnical Evaluation Report for the proposed crossing under Highways 401/403. The purpose of the Geotechnical Evaluation presented herein is to review the geotechnical conditions existing at the Site of the bridge crossing as revealed during the geotechnical investigation for the feedermain project; to conduct a numerical modelling of the tunnel crossing, to comment on whether the trenchless method of installation is appropriate for the subsurface conditions; to examine the effect of the method of installation on the bridge structures; and to discuss possible contingency plans should problems arise during construction. It should be noted that the investigation was completed only recently and that the design by MMM is at this time only at a preliminary stage.

Coffey has prepared this Foundation Investigation Report to support the permitting process for the highway crossing, as required by the Ministry of Transportation (MTO) guidelines for such crossings. Presented in this report are the factual data resulting from the geotechnical investigation including a description of the site, the regional geology, the method of investigation, the field and laboratory test results and a description of the overburden deposits and the bedrock.

1 DESCRIPTION OF THE SITE

The site is located in the City of Mississauga, where Tomken Road passes under the Highways 401/403 structures. The areas adjoining this section of Tomken Road are developed for commercial land use.

The present terrain slopes from north to south, dropping from about Elevation 170 m to 163 m. South of the highways the ground rises back to Elevation 170 m in about 200 m. The local depression of Tomken Road was a result of the construction of the highway structures. Record drawings show that before the highway structures were built, the ground surface was at about Elevation 172 m in the entire area.

In this area, Tomken Road is a four lane road confined within cut slopes on both sides of the road.

2 DESCRIPTION OF STRUCTURES

There are ten (10) highway structures that carry Highways 401 and 403 over Tomken Road. Structural drawings obtained by MMM show that all the bridges are three span structures with prestressed girders resting on two piers and two open abutments. The piers are supported on spread footings founded on shale bedrock, while the abutments are either on footings or short piles driven into rock. Most of the structures are symmetrical about the centreline of Tomken Road.

Drawing 1 in Appendix E shows the MTO numbers of the structures. The general layout drawings of the structures are reproduced in Appendix E.

3 REGIONAL PHYSIOGRAPHY, GEOLOGY AND HYDROGEOLOGY

Southern Ontario, including the Hanlan Feedermain project area, is known to have been subjected to extensive glaciations during the last 200,000 years. Four major periods of glaciation are known to have occurred in North America, which were interrupted by warmer climate inter-glacial periods. The last glacier (Wisconsin glacier) receded from the area approximately 8,000 years to 10,000 years ago. Remnants of the soil deposits laid down during the first three glaciations and the inter-glacial periods have been largely or completely obliterated by the last Wisconsin glacier as it advanced across and then withdrew from the project area. As the last glacier retreated eastward into the Lake Ontario basin, a shallow water body, Lake Peel, was dammed between the ice front and the Niagara Escarpment and Oak Ridges Moraine, which marks the northern terminus of the last major glacial advance out of the Lake Ontario basin. The resulting glacial lake sediments can be found in isolated, shallow depressions along the creek and river valleys. Sands and gravels left behind as near shore or delta deposits can also be found. As the glacier withdrew further and drainage through the forerunner of the present Hudson River into the Atlantic Ocean became possible, lake levels stabilized in the Ontario basin, forming glacial Lake Iroquois the forerunner of present Lake Ontario.

The bedrock underlying this site is the grey Georgian Bay Formation, consisting of shale with interbedded siltstone and limestone layers. The rock surface generally slopes from north to south with local minor undulations.

Drainage in the vicinity of Tomken Road is generally towards the south, or to the Etobicoke Creek located about 3 km to the east. For a long time, the project area has been provided with municipal water services. Consequently, the wells which used to be the source of water are not believed to be in use anymore. The well records indicate that the sources of water for these former wells were either the top weathered and fractured zone of the bedrock or the sand layers that are found on the surface of the shale bedrock in places.

4 METHOD OF INVESTIGATION

The field work for the Hanlan Feedermain investigation consisted of putting down fifty four (54) boreholes, of which eight (8) boreholes: H06 to H11, H07A and H09A, are of relevance for this evaluation. Their

locations are shown on the attached Borehole Location Plan (Drawing 1, **Appendix F**). The locations and depths of the boreholes were selected in consultation with MMM, who also provided the coordinates and ground surface elevations of the boreholes, as listed in the following table.

Table 1 - Borehole Co-ordinates and Elevations

Borehole No.	Northing	Easting	Elevations (m)
H06	4833158.1	608479.4	170.8
H07	4833130.5	608501.4	169.4
H07A	4833083.0	608530.3	167.4
H08	4833047.5	608585.6	165.1
H09	4832978.1	608636.2	163.3
H09A	4832952.6	608681.8	162.7
H10	4832894.5	608720.8	162.9
H11	4832838.9	608802.4	164.5

Coffey retained the services of Aardvark Drilling Inc to carry out the drilling of the boreholes while Coffey provided the technical supervision of the drilling, sampling and field testing procedures. The boreholes were drilled between October 21 and December 13, 2011. The depths of the boreholes ranged between 21.3 and 28.7 m. The boreholes were advanced using hollow stem augers to the surface of the bedrock. Upon encountering the inferred surface of the bedrock, the boreholes were advanced first by augering an additional 0.3 to 2.1 m through the upper zone of the rock beyond which the rock was sampled by diamond core drilling in HQ (61 mm) size.

In the field, the soil strata and the highly weathered zone of the bedrock were identified and described by observing the materials returned on the auger flights and by sampling the soils and the weathered rock at 0.75 m intervals of depth using a 50 mm O.D. Split Spoon sampler, in accordance with the Standard Penetration Test (ASTM D1586) method. This sampling method recovers samples from the soil strata, and the number of blows required to drive the sampler 0.3 m, after an initial 0.15 m, into the undisturbed soil (SPT 'N'-values) gives an indication of the compactness condition or consistency of the sampled soil material. It also recovered small pieces of rock samples.

The recovered rock core samples were visually examined and described in the field and the index properties, including total core recovery (TCR); solid core recovery (SCR); rock quality designation (RQD); fracture index (FI) and the thickness and percentage of hard limestone and siltstone layers (HL%), were measured and recorded. Photographs of the rock cores in the core-boxes were taken. Field testing in the rock consisted of water pressure ("packer") tests to measure the hydraulic conductivity of the rock mass.

Groundwater levels were measured in the boreholes before starting the coring, after the completion of drilling, and in the 50 mm diameter standpipe type monitoring wells installed in the bedrock in all but Boreholes H09 and H11. Water levels in the monitoring wells were measured on February 6, 2012. The date of the readings together with the observed water levels are given on the borehole logs.

The soil and rock core samples were taken to Coffey's laboratory where they were re-examined and classified by a geotechnical engineer. Selected representative samples were subjected to laboratory

testing. The testing program on the soil samples consisted of the measurement of the natural moisture contents of all samples. Test results are shown on the individual borehole log sheets presented in **Appendix A**. Tests on the rock core samples included: Point Load Index Tests, Unconfined compression tests (UCS); density, Young's Modulus (E); Poisson's Ratio (ν), Slake Durability, and Cerchar Abrasiveness testing. The results of these tests are presented in Table 4 and Table 7 of this report.

5 PREVIOUS INVESTIGATION

When the highway structures were constructed, a geotechnical report was prepared for each of the structures. The previous investigations included a number of boreholes, which were drilled from the original ground surface, but were advanced only a short distance into the shale bedrock by augering. The structural drawings obtained by MMM include a drawing showing the simplified stratigraphy for each of the sites. These construction drawings are reproduced in **Appendix E**. Since no rock coring was done in the previous boreholes, and the overburden soils have been excavated, no attempt has been made to obtain the original geotechnical reports from MTO.

6 SUMMARIZED SUBSURFACE CONDITIONS

The following paragraphs provide a brief summary of the subsurface conditions found in the boreholes at the crossing. More details are provided in Section 7 of this report and the individual borehole logs presented in **Appendix A**. An inferred subsurface profile is presented on Drawing 1, **Appendix F**, which also shows the approximate original ground surface and the approximate original rock surface, as inferred from the available structural drawings.

Boreholes H07 to H10 encountered about 100 to 230 mm of asphaltic concrete over about 370 to 1000 mm granular road base. Borehole H06 encountered 200 mm topsoil overlying about 700 mm of clayey silt, which could be highly weathered shale. Borehole H11 encountered 0.3 m of clayey silt fill. The pavement structure or fill is underlain by shale bedrock of the Georgian Bay Formation, at depths of 0.3 to 1.1 m below present ground surface. The quality of the shale is generally fair to good, as indicated by the RQD and the RMR (Rock Mass Rating) values.

The groundwater level in the monitoring wells was at 0.2 to 5.7 m below ground surface on February 6, 2012.

A more detailed description of the shale bedrock follows.

7 DETAILED DESCRIPTION OF THE SHALE BEDROCK

Shale bedrock was encountered in all boreholes, at depths of 0.3 to 1.1 m below the present grade of Tomken Road, which in this area was cut down when the highway structures were constructed. According to the available MTO records, the original rock surface in this area was practically level at about Elevation 170 m, which is about 0.6 to 7.3 m *above* the present road surface.

From the recovered rock cores, the rock was identified as shale belonging to the Georgian Bay Formation, which is of the Middle Ordovician Age. This formation consists of dark grey coloured weak to medium strong laminated shale interbedded with light grey, strong to very strong limestone and siltstone layers.

Typically, the Georgian Bay Formation consists of approximately 80% to 90% shale with various thicknesses of interbedded limestone and calcareous siltstone, and very occasionally, sandstone layers. The shale is thinly laminated and is generally medium strong, while the interbedded limestone and siltstone layers are strong to very strong. The hard layers are usually less than about 100 to 150 mm thick but have been observed to be occasionally 750 to 900 mm thick at other sites. The layers are actually lenses and they can vary significantly in thickness over short distances.

The bedrock contains a joint pattern at close intervals with the major joint in an approximate east-west direction and very minor joints at right angles. The spacing of the joints has been observed in other construction sites to be about 2 to 3 m. The joints are generally vertical although occasional slightly inclined joints were also found. The joints have a persistence of about 3 m.

Stress relief features such as folds and faults are common in the Georgian Bay Formation. In these features the rock is heavily fractured and sheared, and contains layers of shale rubble and clay. Due to the fracturing, these features may also be groundwater conduits, which could result in excessive water flow into excavations. Weathering in these features is much deeper than in the surrounding rock and often there can be a lateral displacement of the stress relief features resulting in sound unweathered bedrock overlying fractured and weather bedrock. The stress relief features are usually in the order of 4 to 6 m wide, but the depth can vary from 4 to 5 m to in excess of 10 m.

The descriptive terms used on the log of rock cores, and throughout this report, are explained on the sheet titled "Explanation of Terms Used in the Bedrock Core Log" which can be found in **Appendix A**. In general, the conventions of the International Society of Rock Mechanics (ISRM, 1981) are adopted herein. The measured index and engineering properties of the formations are summarized in the sections that follow. Photographs of the rock cores are presented in **Appendix D** of this report.

7.1.1 Total Core Recovery (TCR)

The Total Core Recovery (TCR) is the total length of the rock core recovered from each core run expressed as a percentage of the actual length of the core run, which was usually 1.5 m. The TCR of all the rock cores in all the boreholes ranged from 59 to 100%, with an average of 98.5%. Within individual boreholes, the average TCR varied from 96.9 to 100%.

7.1.2 Solid Core Recovery (SCR)

The Solid Core Recovery (SCR) is the total length of full diameter rock cores recovered in each core run expressed as a percentage of the length of the core run. SCR values ranged from 0% to 100%, with an average of 96.0%. For individual boreholes, the average SCR varied from 92.1 to 98.2%. The lower SCR values were generally recorded in the top 5 m below the rock surface due to weathering and/or fracturing within the surface zone.

7.1.3 Rock Quality Designation (RQD)

The Rock Quality Designation (RQD) values were obtained by measuring the total lengths of recovered rock core pieces in each core run that are 100 mm and longer, and expressing the sum total of these as a

percentage of the length of the core run. Breaks caused by drilling or handling are not counted. The RQD values range from 40% to 100% with an average of 92.9%, indicating poor to excellent rock quality according to Deere's (1967) Classification System (see Table 2). The RQD values are plotted against depth below rock surface in Figure 1b, which shows a trend of quality improvement with depth. About 5 m below rock surface, most of the rock is of either good or excellent quality. The average RQD values in the individual boreholes ranged from 85.1% to 98.1%. The RQD values are given on the logs of boreholes. A histogram of the recorded RQD values is presented on Figure 1a.

The RQD values are a general indicator of rock mass quality. Due to the horizontally laminated fissile nature of the Georgian Bay Formation, however, it is our opinion that the RQD indices tend to underestimate the rock quality of shale rocks.

Table 2: Rock Quality Designation

RQD (%)	Designation of Rock Quality
0 – 25	Very poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 – 100	Excellent

Figure 1a: RQD Histogram

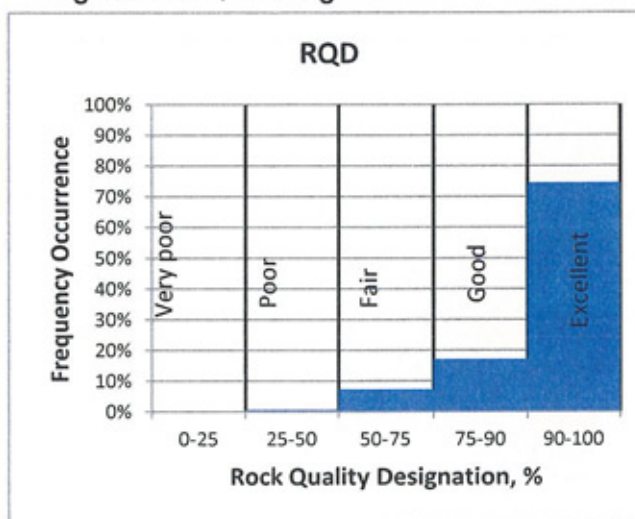
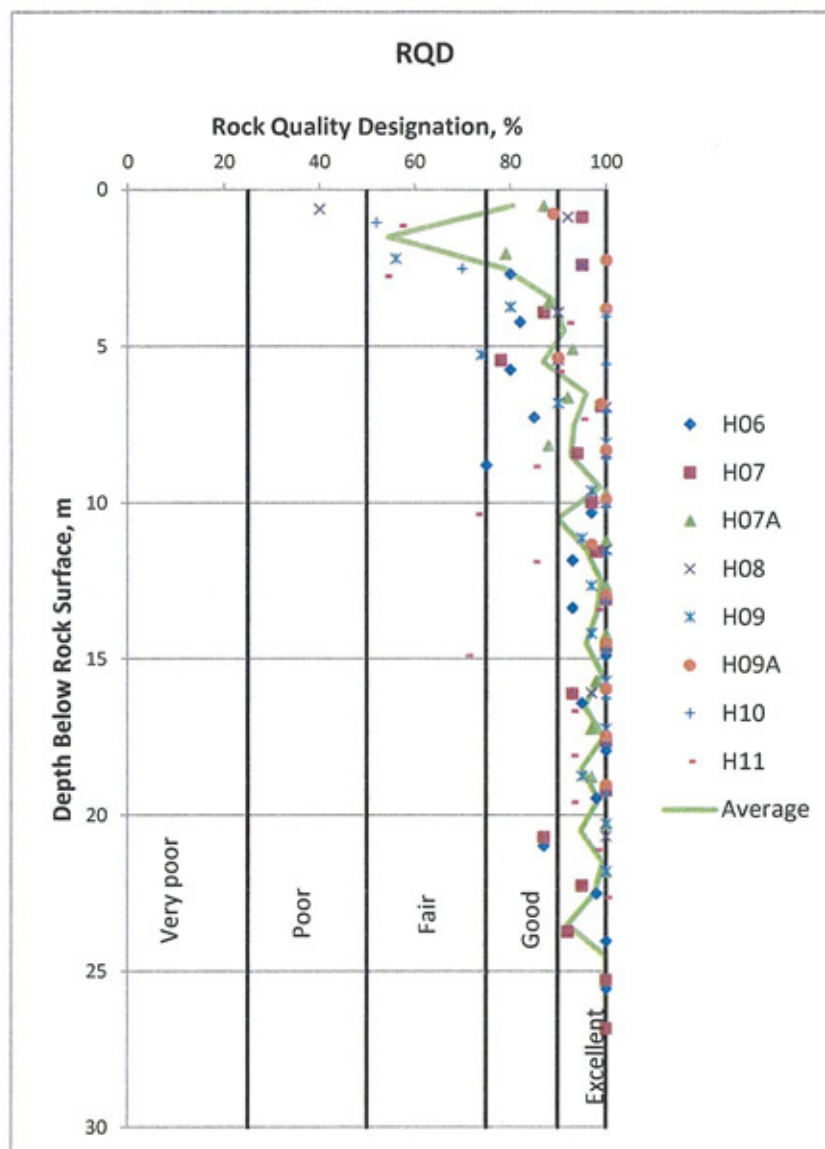


Figure 1b



7.1.4 Fracture Index (FI)

Joint frequency or Fracture Index (FI) is a measure of the observed frequency of fracturing and bedding plane separations in the rock cores. It is expressed as the number of fractures per 300 mm lengths of rock core run. Breaks which are obviously caused by drilling are excluded. A continuous vertical fracture regardless of its length is counted as one fracture. The recorded FI values range between zero and greater than 10. If the values greater than 10 are counted as 10, the average FI is 0.9. Average FI values in the individual boreholes range from 0.5 to 1.6. While there is a wide spread of the FI values, the average value decreases with depth. At about 5 m below rock surface, the FI values are mostly less than 2. Planes of weaknesses along which the core tended to break were the planes of bedding and the contact surface between the shale and the hard layers. These planes of weaknesses were generally very closely to closely spaced, horizontal, planar to undulating, smooth, occasionally rough, tight and without infillings. The joints are open and rough and often with clay infill. The conditions of the discontinuities are described in more detail on the borehole logs.

The inverse of the FI VALUES provides an indication of the spacing of the fractures. Table 3 below shows the approximate relationship between FI and discontinuities spacing classification according to ISRM.

Table 3: Discontinuities Spacing Classification (ISRM 1981)

Spacing Classification	Spacing (m)	Approx. FI
Extremely close	<0.02	>10
Very close	0.02 to 0.06	6 to 10
Close	0.06 to 0.2	2 to 5
Moderately close	0.2 to 0.6	1
Wide	0.6 to 2.0	<1
Very wide	2.0 to 6.0	<1
Extremely wide	>6.0	<1

It should be noted that the shale is known to contain vertical fractures which is only occasionally intercepted in the vertically oriented boreholes. At other previous construction sites, the spacing of the vertical fractures have been observed to be generally in the range of 2 to 3 m.

In addition to the bedding planes, contact planes and fractures, there are occasional fractured zones within the shale bedrock. The thickness of the fractured zones are generally less than 75 mm. The location and thickness of these zones are recorded in the individual borehole logs.

7.1.5 Hard Layers

When recovering the core samples, the thicknesses of the interbedded hard calcareous siltstones and limestone layers were measured and, where appropriate, their aggregate sum was expressed as a percentage of each core run. Recorded hard layer percentages of all core runs range from 0 to 47%, with an average of 13%. (Since shorter core runs tend to over estimate the percentage of hard layers, only core runs that are 1.2 m or longer are included in this analysis). Individual borehole average varied from 10 to 18%.

Hard layers were often thin, in the range of 25 to 75 mm, and could be identified by their lighter grey colour. Occasionally, thicker zones, in the order of 175 mm to 650 mm, were recorded. The hard layers are seldom continuous over a long distance. It has also been observed in other construction site that a cap of hard limestone often exists on the surface of the rock.

7.1.6 Weathering

Below the uppermost zone of the rock which was penetrated by augering, the degree of weathering of the rock in the core samples was visually observed as slight to moderate, but the rock was generally fresh with some weathering on the discontinuity surfaces. Near the rock surface, the degree of weathering, however, is higher, but at the depths where the proposed watermain tunnels will be located, the rock may be considered as fresh to slightly weathered. Occasionally, the shale contains clay layers of variable thicknesses, and where observed, they are indicated on the rock core logs.

7.1.7 Uniaxial Compressive Strength (UCS), Young's Modulus, Poisson's Ratio

Ten (10) samples of rock cores were forwarded to the rock mechanics laboratory of Queen's University Mining Department for testing of uniaxial compressive strength. The results, summarized in Table 4 below, indicate UCS values ranging from 13.2 to 37.4 MPa for shale (average 21.5 MPa). One sample of limestone yielded a UCS of 71.1 MPa. Based on these values, the shale bedrock is classified as a weak to medium strong rock in accordance with the ISRM (1981) convention, with occasional strong limestone layers.

The unit weight, Young's modulus, and Poisson's ratio of the rock cores were measured as part of the UCS tests. The results are summarized in Table 4.

Table 4: Summary of Uniaxial Compression Test Results

Borehole	Depth (m)	UCS (MPa)	Young's Modulus (GPa)	Poisson's Ratio	Unit Weight (kN/m ³)	Rock Type
H06	9.60	13.2	0.91	0.25	2700	Shale
H06	17.22	17.3	2.42	0.18	2620	Shale
H06	18.90	22.7	4.91	0.22	2660	Shale
H09A	11.28	20.3	3.9	0.3	2660	Shale
H09A	14.93	24.7	5.61	0.15	2680	Shale
H11	9.45	37.4	15.75	*	2660	Shale
H11	10.36	18.8	3.86	0.14	2590	Shale
H11	13.41	14.3	2.95	0.12	2620	Shale
H11	15.85	24.6	3.6	0.18	2630	Shale
H06	11.89	71.1**	15.78	0.12	2710	Limestone

* sample failure progression or friable sample surface condition precluded measurement of Poisson's ratio; ** limestone

7.1.8 Point Load Index Strength

Additional indirect evaluation of the compressive strength of the rock was obtained by performing point load tests on a total of two hundred twenty six (226) core samples (See Table B1-1 to B1-6, **Appendix B**). Tests were performed both in the axial and the diametral direction of the shale and limestone/siltstone core samples. As expected, testing of the samples in the diametral direction typically resulted in lower results.

Inferred unconfined compressive strength values were calculated as $UCS = \text{Point Load Index} \times 24$.^{[1] [7] [12]} It should be noted, however, that for rocks with a UCS value less than 25 MPa the results of the point load tests may be ambiguous as the test may underestimate the true strength of the rock mass. The obtained UCS values on the shale cores performed in the axial direction range from 5.9 MPa to 42.9 MPa (Average = 22.2 MPa). Tests in the diametral direction yielded lower values (Range 0.5 to 47.6 MPa, average 9.4 MPa). Inferred UCS values from the tests performed on the hard limestone and siltstone samples range between 35.8 MPa and 280.9 MPa (average of 155.9 MPa) in axial direction, and between 21.4 MPa and 219.4 MPa (average of 101.0 MPa) in diametral direction.

Based on these tests, the shale rock is classified as extremely weak to medium strong, but generally weak, while the limestone/siltstone layers as medium strong to extremely strong. The statistical distribution of the strength values, (as inferred from the above approximate correlation between point load index and UCS), are presented in the form of histograms on Figures 2a and 2b below.

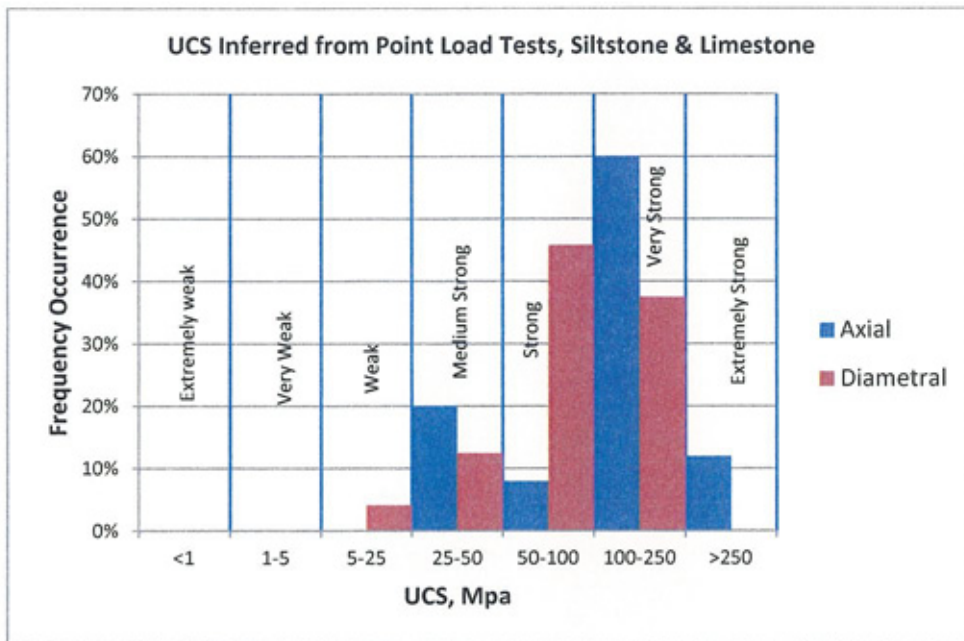


Figure 2a

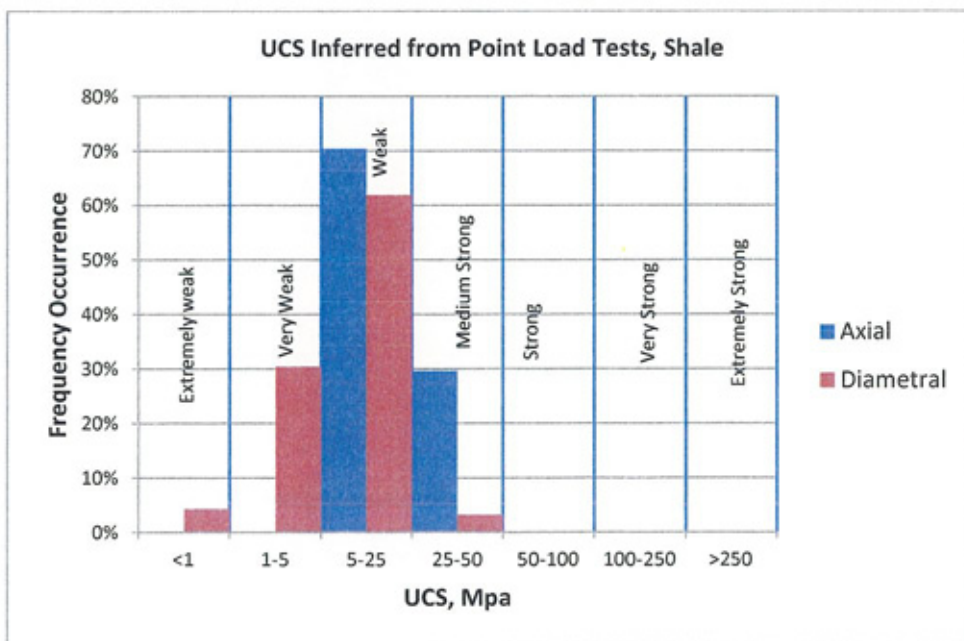


Figure 2b

Table 5: Summary of Inferred UCS from Point Load Tests

	Inferred UCS (MPa)			
	Axial		Diametral	
	Range	Average	Range	Average
Shale	5.9 to 42.9	22.2	0.5 to 47.6	9.4
Limestone, siltstone	35.8 to 280.9	155.9	21.4 to 219.4	101.0

7.1.9 Hydraulic Conductivity

The hydraulic conductivity of the rock mass was estimated from the water pressure (packer) tests performed in the boreholes. These tests were conducted by isolating 1.5 to 3 m long zones in the rock using double inflatable packers and introducing water under three (3) constant pressure heads. The pressures used were in excess of the in-situ water pressure, but ensuring at the same time that the pressure used did not result in the hydro fracturing of the rock. A gasoline-operated pump was used to generate and maintain constant water pressure (measured by a gage) and the rate of delivery of water to the test section of the rock was monitored using a flow meter.

In total, fourteen (14) tests were performed in three (3) boreholes (H06, H08 and H11). The test results are summarized in Table B2, **Appendix B**, and are also presented on the individual borehole log sheets. As shown, the estimated hydraulic conductivity values range from about 7×10^{-5} to less than 10^{-8} cm/s (as inferred from the "no water intake" of the rock at test pressures). Figure 3 is a histogram plot of the hydraulic conductivity test results.

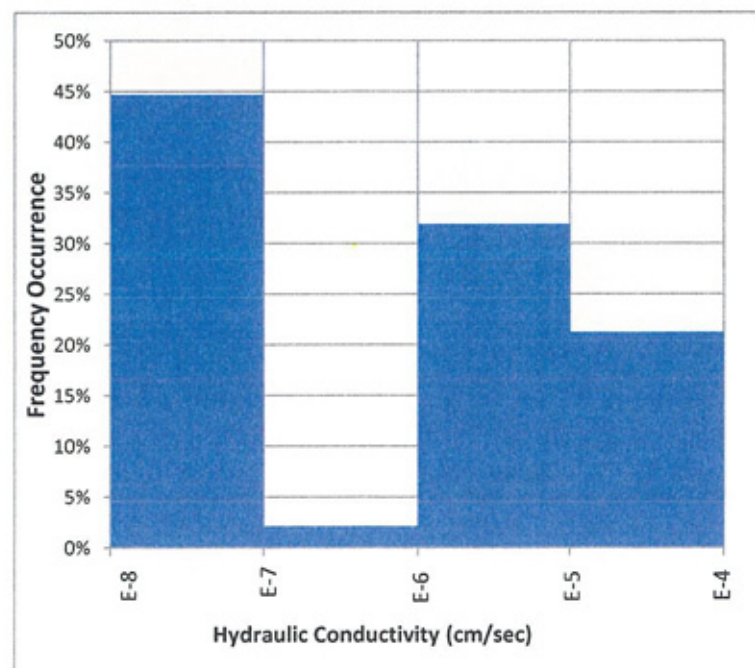


Figure 3

7.1.10 In-situ Stresses

The Palaeozoic sedimentary rock formations in Southern Ontario, including the Georgian Bay Formation, are known to possess high horizontal stresses which exceed the vertical stress often by a factor greater than 4.

In-situ stress measurements were not performed as part of this investigation. Values obtained during a previous geotechnical investigation carried out by Coffey for the Burloak Water Intake Tunnel project, about 28 km to the west, in the same Georgian Bay Formation by the deep-door stopper gauge system (DDGS) over-coring method yielded a maximum horizontal stress of 6.5 MPa and a minimum horizontal stress of 4.6 MPa at a depth of 37m below rock surface. The orientation of the maximum horizontal stress is about Azimuth 300°. The vertical stress at the test location was about 1MPa, thus giving a horizontal to vertical stress ratio of 6.5. Further information on the in-situ stresses is available from the literature.

In-situ stress measurements were carried out by a number of investigators in the Toronto area in the Georgian Bay Formation. These are presented as a general guide. Some of the reported values are presented in Table 6 below.

Table 6: In-situ Horizontal Stress Measurements

Source	Location	Depth Below Ground Surface(m)	Horizontal Stress (MPa)
Trow & Lo, 1989 [11]	Scotia Plaza, Toronto	15 – 26	2.6 – 5.3
Lo et al 1979	Heart Lake Tunnel	5 10	1.5 5.5
Coffey Report	Water Intake, Oakville	37	4.6 to 6.5
Morton, Lo & Belshaw, 1975 [2]	Outfall Tunnel East of Toronto	9 – 15	up to 6.9
Lo & Morton, 1976 [3]	Outfall Tunnels	9 – 10	2 – 4
Franklin & Hungr, 1978 [5]		70	1.7*

* - measurements in a fracture zone

7.1.11 Time-Dependent Deformation Characteristics (TDD)

It has been observed, both in the laboratory and in the field^{[4] [3] [13]}, that upon relief of high residual horizontal stresses within the shale formations, time dependent, creep-like deformations take place. These time-dependent deformations (TDD) persist well beyond the initial elastic deformations and generally exceed the magnitude of the elastic movements. In the various publications, the TDD phenomenon is described as "swelling" or "rock squeeze" by the authors. While "rock squeeze" usually refers to the slow, creep-like deformation of the rock due to stress relief and "swelling" is primarily due to diffusion of salts of the pore water in the presence of freshwater, the two are inter-related and their total is the TDD.

A crude measure of the magnitude of TDD strain can be obtained in the laboratory by "free swell tests". TDD measurements were not performed as part of this investigation and, therefore, only values in the

literature can be used as guidelines. Reported measured values in the laboratory range between 0.03 and 0.26% per log cycle of time.

Further TDD values for the Georgian Bay Formation were obtained from actual field measurements carried out during previous tunnel constructions. Observed values, expressed as a percentage of the original excavated tunnel diameter per log cycle of time (e.g. 1, 10, 100, etc. days), are given below.

Lo and Morton (1976) [3]	$\varepsilon = 0.11\%/\text{Log cycle of time}$
Lieszkowszky, Ng et al. (1994) [13]	$\varepsilon = 0.0013 - 0.08\%/\text{Log cycle of time}$
Lieszkowszky, Ng et al. (1995) [14]	$\varepsilon = 0.02 - 0.08\%/\text{Log cycle of time}$
	$\varepsilon = 0.07 - 0.18\%/\text{Log cycle of time}$

7.1.12 Slake Durability

All rocks, but shale rocks in particular, are prone to disintegrate when exposed to repeated cycles of wetting and drying. The ability of the rock to resist the effect of wetting and drying can be tested by the "slake durability test", the results of which are reported as an index (I_{d2}). This index is the weight of the dry sample remaining in the test drum after two cycles of wetting and drying ("slaking"), which is then expressed as a percentage of the initial dry sample weight. I_{d2} that approach zero (0%) are highly susceptible to slaking and those which are close to 100% are not susceptible, resistant rocks. Those shale rocks that have an Index less than 80% may be regarded as soil-like-shale^{[1][7]}.

Six rock core samples were sent to Amec laboratory for testing of slake durability. The results are summarized in Table 7 below. The durability index (I_{d2}) obtained ranged from 80.7 to 89.2, with an average of 84.6, indicating "low durability".

7.1.13 Cerchar Abrasiveness

Abrasiveness tests are used to evaluate the potential and the rate of wear of tools used to cut the rock. One of these tests is the "Cerchar Abrasivity" test. This test is performed by scratching a freshly broken rock surface with a sharp hardened pin over a distance of 10 mm. The Cerchar Abrasivity Index (CAI) is then calculated as the average abraded diameter of the pin in tenths of a millimeter. These tests were performed in the laboratories of AMEC on four selected samples. The test results indicated very low to low abrasiveness.

Table 7: Slake Durability and Cerchar Abrasiveness Tests Results

Borehole	Depth (m)	Slake Durability		Cerchar Abrasiveness	
		I _{d2}	Type*	CAI	Classification
H07	16.3	83.3	II	-	-
	17.6	89.2	II	0.7	Low
H08	10.2	84.2	II	0.5	Very low to low
	12.9	85.3	II	0.6	Low
H10	10.1	84.9	II	0.6	Low
	12.7	80.7	II	-	-

Type I – retained specimen remains virtually unchanged; Type II – retained specimen consists of large and small fragments; Type III – retained specimen is exclusively small fragments

7.1.14 Rock Mass Rating (RMR)

The Rock Mass Rating (RMR) is another measure of rock quality, as relevant to tunnelling and mining. This geomechanical classification was developed by Bieniawski in 1973. It utilizes the following six parameters that are measurable in the field and laboratory:

- UCS – where UCS were performed, the values were used directly; where point load index tests were performed, the UCS were estimated from the point load test results in the axial direction, using the approximate relationship described in Section 7.1.8 above.
- RQD – as measured for the rock cores.
- Spacing of discontinuities – as calculated from the inverse of the fracture index of the cores.
- Condition of discontinuities (e.g. roughness) – slightly rough and slightly weathered walls assumed for all fractures.
- Groundwater conditions – wet condition is assumed for all cores.
- Orientation of discontinuities – fair condition assumed for all cores.

Each of these parameters is given a rating and the sum of the six ratings is the RMR. Based on the RMR rating the rocks are classified into five (5) categories ranging from very poor to very good rocks.

The calculated RMR values for all boreholes and all depths range from 50 to 74, with an average of 63. Based on the Bieniawski classification system, the rock is classified as fair to good rock. Figure 4 is a plot of the RMR values versus depth below rock surface. The average value improves slightly with depth, although there is considerable scatter. Figure 5 is a histogram of the calculated RMR values for all cores.

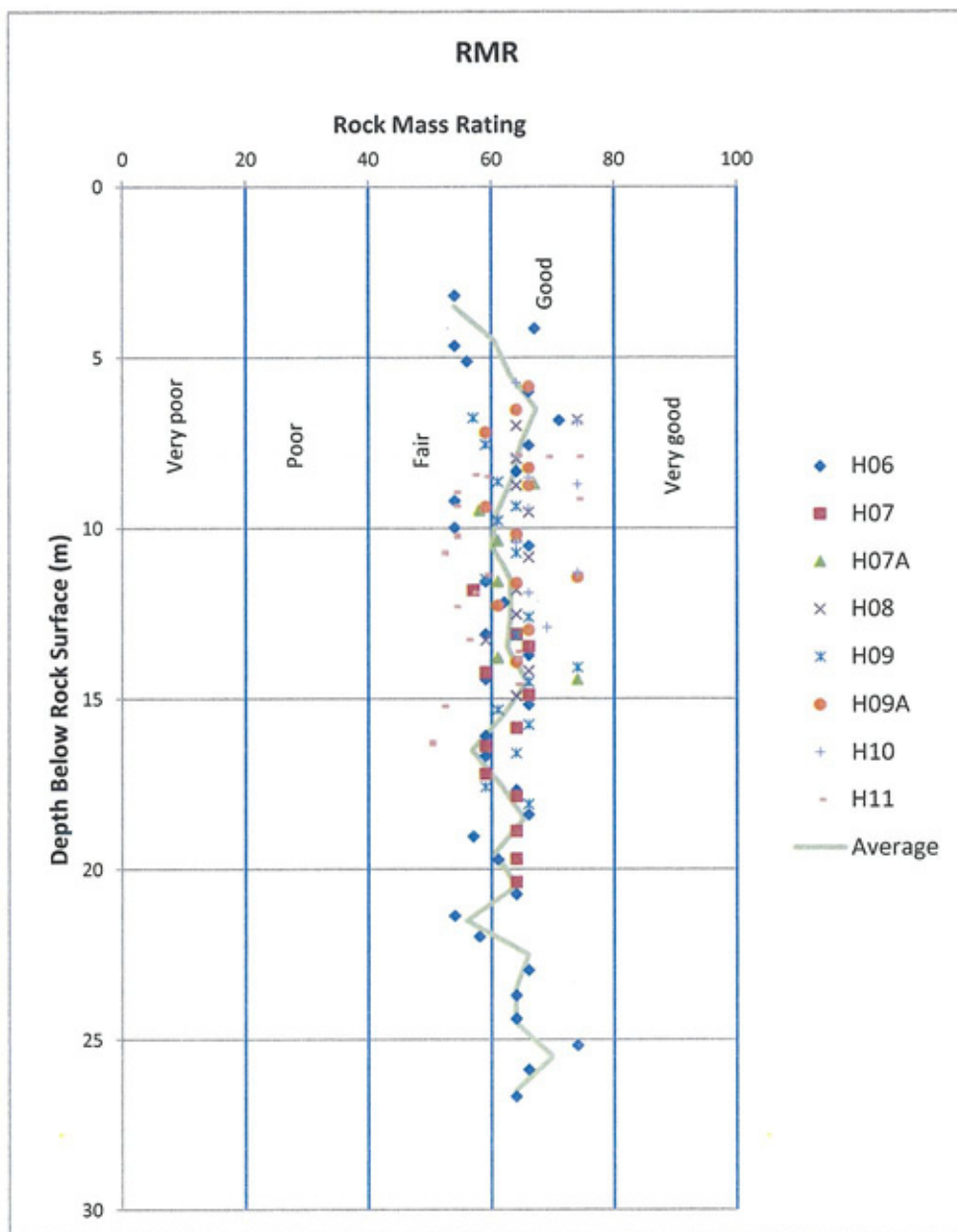
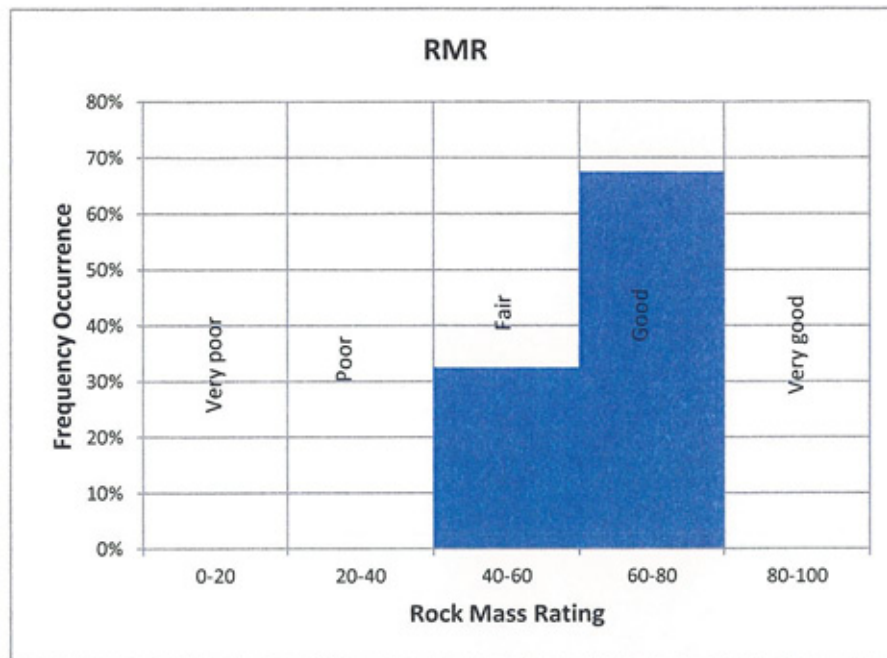


Figure 4

Fig. 5



8 GROUNDWATER

50 mm diameter monitoring wells were installed in all boreholes except Borehole H09 to facilitate long-term water-level observations. The ground water levels in the wells were monitored during the field work, and on February 6, 2012, eight to fifteen weeks after they were installed. On February 5, 2012, the water level was observed at 0.2 to 5.7 m below ground surface. The observed water levels are summarized in Table 8 below.

Seasonal fluctuations in groundwater levels should be expected. Groundwater levels will also rise and fall in response to precipitation.

Table 8: Measured Water Levels in Monitoring Wells

BH No	Date Installed	Water Level		Water Level on 2012 02 06 Depth / Elevation (m)
		Date	Depth / Elevation (m)	
H06	2011 11 21			4.8 / 164.0
H07	2011 11 21	2011 11 21	6.7 / 162.7	1.8 / 167.6
H07A	2011 12 19			0.4 / 167.0
H08	2011 11 16			0.2 / 164.9
H09A	2011 11 23	2011 11 25	2.7 / 160.0	1.0 / 161.7
H10	2011 12 13			5.7 / 157.2
H11	2011 10 21			3.6 / 160.9

Foundation Investigation & Design Report, Geotechnical Evaluation, Proposed Hanlan Feedermain North, Highway 401/403 Crossing,
Mississauga, Ontario

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FOUNDATION DESIGN REPORT GEOSTRUCTURAL EVALUATION, PROPOSED HANLAN FEEDERMAIN NORTH, HIGHWAY 401/403 CROSSING, MISSISSAUGA, ONTARIO

9 INTERPRETATION AND DISCUSSION OF RESULTS

This section provides a brief description of the anticipated geotechnical and tunneling conditions related to the proposed tunnel crossing of Highway 401/403. Certain aspects of constructability are assessed and the effect of the construction on the integrity of the existing highway structures and the MTO operations is also evaluated. It should be noted that the geotechnical investigation has only recently been completed and, therefore, the design aspects of the tunnels for the watermain, including the highway crossing, are only at a preliminary stage.

9.1 Proposed Construction

Preliminary details of the proposed crossing are shown on Plan Nos. T4 and T5, dated January 2012, prepared by MMM. As shown on those drawings, the length of the crossing under the highway is about 400 m. Both the Hanlan Feedermain and the MCC Watermain are to be installed by tunnelling under Tomken Road. As currently envisioned, the 1500 mm diameter MCC will be installed in a 2500 mm diameter tunnel, at invert elevations varying from 158.6 m at the north end to 152.4 m at the south end. The 2400 mm diameter Hanlan Feedermain will be installed in a 3500 mm diameter tunnel at invert elevations of 153.1 m at the north to 150.3 m at the south.

Table 9: Watermain Tunnel Depths

	Tomken Road Centre Line	Hanlan Feedermain			MCC Watermain		
		Tunnel Invert Elev	Depth to Invert	Depth to Overt	Tunnel Invert Elev	Depth to Invert	Depth to Overt
North end	170.2 m	152.7 m	17.5 m	14.0 m	158.1 m	12.1 m	9.6 m
South end	164.0 m	149.8 m	14.2 m	10.7 m	151.8 m	12.2 m	9.7 m

The minimum clear distance between the two tunnels will be about 7 m. In the area under the highway structures, the tunnels will be provided with a steel liner in addition to the primary support. The watermain pipes are shown as C.P.P. The space between the primary support and the rock will be pressure grouted with sand-cement grout; the space between the exterior diameter of the steel liner and the rock, and the space between the watermain and the steel liner will be grouted with a compressible foam grout. The sequence of construction of the tunnels has not been specified.

The general arrangement drawing of the structures obtained by MMM are reproduced in **Appendix E**. There are ten (10) highway structures that carry Highways 401 and 403 over Tomken Road. All the bridges

are three span structures with prestressed girders resting on two piers and two open abutments. The piers are supported on spread footings founded on shale bedrock, while the abutments are either on footings or short piles driven into rock. Most of the structures are symmetrical about the centreline of Tomken Road.

As presently envisaged, the MCC tunnel will be closest to the footings supporting the east piers of the structures. The clear horizontal distance (H) between the edges of the footings and the spring line of the tunnels, as well as the vertical distances (V) between the underside of the footings and the crown of the tunnels are summarized in Table 10 below.

Table 10: Distance of Closest Bridge Footing from Tunnel

Structure	MCC Tunnel			Feedermain Tunnel		
	V*	H**	below original rock***	V	H	below original rock
24-332	5.1	2.6	8.9	11.8	2.2	15.5
24-315	7.8	17.8	9.0	13.5	14.9	15.1
24-314	3.3	3.0	8.9	9.1	2.8	14.5
24-467	2.9	3.3	10.7	7.8	12.5	15.6
24-494	2.8	3.0	11.8	6.5	2.6	16.2
24-465	3.2	2.9	12.5	6.4	3.2	16.0
24-316	4.5	3.0	13.3	7.3	3.1	16.1
24-317	8.8	13.2	14.6	10.2	13.0	16.6
24-331	6.1	3.0	15.0	8.1	2.4	17.0

* Vertical distance from bottom of footing to crown of tunnel, m; ** Horizontal distance from edge of footing to spring line of tunnel, m;

*** Estimated distance from original rock surface to crown of tunnel, m

10 ANTICIPATED GEOTECHNICAL CONDITIONS

Both the Hanlan Feedermain tunnel and the MCC watermain tunnel will be excavated in shale bedrock, at depths of 4 to more than 20 m below the present rock surface. Since the original rock elevation before the construction of Highway 401 was a lot higher, the tunnels will be at least 9 m below the original rock surface. At the depths of the tunnels, the shale bedrock is expected to be slightly weathered to fresh, and of fair to excellent quality. Based on the borehole information, the expected properties of the shale at tunnel depths are as follows:

RQD	80 to 100%, good to excellent quality
RMR	50 to 70, fair to good rock
UCS	14 to 37 MPa for shale, up to 70 MPa for limestone
UCS inferred from point load tests	10 to 40 MPa for shale, 40 to 280 MPa for siltstone and limestone
Hydraulic conductivity	6×10^{-6} to less than 10^{-7} cm/sec

The footings of the existing structures are all founded on the shale bedrock, at depths ranging from about 1.5 to more than 9 m below original rock surface. The rock on which the footings are founded could be of slightly lower quality for some of the shallow footings, but for most of the footings, sound shale conditions

are expected. The design footing pressures are not shown on the foundation drawings. MTO generally accepts up to 1,000 kPa geotechnical resistance at SLS for footings founded on sound rock. MMM estimated that the actual footing pressure is in the range of 450 to 650 kPa for the pier footings.

11 ANTICIPATED CONSTRUCTION METHOD

At present, the proposed construction method is not known. Considering, however, the size (approximately 2.5 and 3.5 m diameter) of the tunnel excavations, and the fact that the tunnel for the Hanlan Feedermain will be part of a much longer tunnel drive, it is expected that a Tunnel Boring Machine (TBM) will be utilized to advance the tunnels. The selection of the specific type of TBM may be left to the contractor, however, the tunnel designer should consider and include in the specifications any relevant criteria or restrictions.

The TBM and the cutter head will need to be designed to accommodate the laminated nature of the rock and the presence of interbedded very strong to extremely strong limestone and siltstone layers.

It is anticipated that the tunnel construction will be from south to north, following a slight upward gradient.

Primary tunnel support under the crossing will be the responsibility of the contractor, but is expected to be steel ribs and timber lagging erected immediately behind the TBM shield. Other support system, e.g. steel ribs with rock bolts installed in a regular pattern, may also be considered. The space between the primary liner and the excavated rock should be grouted.

Past experience with numerous tunnels in the same rock formation indicates that the above primary support systems should provide adequate support to the rock and a stable excavation. The primary liner will have to be installed immediately behind the tail of the TBM in order to minimize "coning" (the dropping out of cone shaped rock pieces) at the roof. The "coning" is the result of the overstressing of the rock in compression at the obvert and the invert of the excavation due to the high in-situ horizontal stresses in the rock. This typically occurs soon after the excavation is made, hence the need for the timely installation of the roof support.

As long as the primary support system is installed in a timely manner it is Coffey's opinion, that the anticipated construction method, i.e. the use of a TBM and a properly designed primary ground support, is appropriate for the geotechnical conditions found at the site of the crossing.

While not encountered in the boreholes drilled for this crossing, the Georgian Bay Formation is known to contain pockets of combustible gas. The presence of gas was also observed in some of the other boreholes drilled for this project. The design of the TBM will have to take this into account and should be compatible with the possible presence of gas. The presence of combustible gas is typically addressed by continuous gas monitoring during all underground work and by provision of an appropriately designed ventilation system.

In recognition and anticipation that the shale surrounding the tunnel has long term time dependent deformation properties and that it will tend to squeeze into the tunnel opening, it is recommended that the annular space between the feedermain pipe and the steel liner, and between the steel liner and the primary liner be grouted only after a delay time of three (3) to four (4) months following excavation. The actual delay time needed must be verified in-situ by means of convergence monitoring of the excavated rock at a number of locations in the tunnel. As an alternative to an extensive delay period, a compressible grout

could be injected between the primary tunnel support and the steel liner and between the steel liner and the CPP so that the grout can absorb the rock deformations without transferring the horizontal stresses to the CPP. It is understood that such a method may be considered as the design proceeds.

12 NUMERICAL MODELING

To assess the possible effect of the proposed watermain construction on the existing highway structures, numerical modelling using an elasto-plastic finite element software (Phase2 by Rocscience Inc.), developed specifically for underground excavations in rock or soil.

After reviewing the geometry of the structure sections in relationship to the proposed tunnels, the sections for Structure Nos. 24-314 and 24-494 were judged to be most critical, hence they were analysed using the Phase2 software. A two dimensional, multi stage analysis was carried out for each of the sections. Stage 1 is the original ground before the highway structures were constructed. Stages 2 and 3 simulate the excavation and backfilling of the bridge footings; Stage 4 is the application of the footing loads; in Stages 5 and 6 the tunnels are excavated. It is assumed that the larger Feedermain tunnel will be excavated before the MCC tunnel. The modelling stages, soil/rock stratigraphy, and finite element discretization are shown on Figure C1, **Appendix C**.

The soil / rock parameters used in the numerical analyses are summarized in Table 11 below. Although not encountered in the boreholes drilled for this study, it is assumed that the rock from the original rock surface to the founding level of the bridge footings was highly weathered, and of poorer quality. The generalized Hoek-Brown failure criteria are used, with parameters representative of the rock mass properties, by taking into consideration the discontinuities in the rock mass, so that a discrete joint pattern is not necessary for the modelling.

Table 11: Material Properties Used in Numerical Modeling

Material	Type	GSI ¹ (Intact)	GSI (Residual)	UCS (MPa)	m _i ²	E (MPa) ³	ν ⁴
Overburden	Elastic	-	-	-	-	20	0.25
Weathered Shale	Plastic (strain softening)	45	38	10	5	500	0.27
Sound Shale		70	38	30	8	4,000	0.27

1. Geological Strength Index; 2 intact Hoek-Brown rock parameter; 3 Young's Modulus; 4 Poisson's ratio

No measurement of the insitu horizontal stress in the bedrock was made at this site. Past measurement in the same formation recorded up to 6.9 MPa at various depths, generally resulting in a horizontal to vertical stress ratio of about 5. The direction of the principal horizontal stress has been found to be about 300° azimuth. For this study, a constant in-plane horizontal stress of 2.6 MPa (4.6 MPa out of plane) has been used. Together with the body stress, the horizontal in plane stress at the tunnel level is about 3 MPa. For the body stress, a k ratio of 1 is assumed for the shale bedrock.

The calculated movements of the bridge pier footings and the closure of the tunnel spring line are shown in Figures C2 to C7 in **Appendix C**, and are summarized in Table 12 below. In Figures C2 to C7, and in the following discussion, the movements of the footings do not include the past settlements of the footings that may have already taken place.

Table 12: Results of Numerical Modeling

Structure	East Pier Footing		West Pier Footing		Tunnel Closure**	
	Settlement	Lateral Movement*	Settlement	Lateral Movement*	MCC	Hanlan Feedermain
24-314	0.3 mm	3.3 mm	0.1 mm	2.6 mm	21 mm	13 mm
24-494	0.5 mm	3.0 mm	0.6 mm	3.4 mm	25 mm	17 mm

* towards tunnel; ** not including long term time dependent movements

The above results indicate that the existing footings of the bridges should experience less than 1 mm settlement (Figures C2 and C4, Appendix C) due to the construction of the watermain tunnels, but could move laterally towards the tunnels by about 3 mm (Figures C3 and C5, Appendix C). The calculated closures of the tunnels (shortening of the tunnel diameter at the spring line) range from 0.4 to 1.0% of the tunnel diameter, which is consistent with experiences with other tunnel projects. The analyses also indicate that theoretically Tomken Road could experience some heave (about 8 mm) due to the tunnel construction. The heaving is a result of the high horizontal stress which causes the shortening of the tunnel diameter in the horizontal direction, but elongation in the vertical direction. This vertical movement, however, is not supported by past experience and observations made at previous construction sites.

For comparison, we have also analyzed the scenario of a higher locked-in stress in the rock - 4 MPa in-plane; 6 MPa out-of plane. Even with the higher horizontal stress, the analyses show that the bridge footings should experience less than 5 mm total movement (Figures C6 and C7). This higher horizontal stress scenario, however, is considered unrealistic since the analyses show extensive failure of the rock even before the highway structures were constructed, and large heaving (16 mm) of Tomken Road during the construction of the tunnels, and large tunnel closure (up to 1.2%).

Analyses were also performed for the case that the MCC watermain is constructed ahead of the Hanlan Feedermain. In this case, the analyses show that the bridge footings could experience slightly larger movements (about 1 mm larger).

13 DISCUSSION OF NUMERICAL MODELING RESULTS

The above results indicate that the pier footings of Structure Nos. 24-314 and 24-494 are expected to experience very slight movements due to the construction of Hanlan Feedermain and the MCC Watermain. The total movement is expected to be less than 4 mm, which is mostly lateral movement towards the tunnels. The abutment footings, being further away from Tomken Road, are not expected to be affected. By comparison, the other structures are expected to experience less movements.

The above analyses do not include long term time dependent deformations (TDD). Based on past experience, we estimate that the tunnels could experience additional closure of about 0.1% (2.5 mm for the MCC tunnel) per log cycle of time. This TDD is not expected to affect the stress and strain distribution in the rock mass except in the immediate vicinity of the tunnels. The TDD of the tunnels is not expected to cause additional movements to the bridge footings.

A structure assessment of all the existing highway structures was completed by McCormick Rankin Corporation (MRC) in November 2011. The report concluded that the structures showed no sign of movement, settlement or other distress.

It is Coffey's opinion that the proposed watermain, constructed as tunnels in the manner described above, will not adversely affect the operations or the integrity of the bridge structures.

14 MONITORING AND CONTINGENCY PLANS

To verify the effect of the tunnel construction on the existing structures, it is recommended that the structures and the ground above and adjacent to the tunnels be carefully monitored. As presently envisaged, the launching shaft for the Feedermain tunnel will be located about 80 m south of the southernmost structure (Structure No. 24-331). This will provide ample opportunity to monitor the deformations in the rock at various depths above the tunnel obvert by installing deep settlement points into the rock. We recommend that settlement monitoring stations be established between the launching shaft and the north end of the crossing. A typical arrangement would be for each monitoring station to include one surface settlement point and two deep settlement points. One of the deep settlement points would be installed at 1.5 m below the rock surface and another at about one tunnel diameters above the tunnel obvert. At least two monitoring stations should be established between the launching shaft and the southernmost structure.

The Structure Assessment Report by MRC recommended pre-condition survey for all the structures. In addition, we recommend that targets be installed on all piers and abutments located less than 15 m (on plan) from the centre lines of the tunnels, to monitor the settlements and lateral movements of the structures. Specifics and details of the monitoring plan will be developed as the design proceeds.

By monitoring the settlement points installed between the launching shaft and the first structure that the tunnels will cross under, it will be possible to compare the actual deformations of the rock to the deformations calculated by the numerical model, and to make adjustments in excavation and ground support if and as necessary prior to initiating the crossing.

It is expected that as the design proceeds, action limits will be established for the various instruments included in the monitoring program. In the unlikely event that the monitoring program would indicate ground movements (settlements and lateral movements) that either reach or exceed established action limits, then preventive or corrective measures such as the following could be implemented:

- Mining could be temporarily halted while excavation and ground support methods are reviewed to determine what adjustments may be appropriate;
- Additional primary ground support in the form of same elements at a closer spacing or greater lengths or different ground support methods could be implemented;
- Rock support above tunnel obvert could be installed in advance of the excavation in holes drilled at a 45 degree or flatter angle at the face in which epoxy grouted rock bolts are installed.

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Appendix A

List of Symbols and Abbreviations	2 Sheets
Explanation of Terms Used in the Bedrock Core Logs	2 Sheets
Logs of Boreholes	20 Sheets

LIST OF SYMBOLS & ABBREVIATIONS

The following are common symbols and abbreviations used in Coffey borehole logs and geotechnical report:

I. SAMPLE TYPE/FIELD TEST

AS	Auger Sample
GS	Grab Sample
NR	No Recovery
RC	Rock Core
NQ,RC	NQ-Size Rock Core (47.5mm)
HQ,RC	HQ-Size Rock Core (63.4mm)
SC	Soil Core
SH	Shelby Tube
SS	Split Spoon (Split Barrel)
TW	Thin Walled Tube, e.g. Pitcher Sampler
VANE, V	Vane Test

Consistency	C_u (kPa)	N (blows/30cm)*
Very soft	0 – 12	0 – 2
Soft	12 – 25	2 – 4
Firm	25 – 50	4 – 8
Stiff	50 – 100	8 – 15
Very Stiff	100 – 200	15 – 30
Hard	over 200	over 30

*Based on the Canadian Foundation Engineering Manual, and would be used if direct field/lab measurement of shear strength is not conducted.

II. PENETRATION RESISTANCE

Standard Penetration Test (SPT):

The SPT "N" value is defined as the number of blows required to drive a standard 51mm (2in) O.D. Split Spoon Sampler 30cm (12in) into undisturbed ground in a borehole by means of a hammer weighing 63.5kg (140lb) and falling freely a distance of 76cm (30in). For penetrations less than 30cm (12in), "N" values are indicated as the number of blows for the penetration achieved.

HB:	Hammer Bouncing
HW:	Hammer Weight; sampler is penetrated under hammer weight only, i.e. without impact load.

Dynamic Cone Penetration Test:

It is the continuous penetration of a 50mm (2in) O.D., 60° conical steel point 30cm (12in) into undisturbed ground in a borehole by means of a hammer weighing 63.5kg (140lb) and falling freely a distance of 76cm (30in). The resistance to the Dynamic Cone Penetration Test is measured as the number of blows required to drive the conical steel point as specified.

Peizo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60° conical tip and a projected end area of 10cm² pushed through ground at a penetration rate of 2cm/s. Measurements of tip resistance q_t , porewater pressure u_t , and sleeve friction f_s , are recorded electronically at 25mm (1in) penetration intervals.

III. SOIL CONSISTENCY/COMPACTNESS

(a) Cohesionless Soils

Cohesionless soils are described on the basis of their compactness as indicated by SPT N values as follows:

Compactness	N (blows/30cm)
Very loose	0 – 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	over 50

(b) Cohesive Soils

Cohesive soils are described on the basis of their consistency as indicated by undrained shear strength C_u , values as follows:

IV SOIL CLASSIFICATION

All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system which follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering, with the exception that soil fractions are classified on the basis of the following grain size diameters:

Boulder	>200mm
Cobbles	76.2 -200mm
Gravel	4.75-76.2mm
Sand	0.075-4.75mm
Silt	0.002-0.075mm
Clay	<0.002mm

The classification is based on the amounts by weight within the respective grain-size fractions, as follows:

Noun	gravel, sand, silt, clay	>35% and main fraction
"and"	and gravel, and silt etc	>35%
adjective	gravelly, sandy etc	20-35%
"some"	some sand, some silt etc	10-20%
"trace"	trace sand, trace silt etc	1-10%

Clay soils are classified based on their measured or estimated plasticity and their plot on the plasticity chart of the Unified Soil Classification System (USCS) as follows:

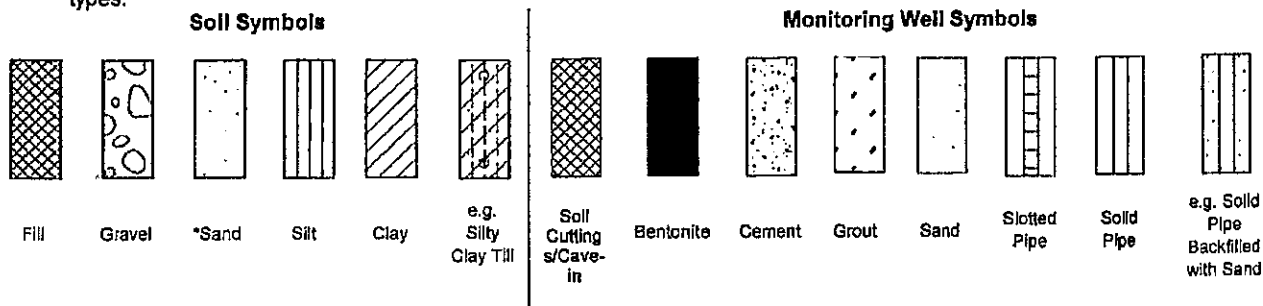
CL-ML	clayey silt
CL	silty clay
CI	clay of medium plasticity
CH	clay of high plasticity

With the exception of those samples for which a grain size analyses and / or Atterberg Limits test has been conducted, all samples are primary classified based on visual inspection. Visual inspection, however, is not sufficiently accurate to provide an exact estimate of grain sizes or precise differentiation between soil groups based on grain sizes. Similarly estimates of the plasticity of the soils are subject to error.

LIST OF SYMBOLS & ABBREVIATIONS

V. SOIL / MONITORING WELL SYMBOLS

The following are common graphic symbols used in the borehole logs to represent basic soil types and monitoring well installations. Combinations of the shown symbols are used in the borehole logs to represent soils composed of different soil types:



VI. ADDITIONAL NOTES

Stratification lines shown in the borehole logs represent approximate boundary lines between material types; vertical and lateral transitions may be gradual. In addition, water level readings were made at time(s) noted on the borehole logs. Fluctuations of groundwater levels may occur and should be expected.

VII. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. In stress: $\Delta\sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
u	porewater pressure
σ	total stress
σ'	effective stress ($\sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
σ_{oct}	mean/octahedral stress $(\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
E	Young's modulus of deformation
G	Shear modulus of deformation
K	Bulk modulus of compressibility

VIII. SOIL PROPERTIES

(a) Index Properties

ρ, γ	bulk density, unit weight
ρ_d, γ_d	dry density, unit weight
ρ_w, γ_w	density, unit weight of water
ρ_{sat}, γ_{sat}	saturated density, unit weight
ρ', γ'	submerged density, unit weight ($\gamma - \gamma_w$)
G_s	specific gravity of solid particles
e	void ratio
n	porosity
S	degree of saturation
MC, w	moisture/water content
LL, w_L	liquid limit
PL, w_P	plastic limit
w_s	shrinkage limit
PI, I_P	plasticity index ($w_L - w_P$)
I_L	liquidity index ($w - w_P$)/ I_P
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state

D_R relative density $(e_{max} - e)/(e_{max} - e_{min})$

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index
C_r	recompression index
C_s	swelling index
C_a	coefficient of secondary compression
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	overconsolidation ratio

(d) Shear Strength

τ_p	peak shear strength
τ_r	residual shear strength
ϕ', ϕ''	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction ($\tan \delta$)
c'	effective cohesion
c_u, s_u	undrained shear strength
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_i	Sensitivity
UCS	Unconfined Compressive Strength (associated strains reported are rounded)

Explanation of Terms Used in the Bedrock Core Log

Strength (ISRM)

Term	Grade	Description	Unconfined Compressive Strength	
			(MPa)	(psi)
Extremely weak rock	R0	Indented by thumbnail	0.25-1.0	36-145
Very weak	R1	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	1.0-5.0	145-725
Weak rock	R2	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	5.0-25	725-3625
Medium Strong	R3	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	25-50	3625-7250
Strong rock	R4	Specimen require more than one blow of geological hammer to fracture it	50-100	7250-14500
Very strong rock	R5	Specimen requires many blows of geological hammer to fracture it	100-250	14500-36250
Extremely strong rock	R6	Specimen can only be chipped with geological hammer	>250	>36250

Bedding (Geological Society Eng. Group Working Party, 1970. Q.J. of Eng. Geol. Vol. 3)

Term	Bed Thickness	
Very thickly bedded	>2 m	>6.5 ft
Thickly bedded	600 mm-2 m	2.00-6.50 ft
Medium bedded	200 mm-600 mm	0.65-2.00 ft
Thinly bedded	60 mm-200 mm	0.20-0.65 ft
Very thinly bedded	20 mm-60 mm	0.06-0.20 ft
Laminated	6 mm-20 mm	0.02-0.06 ft
Thinly laminated	<6 mm	<0.02 ft

TCR (Total Core Recovery)

Sum of lengths of rock core recovered from a core run, divided by the length of the core run and expressed as a percentage.

SCR (Solid Core Recovery)

Sum length of solid, full diameter drill core recovered expressed as a percentage of the total length of the core run.

Weathering (ISRM)

Term	Grade	Description
Fresh	W1	No visible sign of rock material weathering
Slightly weathered	W2	Discolouration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discoloured by weathering and may be somewhat weaker than in its fresh condition
Moderately weathered	W3	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a corestone
Highly weathered	W4	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as corestones
Completely weathered	W5	All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact
Residual soil	W6	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported

RQD (Rock Quality Designation, after Deere, 1968)

Sum of lengths of pieces of rock core measured along centreline of core equal to or greater than 100 mm from a core run, divided by the length of the core run and expressed as a percentage. Core fractured by drilling is considered intact. RQD normally quoted for N-size core.

RQD(%)	Rock Quality
90-100	Excellent
75-90	Good
50-75	Fair
25-50	Poor
0-25	Very poor

(FI) Fracture Index

Expressed as the number of discontinuities per 300mm (1 ft). Excludes drill-induced fractures and fragmented zones. Reported as ">25" if frequency exceeds 25 fractures/0.3m.

Broken Zone

Zone of full diameter core of very low RQD which may include some drill-induced fractures.

Fragmented Zone

Zone where core is less than full diameter and RQD = 0

Explanation of Terms Used in the Bedrock Core Log

Discontinuity Spacing (SRM)

Term	Average Spacing	
Extremely widely spaced	>6 m	>20.00 ft
Very widely spaced	2 m-6 m	6.50-20.00 ft
Widely spaced	600 mm-2 m	2.00-6.50 ft
Moderately spaced	200 mm-600 mm	0.65-2.00 ft
Closely spaced	60 mm-200 mm	0.20-0.65 ft
Very closely spaced	20 mm-60 mm	0.06-0.20 ft
Extremely closely spaced	<20 mm	>0.06 ft

Note: Excludes drill-induced fractures and fragmented rock.

Discontinuity Orientation

Discontinuity, fracture and bedding plane orientations are cited as the acute angle measured with respect to the core axis. Fractures perpendicular to the core axis are at 90° and those parallel to the core axis are at 0°.

PROJECT: Hanlan Feedermain North
 CLIENT: MMM Group Limited
 PROJECT LOCATION: City of Mississauga
 DATUM ELEVATION: Geodetic
 BOREHOLE LOCATION: N 4833158.1 E 608479.4

DRILLING DATA
 Method: Hollow Stem Augering
 Diameter: 200 mm
 Date: 2011 11 21

REF. NO.: GEOTMARK00231AA
 ENCL NO.:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)					WATER CONTENT (%)				
								20 40 60 80 100					W _p W W _L				
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE											
170.8	Ground Surface																
170.8 0.2	~200 mm topsoil																
170.1	CLAYEY SILT brown, hard (possible completely weathered shale)															auger grinding to 1.5m	
0.8	SHALE BEDROCK Georgian Bay Formation Grey shale weathered, weak		1	SS	44		170										
	some siltstone fragments from 0.75 to 1.2m		2	SS	50/ 140 mm		169										
			3	SS	50/ 100 mm												
167.9 2.9	switched to rock coring see rock core logs						168										
							167										
							166										
							165										
							164										
							163										
							162										
							161										

Continued Next Page

GRAPH
NOTES

+ 3, X 3; Numbers refer to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4833158.1 E 608479.4

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 11 21

REF. NO.: GEOTMARK00231AA

ENCL NO.:

COFFEY ROCK CORE GEOTMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
159.6	Rock Surface														
11.3	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures weak to medium strong Slightly weathered		1	HQ	100	50	5	0	>10	2.96m...Highly to moderately weathered	3.09E-06 to 1.54E-05 @ 10 to 20 psi				
167.4									>10	3.20m...25 mm siltstone, fractured					
3.5									2	3.43m...15 mm siltstone					
									3	3.86m...25 mm siltstone		15.9	1.9		
			2	HQ	100	98	9	80	2	4.11m...25 mm siltstone					
									1	4.34m...15 mm siltstone					
165.9									3	4.80m...15 mm siltstone		255.4	153.6		
5.0									2	4.85m...65 mm siltstone					
			Bentonite						3	5.21m...15 mm siltstone		20.4	3.2		
			3	HQ	100	92	13	82	1	5.49m...25 mm siltstone		29.7	6.9		
	Very strong seam								3	5.64m...25 mm siltstone	No take @ 10 to 30 psi				
									3	5.74m...25 mm siltstone					
									3	5.74m...25 mm siltstone					
									3	6.00m...25 mm siltstone					
164.3									2	6.43m...75 mm siltstone					
6.5									5	6.71m...100 mm siltstone		204.1	66.4		
									1	7.09m...50 mm siltstone				13.2	2.70
			4	HQ	100	98	32	80	1	7.32m...125 mm siltstone					0.91
									3	7.49m...175 mm siltstone		220.4	159.5		
									0	7.92m...25 mm siltstone					
162.8	very strong seam								3	8.28m...150 mm siltstone	No take @ 10 to 30 psi				
8.0									1	8.53m...125 mm siltstone					
			5	HQ	100	100	35	85	1	8.84m...100 mm siltstone					
									2	9.09m...75 mm siltstone		184.5	69.5		
									0	9.30m...75 mm siltstone					
161.3									0	9.73m...40 mm limestone					
9.5									2	10.03m...25 mm siltstone		14.3	5.3		
			6	HQ	100	92	13	75	2	10.11m...75 mm siltstone					
									0	10.34m...25 mm siltstone		9.9	12.5		
									4	11.05m...25 mm siltstone					
159.8	Fresh								3	11.07m...25 mm siltstone	No take @ 15 to 40 psi	25.0	6.3		
11.1									0	11.58m...40 mm siltstone					
			7	HQ	100	100	41	97	2	11.73m...125 mm limestone				71.7	2.71
									1	11.91m...25 mm limestone					15.78
									1	11.94m...100 mm siltstone					
									1	12.09m...125 mm siltstone		24.8	15.1		
									1	12.32m...100 mm siltstone					
									1	12.44m...75 mm siltstone					
158.3									0	12.65m...75 mm siltstone					
12.6									0						

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4833158.1 E 608479.4

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 11 21

REF. NO.: GEOTMARK00231AA

ENCL NO.:

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
156.7 14.1	Strong seam SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures		8	HQ	100	98	23	93	2 0	12.88m...75 mm limestone 13.05m...50 mm siltstone 13.21m...50 mm siltstone	No take @ 20 to 50 psi	83.3	219.4		
									1	13.49m...25 mm siltstone 13.66m...25 mm siltstone		12.4	23.4		
	weak to medium strong (continued)								1	14.02m...50 mm siltstone 14.12m...125 mm siltstone 14.40m...100 mm siltstone		44.1	3.2		
			9	HQ	100	100	17	93	0			16.3	8.2		
155.2 15.6	Slightly weathered to fresh								0	15.44m...25 mm siltstone				17.3	2.62 2.42
									1	15.72m...50 mm siltstone 15.77m...25 mm limestone 15.93m...50 mm siltstone		36.7	68.9		
			10	HQ	100	100	9	100	0			22.5	11.8		
153.7 17.2									0			23.4	11.5		
									1	17.63m...50 mm siltstone 17.75m...125 mm siltstone 18.01m...75 mm siltstone		22.0	17.7		
152.2 18.7			11	HQ	100	98	17	95	>10						
									1		No take @ 20 to 60 psi				
									0						
									0	19.10m...75 mm siltstone		28.3	20.2		
			12	HQ	100	100	17	100	1	19.51m...125 mm siltstone 19.71m...25 mm siltstone 19.94m...25 mm siltstone		16.0	10.0		
150.6 20.2									2						
									1						
									1						
			13	HQ	100	100	15	98	0			29.9	21.4		
									0	21.18m...50 mm siltstone 21.36m...50 mm siltstone 21.46m...50 mm siltstone 21.69m...25 mm siltstone		20.1	16.4		
149.1 21.7	Slightly weathered to fresh								0	21.92m...15 mm siltstone 22.00m...15 mm siltstone		18.6	5.3		
									2		No take @ 25 to 70 psi				
			14	HQ	100	98	12	87	>10	22.38m...15 mm siltstone 22.61m...15 mm siltstone 22.68m...50 mm siltstone		28.4	47.6		
									1						

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4833158.1 E 608479.4

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 11 21

REF. NO.: GEOTMARK00231AA

ENCL NO.:


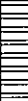
(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
147.6 23.3	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures weak to medium strong <i>(continued)</i> 														

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

PROJECT: Hanlan Feedermain North
 CLIENT: MMM Group Limited
 PROJECT LOCATION: City of Mississauga
 DATUM ELEVATION: Geodetic
 BOREHOLE LOCATION: N 4833130.5 E 608501.4

DRILLING DATA
 Method: Hollow Stem Augering
 Diameter: 200 mm
 Date: 2011 11 21

REF. NO.: GEOTMARK00231AA
 ENCL NO.:

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)					WATER CONTENT (%)										
						20			40	60	80	100	W _p	W	W _L						
169.4	Ground Surface																				
169.0 0.1	~100 mm asphaltic concrete FILL granular road base		1	AS																	
168.7 0.8	SHALE BEDROCK Georgian Bay Formation Grey shale weathered, weak		2	SS	73/ 200 mm																
168.0 1.5	switched to rock coring see rock core logs																				
																</					

W. L. 167.64 m
Feb 06, 2012

Bentonite
163

W. L. 162.7 m
Nov 21, 2011

COFFEY SOIL LOG -2 GEOTMARK00231AA HANLAN NORTH.GPJ 4/2/12

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GRAPH
NOTES

+ 3, x 3: Numbers refer
to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4833130.5 E 608501.4

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 11 21

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
168.0	Rock Surface														
1.5	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures Weak to medium strong		1	HQ	100	75	0	0	5	1.65m...25 mm fractured zone					
167.7									0	2.03m...25 mm siltstone					
1.8									0						
			2	HQ	100	100	2	95	1						
									1						
									1						
166.1									1	3.47m...60 mm siltstone					
3.3									2						
			3	HQ	100	100	4	95	1						
									0						
164.6	Slightly weathered								0	5.05m...75 mm siltstone					
4.8									4	5.33m...50 mm siltstone					
			4	HQ	98	97	23	87	0						
									0	5.92m...25 mm siltstone					
									1	5.97m...25 mm siltstone, 50 mm limestone					
									0	6.12m...125 mm siltstone					
163.1									3	6.71m...50 mm siltstone					
6.3									1	6.93m...250 mm siltstone					
			5	HQ	100	97	27	78	2	7.32m...25 mm siltstone					
									3	7.37m...50 mm siltstone					
161.6	Slightly weathered								0	7.60m...25 mm siltstone					
7.8									0	8.03m...25 mm siltstone					
									0	8.36m...25 mm siltstone					
			6	HQ	99	99	18	99	1	8.66m...25 mm siltstone					
									1	8.71m...100 mm siltstone					
									0	8.94m...25 mm siltstone					
									0	9.07m...50 mm siltstone					
160.1									2	9.27m...25 mm siltstone					
9.3									0	9.60m...25 mm siltstone					
			7	HQ	100	97	23	94	2						
									1						
158.5									2	10.92m...50 mm siltstone					
10.9									0	11.02m...25 mm siltstone					
									0	11.13m...25 mm siltstone					
									0	11.13m...50 mm siltstone					

COFFEY ROCK CORE GEOTMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4833130.5 E 608501.4

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 11 21

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cm ³) E (GPa)
			NUMBER	SIZE											
157.0	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures		8	HQ	97	97	13	97	1	11.35m...25 mm siltstone 11.66m...225 mm siltstone 11.66m...25 mm siltstone 12.04m...25 mm siltstone					
12.5	Weak to medium strong (continued)								0						
155.4									1	12.50m...25 mm siltstone		9.5	8.8		
14.0									2	12.75m...100 mm siltstone 12.88m...25 mm siltstone					
			9	HQ	100	100	12	98	0	13.36m...25 mm siltstone					
									0						
									1	Sand filter		23.7	2.0		
									0			35.7	6.8		
									0						
	Fresh		10	HQ	100	100	2	100	1	14.61m...25 mm siltstone		16.5	12.8		
									0						
153.9									1						
15.5									0			30.8	11.3		
									0						
			11	HQ	100	100	12	100	1	15.95m...25 mm siltstone 16.15m...50 mmsiltstone 16.31m...50 mm siltstone					
									1						
									0	16.71m...25 mm siltstone 16.76m...25 mm siltstone		20.8	5.6		
152.4									1	17.04m...25 mm siltstone					
17.0									0	17.25m...25 mm siltstone		19.2	3.0		
									0						
			12	HQ	100	100	10	93	0	17.73m...25 mm siltstone		20.9	4.5		
									0						
									1	18.14m...25 mm siltstone 18.31m...50 mm siltstone					
150.9									0	18.54m...25 mm siltstone		14.9	7.8		
18.5									0	18.87m...25 mm siltstone					
									0						
			13	HQ	100	100	12	100	0	19.28m...50 mm siltstone					
									0						
									0	19.71m...25 mm siltstone 19.81m...25 mm siltstone		19.6	10.7		
149.3									0	20.06m...25 mm siltstone					
20.1	Fresh								0	20.32m...50 mm siltstone					
	strong seam								1			62.9	174.3		
			14	HQ	100	100	12	100	0	20.60m...50 mm siltstone 20.78m...25 mm siltstone					
									1						
									0			9.8	15.4		
									1	21.34m...50 mm siltstone					

Continued Next Page

E = Modulus of Elasticity

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

CLIENT: MMM Group Limited	DRILLING DATA	REF. NO.: GEOTMARK00231AA
PROJECT: Hanlan Feedermain North	Method: Rock Coring	ENCL NO.:
LOCATION: City of Mississauga	Diameter: 200 mm	
DATUM ELEVATION: Geodetic	Date: 2011 11 21	
BOREHOLE LOCATION: N 4833130.5 E 608501.4		

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
147.8 21.6	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures Weak to medium strong (continued) methane gas		15	HQ	98	98	15	87	0	21.72m...25 mm siltstone 21.92m...25 mm siltstone 22.27m...25 mm siltstone 22.33m...75 mm siltstone 22.66m...25 mm siltstone 22.73m...25 mm siltstone 22.86m...25 mm siltstone					
1															
1															
2															
2															
0															
2															
2															
1															
0															
0															
0															
4															
0															
0															
0															
0															
0															
0															
0															
146.3 23.2	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures Weak to medium strong (continued) methane gas		16	HQ	100	97	21	95	2	23.49m...25 mm siltstone 23.70m...25 mm siltstone 24.33m...150 mm siltstone 24.54m...100 mm siltstone					
2															
2															
1															
0															
0															
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0															
0															
0															
144.8 24.6			SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures Weak to medium strong (continued) methane gas		17	HQ	100	97	2	92					0
0															
0															
0															
0															
0															
0															
0															
0															
0															
0															
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0															
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0															
143.2 26.2	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures Weak to medium strong (continued) methane gas				18	HQ	100	100	15	100	0	27.66m...75 mm siltstone 27.74m...50 mm siltstone 27.79m...40 mm limestone 27.84m...150 mm siltstone			
0															
0															
0															
0															
0															
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0															
0															
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0															
0															
0															
0															
141.7 27.7			SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures Weak to medium strong (continued) methane gas		19	HQ	100	100	20	100	0	27.66m...75 mm siltstone 27.74m...50 mm siltstone 27.79m...40 mm limestone 27.84m...150 mm siltstone			
0															
0															
0															
0															
0															
0															
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0															
0															
0															
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0															
0															
0															
0															
0															
140.8 28.7	END OF BOREHOLE Water level at 6.7 m (not stabilized) upon completion. 50mm-diameter monitoring well installed to 18.3 m. <u>Water Level Date</u> <u>Depth (m)</u> November 21, 2011 6.70 February 6, 2012 1.80														

COFFEY SOIL LOG -2 GEOMARK0231AA HANLAN NORTH.GPJ 4/2/12

○ $\epsilon=3\%$ Strain at Failure

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4833083 E 608530.3

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 12 19

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
165.8	Rock Surface														
1.6	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures weak to medium strong		1	HQ	100	90	13	87	>10	1.58m...150 mm fracture zone					
									0	1.73m...50 mm siltstone					
									0	2.08m...25 mm siltstone					
									0	2.49m...75 mm siltstone					
									0						
									2	2.97m...50 mm siltstone					
									3	3.33m...50 mm siltstone					
									0	3.61m...100 mm siltstone					
									3						
									1	4.22m...75 mm siltstone					
164.3	Slightly weathered to fresh		2	HQ	97	92	21	79	0	4.44m...100 mm siltstone					
3.1									3						
									0						
									4						
									2	5.33m...100 mm siltstone					
									2	5.54m...50 mm siltstone					
									1	5.64m...25 mm siltstone					
									0						
									0	6.17m...25 mm siltstone					
									2						
162.7			3	HQ	100	98	12	88	2	6.88m...25 mm siltstone					
4.7									2	6.93m...100 mm siltstone					
									2	7.19m...25 mm siltstone					
									1	7.32m...25 mm siltstone					
									0	7.47m...50 mm siltstone					
									2						
									2	7.90m...25 mm siltstone					
									1	8.38m...25 mm siltstone					
									1	8.53m...200 mm siltstone					
									0	8.63m...200 mm vertical fracture					
161.3	Slightly weathered to fresh		4	HQ	100	100	16	93	0	8.81m...25 mm siltstone					
6.1									0	8.97m...175 mm siltstone					
									>10						
									2	9.22m...75 mm fracture zone					
									2	9.32m...225 mm siltstone					
									3	9.73m...125 mm siltstone					
									1	9.98m...25 mm siltstone					
									0	10.06m...25 mm siltstone					
									0	10.13m...25 mm siltstone					
									1	10.49m...25 mm siltstone					
159.7	Extremely strong seam		5	HQ	98	95	30	92	1	10.97m...25 mm limestone; 125 mm vertical fracture					
7.7									1	11.00m...25 mm siltstone					
									0	11.02m...25 mm limestone					
									1						
									1						
									0						
									1						
									1						
									0						
									0						
158.2			6	HQ	100	95	30	88	2						
9.2									3						
									1						
									0						
									1						
									1						
									0						
									0						
									0						
									0						
156.7			7	HQ	100	100	10	100	0						
10.7									0						
									0						
									0						
									0						
									0						
									0						
									0						
									0						
									0						

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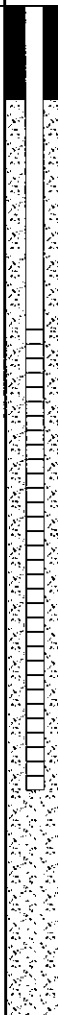
E = Modulus of Elasticity

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

CLIENT: MMM Group Limited
PROJECT: Hanlan Feedermain North
LOCATION: City of Mississauga
DATUM ELEVATION: Geodetic
BOREHOLE LOCATION: N 4833083 E 608530.3

DRILLING DATA
Method: Rock Coring
Diameter: 200 mm
Date: 2011 12 19

REF. NO.: GEOTMARK00231AA
ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)	
			NUMBER	SIZE												
155.1 12.3	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures weak to medium strong (continued)		8	HQ	100	100	2	100	1	11.05m...25 mm siltstone 11.07m...25 mm limestone 11.30m...25 mm siltstone						
	0															
	0															
	1															
	0															
	1															
153.7 13.7	Slightly weathered to fresh		9	HQ	100	100	7	100	1	14.45m...25 mm siltstone 14.58m...25 mm siltstone						
									0							
									0							
									1							
									1							
									1							
152.1 15.3	Very strong seam		10	HQ	100	100	9	100	1	15.09m...25 mm siltstone 15.19m...25 mm siltstone 15.49m...25 mm siltstone						
									0							
									0							
									0							
									0							
									0							
150.6 16.8			11	HQ	98	98	5	98	0	15.98m...25 mm siltstone 16.38m...75 mm siltstone 16.54m...12 mm limestone						
									0							
									0							
		0														
		0														
		0														
149.1 18.3		12	HQ	100	100	7	97	0	17.70m...25 mm siltstone 17.98m...25 mm siltstone 18.14m...25 mm siltstone 18.57m...12 mm limestone 18.63m...12 mm limestone 18.80m...75 mm siltstone							
								0								
								0								
								0								
								0								
								0								
147.6 19.8	Slightly weathered to fresh	13	HQ	100	100	2	97	0	19.56m...12 mm siltstone 20.50m...25 mm siltstone							
								0								
								0								
								0								
								0								
								0								
146.1 21.3								1								

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited PROJECT: Hanlan Feedermain North LOCATION: City of Mississauga DATUM ELEVATION: Geodetic BOREHOLE LOCATION: N 4833083 E 608530.3	DRILLING DATA Method: Rock Coring Diameter: 200 mm Date: 2011 12 19	REF. NO.: GEOTMARK00231AA ENCL NO.:
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(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	ROD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)						
			NUMBER	SIZE																	
144.5 22.9	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures weak to medium strong (continued)		14	HQ	100	100	5	100	0 0 0 0	22.78m...75 mm siltstone											
143.0			15	HQ	100	100	0	100	0 0 0 0												
24.4	END OF BOREHOLE 50mm-diameter monitoring well installed to 16.8 m. <u>Water Level Date</u> <u>Depth (m)</u> February 6, 2012 0.38																				

COFFEY ROCK CORE GEOTMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

REF. NO.: GEOTMARK00231AA
ENCL NO.:

COFFEY SOIL LOG -2 GEOMARK00231AA HANLAN NORTH.GPJ 4/2/12

○ $\epsilon=3\%$ Strain at Failure

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4833047.5 E 608585.6

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 11 16

REF. NO.: GEOTMARK00231AA

ENCL NO.:

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cm ³) E (GPa)
			NUMBER	SIZE											
163.6	Rock Surface														
1.5 163.4	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures weak to medium strong highly to moderately weathered		1	HQ	70	70	20	40	2	1.53m...50 mm siltstone					
1.8									3	1.78m...100 mm fractured zone					
									1	2.01m...25 mm siltstone					
									2	2.29m...50 mm siltstone					
			2	HQ	100	95	13	92	2	2.57m...25 mm siltstone					
									2	2.90m...25 mm siltstone					
									1	3.00m...20 mm siltstone					
									1	3.20m...25 mm siltstone					
161.8 3.3									2	3.33m...25 mm siltstone					
									2	3.40m...25 mm siltstone					
	slightly weathered		3	HQ	100	100	12	95	1	3.83m...25 mm siltstone					
									0						
									1	4.72m...25 mm siltstone					
160.3 4.8									2	4.75m...75 mm siltstone					
									0	5.00m...25 mm siltstone					
									0	5.08m...25 mm siltstone					
			4	HQ	98	97	7	90	4	5.61m...25 mm siltstone					
									1						
158.8 6.3									0	6.17m...25 mm siltstone					
									0	6.32m...225 mm siltstone					
	slightly weathered to fresh		5	HQ	100	100	47	90	0	6.93m...50 mm siltstone	3.12E-06 @ 30 psi, no take @ 45 and 60 psi				
									0	7.06m...50 mm siltstone					
									1	7.19m...25 mm siltstone					
									2	7.39m...75 mm siltstone		147.3	115.7		
157.3 7.8									0	7.49m...25 mm siltstone		19.8	20.0		
									0	7.54m...25 mm siltstone					
									0	7.62m...225 mm siltstone					
									0	7.92m...50 mm siltstone					
			6	HQ	100	100	12	100	0	8.41m...25 mm siltstone					
									0	8.51m...25 mm siltstone					
									0	8.76m...50 mm siltstone		20.0	5.8		
155.8 9.3									0	8.86m...25 mm siltstone					
									0						
									0						
									0						
									0						
									0						
			7	HQ	100	100	5	100	1	9.83m...25 mm siltstone		10.3	2.0		
									0	10.08m...25 mm siltstone					
									0			25.7	14.5		
154.3 10.9									0	10.59m...50 mm siltstone					
									0						
									0			22.5	2.1		

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4833047.5 E 608585.6

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 11 16

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cm ³) E (GPa)
			NUMBER	SIZE											
152.7 12.4	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures weak to medium strong (continued)		8	HQ	100	100	5	100	0	12.19m...25 mm siltstone 12.27m...50 mm siltstone	4.09E-07 @ 60 psi, no take @ 45 and 75 psi	26.1	5.5		
									0						
									0						
									0						
									0						
			9	HQ	100	100	8	100	0	13.05m...25 mm siltstone 13.26m...25 mm siltstone		17.3	7.5		
									0						
									0						
151.2 13.9			Sand filter Screen						0	13.74m...75 mm siltstone		21.5	11.2		
									0						
									1	14.12m...75 mm siltstone 14.23m...25 mm siltstone 14.35m...25 mm siltstone 14.35m...50 mm siltstone 14.65m...50 mm limestone		21.0	42.4		
	fresh		10	HQ	100	100	18	100	0						
									0						
149.7 15.5									0	15.09m...50 mm limestone 15.29m...50 mm siltstone		41.5	3.3		
									0						
									0						
			11	HQ	100	100	7	100	0	16.10m...25 mm siltstone 16.36m...25 mm siltstone 16.56m...25 mm siltstone		18.5	0.7		
									0						
148.2 17.0									0						
									0						
			12	HQ	98	98	15	97	2	17.78m...25 mm siltstone 17.93m...25 mm siltstone					
									0						
146.6 18.5									0	18.31m...75 mm siltstone 18.39m...50 mm limestone 18.54m...100 mm siltstone					
									0						
			Bentonite						0	18.90m...50 mm siltstone					
			13	HQ	100	100	7	100	1						
									0						
									0	19.71m...50 mm siltstone					
145.1 20.1									0						
									0	20.19m...50 mm siltstone 20.40m...50 mm siltstone 20.55m...75 mm siltstone					
			14	HQ	100	100	22	100	0	20.75m...25 mm siltstone					
									1						
									1	21.21m...25 mm siltstone					

Continued Next Page

E = Modulus of Elasticity

COFFEY ROCK CORE GEOTMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

CLIENT: MMM Group Limited
 PROJECT: Hanlan Feedermain North
 LOCATION: City of Mississauga
 DATUM ELEVATION: Geodetic
 BOREHOLE LOCATION: N 4833047.5 E 608585.6

DRILLING DATA
 Method: Rock Coring
 Diameter: 200 mm
 Date: 2011 11 16


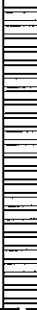
REF. NO.: GEOTMARK00231AA
 ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm ³) E (GPa)
			NUMBER	SIZE											
154.5 21.5	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique and near vertical fractures weak to medium strong <i>(continued)</i>		15	HQ	100	100	10	100	1 1 0 0	22.25m...50 mm siltstone 22.38m...25 mm siltstone 22.68m...50 mm siltstone					
142.3 22.9	END OF BOREHOLE 50mm-diameter monitoring well installed to 15.2 m. <u>Water Level Date</u> <u>Depth (m)</u> February 6, 2012 0.15														

PROJECT: Hanlan Feedermain North
 CLIENT: MMM Group Limited
 PROJECT LOCATION: City of Mississauga
 DATUM ELEVATION: Geodetic
 BOREHOLE LOCATION: N 4832978.1 E 608636.2

DRILLING DATA
 Method: Hollow Stem Augering
 Diameter: 200 mm
 Date: 2011 12 01

REF. NO.: GEOTMARK00231AA
 ENCL NO.:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT (%) w _p w w _L				
								20 40 60 80 100						
163.3	Ground Surface													
160.0 0.1	~100 mm asphaltic concrete FILL granular road base		1	SS	26									
162.2			2	SS	62/ 275 mm									
1.1	SHALE BEDROCK Georgian Bay formation, grey shale with siltstone & limestone laminations, moderately to highly weathered, weak		3	SS	30									
			4	SS	50/ 90 mm									
160.1 3.1	switched to rock coring see rock core logs													
														</

Continued Next Page

GRAPH
NOTES

+ 3, x 3: Numbers refer
to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832978.1 E 608636.2

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 12 01

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm ³) E (GPa)
			NUMBER	SIZE											
160.1	Rock Surface														
159.9 3.3	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures weak to medium strong		1	HQ	100	100	100		4	3.15m...100 mm siltstone					
									4	3.40m...25 mm siltstone					
			2	HQ	98	90	5	56	6	3.91m...75 mm fractured zone 3.99m...25 mm siltstone					
									2						
									1	4.52m...25 mm siltstone					
158.5 4.8									1	4.80m...75 mm siltstone 4.90m...25 mm siltstone					
									3						
			3	HQ	98	98	28	80	2	5.28m...100 mm siltstone					
									1	5.74m...25 mm siltstone 5.87m...25 mm siltstone 5.94m...25 mm siltstone 6.04m...125 mm siltstone 6.20m...25 mm siltstone					
									3						
156.9 6.3	Slightly weathered								3						
			4	HQ	98	95	16	74	3	6.81m...25 mm siltstone 6.91m...50 mm siltstone 7.11m...150 mm siltstone					
									3						
									0	7.47m...25 mm siltstone					
155.4 7.9									0			20.3	3.6		
			5	HQ	98	98		90	1						
									1			20.1	6.8		
									2						
154.1 9.1									0						
									0						
	Medium strong to strong		6	HQ	100	100		100	1			41.2	7.7		
									1						
									0						
									1			18.3	8.4		
152.6 10.7									0						
									1			35.8	37.6		
									1						
			7	HQ	97	97	2	97	1						
									0	11.63m...25 mm limestone		17.9	2.9		
									0						
151.1 12.2	slightly weathered to fresh								0	12.27m...75 mm sandstone					
									2			17.8	7.5		
			8	HQ	100	100	17	95	1	12.67m...125 mm sandstone					

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832978.1 E 608636.2

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 12 01

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
149.6	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures weak to medium strong (continued)		9	HQ	100	100		97	0	13.41m...50 mm sandstone		35.4	10.8		
13.7									2	13.72m...Thin seams of siltstone and sandstone throughout					
									0						
									0			18.8	10.7		
									0						
									1						
148.0									1	15.14m...Very strong seam		222.7	76.1		
15.2									0						
									1			42.9	16.2		
									0						
	fresh		10	HQ	97	97	3	97	0	15.93m...12 mm limestone 15.95m...25 mm sandstone		25.8	20.6		
									0						
									0						
146.5									1						
16.8									0	16.76m...Thin seams of siltstone and sandstone throughout		26.0	5.5		
									1						
									2						
									0						
									1						
145.0									2						
18.3									0						
			12	HQ	100	100		100	1			22.8	11.7		
									2						
									0						
									2			45.2	162.9 49.0		
									0						
									1						
143.5									1	19.81m...25 mm siltstone					
19.8									2						
									0	20.70m...25 mm siltstone					
									0	21.03m...50 mm siltstone 21.21m...50 mm siltstone					
141.9									1						
21.3									0						
			14	HQ	100	100	13	100	1						
									0						
									1						
									0						
									1						
									0						
									1						
									0						
									0						
140.4									0						
22.9									0						

COFFEY ROCK CORE GEOTMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832978.1 E 608636.2

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 12 01

REF. NO.: GEOTMARK00231AA





ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm³) E (GPa)
			NUMBER	SIZE											
139.5			15	HQ	100	100	14	100	0	23.24m...25 mm siltstone 23.32m...75 mm siltstone 23.39m...25 mm siltstone					
23.8	END OF BOREHOLE														

PROJECT: Hanlan Feedermain North
 CLIENT: MMM Group Limited
 PROJECT LOCATION: City of Mississauga
 DATUM ELEVATION: Geodetic
 BOREHOLE LOCATION: N 4832952.6 E 608681.8

DRILLING DATA
 Method: Hollow Stem Augering
 Diameter: 200 mm
 Date: 2011 11 23

REF. NO.: GEOTMARK00231AA
 ENCL NO.:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)						
162.7	Ground Surface							20 40 60 80 100						
162.8 0.2	~160 mm asphaltic concrete FILL granular road base		1	AS										
161.6			2	SS	22									
1.1	SHALE BEDROCK													
161.3	Georgian Bay Formation													
1.4	Grey shale weathered, very weak switched to rock coring see rock core logs													

COFFEY SOIL LOG -2 GEOTMARK00231AA HANLAN NORTH.GPJ 4/2/12

Continued Next Page

GRAPH
NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832952.6 E 608681.8

DRILLING DATA

Method: Rock Coring






Diameter: 200 mm

Date: 2011 11 23

REF. NO.: GEOTMARK00231AA

ENCL NO.:

COFFEY ROCK CORE GEOTMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)	
			NUMBER	SIZE												
161.3	Rock Surface															
1.4	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures weak to medium strong		1	HQ	59	0	12	0	>12	1.40m...fractured 1.50m...50 mm siltstone 1.65m...highly weathered						
160.9																
1.8										2	2.03m...25 mm siltstone					
										0						
			2	HQ	99	93	7	89	1	2.80m...50 mm siltstone						
										3	3.10m...25 mm siltstone					
159.4										2						
3.3										1	3.73m...25 mm siltstone					
										2						
			3	HQ	100	100	15	100	3	4.34m...25 mm siltstone 4.45m...125 mm siltstone						
								1								
157.9	Bentonite								0	4.80m...50 mm siltstone 4.85m...250 mm siltstone						
4.9									1	5.21m...25 mm siltstone						
									2	5.49m...50 mm siltstone						
			4	HQ	100	100	21	100	0							
									1							
									0							
156.3										1	6.78m...75 mm siltstone		42.0	2.5		
6.4										1	7.06m...25 mm siltstone					
			5	HQ	100	100	7	90	0				15.9	1.2		
										0						
154.8	slightly weathered to fresh								0	8.05m...25 mm siltstone						
7.9									1	8.41m...25 mm siltstone						
									0	8.59m...75 mm siltstone						
			6	HQ	99	99	9	99	0				23.7	16.2		
									0							
									0							
153.3										0			25.1	10.9		
9.4										0						
										0			25.3	19.6	20.3	2.66
										0						3.90
	Sand filter		7	HQ	100	100	5	100	0	10.31m...75 mm siltstone						
									1			19.2	2.6			
									0							
151.8									0	11.02m...25 mm siltstone						
10.9									0	11.10m...50 mm siltstone						
									0			22.7	0.8			

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832952.6 E 608681.8

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 11 23

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm ³) E (GPa)	
			NUMBER	SIZE												
150.3 12.4	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures weak to medium strong (continued) very strong seam		8	HQ	100	100	23	100	0	11.30m...25 mm siltstone						
			Screen							0	11.76m...25 mm limestone 11.84m...25 mm limestone 11.96m...25 mm siltstone					
										1	12.24m...150 mm limestone 12.44m...25 mm limestone				24.7	5.61
										0						
										0						
				9	HQ	100	97	7	97	0	13.36m...25 mm limestone					
										1						
										1	13.87m...25 mm limestone 13.92m...25 mm limestone 14.02m...50 mm siltstone					
										0						
										0						
				10	HQ	100	100	15	100	0	14.63m...25 mm siltstone 14.81m...25 mm siltstone					
										0						
										0	15.39m...50 mm siltstone 15.47m...75 mm siltstone					
										1						
148.7 14.0	fresh		11	HQ	100	100	7	100	0	15.90m...25 mm siltstone 16.08m...25 mm siltstone		46.7	113.0			
									0	16.46m...25 mm siltstone						
									0	16.84m...25 mm siltstone						
147.2 15.5									0							
									0							
			12	HQ	100	100	2	100	0							
									0							
									0	18.26m...25 mm siltstone						
145.7 17.0									0	18.59m...50 mm siltstone 18.77m...25 mm siltstone						
									0							
			13	HQ	100	100	8	100	0	19.18m...25 mm siltstone						
									1							
									0							
142.6 20.1	fresh								0	20.17m...50 mm siltstone 20.40m...25 mm siltstone						
			14	HQ	100	100	9	100	1	20.70m...25 mm siltstone						
									0							
141.4									0							

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited	DRILLING DATA	REF. NO.: GEOTMARK00231AA
PROJECT: Hanlan Feedermain North	Method: Rock Coring	ENCL NO.:
LOCATION: City of Mississauga	Diameter: 200 mm	
DATUM ELEVATION: Geodetic	Date: 2011 11 23	
BOREHOLE LOCATION: N 4832952.6 E 608681.8		

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
21.3	END OF BOREHOLE Water level at 2.7 m (not stabilized) upon completion. 50mm-diameter monitoring well installed to 13.7 m. <u>Water Level Date</u> <u>Depth (m)</u> November 25, 2011 2.70 February 6, 2012 0.96														

○ $\epsilon=3\%$ Strain at Failure

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832894.5 E 608720.8

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 12 13

REF. NO.: GEOTMARK00231AA

ENCL NO.:


(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cm ³) E (GPa)
			NUMBER	SIZE											
161.4	Rock Surface														
1.5	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures Slightly weathered Weak to medium strong		1	HQ	71	59	17	52	>10 2 1 0 0	1.50m...125 mm siltstone 1.80m...125 mm siltstone					
159.9 3.0			2	HQ	97	88	12	70	>10 2 0 1 1	3.26m...50 mm fractured zone 3.28m...75 mm siltstone 3.51m...25 mm siltstone 4.09m...50 mm siltstone 4.22m...25 mm siltstone					
158.4 4.5	Fresh		3	HQ	100	100	35	100	0 0 0 1 0 0 0 0	4.70m...50 mm siltstone 4.82m...50 mm limestone 4.93m...125 mm siltstone 5.23m...25 mm siltstone 5.36m...25 mm siltstone 5.49m...75 mm siltstone 5.61m...50 mm siltstone 5.79m...25 mm siltstone 5.92m...100 mm siltstone 6.12m...25 mm siltstone 6.20m...25 mm siltstone					
156.9 6.0			4	HQ	100	100	18	100	0 0 0 0 0 0 0 0	6.91m...25 mm siltstone 6.99m...50 mm siltstone 7.09m...50 mm limestone 7.29m...100 mm siltstone		5.9	2.8		
155.3 7.5	very strong seam fresh		5	HQ	100	100	3	100	0 0 0 0 0 0 0 0			216.8	95.9		
153.8 9.0	very strong seam		6	HQ	100	100	3	100	0 0 0 0 0 0 0 0	8.94m...50 mm siltstone 9.14m...50 mm siltstone		30.5	20.3		
152.3 10.6			7	HQ	100	100	4	100	0 0 0 0 0 0 0 0			101.4	89.5 31.0		
												19.1	30.2		

Continued Next Page

E = Modulus of Elasticity

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

CLIENT: MMM Group Limited	DRILLING DATA	REF. NO.: GEOTMARK00231AA
PROJECT: Hanlan Feedermain North	Method: Rock Coring	ENCL NO.:
LOCATION: City of Mississauga	Diameter: 200 mm	
DATUM ELEVATION: Geodetic	Date: 2011 12 13	
BOREHOLE LOCATION: N 4832894.5 E 608720.8		

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
150.8 12.1	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures Slightly weathered Weak to medium strong (continued) very strong seam fresh Very strong seam								1 0	11.76m...25 mm siltstone 11.81m...25 mm siltstone	164.6	2.2			
			Sand filter						1 0						
			8	HQ	100	100	5	100	1 1 0	13.08m...25 mm siltstone 13.44m...50 mm siltstone	217.6	88.5			
149.3 13.6			Screen						1 0 0 0						
			9	HQ	100	100	3	100	0 0 0 0	15.16m...25 mm siltstone 15.85m...25 mm siltstone 15.95m...25 mm siltstone 16.10m...25 mm siltstone 16.59m...25 mm siltstone 16.76m...25 mm siltstone 17.27m...25 mm siltstone 17.55m...25 mm siltstone 17.75m...25 mm siltstone 18.26m...25 mm siltstone 19.18m...25 mm siltstone 19.48m...25 mm siltstone 19.79m...25 mm siltstone 19.79m...50 mm siltstone 19.96m...50 mm siltstone 20.50m...25 mm siltstone 20.85m...25 mm siltstone 21.03m...25 mm siltstone					
147.7 15.2									0 0 1 0 0						
			10	HQ	100	100	7	100	0 0 0 0 0	15.85m...25 mm siltstone 15.95m...25 mm siltstone 16.10m...25 mm siltstone 16.59m...25 mm siltstone 16.76m...25 mm siltstone 17.27m...25 mm siltstone 17.55m...25 mm siltstone 17.75m...25 mm siltstone 18.26m...25 mm siltstone 19.18m...25 mm siltstone 19.48m...25 mm siltstone 19.79m...25 mm siltstone 19.79m...50 mm siltstone 19.96m...50 mm siltstone 20.50m...25 mm siltstone 20.85m...25 mm siltstone 21.03m...25 mm siltstone					
146.2 16.7									0 0 0 0 0						
			11	HQ	100	100	5	100	0 0 0 0 0	15.16m...25 mm siltstone 15.85m...25 mm siltstone 15.95m...25 mm siltstone 16.10m...25 mm siltstone 16.59m...25 mm siltstone 16.76m...25 mm siltstone 17.27m...25 mm siltstone 17.55m...25 mm siltstone 17.75m...25 mm siltstone 18.26m...25 mm siltstone 19.18m...25 mm siltstone 19.48m...25 mm siltstone 19.79m...25 mm siltstone 19.79m...50 mm siltstone 19.96m...50 mm siltstone 20.50m...25 mm siltstone 20.85m...25 mm siltstone 21.03m...25 mm siltstone					
144.6 18.3			Bentonite						0 0 0 0 0						
			12	HQ	100	100	7	100	0 0 0 0 0	15.16m...25 mm siltstone 15.85m...25 mm siltstone 15.95m...25 mm siltstone 16.10m...25 mm siltstone 16.59m...25 mm siltstone 16.76m...25 mm siltstone 17.27m...25 mm siltstone 17.55m...25 mm siltstone 17.75m...25 mm siltstone 18.26m...25 mm siltstone 19.18m...25 mm siltstone 19.48m...25 mm siltstone 19.79m...25 mm siltstone 19.79m...50 mm siltstone 19.96m...50 mm siltstone 20.50m...25 mm siltstone 20.85m...25 mm siltstone 21.03m...25 mm siltstone					
143.1 19.8									0 0 0 0 0						
			13	HQ	100	100	12	100	0 0 0 1 0	15.16m...25 mm siltstone 15.85m...25 mm siltstone 15.95m...25 mm siltstone 16.10m...25 mm siltstone 16.59m...25 mm siltstone 16.76m...25 mm siltstone 17.27m...25 mm siltstone 17.55m...25 mm siltstone 17.75m...25 mm siltstone 18.26m...25 mm siltstone 19.18m...25 mm siltstone 19.48m...25 mm siltstone 19.79m...25 mm siltstone 19.79m...50 mm siltstone 19.96m...50 mm siltstone 20.50m...25 mm siltstone 20.85m...25 mm siltstone 21.03m...25 mm siltstone					
141.6 21.3			END OF BOREHOLE												

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

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E = Modulus of Elasticity

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832894.5 E 608720.8

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 12 13

REF. NO.: GEOTMARK00231AA

ENCL NO.:

[illegible]

E = Modulus of Elasticity

COFFEY SOIL LOG -2 GEOMARK00231AA HANLAN NORTH.GPJ 4/2/12

○ $\epsilon=3\%$ Strain at Failure

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832838.9 E 608802.4

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 10 21

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAxIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
163.0	Rock Surface														
162.8 1.8	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures Weak to medium strong moderately weathered		1	HQ	89	67		0	5	1.52m...Highly weathered					
									2						
									3	2.08m...25 mm siltstone					
			2	HQ	97	83	13	57	5	2.41m...25 mm siltstone					
									3	2.49m...25 mm siltstone					
									3	2.57m...25 mm siltstone					
161.2 3.4	slightly weathered	▼							3	3.18m...100 mm siltstone					
									3	3.38m...25 mm siltstone					
									3	3.61m...25 mm siltstone					
			3	HQ	85	76	9	54	2	3.76m...25 mm siltstone					
									0	3.79m...50 mm limestone					
159.7 4.9									0						
									2	5.21m...75 mm siltstone					
			4	HQ	97	97	12	92	0	5.69m...25 mm siltstone					
									0						
									3	6.02m...25 mm siltstone					
158.1 6.4									1	6.20m...25 mm siltstone					
									1	6.27m...25 mm siltstone					
									1	6.65m...25 mm siltstone					
									1	6.83m...125 mm limestone					
			5	HQ	100	100	34	90	3	7.01m...25 mm siltstone					
									1	7.06m...50 mm siltstone					
									1	7.32m...125 mm siltstone					
									1	7.47m...25 mm siltstone				37.4	2.66
									1	7.57m...100 mm siltstone					15.75
156.6 7.9									0	7.90m...25 mm siltstone					
									2	7.98m...25 mm siltstone					
									2	8.08m...75 mm siltstone					
									0	8.21m...50 mm siltstone					
									3	8.31m...25 mm siltstone					
	slightly weathered to fresh very strong seam		6	HQ	100	100	22	95	0	8.86m...50 mm siltstone		17.2	90.6		
									3	8.99m...25 mm siltstone		79.5			
									2	9.20m...25 mm siltstone		215.3			
155.1 9.4	very strong seam								3	9.27m...50 mm siltstone		15.5	6.3		
									0	9.58m...25 mm siltstone		49.7			
									3			8.8	1.6		
									0			250.4			
			7	HQ	98	98	2	85	2	10.39m...25 mm clay infill		16.6	10.2	18.8	2.59
									3						3.86
153.5 11.0									5	11.10m...50 mm siltstone		12.1	2.8		
									1			24.6			
												11.5	0.5		
												17.2			

Continued Next Page

E = Modulus of Elasticity

COFFEY ROCK CORE GEOTMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12

CLIENT: MMM Group Limited

PROJECT: Hanlan Feedermain North

LOCATION: City of Mississauga

DATUM ELEVATION: Geodetic

BOREHOLE LOCATION: N 4832838.9 E 608802.4

DRILLING DATA

Method: Rock Coring

Diameter: 200 mm

Date: 2011 10 21

REF. NO.: GEOTMARK00231AA

ENCL NO.:

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm ³) E (GPa)
			NUMBER	SIZE											
152.0 12.5	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures Weak to medium strong (continued)		8	HQ	98	98	4	73	1 0 0 1		psi	36.8	4.9	14.3	2.62 2.95
150.5 14.0			9	HQ	98	95	0	85	0 3 4 2 1			17.4 24.6	0.6 12.1		
149.0 15.5	fresh		10	HQ	98	98	6	98	0 0 0 1 0	14.25m...25 mm siltstone 14.30m...25 mm siltstone 14.81m...25 mm siltstone		7.7 16.0 21.2	1.9		
147.2 17.3			11	HQ	98	96	5	71	1 1 2 3 2 2	15.80m...25 mm siltstone 16.43m...25 mm siltstone 16.56m...25 mm siltstone	1.76E-06 to 2.19E-06 @ 25 to 45 psi 1.76E-06 to 5.56E-06 @ 25 to 45 psi 1.76E-06 to 5.56E-06 @ 25 to 45 psi 1.76E-06 to 2.19E-06 @ 30 to 45 psi	16.6	1.8		
145.8 18.7			12	HQ	100	100	9	93	1 3 2 0 0	17.81m...25 mm siltstone 18.44m...25 mm limestone		16.3	2.7	24.6	2.63 3.60
144.3 20.2			13	HQ	100	93	7	93	0 1 0 0	19.48m...25 mm limestone 19.71m...50 mm limestone 19.91m...25 mm limestone		13.3 13.3	1.6		
			14	HQ	95	95	7	93	0 1 0	20.50m...75 mm clay infill					

Continued Next Page

E = Modulus of Elasticity

CLIENT: MMM Group Limited	DRILLING DATA	REF. NO.: GEOTMARK00231AA
PROJECT: Hanlan Feedermain North	Method: Rock Coring	ENCL NO.:
LOCATION: City of Mississauga	Diameter: 200 mm	
DATUM ELEVATION: Geodetic	Date: 2011 10 21	
BOREHOLE LOCATION: N 4832838.9 E 608802.4		

(m) ELEV DEPTH	ROCK DESCRIPTION	GROUND WATER CONDITIONS	CORE SAMPLE		TOTAL CORE RECOVERY (%)	SOLID CORE RECOVERY (%)	HARD LAYER (%)	RQD (%)	FRACTURE INDEX (per 0.3 m)	DISCONTINUITIES AND WEATHERING	HYDRAULIC CONDUCTIVITY (cm/sec)	POINT LOAD TEST UCS AXIAL (MPa)*	POINT LOAD TEST UCS DIAMETRAL (MPa)*	UNIAXIAL COMPRESSION (MPa)	DENSITY (g/cm3) E (GPa)
			NUMBER	SIZE											
142.8 21.7	SHALE BEDROCK Georgian Bay Formation, grey shale with siltstone & limestone laminations, near horizontal bedding & contact planes, occasional oblique & vertical fractures Weak to medium strong <i>(continued)</i>		15	HQ	100	100	9	98	0	21.41m...25 mm siltstone					
									0	21.56m...25 mm siltstone					
									0	21.67m...50 mm siltstone					
									0	21.85m...75 mm siltstone					
									1						
									2	22.71m...50 mm limestone					
									1						
141.3 23.2									1						
									0	23.52m...25 mm siltstone					
									0	23.55m...50 mm limestone					
			16	HQ	100	100	20	100	0	23.62m...100 mm siltstone					
									0	23.77m...25 mm siltstone					
									0	24.18m...100 mm siltstone					
									0						
139.7 24.8	END OF BOREHOLE <u>Water Level Date</u> <u>Depth (m)</u> February 6, 2012 3.58														

COFFEY ROCK CORE GEOMARK00231AA HANLAN NORTH.GPJ COFFEY TEMPLATE.GDT 4/2/12


Appendix B

Summary of Point Load Index Strength Testing
Summary of Hydraulic Conductivity Test Results


Table B1
Table B2


[illegible]


[illegible]

BH	Core Dia. (mm)	Depth (m)	Rock type	Orientation	D for Axial (mm)	Point Load (kN)	Is (N/mm ²)	Equiv. UCS (MPa)
H06	61	6.76	Shale	A	36	2.32	0.85	20.4
H06	61	7.59	Shale	A	41	3.71	1.24	29.7
H06	61	7.72	Shale	A	47	5.91	1.78	42.7
H06	61	7.90	Shale	A	36	1.28	0.47	11.3
H06	61	8.33	Shale	A	48	2.24	0.66	15.9
H06	61	11.28	Shale	A	34	1.55	0.60	14.3
H06	61	12.32	Shale	A	40	1.21	0.41	9.9
H06	61	12.93	Shale	A	42	3.18	1.04	25.0
H06	61	13.87	Shale	A	38	2.92	1.03	24.8
H06	61	14.48	Shale	A	37	1.44	0.52	12.4
H06	61	15.93	Shale	A	57	2.61	0.68	16.3
H06	61	17.42	Shale	A	34	3.98	1.53	36.7
H06	61	18.44	Shale	A	50	3.26	0.94	22.5
H06	61	19.15	Shale	A	35	2.59	0.97	23.4
H06	61	19.79	Shale	A	37	2.54	0.92	22.0
H06	61	20.47	Shale	A	40	3.47	1.18	28.3
H06	61	21.49	Shale	A	41	2.00	0.67	16.0
H06	61	22.12	Shale	A	52	4.47	1.25	29.9
H06	61	22.73	Shale	A	36	2.28	0.84	20.1
H06	61	23.72	Shale	A	43	2.41	0.77	18.6
H06	61	24.46	Shale	A	45	3.81	1.19	28.4
H06	61	25.14	Shale	A	40	4.39	1.49	35.8
H06	61	25.93	Shale	A	41	2.81	0.94	22.5
H06	61	26.64	Shale	A	37	2.74	0.99	23.7
H07	61	7.59	Shale	A	30	0.97	0.41	9.8
H07	61	14.38	Shale	A	30	0.94	0.40	9.5
H07	61	15.14	Shale	A	34	2.57	0.99	23.7
H07	61	15.80	Shale	A	34	3.87	1.49	35.7
H07	61	16.76	Shale	A	40	2.02	0.69	16.5
H07	61	17.30	Shale	A	32	3.20	1.28	30.8
H07	61	18.11	Shale	A	37	2.41	0.87	20.8
H07	61	18.77	Shale	A	34	2.08	0.80	19.2
H07	61	19.79	Shale	A	32	2.17	0.87	20.9
H07	61	20.60	Shale	A	41	1.87	0.62	14.9
H07	61	21.28	Shale	A	40	2.40	0.82	19.6
H07A	61	10.54	Shale	A	30	3.48	1.47	35.2
H07A	61	11.43	Shale	A	38	3.70	1.31	31.4
H07A	61	12.62	Shale	A	30	3.06	1.29	31.0
H07A	61	14.86	Shale	A	37	4.17	1.50	36.0
H08	61	9.65	Shale	A	37	2.29	0.82	19.8
H08	61	10.44	Shale	A	33	2.12	0.83	20.0
H08	61	11.15	Shale	A	34	1.12	0.43	10.3
H08	61	11.76	Shale	A	46	3.51	1.07	25.7
H08	61	12.72	Shale	A	40	2.76	0.94	22.5
H08	61	12.72	Shale	A	37	4.80	1.73	41.5
H08	61	13.44	Shale	A	41	3.26	1.09	26.1
H08	61	14.02	Shale	A	41	2.32	0.77	18.5
H08	61	14.20	Shale	A	40	2.12	0.72	17.3
H08	61	15.09	Shale	A	32	2.23	0.90	21.5
drawn	BL			client:	MMM Group			
approved	NG			project:	Hanlan Feedermain North			
date	Mar-12				Geo-Structural Evaluation			
scale	NTS			title:	Point Load Test			
original size	A4			project no:	Geotmark00231AA	table no:	B1-3	

BH	Core Dia. (mm)	Depth (m)	Rock type	Orientation	D for Axial (mm)	Point Load (kN)	Is (N/mm2)	Equiv. UCS (MPa)
H08	61	15.82	Shale	A	38	2.47	0.87	21.0
H09	61	9.70	Shale	A	34	2.20	0.85	20.3
H09	61	10.41	Shale	A	36	2.28	0.84	20.1
H09	61	10.85	Shale	A	33	4.37	1.72	41.2
H09	61	11.79	Shale	A	38	2.16	0.76	18.3
H09	61	13.66	Shale	A	30	1.77	0.75	17.9
H09	61	14.20	Shale	A	33	3.76	1.48	35.4
H09	61	15.14	Shale	A	36	2.01	0.74	17.8
H09	61	15.57	Shale	A	46	2.56	0.78	18.8
H09	61	16.81	Shale	A	34	2.80	1.07	25.8
H09	61	17.65	Shale	A	30	4.24	1.79	42.9
H09	61	18.64	Shale	A	30	2.57	1.08	26.0
H09	61	19.13	Shale	A	42	2.18	0.71	17.1
H09	61	19.15	Shale	A	33	2.42	0.95	22.8
H09A	61	8.25	Shale	A	39	5.05	1.75	42.0
H09A	61	9.30	Shale	A	38	1.88	0.66	15.9
H09A	61	9.80	Shale	A	43	3.07	0.99	23.7
H09A	61	10.21	Shale	A	44	2.87	0.91	21.8
H09A	61	10.44	Shale	A	30	2.48	1.05	25.1
H09A	61	11.25	Shale	A	39	2.31	0.80	19.2
H09A	61	12.50	Shale	A	38	2.99	1.05	25.3
H09A	61	13.33	Shale	A	33	2.41	0.95	22.7
H09A	61	14.05	Shale	A	47	2.83	0.85	20.5
H09A	61	14.99	Shale	A	43	4.67	1.50	36.1
H10	61	7.34	Shale	A	50	4.31	1.24	29.8
H10	61	9.14	Shale	A	39	2.32	0.80	19.3
H10	61	9.17	Shale	A	33	3.24	1.27	30.5
H10	61	10.87	Shale	A	33	0.62	0.24	5.9
H10	61	12.34	Shale	A	38	2.25	0.79	19.1
H10	61	15.39	Shale	A	38	3.36	1.19	28.5
H11	61	6.22	Shale	A	34	1.31	0.50	12.1
H11	61	6.71	Shale	A	25	2.12	1.03	24.6
H11	61	8.46	Shale	A	37	1.54	0.55	13.3
H11	61	8.51	Shale	A	31	1.35	0.56	13.3
H11	61	9.09	Shale	A	49	2.46	0.72	17.2
H11	61	9.75	Shale	A	29	0.85	0.37	8.8
H11	61	9.96	Shale	A	40	1.90	0.65	15.5
H11	61	10.79	Shale	A	54	2.54	0.69	16.6
H11	61	11.96	Shale	A	27	1.05	0.48	11.5
H11	61	12.50	Shale	A	33	1.82	0.72	17.2
H11	61	12.90	Shale	A	45	4.93	1.53	36.8
H11	61	13.87	Shale	A	28	1.63	0.73	17.4
H11	61	14.22	Shale	A	39	2.96	1.03	24.6
H11	61	14.40	Shale	A	27	0.63	0.29	6.9
H11	61	14.45	Shale	A	36	0.88	0.32	7.7
H11	61	15.19	Shale	A	33	1.70	0.67	16.0
H11	61	15.82	Shale	A	32	2.20	0.89	21.2
H11	61	16.86	Shale	A	31	1.68	0.69	16.6
H11	61	16.94	Shale	A	27	1.49	0.68	16.3
drawn	BL	<div>coffey</div> <div>geotechnics</div> <div>SPECIALISTS MANAGING THE EARTH</div>	client: MMM Group					
approved	NG		project: Hanlan Feedermain North					
date	Mar-12		title: Point Load Test					
scale	NTS		project no: Geotmark00231AA			table no: B1-4		
original size	A4							

BH	Core Dia. (mm)	Depth (m)	Rock type	Orientation	D for Axial (mm)	Point Load (kN)	Is (N/mm ²)	Equiv. UCS (MPa)
H06	61	4.90	Shale	D		0.27	0.08	1.9
H06	61	5.87	Shale	D		0.45	0.13	3.2
H06	61	6.76	Shale	D		0.97	0.29	6.9
H06	61	7.72	Shale	D		1.36	0.40	9.7
H06	61	10.74	Shale	D		0.75	0.22	5.3
H06	61	11.28	Shale	D		1.76	0.52	12.5
H06	61	12.32	Shale	D		0.89	0.26	6.3
H06	61	12.93	Shale	D		2.12	0.63	15.1
H06	61	14.48	Shale	D		1.15	0.34	8.2
H06	61	15.19	Shale	D		3.28	0.97	23.4
H06	61	15.93	Shale	D		0.46	0.14	3.2
H06	61	17.42	Shale	D		1.66	0.49	11.8
H06	61	18.44	Shale	D		1.62	0.48	11.5
H06	61	19.15	Shale	D		2.48	0.74	17.7
H06	61	19.79	Shale	D		2.84	0.84	20.2
H06	61	20.47	Shale	D		1.40	0.41	10.0
H06	61	22.12	Shale	D		2.30	0.68	16.4
H06	61	22.73	Shale	D		0.74	0.22	5.3
H06	61	23.72	Shale	D		6.68	1.98	47.6
H06	61	24.46	Shale	D		1.85	0.55	13.2
H06	61	25.14	Shale	D		1.20	0.36	8.6
H06	61	25.93	Shale	D		1.20	0.36	8.6
H06	61	27.43	Shale	D		0.86	0.26	6.1
H07	61	6.91	Shale	D		2.16	0.64	15.4
H07	61	14.02	Shale	D		1.24	0.37	8.8
H07	61	14.38	Shale	D		0.28	0.08	2.0
H07	61	15.14	Shale	D		0.95	0.28	6.8
H07	61	15.80	Shale	D		1.79	0.53	12.8
H07	61	16.76	Shale	D		1.58	0.47	11.3
H07	61	17.30	Shale	D		0.79	0.23	5.6
H07	61	18.11	Shale	D		0.42	0.12	3.0
H07	61	18.77	Shale	D		0.64	0.19	4.5
H07	61	19.79	Shale	D		1.09	0.32	7.8
H07	61	20.60	Shale	D		1.50	0.45	10.7
H07A	61	10.54	Shale	D		0.54	0.16	3.9
H07A	61	11.43	Shale	D		0.80	0.24	5.7
H07A	61	12.62	Shale	D		2.00	0.59	14.2
H07A	61	14.86	Shale	D		2.71	0.80	19.3
H08	61	8.86	Shale	D		2.81	0.83	20.0
H08	61	9.65	Shale	D		0.82	0.24	5.8
H08	61	10.44	Shale	D		0.28	0.08	2.0
H08	61	11.15	Shale	D		2.03	0.60	14.5
H08	61	11.76	Shale	D		0.29	0.09	2.1
H08	61	12.72	Shale	D		0.78	0.23	5.5
H08	61	12.72	Shale	D		0.09	0.03	0.7
H08	61	13.44	Shale	D		1.05	0.31	7.5
H08	61	14.20	Shale	D		1.58	0.47	11.2
H08	61	15.09	Shale	D		5.95	1.77	42.4
H08	61	15.82	Shale	D		0.47	0.14	3.3
drawn	BL	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>		client:	MMM Group			
approved	NG			project:	Hanlan Feedermain North			
date	Mar-12				Geo-Structural Evaluation			
scale	NTS			title:	Point Load Test			
original size	A4			project no:	Geotmark00231AA	table no:	B1-5	

BH	Core Dia. (mm)	Depth (m)	Rock type	Orientation	D for Axial (mm)	Point Load (kN)	Is (N/mm ²)	Equiv. UCS (MPa)
H09	61	8.61	Shale	D		0.50	0.15	3.6
H09	61	9.70	Shale	D		0.96	0.28	6.8
H09	61	10.41	Shale	D		1.08	0.32	7.7
H09	61	10.85	Shale	D		1.18	0.35	8.4
H09	61	12.55	Shale	D		0.41	0.12	2.9
H09	61	13.66	Shale	D		1.06	0.31	7.5
H09	61	15.14	Shale	D		1.51	0.45	10.8
H09	61	15.57	Shale	D		2.90	0.86	20.6
H09	61	16.38	Shale	D		1.50	0.44	10.7
H09	61	16.81	Shale	D		2.28	0.68	16.2
H09	61	17.65	Shale	D		0.77	0.23	5.5
H09	61	18.64	Shale	D		1.89	0.56	13.5
H09	61	19.15	Shale	D		1.65	0.49	11.7
H09A	61	7.59	Shale	D		0.35	0.10	2.5
H09A	61	8.25	Shale	D		0.17	0.05	1.2
H09A	61	9.07	Shale	D		0.61	0.18	4.3
H09A	61	9.30	Shale	D		2.28	0.68	16.2
H09A	61	9.80	Shale	D		1.53	0.45	10.9
H09A	61	10.44	Shale	D		2.75	0.82	19.6
H09A	61	12.50	Shale	D		0.37	0.11	2.6
H09A	61	12.67	Shale	D		0.11	0.03	0.8
H09A	61	13.33	Shale	D		2.91	0.86	20.7
H09A	61	14.05	Shale	D		0.66	0.20	4.7
H10	61	6.20	Shale	D		3.00	0.89	21.4
H10	61	7.34	Shale	D		0.39	0.12	2.8
H10	61	8.97	Shale	D		0.31	0.09	2.2
H10	61	9.17	Shale	D		2.84	0.84	20.3
H10	61	11.76	Shale	D		4.24	1.26	30.2
H10	61	12.34	Shale	D		0.31	0.09	2.2
H10	61	13.36	Shale	D		1.49	0.44	10.6
H11	61	6.22	Shale	D		0.40	0.12	2.8
H11	61	8.46	Shale	D		0.23	0.07	1.6
H11	61	9.55	Shale	D		0.89	0.26	6.3
H11	61	9.96	Shale	D		0.23	0.07	1.6
H11	61	10.79	Shale	D		1.43	0.42	10.2
H11	61	11.96	Shale	D		0.07	0.02	0.5
H11	61	12.50	Shale	D		0.69	0.20	4.9
H11	61	12.90	Shale	D		0.08	0.02	0.6
H11	61	13.87	Shale	D		1.70	0.51	12.1
H11	61	14.40	Shale	D		0.22	0.07	1.6
H11	61	15.19	Shale	D		0.27	0.08	1.9
H11	61	15.82	Shale	D		0.25	0.07	1.8
H11	61	16.86	Shale	D		0.38	0.11	2.7
drawn	BL	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>		client:	MMM Group			
approved	NG			project:	Hanlan Feedermain North Geo-Structural Evaluation			
date	Mar-12			title:	Point Load Test			
scale	NTS			project no:	Geotmark00231AA	table no:	B1-6	
original size	A4							

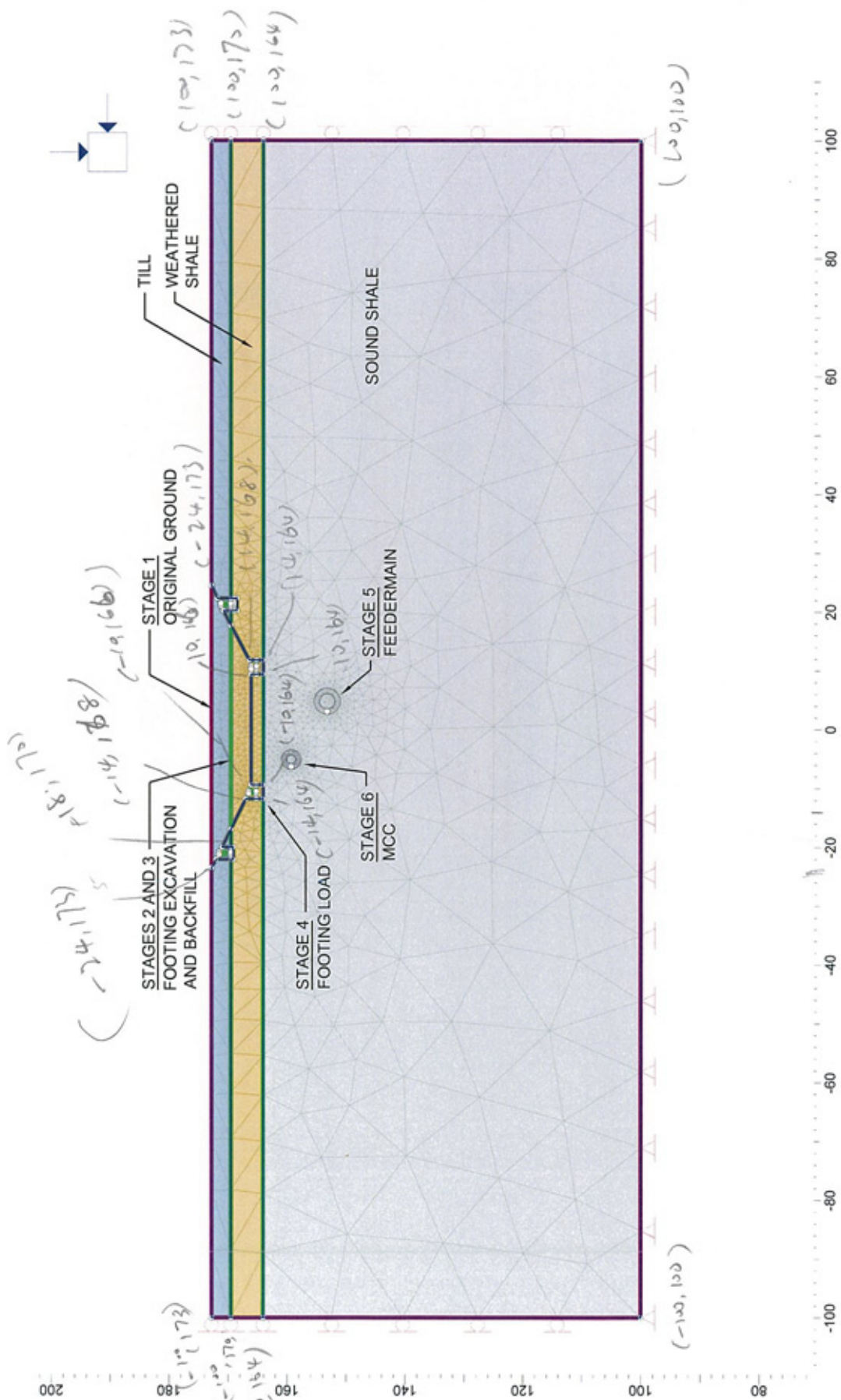
BH	Test Depth Top (m)	Test Depth Bottom (m)	Test Pressure (kPa)	Take (L/min)	Hyrdraulic Conductivity (cm/s)
H06	4.27	7.31	114.68	0.10	3.09E-06
H06	4.27	7.31	149.16	0.50	1.19E-05
H06	4.27	7.31	183.64	0.80	1.54E-05
H06	4.27	7.31	183.64	0.80	1.54E-05
H06	4.27	7.31	149.16	0.50	1.19E-05
H06	4.27	7.31	114.68	0.40	1.24E-05
H06	7.31	10.36	114.68	0.00	<1E-08
H06	7.31	10.36	183.64	0.00	<1E-08
H06	7.31	10.36	252.61	0.00	<1E-08
H06	10.36	13.41	149.16	0.00	<1E-08
H06	10.36	13.41	252.61	0.00	<1E-08
H06	10.36	13.41	321.57	0.00	<1E-08
H06	13.41	16.46	183.64	0.00	<1E-08
H06	13.41	16.46	287.09	0.00	<1E-08
H06	13.41	16.46	390.54	0.00	<1E-08
H06	16.46	19.51	183.64	0.00	<1E-08
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H06	19.51	22.55	528.46	0.00	<1E-08
H08	9.14	12.19	227.00	0.20	3.12E-06
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H08	9.14	12.19	433.90	0.00	<1E-08
H08	12.19	15.24	329.67	0.00	<1E-08
H08	12.19	15.24	433.11	0.05	4.09E-07
H08	12.19	15.24	536.56	0.00	<1E-08
H11	14.93	16.46	108.89	0.10	1.76E-06
H11	14.93	16.46	143.37	0.15	2.19E-06
H11	14.93	16.46	177.86	0.15	1.87E-06
H11	13.41	14.93	143.37	0.20	5.56E-06
H11	13.41	14.93	108.89	0.15	3.15E-06
H11	13.41	14.93	143.37	0.15	2.53E-06
H11	11.89	13.41	177.86	0.10	2.78E-06
H11	11.89	13.41	212.34	0.10	2.10E-06
H11	11.89	13.41	177.86	0.25	4.21E-06
H11	8.84	10.36	246.82	0.15	4.98E-06
H11	8.84	10.36	315.78	0.05	1.20E-06
H11	8.84	10.36	212.34	0.50	9.35E-06
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H11	5.79	7.31	212.34	0.25	6.95E-06
drawn	BL			client: MMM Group	
approved	JN			project: Hanlan North Feedermain	
date	Mar-12			title: Packer Test	
scale	NTS			project no: Geotmark00231AA	table no: B2-1
original	A4				


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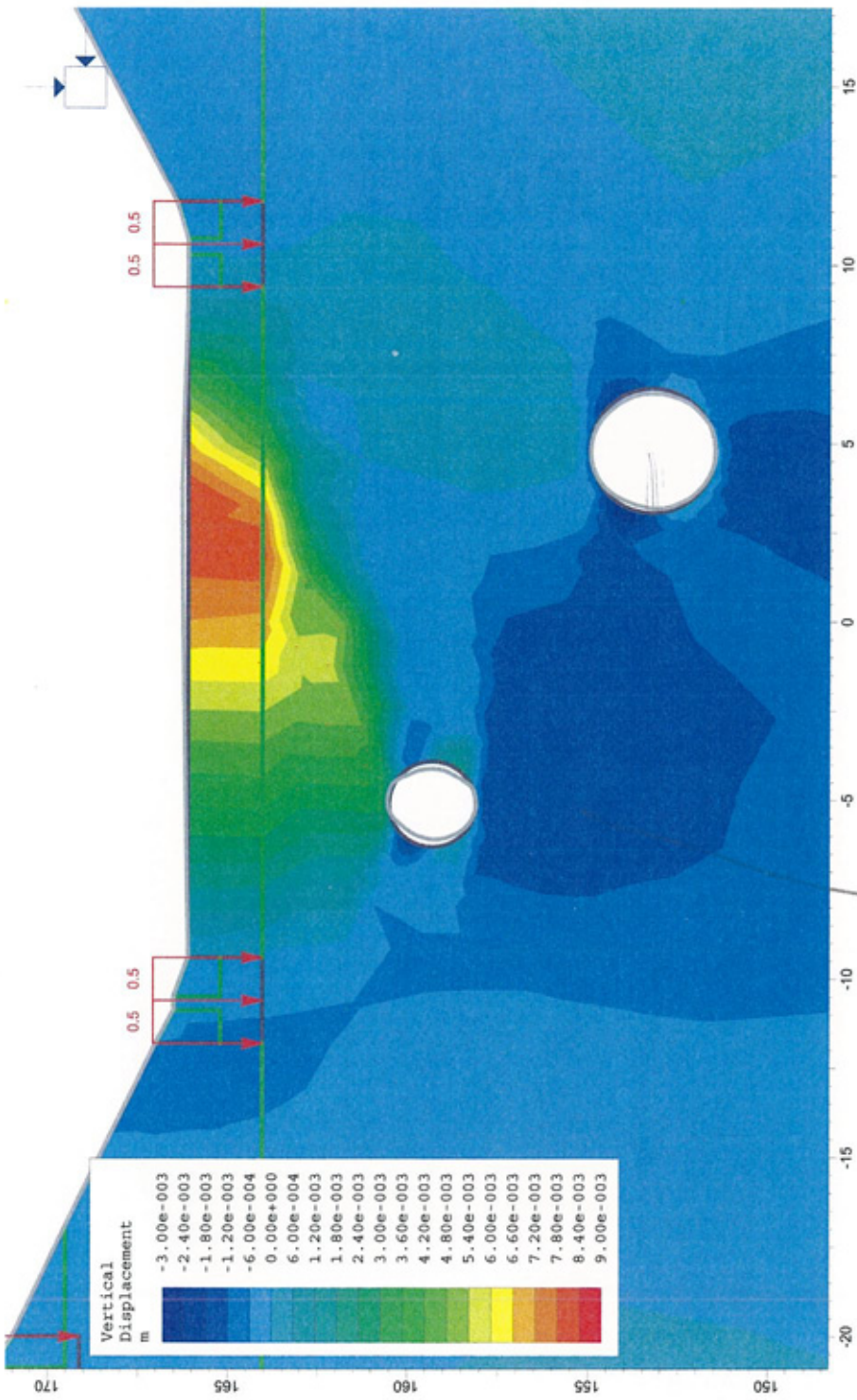
Appendix C

Numerical Modelling Results

Figures C1 to C7

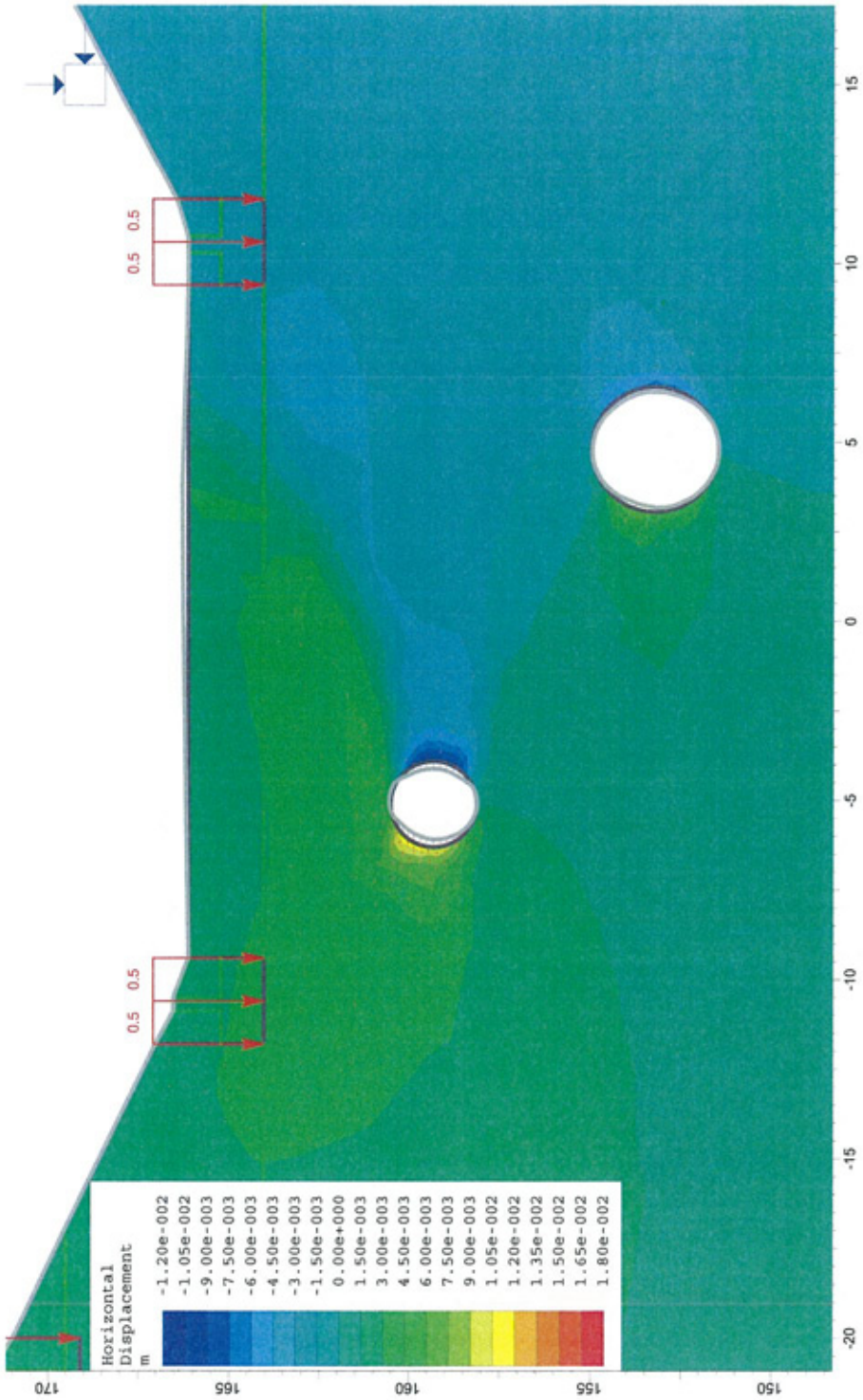


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approved	BL		project:	GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN NORTH SECTION
date	APRIL 2012		title:	STRESS ANALYSIS STRUCTURE 24-314 K ₀ = 1 2.6M 4.6M lockin
scale	AS SHOWN		project no:	GEOTMARK00231AA
original size	LETTER		drawing no:	C1

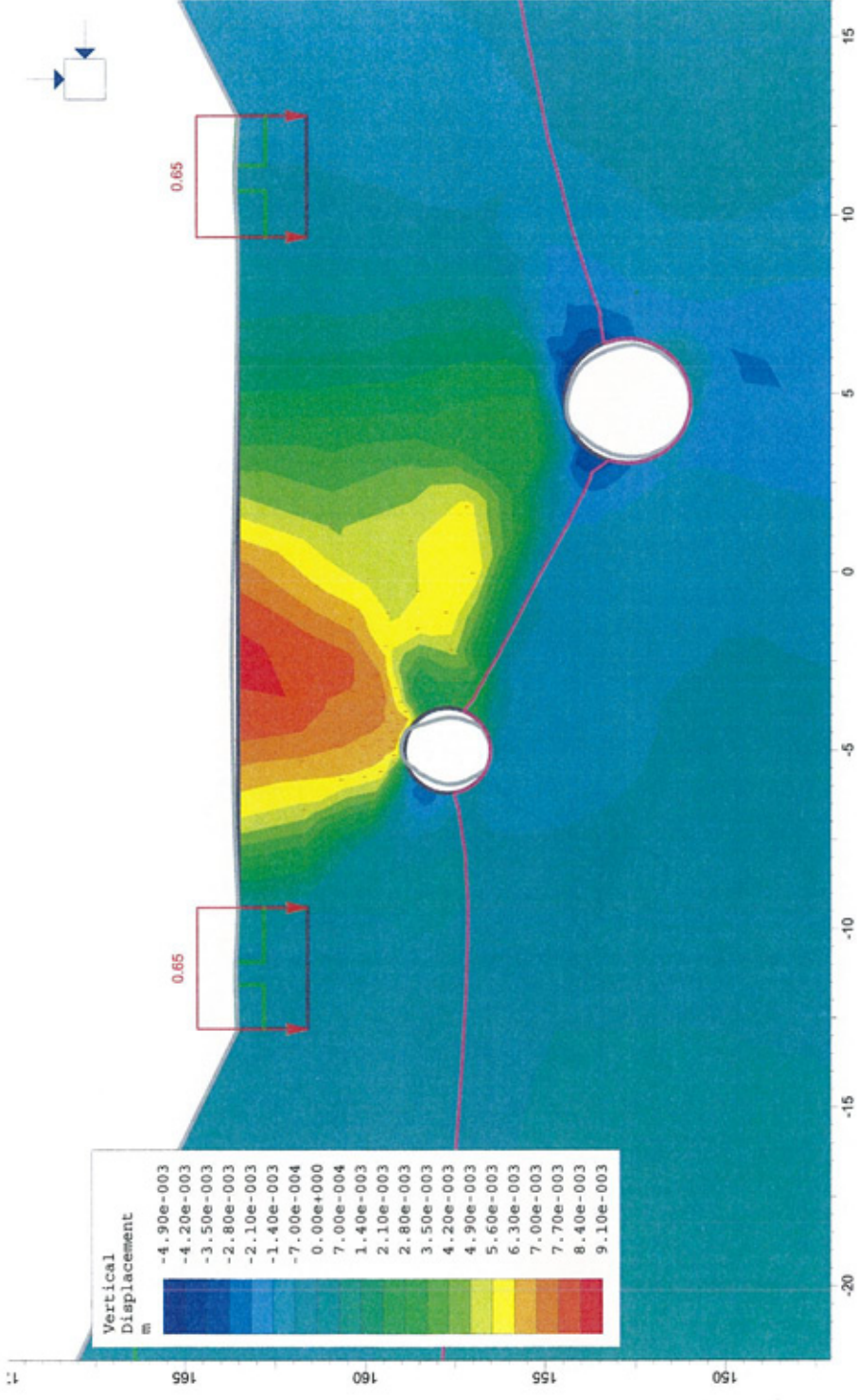


drawn	SH	client: MMM GROUP	
approved	BL	project: GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN NORTH SECTION	
date	APRIL 2012	title: STRESS ANALYSIS STRUCTURE 24-314 Ko = 1 2.6M 4.6M lockin	
scale	AS SHOWN	project no: GEOTMARK00231AA	drawing no: C2
original size	LETTER		



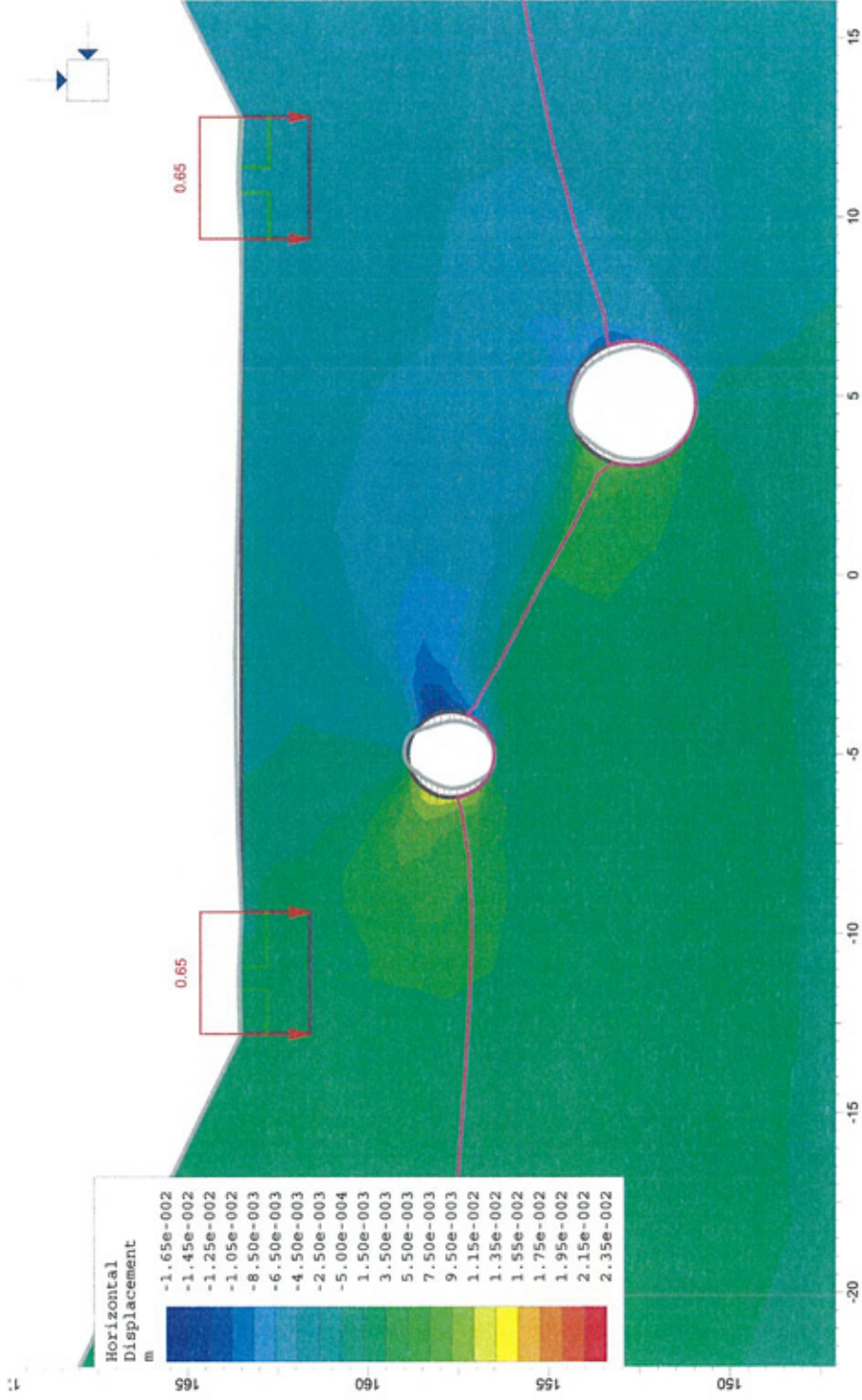


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approved	BL	project: GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN NORTH SECTION	
date	APRIL 2012	title: STRESS ANALYSIS STRUCTURE 24-314 Ko = 1 2.6M 4.6M lockin	
scale	AS SHOWN	project no: GEOTMARK00231AA	drawing no: C3
original size	LETTER		

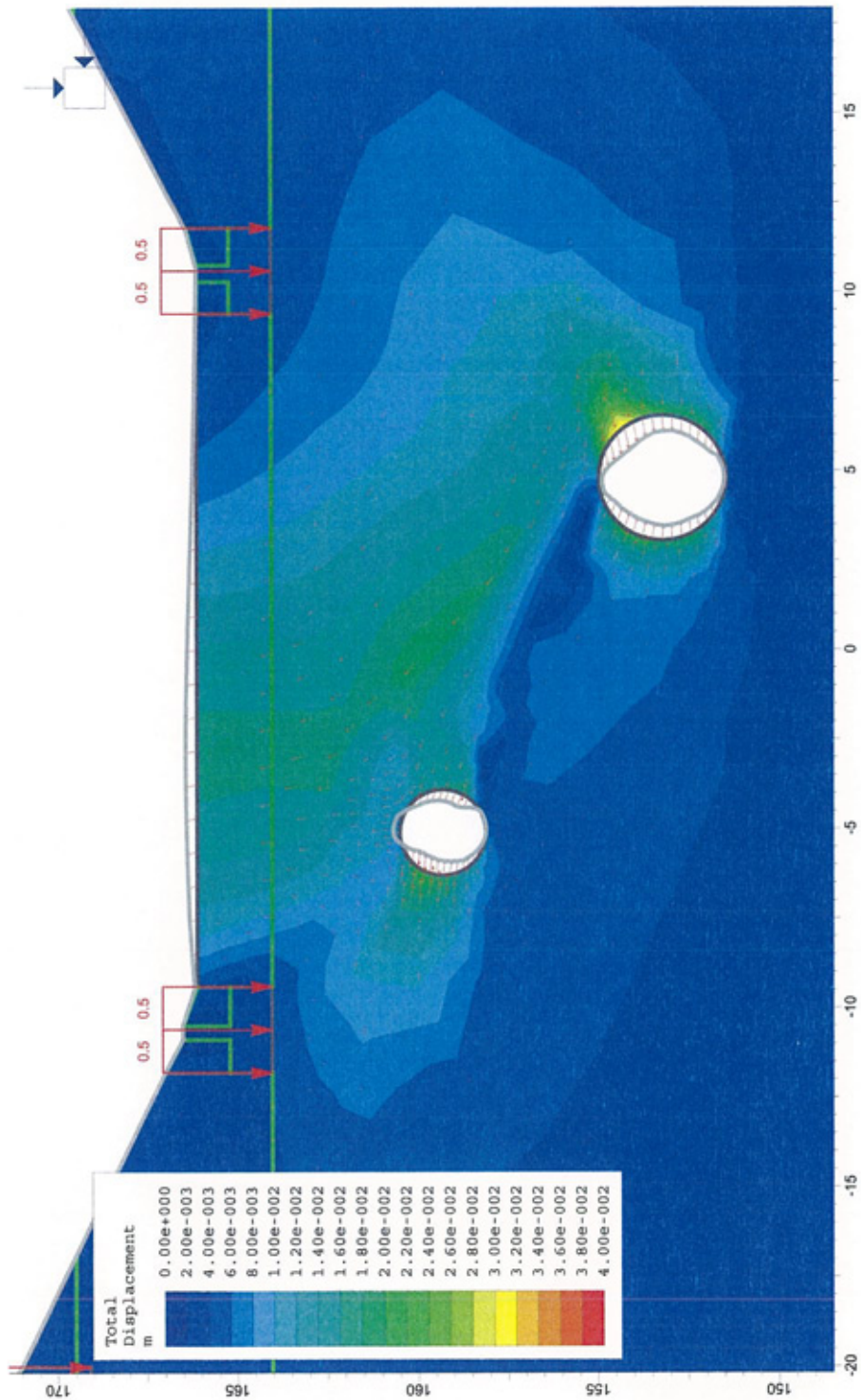


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approved	BL	project: GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN NORTH SECTION	
date	APRIL 2012	title: STRESS ANALYSIS STRUCTURE 24-494 Ko = 1 2.6MPa 4.6MPa lockin	
scale	AS SHOWN	project no: GEOTMARK00231AA	
original size	LETTER	drawing no: C4	



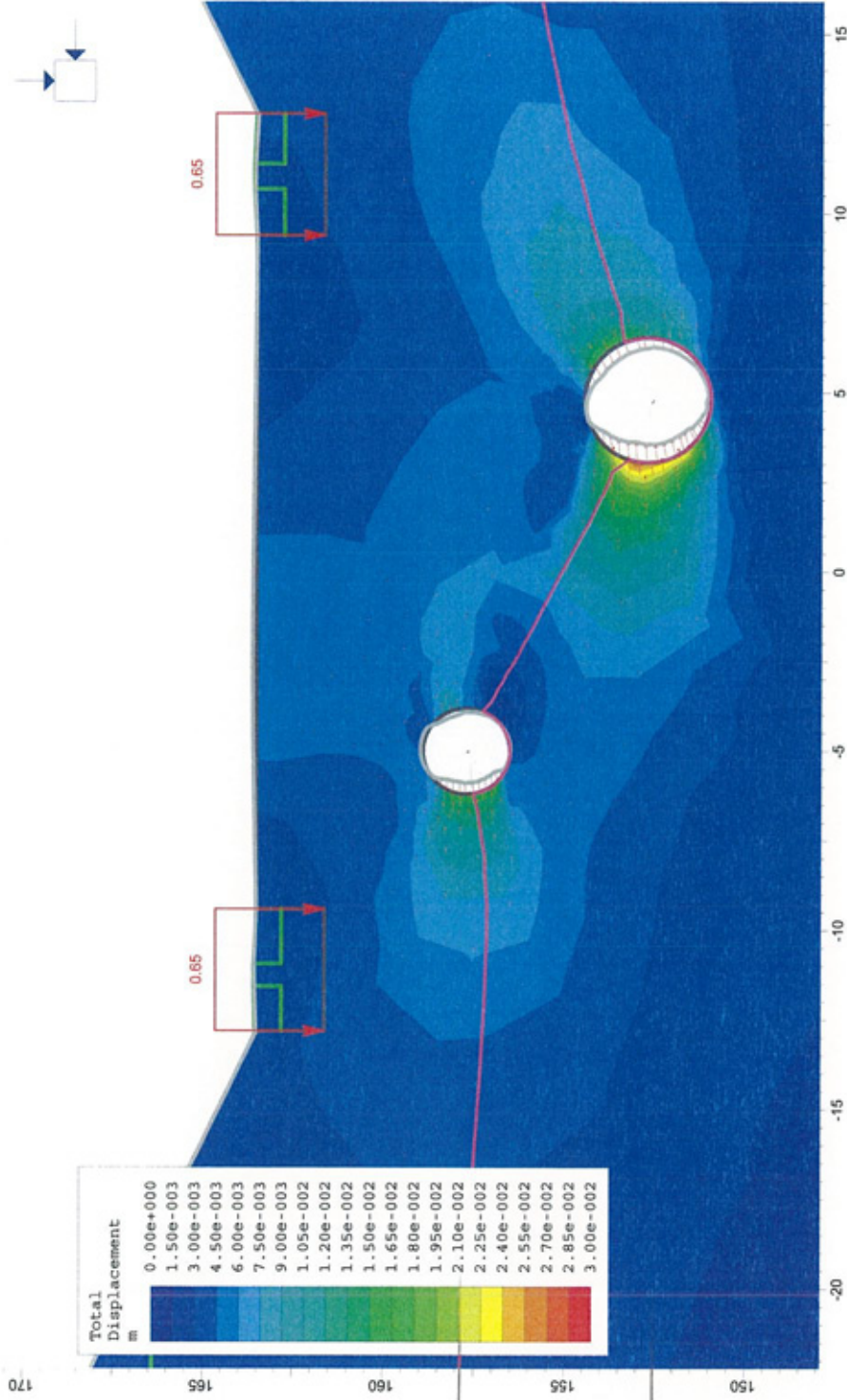


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approved	BL	project: GEOTECHNICAL INVESTIGATION HANLAN FEEDMAIN NORTH SECTION		
date	APRIL 2012	title: STRESS ANALYSIS STRUCTURE 24-494 Ko = 1 2.6MPa 4.6MPa lockin		
scale	AS SHOWN	project no: GEOTMARK00231AA		
original size	LETTER	drawing no: C5		



drawn	SH	client: MMM GROUP	
approved	BL	project: GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN NORTH SECTION	
date	APRIL 2012	title: STRESS ANALYSIS STRUCTURE 24-314 Ko = 1 4MPa 6MPa lockin	
scale	AS SHOWN	project no: GEOTMARK00231AA	
original size	LETTER	drawing no: C6	





drawn	SH	client: MMM GROUP	
approved	BL	project: GEOTECHNICAL INVESTIGATION HANLAN FEEDERMAIN NORTH SECTION	
date	APRIL 2012	title: STRESS ANALYSIS STRUCTURE 24-494 Ko = 1 4MPa 6MPa lockin	
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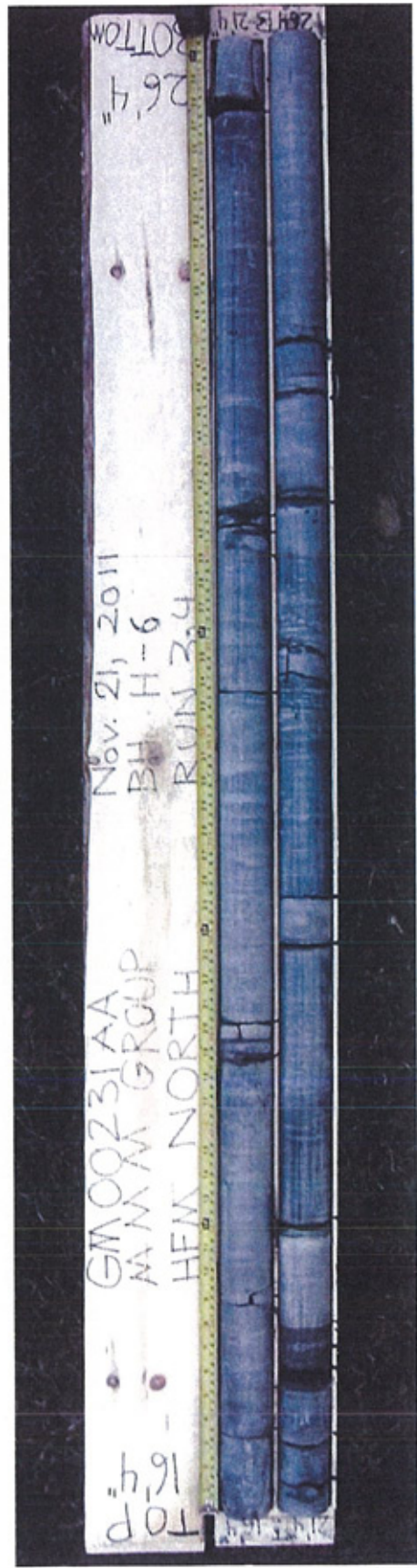


Appendix D


Rock Core Photographs

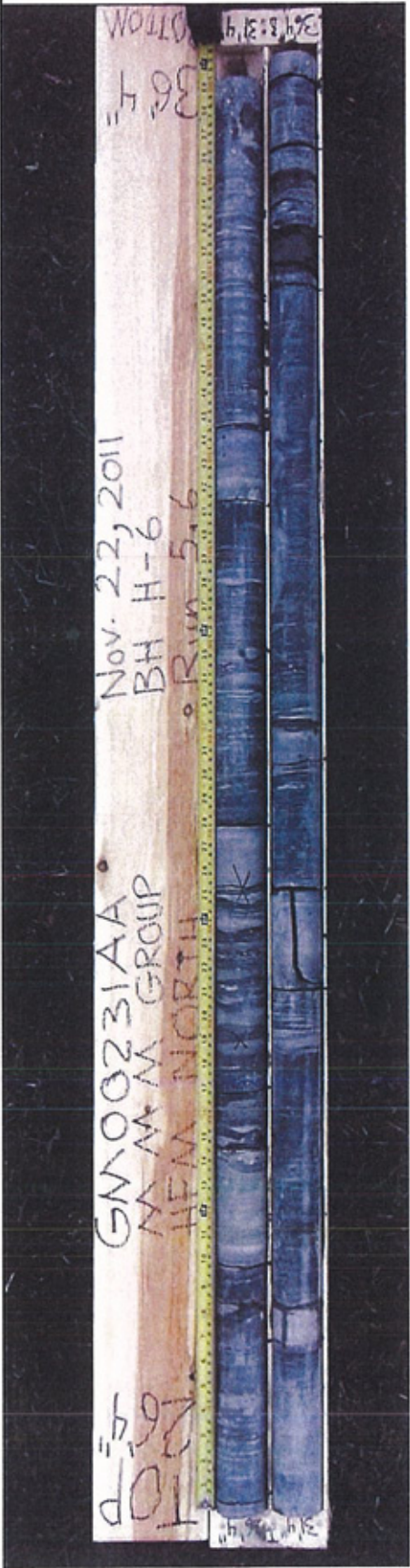


BH H06, Runs 01 and 02

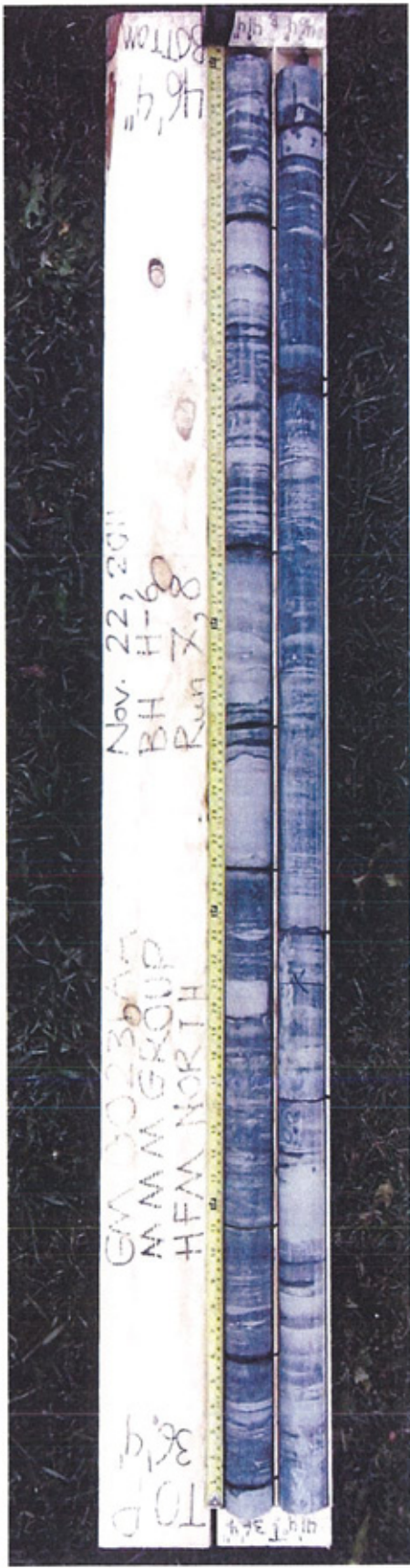


BH H06, Runs 03 and 04

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approved	JIN			project:	Harlan Feedmain North
date	Mar-12			title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S			project no:	GEOTMARK00231AA
original size	letter			figure no:	D-1



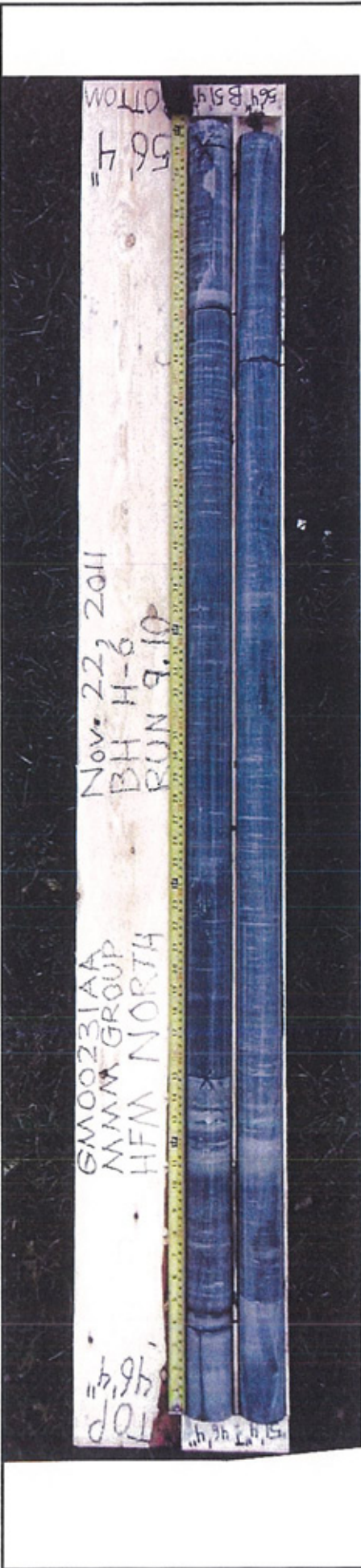
BH H06, Runs 05 and 06



BH H06, Runs 07 and 08

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approved	JN	project: Harlan Feedermain North	
date	Mar-12	title: ROCK CORE PHOTOGRAPHS	
scale	N.T.S	project no: GEOTMARK00231AA	figure no: D-2
original size	letter		



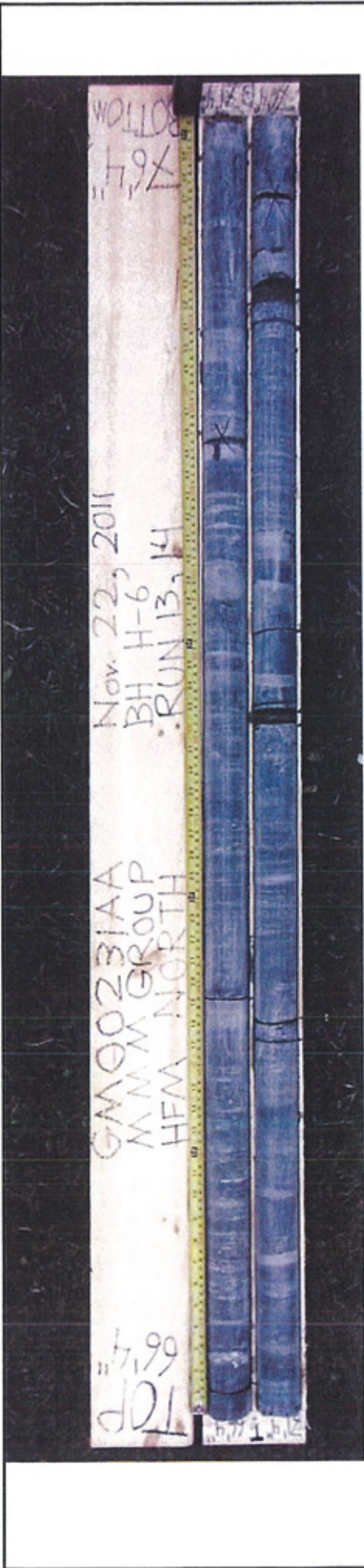


BH H06, Runs 09 and 10

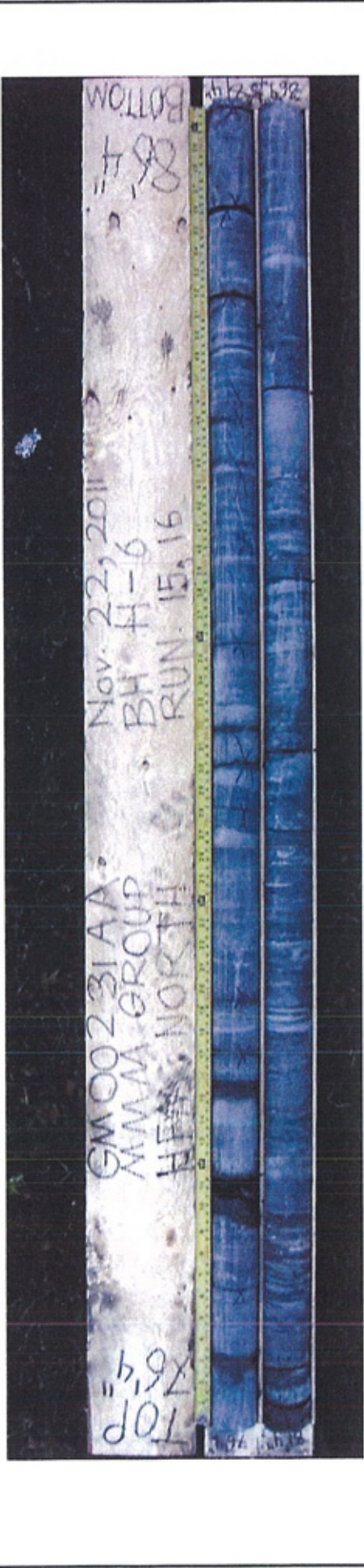


BH H06, Runs 11 and 12

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approved	JN	project: Hanlan Feedermain North	
date	Mar-12	title: ROCK CORE PHOTOGRAPHS	
scale	N.T.S	project no: GEOTMARK00231AA	
original size	letter	figure no: D-3	



BH H06, Runs 13 and 14



BH H06, Runs 15 and 16


drawn	AC	client: MMM Group	
approved	JN	project: Harlan Feedermain North	
date	Mar-12	title: ROCK CORE PHOTOGRAPHS	
scale	N.T.S	project no: GEOTMARK00231AA	figure no: D-4
original/size	letter		



BH H06, Runs 17



BH H07, Runs 01 and 02

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Hanlan Feedermain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-5



BH H07, Runs 03 and 04

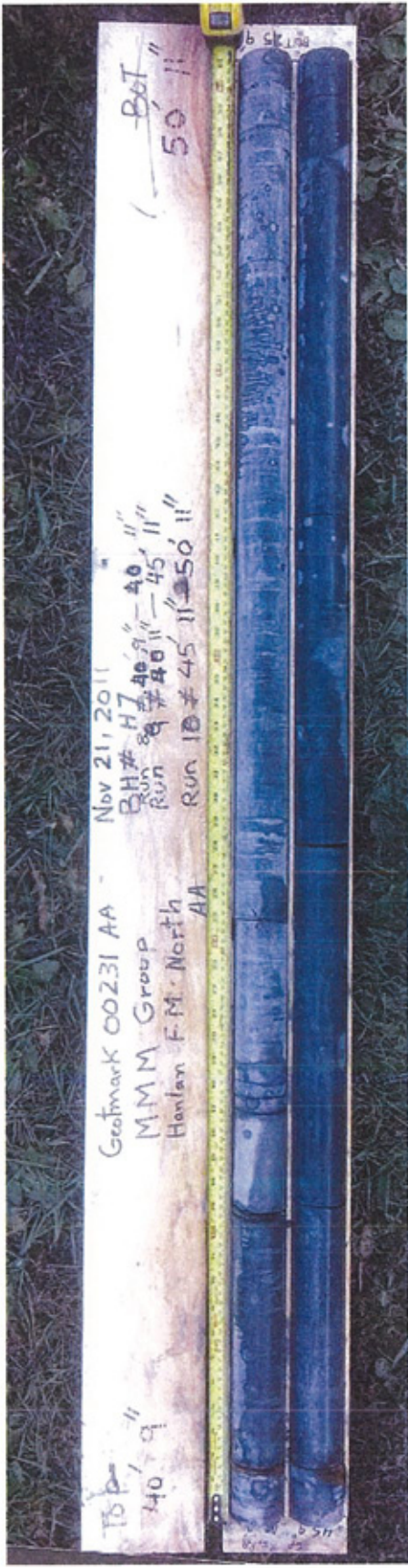


BH H07, Runs 05 and 06


drawn	AC	client:	MMM Group
approved	JN	project:	Harlan Feedmain North
date	Mar-12	title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S	project no:	GEOTMARK00231AA
original size	letter	figure no:	D-6



BH H07, Runs 07 and 08



BH H07, Run 08, 09 and 10


drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Harlan Feedermain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-7



BH H07, Runs 10, 11 and 12

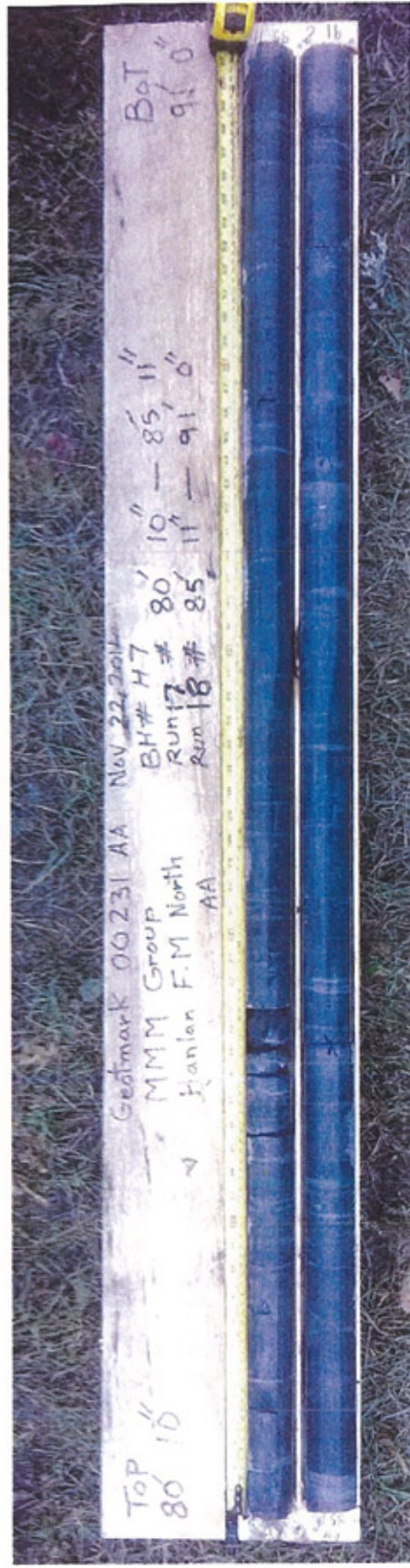


BH H07, Runs 13, 14 and 15


drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	MMM Group
approved	JN		project:	Harlan Feedermain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-8

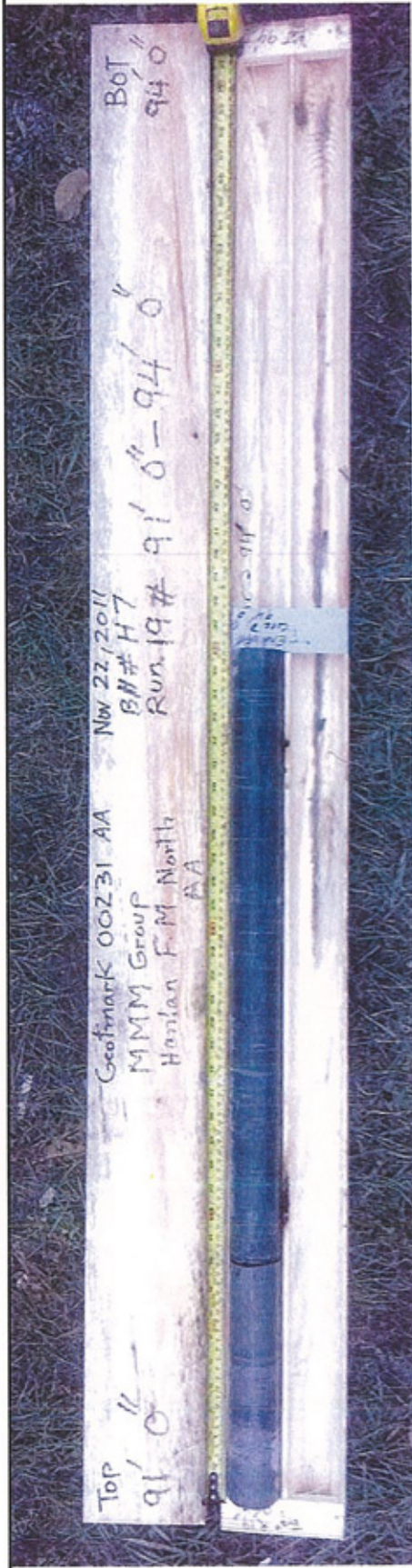


BH H07, Runs 15, and 16

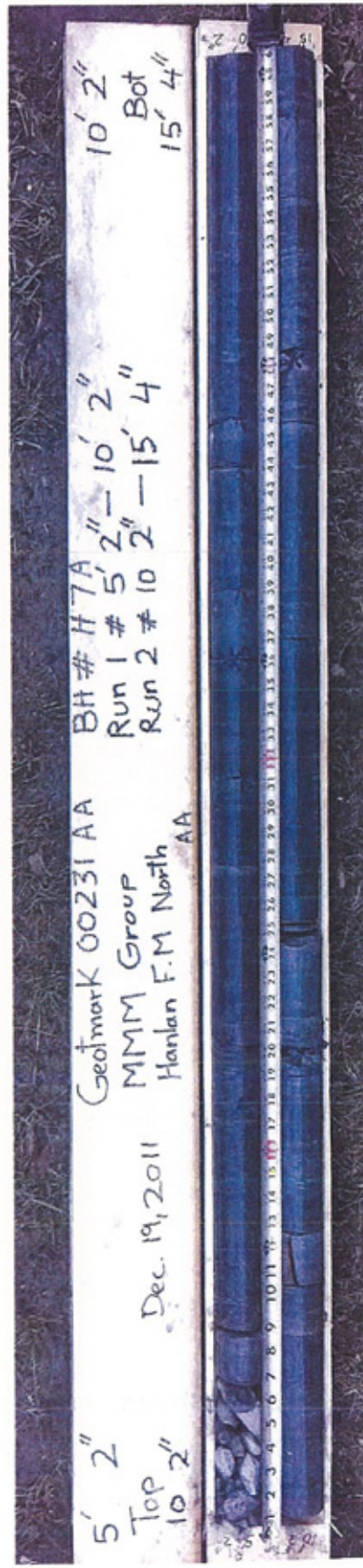


BH H07, Runs 17, and 18

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approved	JN		project:	Hanlan Feedermain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-9



BH H07, Runs 19



BH H07A, Runs 01, and 02

drawn	AC	client:	MMM Group
approved	JN	project:	Hanlan Feedmain North
date	Mar-12	title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S	project no:	GEOTMARK00231AA
original size	letter	figure no:	D-10

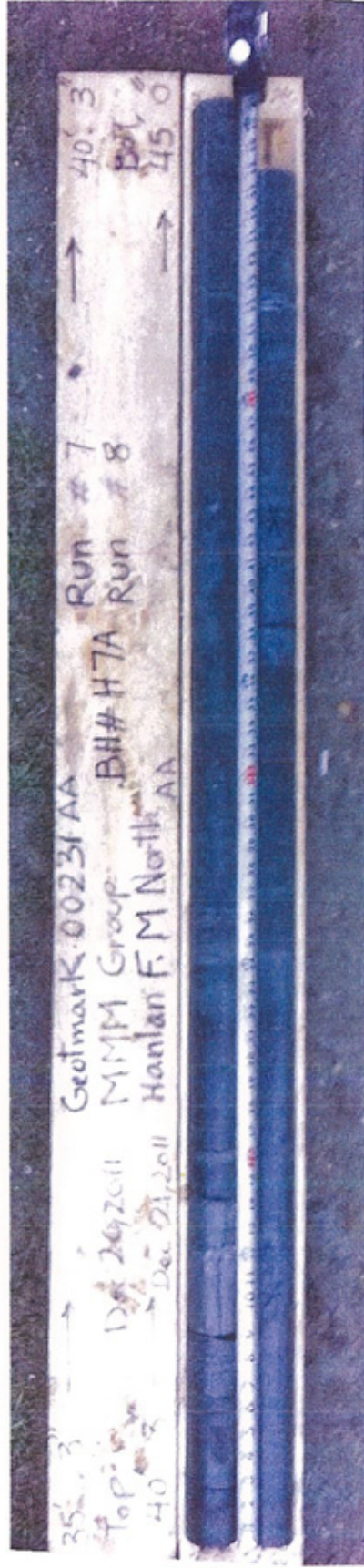


BH H07A, Runs 03 and 04

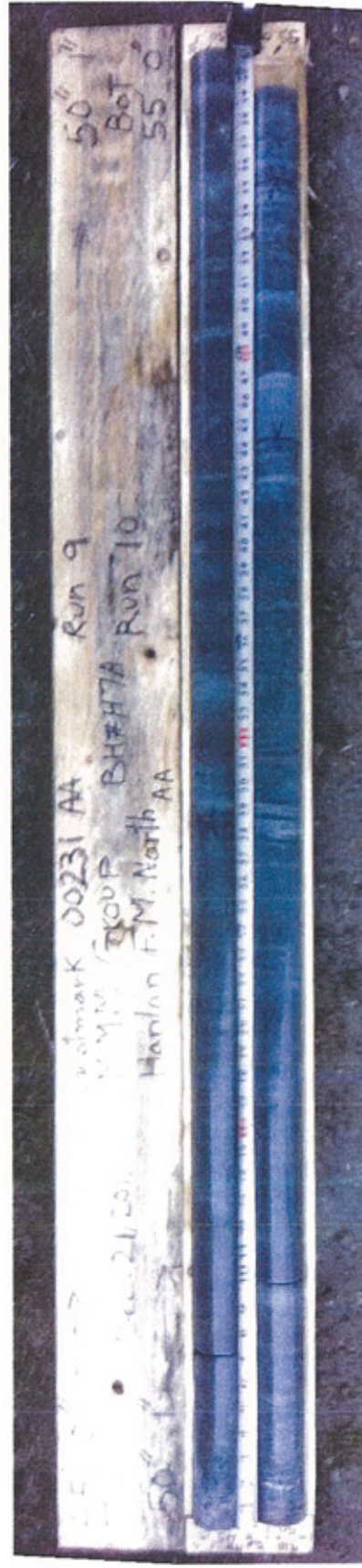


BH H07A, Runs 05, and 06


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approved	JN	project: Hanlan Feedermain North	
date	Mar-12	title: ROCK CORE PHOTOGRAPHS	
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original/size	letter	figure no: D-11	



BH H07A, Runs 07 and 08



BH H07A, Runs 09, and 10

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Hanlan Feedmain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
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original/size	letter		figure no:	D-12

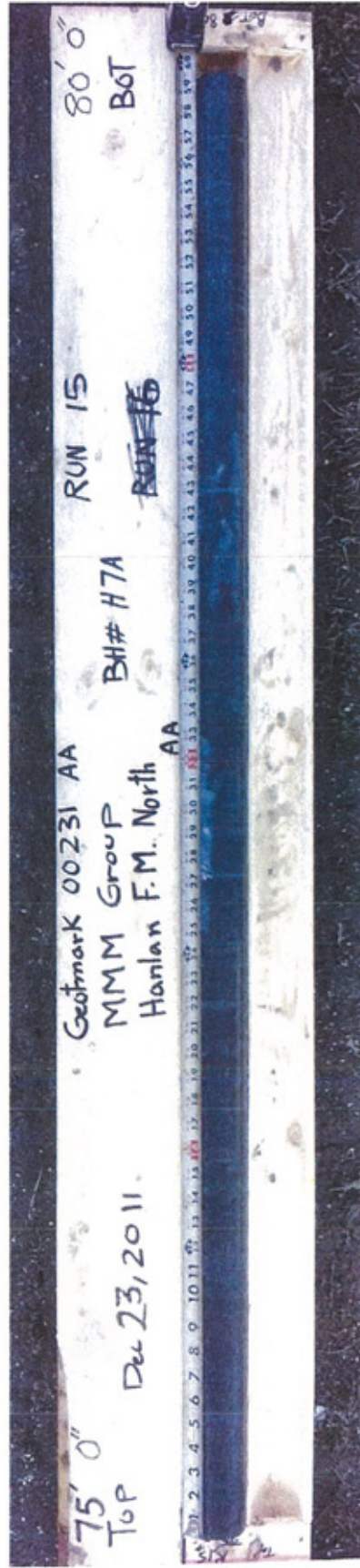


BH H07A, Runs 11 and 12

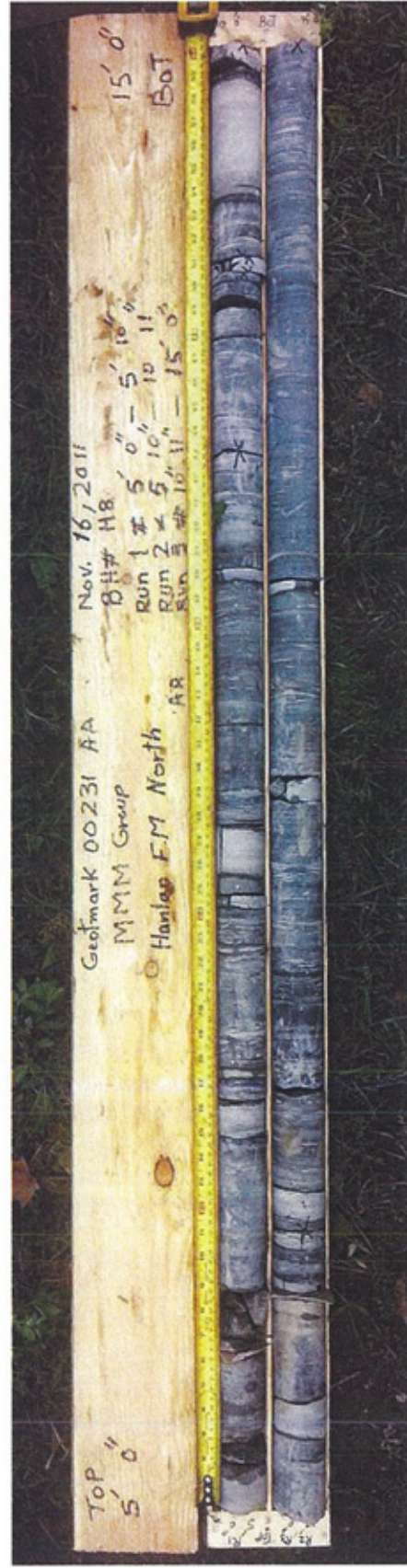


BH H07A, Runs 13, and 14


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approved	JN	project:	Hanlan Feedermain North
date	Mar-12	title:	ROCK CORE PHOTOGRAPHS
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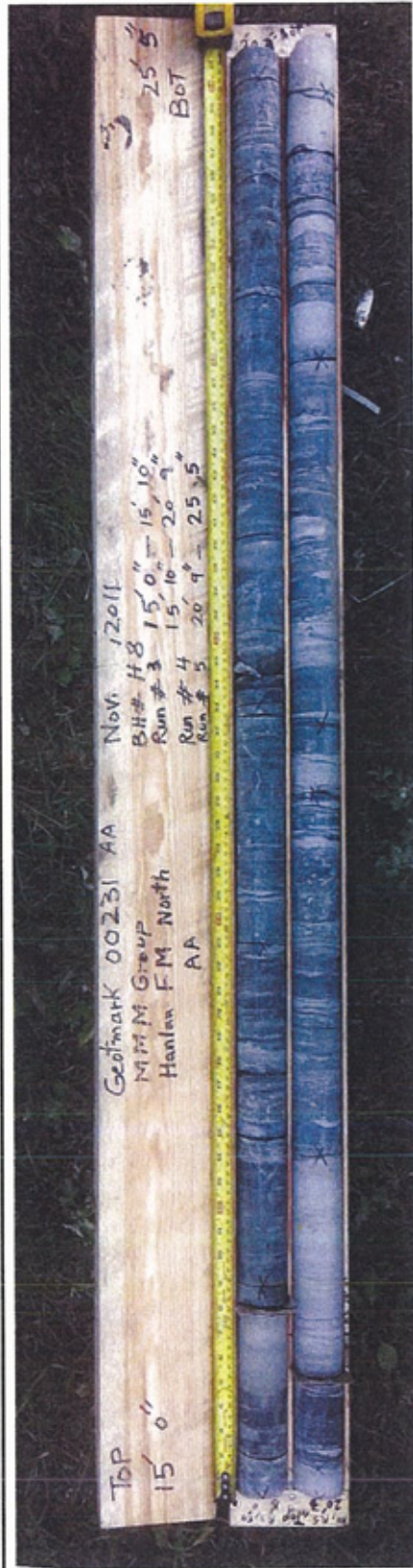


BH H07A, Runs 15

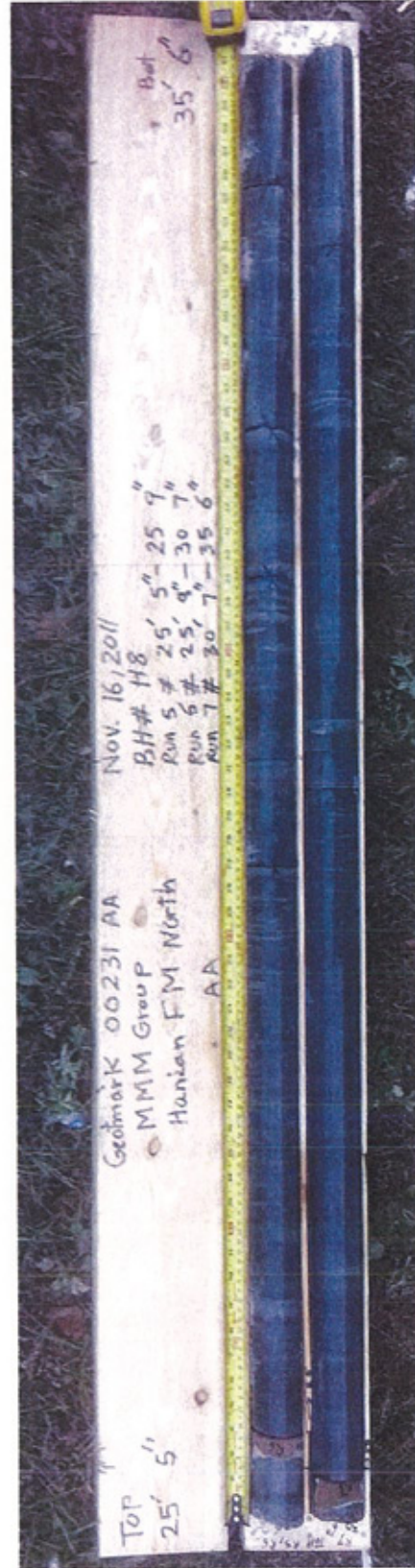


BH H08, Runs 1, 2 and 3


drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Hanlan Feedmain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
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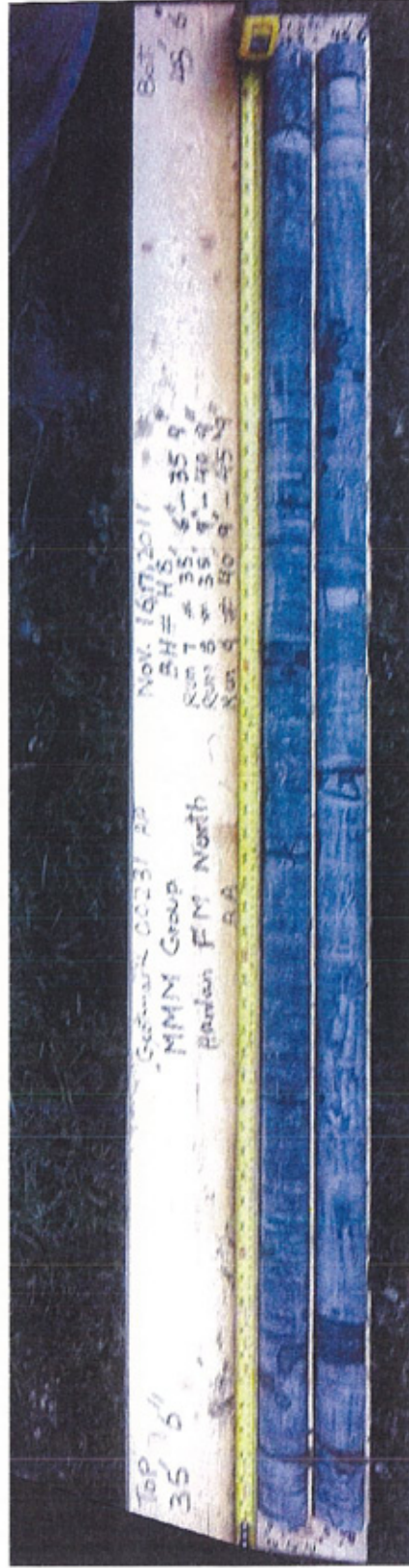


BH H08, Runs 3, 4 and 5



BH H08, Runs 5, 6 and 7


drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	MMM Group
approved	JN		project:	Hanlan Feedmain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-15

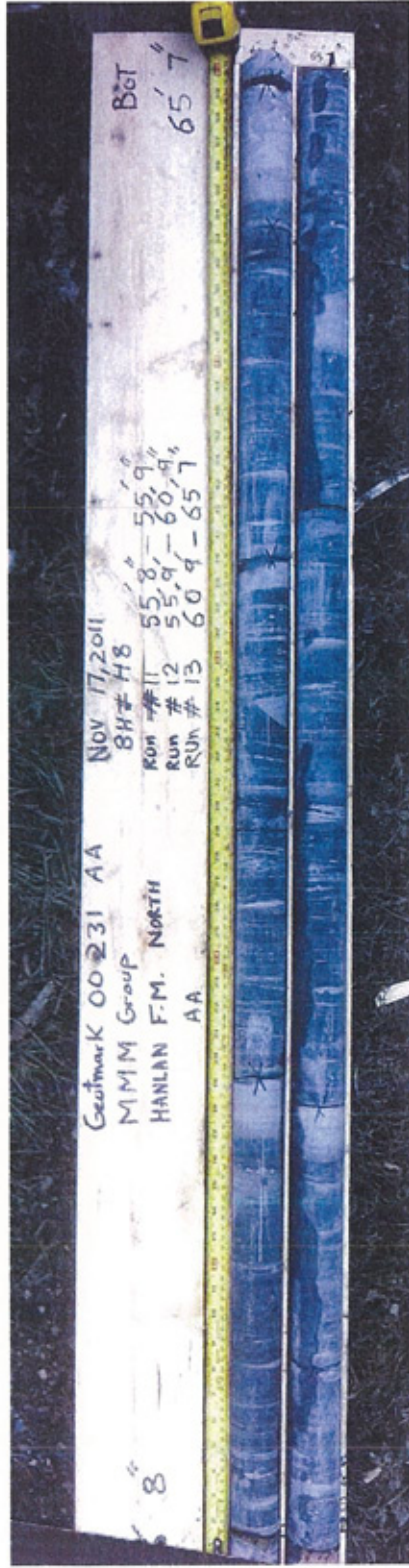


BH H08, Runs 7, 8 and 9

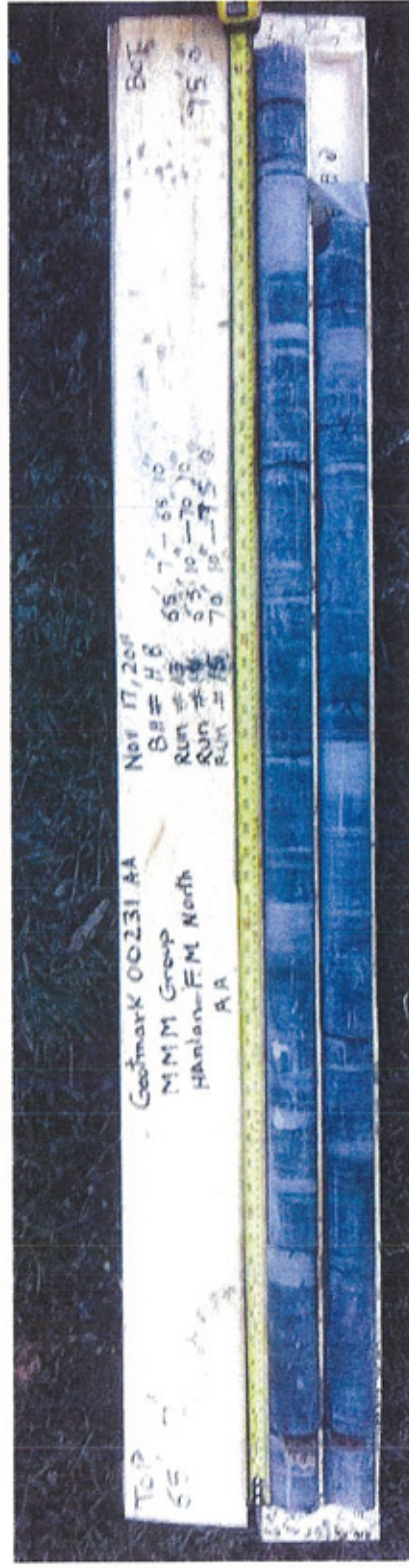


BH H08, Runs 9, 10 and 11


drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Harlan Feedmain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-16



BH H08, Runs 11, 12 and 13



BH H08, Runs 13, 14 and 15


drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Hanlan Feedermain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-17



BH H09, Runs 1 and 2



BH H09, Runs 3 and 4

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Hanlan Feedermain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-18

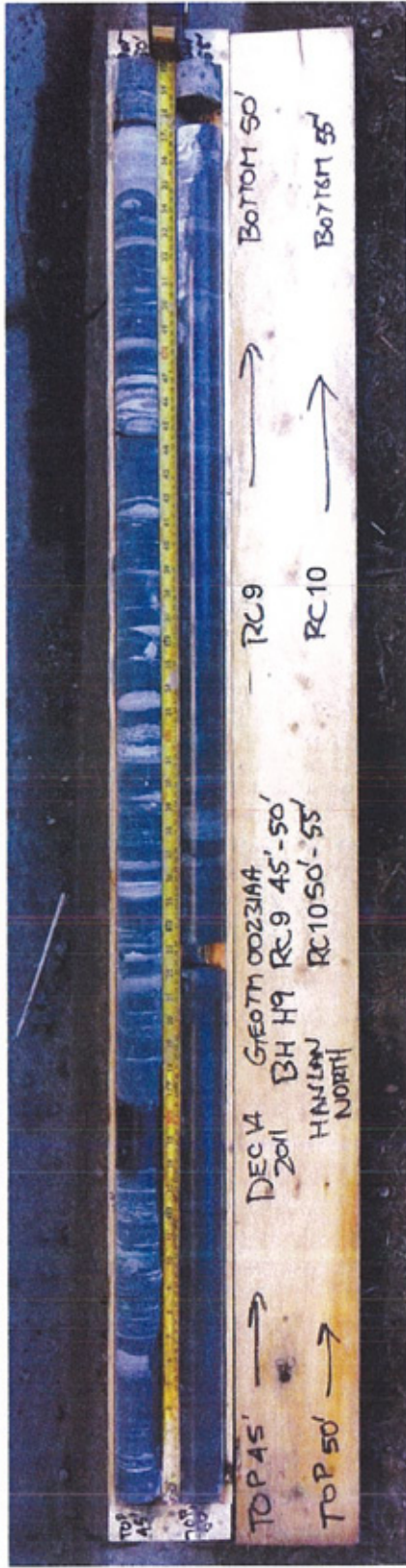


BH H09, Runs 5 and 6

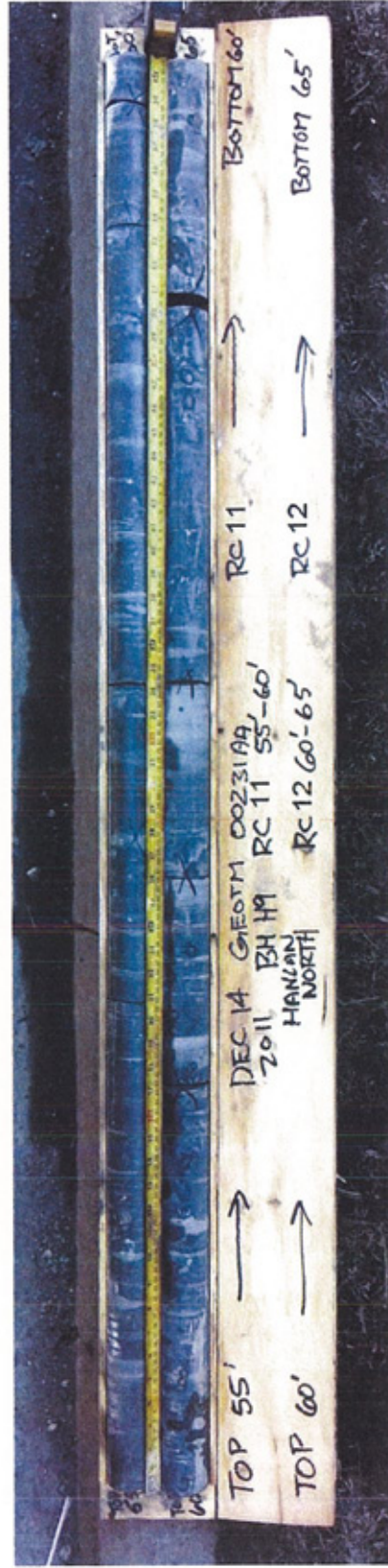


BH H09, Runs 7 and 8

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approved	JN	project:	Hamlin Feedmain North
date	Mar-12	title:	ROCK CORE PHOTOGRAPHS
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original size	letter	figure no:	D-19



BH H09, Runs 9 and 10

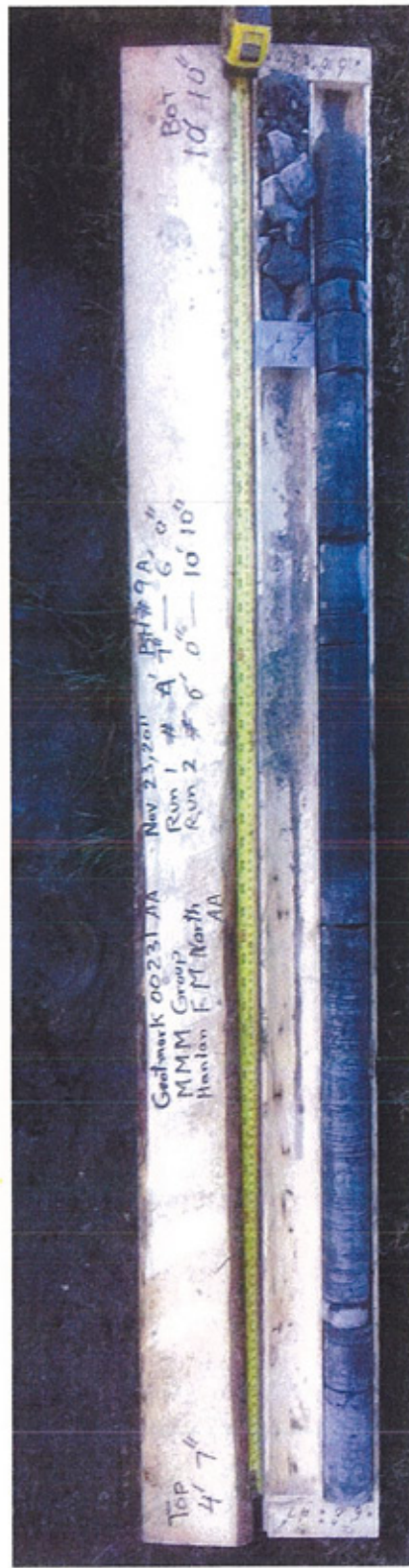


BH H09, Runs 11 and 12

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approved	JN	project:	Hanlan Feedmain North
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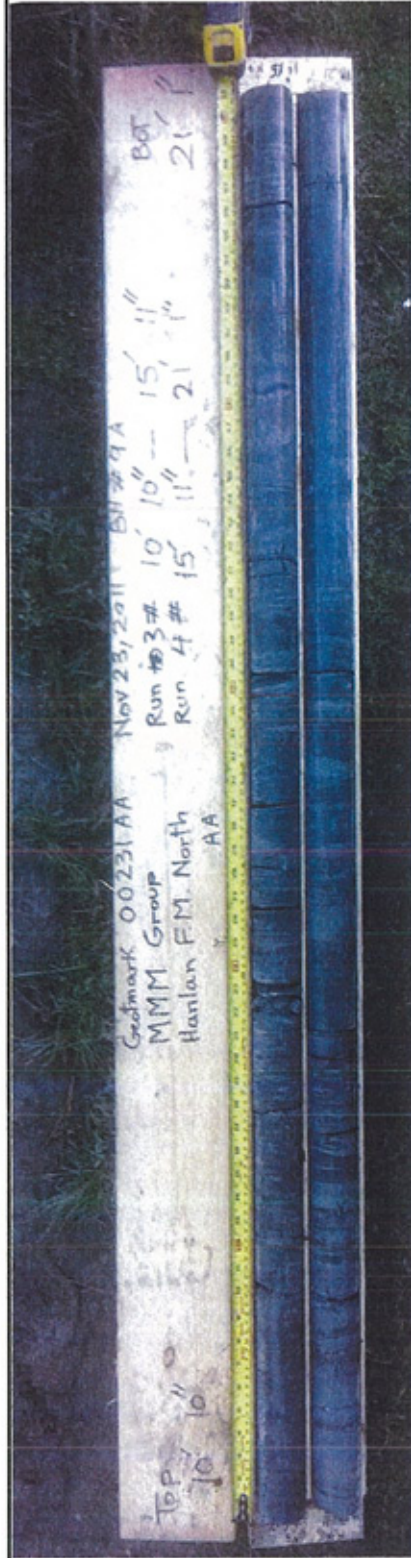


BH H09, Runs 13 and 14

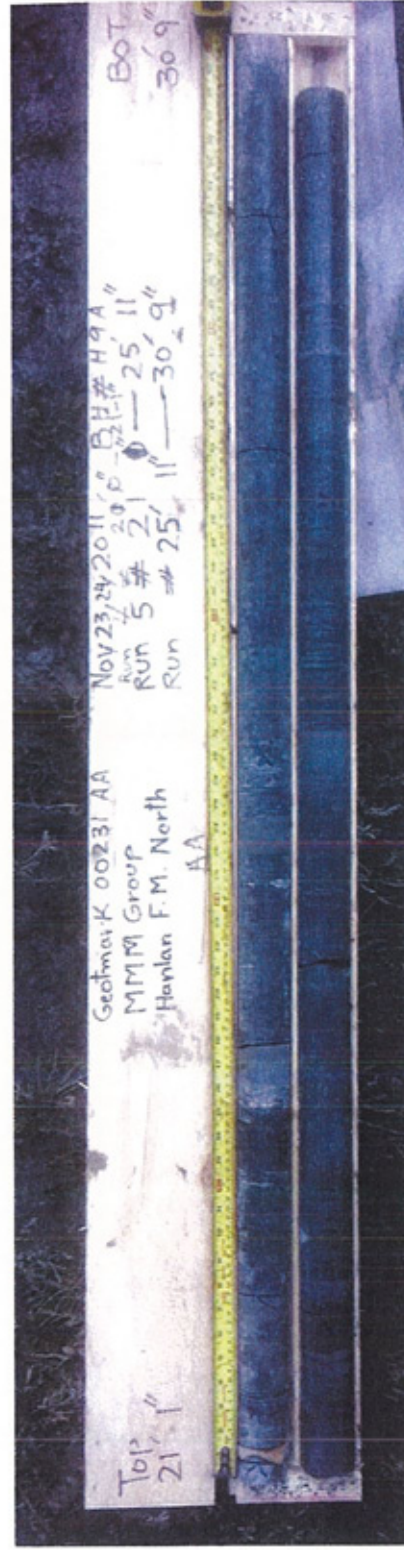


BH H09A, Runs 1 and 2


drawn	AC	client:	MMM Group
approved	JN	project:	Hanlan Feedermain North
date	Mar-12	title:	ROCK CORE PHOTOGRAPHS
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BH H09A, Runs 3 and 4

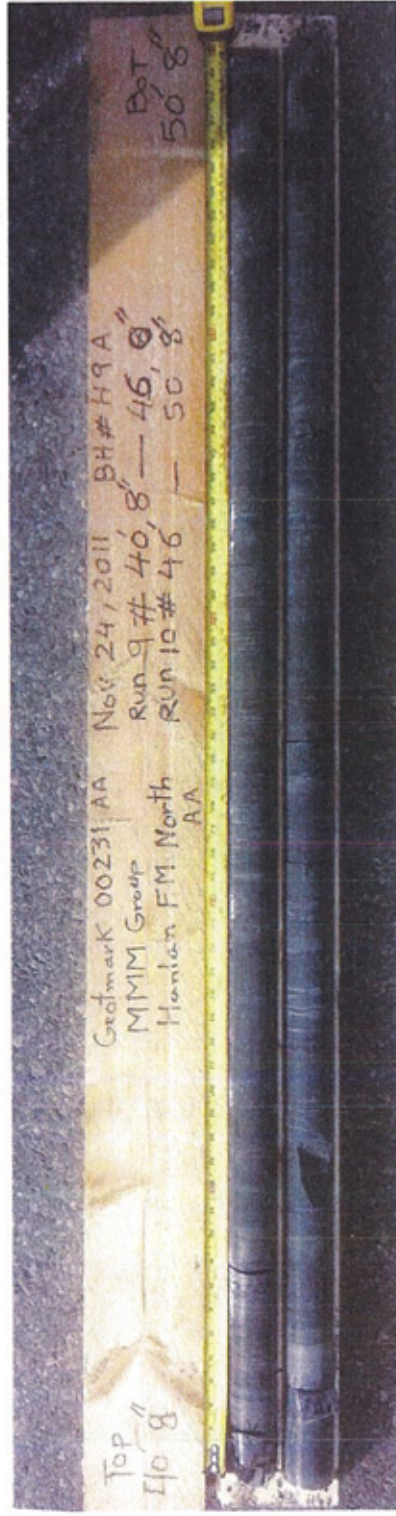


BH H09A, Runs 4, 5 and 6

drawn	AC	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Harlan Feedmain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
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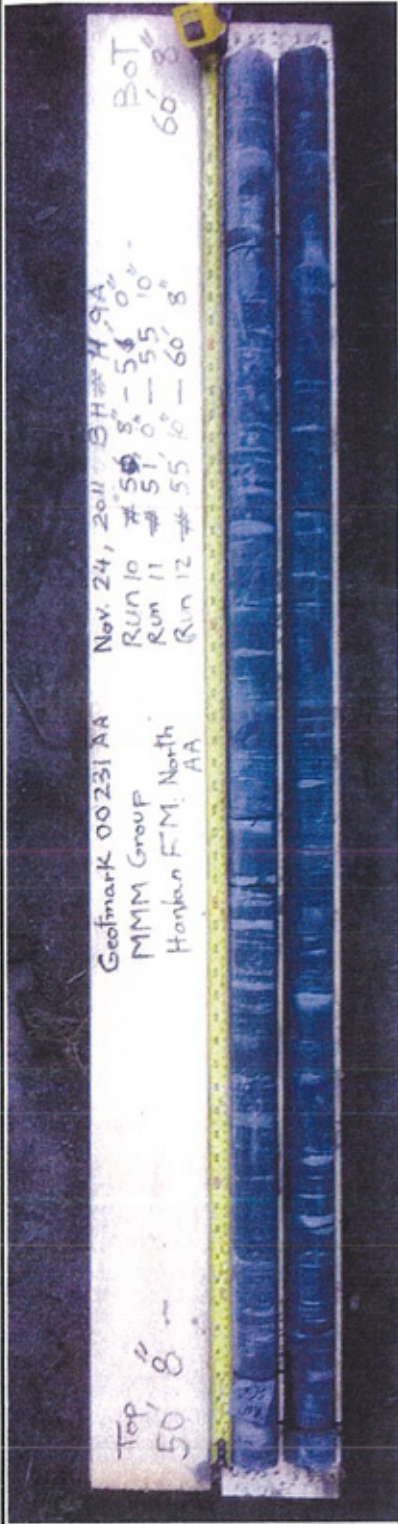


BH H09A, Runs 7 and 8

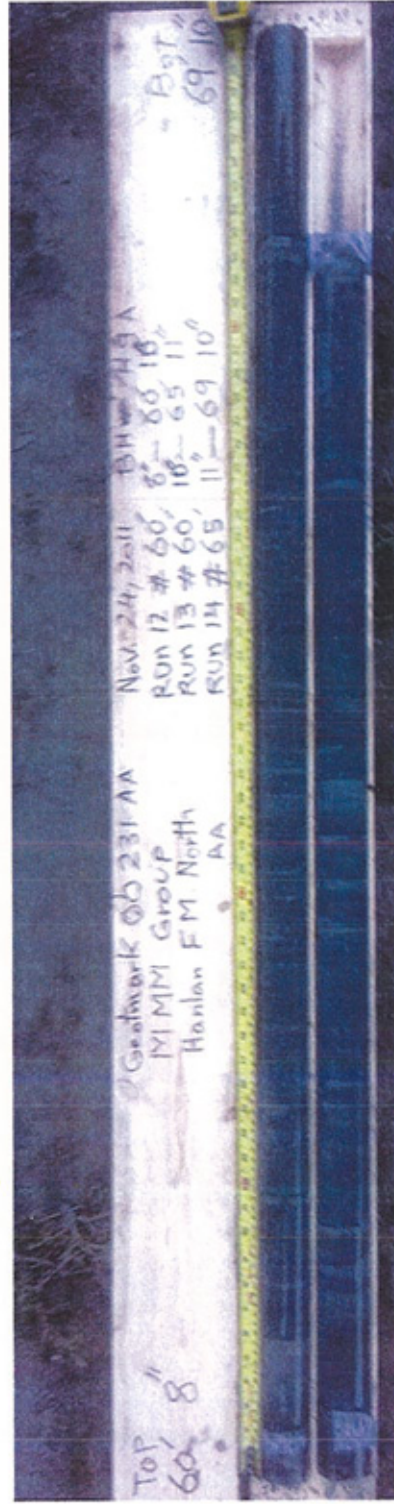


BH H09A, Runs 9 and 10


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approved	JN	project:	Hanlan Feedmain North
date	Mar-12	title:	ROCK CORE PHOTOGRAPHS
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BH H09A, Runs 10, 11 and 12

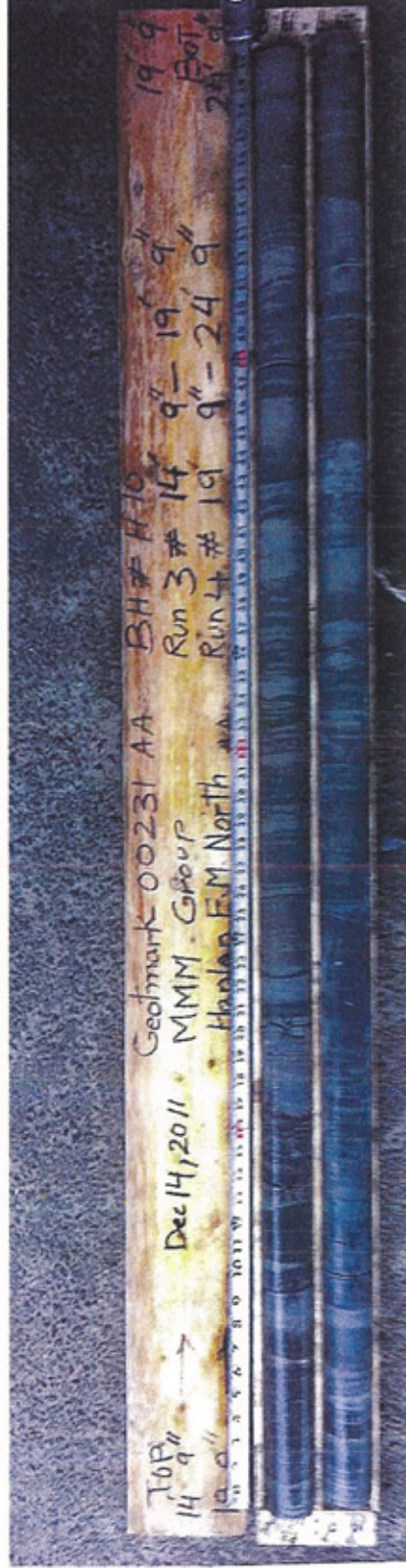


BH H09A, Runs 12, 13 and 14

drawn	AC	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	MMM Group
approved	JN		project:	Harlan Feedmain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
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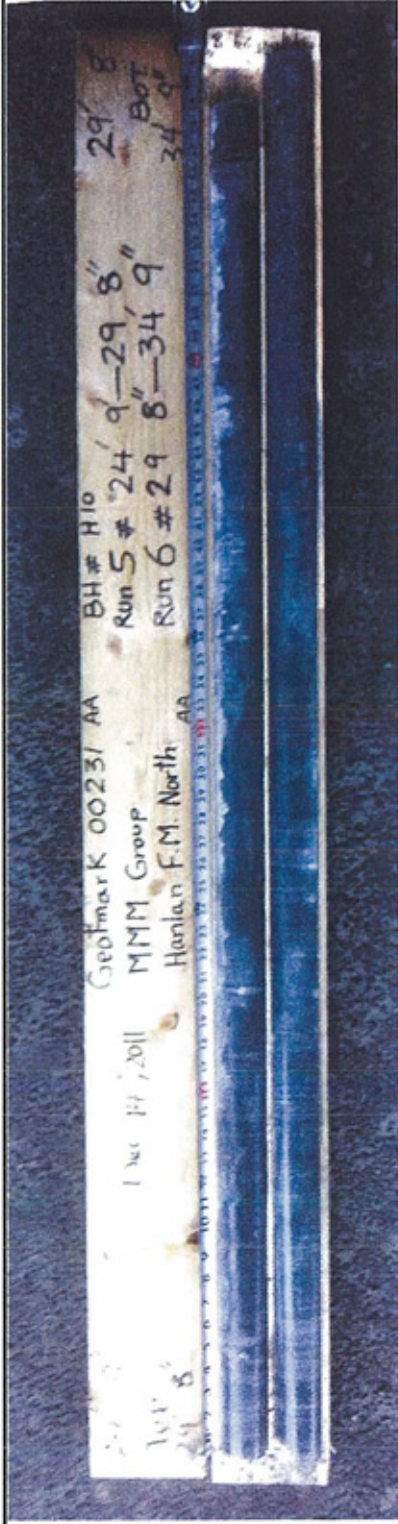


BH H10, Runs 01 and 02

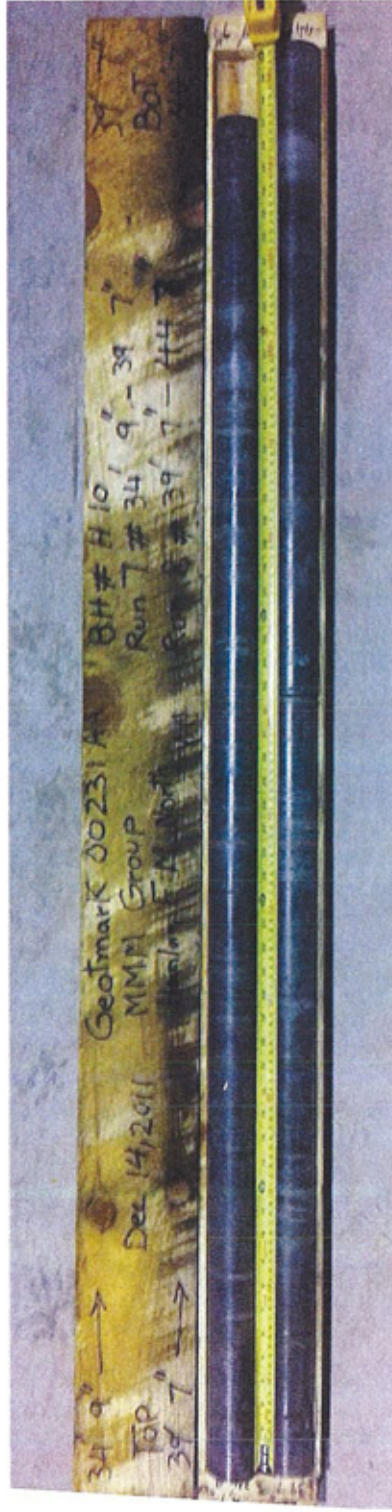


BH H10, Runs 03 and 04


drawn	AC	client:	MMM Group
approved	JN	project:	Hanlan Feedermain North
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original/size	letter	figure no:	D-25

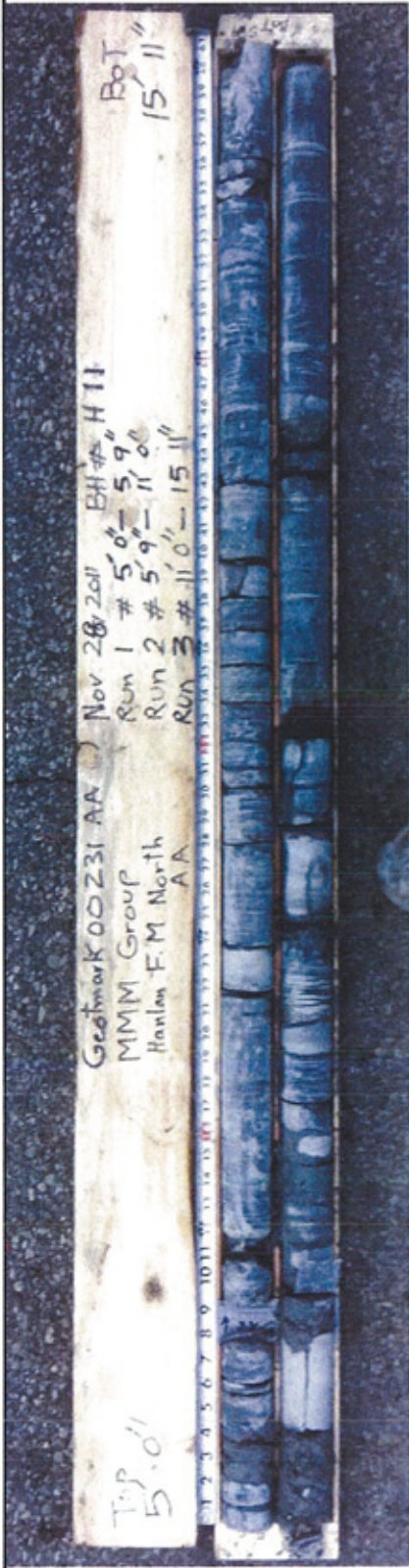


BH H10, Runs 05 and 06

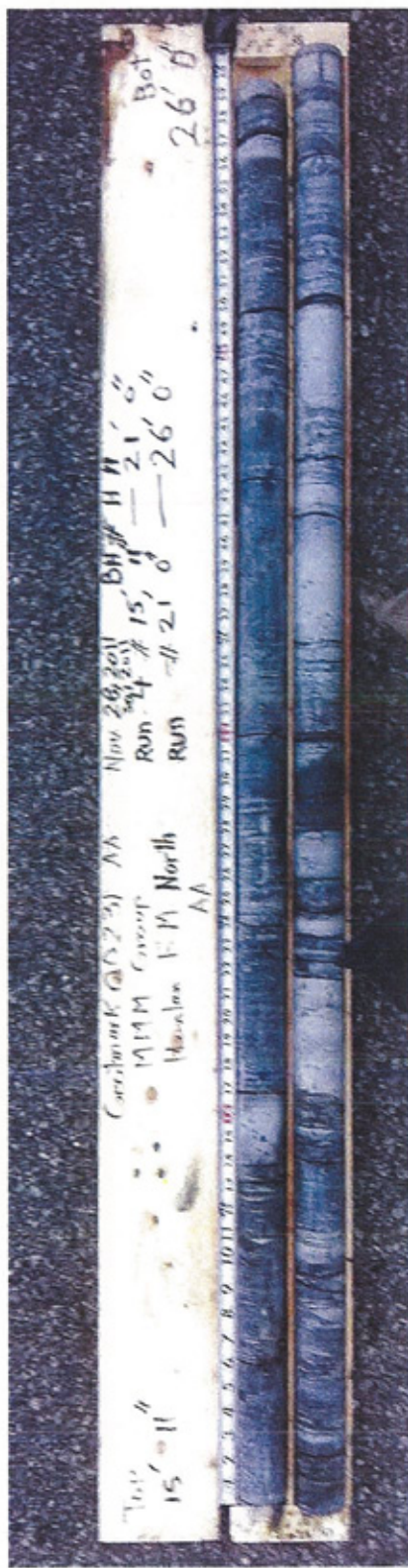


BH H10, Runs 07 and 08

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Hanlan Feedermain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original/size	letter		figure no:	D-26



BH H11, Runs 01, 02 and 03



BH H11, Runs 04 and 05

drawn	AC	client:	MMM Group
approved	JN	project:	Hanlan Feedmain North
date	Mar-12	title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S	project no:	GEOTMARK00231AA
original size	letter	figure no:	D-27



BH H11, Runs 06 and 07




BH H11, Runs 08 and 09

drawn	AC	client:	MMM Group
approved	JN	project:	Hanlan Feedmain North
date	Mar-12	title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S	project no:	GEOTMARK00231AA
original size	letter	figure no:	D-28

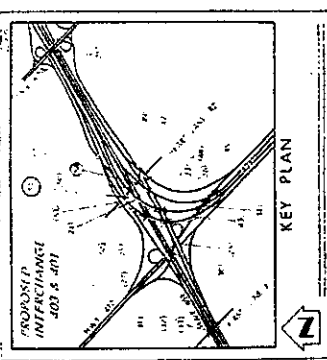


BH H11, Runs 10 and 11

drawn	AC	 SPECIALISTS MANAGING THE EARTH	client:	MMM Group
approved	JN		project:	Hanlan Feedermain North
date	Mar-12		title:	ROCK CORE PHOTOGRAPHS
scale	N.T.S		project no:	GEOTMARK00231AA
original size	letter		figure no:	D-29

Appendix E

General Arrangement Drawings of Existing Bridge Structures



LEGEND

- Bore Hole
- Case Test
- △ Bore Hole & Case Test
- ⊕ Water Level established at time of field investigation March 1973

NO.	ELEVATION	C.O. - ORIGINALLY	
		NORTH	EAST
1	56.4	15,457.75	959.217
2	56.4	15,457.75	959.217
3	56.8	15,457.75	959.217
4	56.8	15,457.75	959.217

NOTE
The boundaries between soil units have been established only as a guide. The actual boundaries between soil units are assumed to be continuous throughout the site.

REVISION	
NO.	DATE
1	1973

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATIONS OFFICE

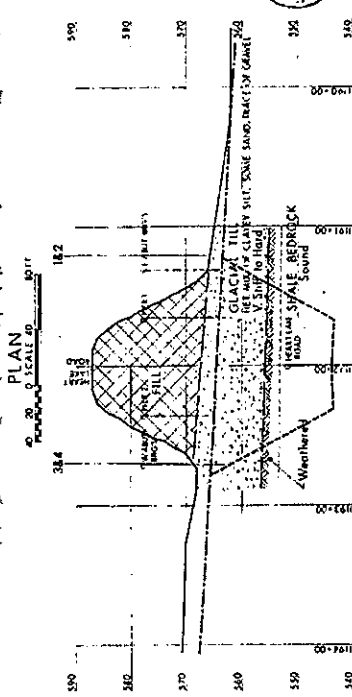
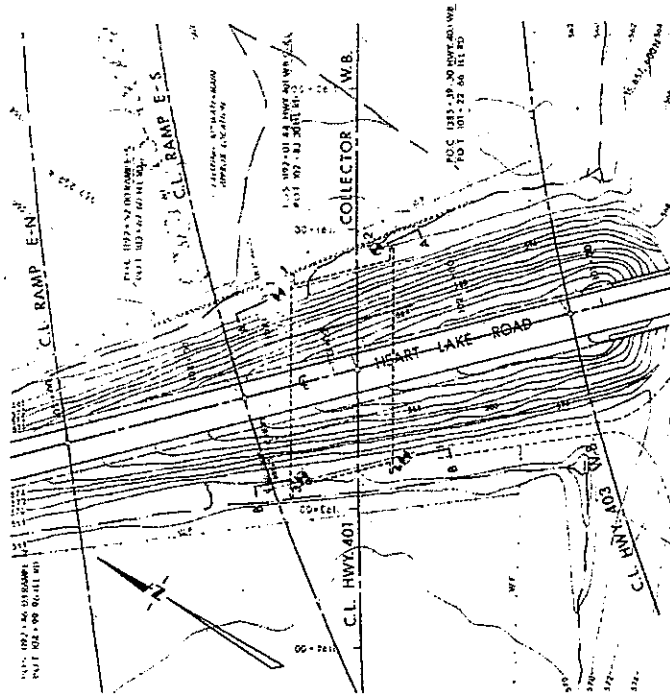
BRIDGE No. 51
HWY 401 W.B. OVER HEART LAKE ROAD
CO. BELLEVILLE DIST. NO. 6

TOWN OF MISSISSAUGA CO. COV.

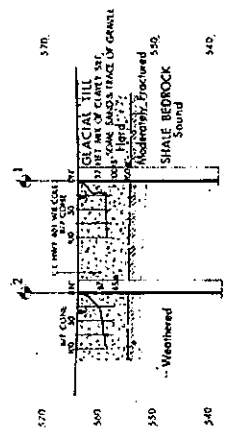
BORE HOLE LOCATIONS & SOIL STRATA

BORE HOLE NO.	DATE	DEPTH (M)	SOIL STRATA
1	1973	12.7	GLACIAL TILL
2	1973	12.7	GLACIAL TILL
3	1973	12.7	GLACIAL TILL
4	1973	12.7	GLACIAL TILL

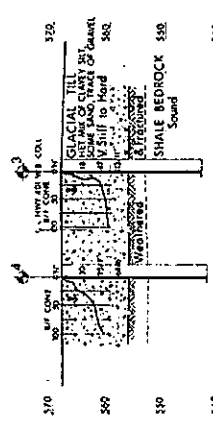
DATE: MAY 24, 1973
DRAWN: J. S. [illegible]
CHECKED: [illegible]
APPROVED: [illegible]



NOTE
The complete foundation investigation report for this project is available from the Ontario Ministry of Transportation and Communications, Design Services Branch, Foundations Office, Downsview, Ontario, Canada.

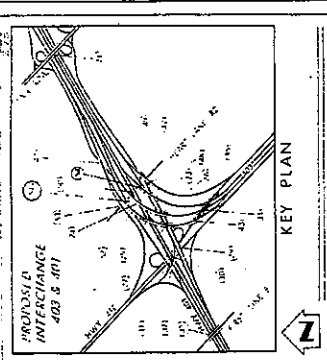


A - A



B - B

SECTIONS & PROFILE
HORIZONTAL SCALE 1" = 20 FT
VERTICAL SCALE 1" = 10 FT



LEGEND

- Bore Hole
- Core Penetration Test
- ◆ River (Hwy. & Core Test)
- ✈ Water Levels established at time of field investigation March 1973

NO	ELEVATION	COORDINATES	
		NORTH	EAST
1	54.4	15,857.752	959.212
2	54.4	15,857.700	959.276
3	54.8	15,857.697	959.137
4	54.8	15,857.614	959.137

NOTE —
The boundaries between soil units have been established only at the bore hole locations. Between Bore Holes the boundaries are assumed from geologic information.

REVISIONS	
NO.	DESCRIPTION
1	ISSUED

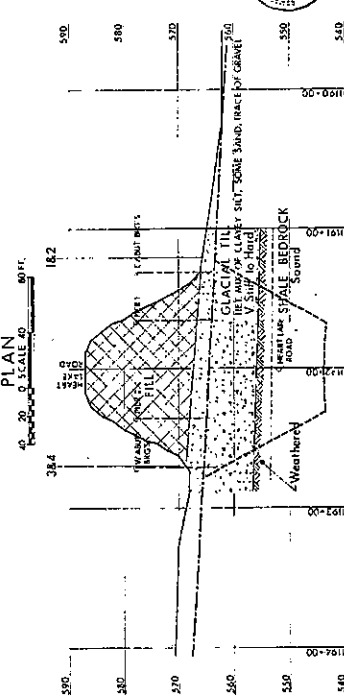
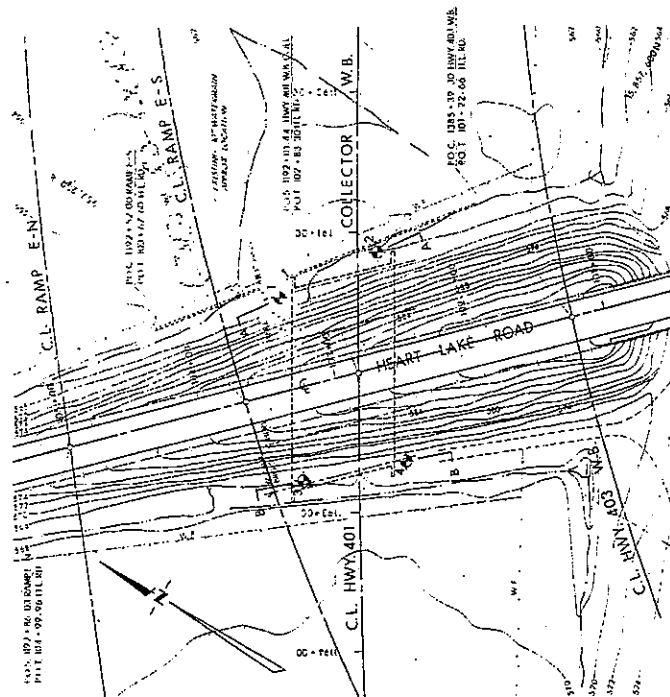
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATION DIVISION

BRIDGE No. 51
HWY 401 WB. COIL OVER HEART LAKE ROAD
HIGHWAY NO. 401 & 403 DIST NO. 6
CO. PEEL TOWN OF MISSISSAUGA, ONT. COM.

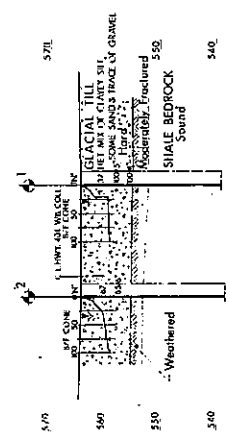
BORE HOLE LOCATIONS & SOIL STRATA

STANDARD NO.	CHECKED BY	DATE	REVISION NO.
1000	W. K. COLE	1973-04-10	1
1001	W. K. COLE	1973-04-10	1
1002	W. K. COLE	1973-04-10	1
1003	W. K. COLE	1973-04-10	1
1004	W. K. COLE	1973-04-10	1
1005	W. K. COLE	1973-04-10	1
1006	W. K. COLE	1973-04-10	1
1007	W. K. COLE	1973-04-10	1
1008	W. K. COLE	1973-04-10	1
1009	W. K. COLE	1973-04-10	1
1010	W. K. COLE	1973-04-10	1

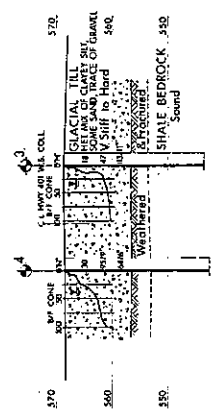
DATE: MAY 24, 1973
APPROVED: [Signature]
PROJECT NO. 25-16
DRAWING NO. 24-314-2



NOTE:
The complete foundation investigation report for this project is available from the District Office and the District Office, Downsview, and at the District Office.

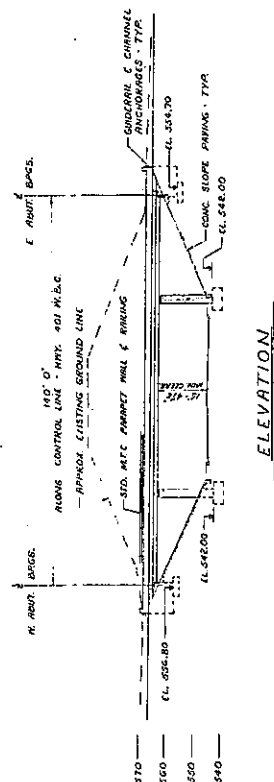
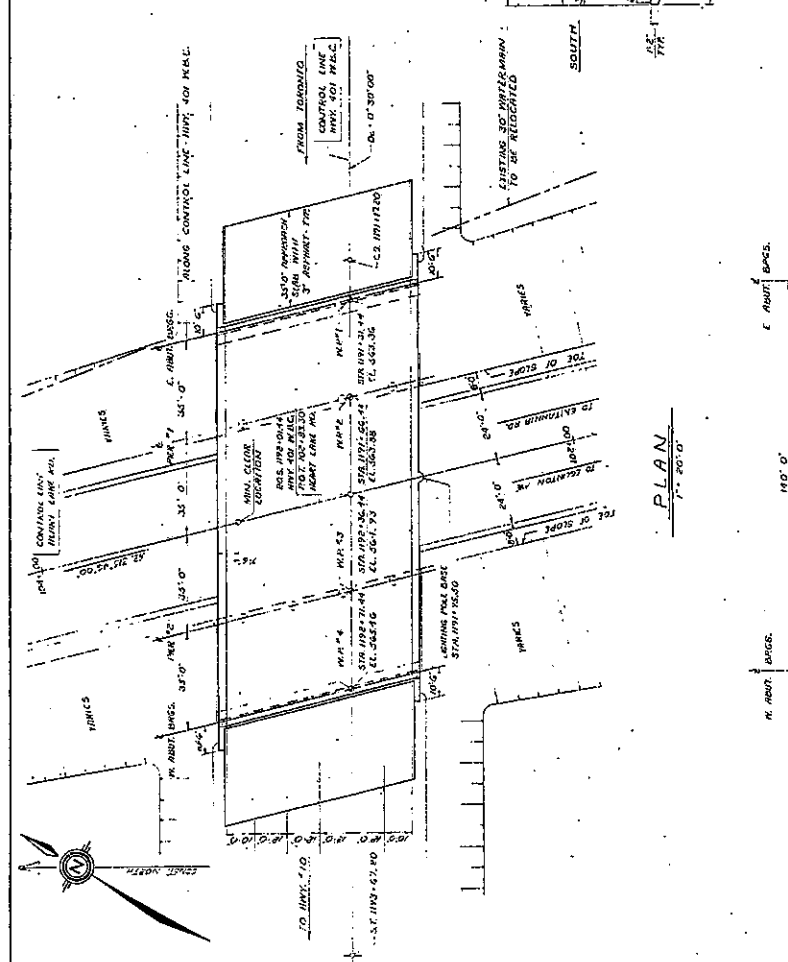
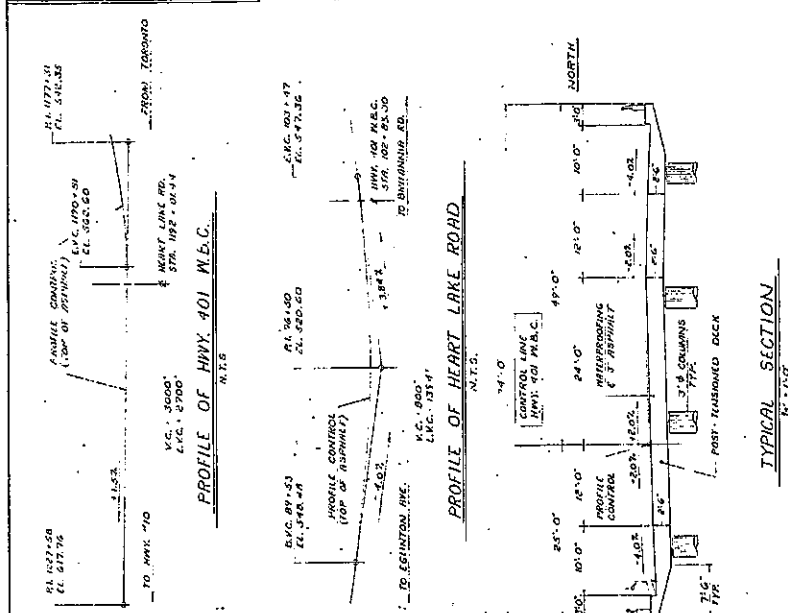
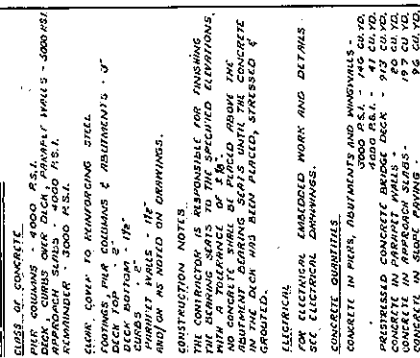


A - A



B - B

SECTIONS & PROFILE
HORIZ. 40' 20' 0' SCALE 40' 20' FT.
VERT. 10' 5' 0' SCALE 40' 20' FT.



LIST OF DRAWINGS	
SHEET 1	GENERAL LAYOUT
2	BASE RAIL LOCATIONS & SOIL STRATA
3	FOOTING LAYOUT
4	ABUTMENT REINFORCING
5	PIER DETAILS
6	PIER DETAILS & DETAILS
7	PIER DETAILS & DETAILS
8	DECK LAYOUT & ELEVATIONS
9	CABLE DETAILS
10	DECK REINFORCING II
11	DECK REINFORCING II
12	PARAPET WALL DETAILS
13	STANDARD STEEL PARAPET RAIL
14	DETAILS OF CONC. SLOPE PAYING
15	STANDARD DETAILS I
16	STANDARD DETAILS II
17	ELECT. WIRING WORK
SHEET 18	ELECT. STANDARD 6.

[illegible]

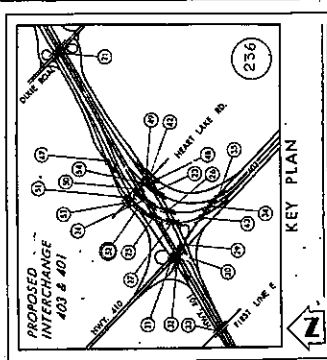
FOR REDUCED PLAN

USE SCALE BELOW

10 9 8 7 6 5 4 3 2 1 0

INCHES ON ORIGINAL DRAWING

TEMP 81-314-1-A



LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Notes: Tests established in the field from geologic logs and logs.

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	563.8	15,857,727	939,224
2	563.6	15,857,637	939,183
3	568.3	15,857,663	939,074
4	572.4	15,857,692	938,966
5	574.9	15,857,368	938,907
6	576.6	15,857,370	938,830

NOTE:
The complete foundation investigation file for this project may be obtained from the Engineer in Charge of the project. The data contained in this file and any supplementary file, is specifically included in accordance with the conditions of Section 602.2 of Form D20.

NOTE:
The boundaries between soil strata have been established only at Bore Hole locations. Between bore holes the boundaries are assumed to be straight lines.

END SHEET

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE

BRIDGE No. 52
HWY 403 W.B. OVER HWY 401 W.B.
REG. MUN. OF FEELE DIST. NO. 6

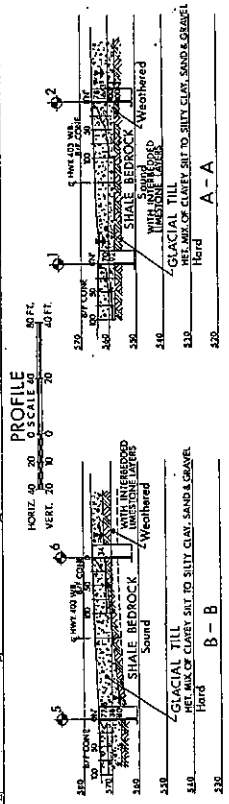
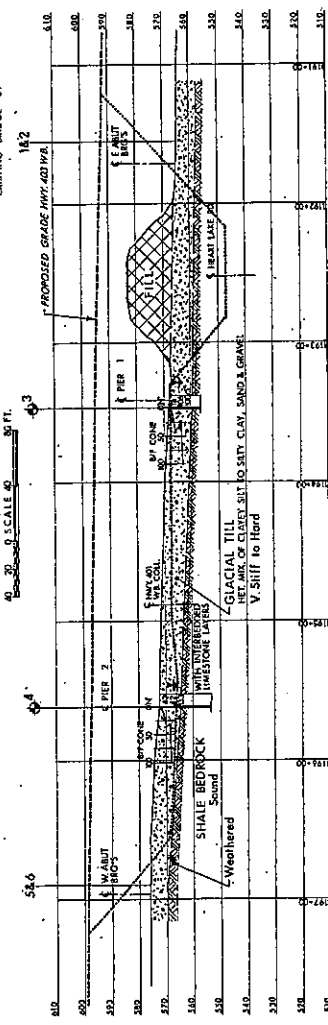
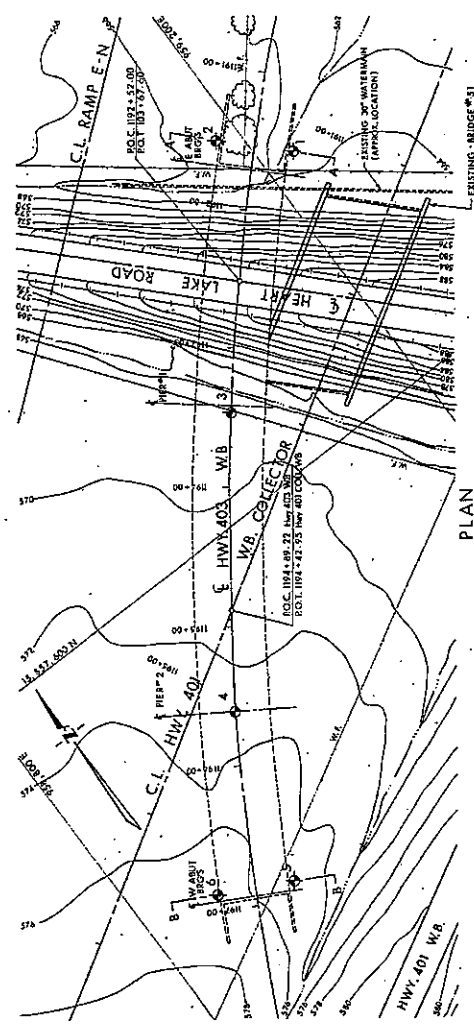
CITY OF MISSISSAUGA LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

STATION: V.E. [unclear] W.B. NO. 127-65-07 DRAWING NO. 24-315-2
DRAWN S.E. [unclear] W.D. NO. 24-315
DATE OCT. 15, 1973 SHEET NO. 76-120
APPROVED: [signature] CONT. NO. 76-120

Typed 91-315-2-A

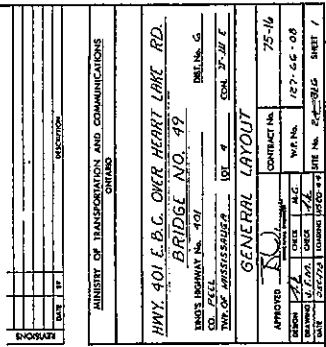
NOTE:
Consult on plan and order to construction of bridge No. 52.

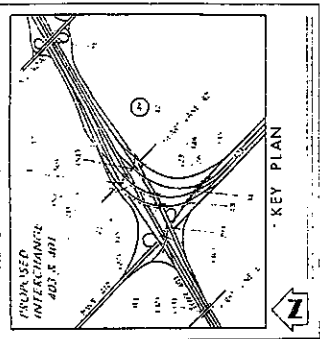


SECTIONS
20 10 0 SCALE 20 40 FT.

REF NO. ENCO 3783-31-3

[illegible]

[illegible][illegible]



LEGEND

- ◆ Bore Hole
- ⊕ Core Penetration Test
- ⊕ Bore Hole & Core Test
- Water Level established at time of field investigation (March 1973)

NO	ELEVATION	CO-ORDINATES	
		TORONTO	EAST
1	564.4	857.272	859.671
2	565.5	857.207	859.791
3	568.2	857.191	859.576
4	567.8	857.137	859.790

NOTE:
The complete foundation investigation report for this study may be obtained from the Structural Office of the Ontario Highway Design Office at the 100th Street, Ontario Highway Design Office.

NOTE
The foundation bearing capacity has been established and the bore hole locations have been determined from the geological evidence.

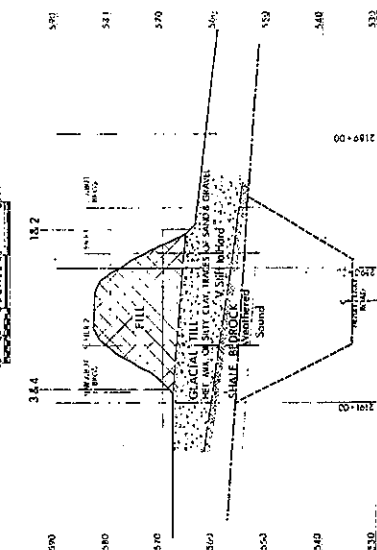
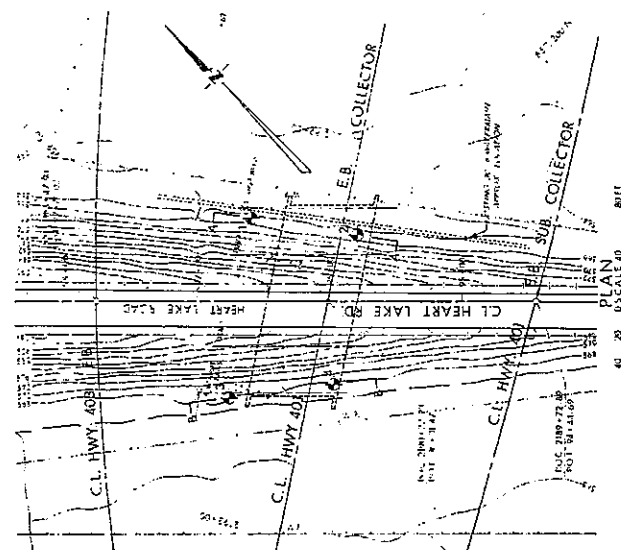
ELEVATION	
1	564.4
2	565.5
3	568.2
4	567.8

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
DESIGN SERVICES BRANCH-FOUNDATIONS OFFICE

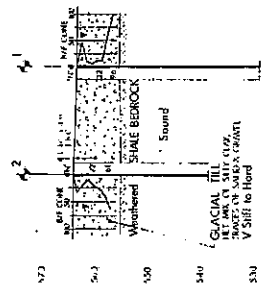
BRIDGE No. 49
HWY 401 EB COLLECTOR OVER HEART LAKE ROAD
CO. 1000

JOHN OF MISSISSAUGA LOT CON
DRAWING NO. 72-11157A
DATE MAY 5, 1973
PROJECT NO. 75-16
SHEET NO. 24-316-2

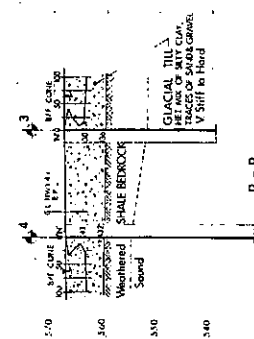
BORE HOLE LOCATIONS & SOIL STRATA
HEART LAKE ROAD
HWY 401 EB COLLECTOR
DRAWING NO. 72-11157A
DATE MAY 5, 1973
PROJECT NO. 75-16
SHEET NO. 24-316-2



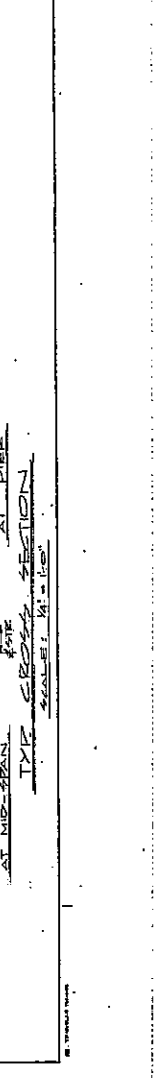
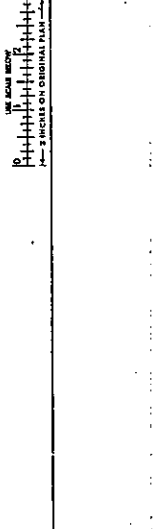
PROFILE & SECTIONS
HEART LAKE ROAD
HWY 401 EB COLLECTOR
DRAWING NO. 72-11157A
DATE MAY 5, 1973
PROJECT NO. 75-16
SHEET NO. 24-316-2

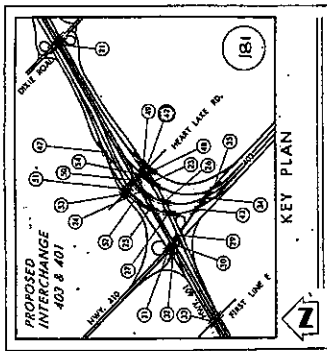


A-A



B-B





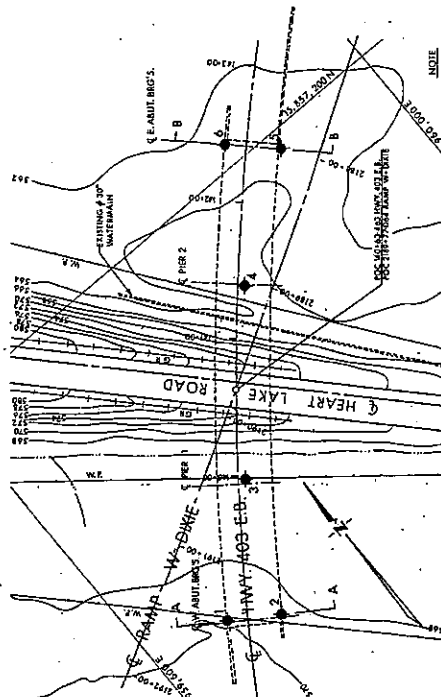
LEGEND

- Core Hole
- Cone Penetration Test
- Bore Hole & Core Test
- Worst Levels established or Line of Field Investigation, Aug. & Sept. 1973

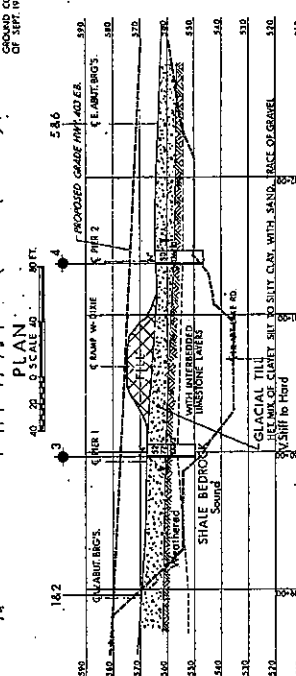
NO.	ELEVATION		COORDINATES	
	NORTH	EAST	NORTH	EAST
1	508.5	15,856,948	955,001	
2	509.5	15,856,926	955,095	
3	507.7	15,857,017	955,737	
4	504.4	15,857,127	955,827	
5	505.1	15,857,187	955,911	
6	502.9	15,857,215	955,880	

NOTE
The boundaries between soil types have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed to be straight lines.
The complete borehole investigation file for this project may be obtained at the Highway Engineering Division, Ontario Ministry of Transportation, 127-128-09, Queen's Park, Toronto, Ontario, Canada.
This investigation file is specifically included in accordance with the conditions of Section 072-7 of Form 100.

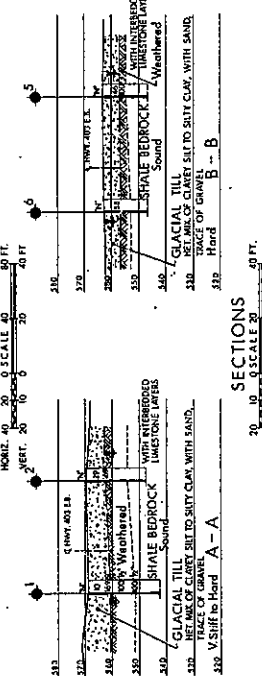
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO	
ENGINEERING DIVISION - TORONTO OFFICE	
BRIDGE No. 42 - DIXIE	
HWY. 403 - HWY. 210 INTERCHANGE	
REG. MUN. OF PEEL	
CONTRACT NO. 76-120	DIST. NO. 6
CITY OF MISSISSAUGA, 101	
BORE HOLE LOCATIONS & SOIL STRATA	
DATE: 12/1/73	BY: J.E. 127-128-09
DESIGNED BY: J.E. 127-128-09	QUANTITY NO.
CHECKED BY: J.E. 127-128-09	DATE: 12/1/73
APPROVED BY: J.E. 127-128-09	DATE: 12/1/73



NOTE: GROUND CONDITIONS AS OF SEPT. 1973

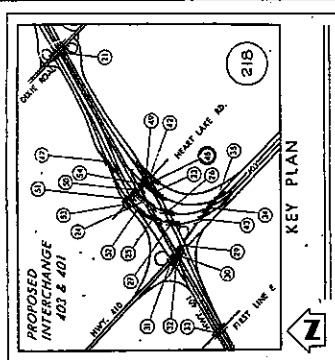


PROFILE - HWY 403 E.B.



SECTIONS

REF: No. 127-128-09



LEGEND

- Bore Hole
- Cone Penetration Test
- ⊕ Bore Hole & Cone Test
- Water Levels established at time of field investigation, July 1973.

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	564.4	15,857,072	959,826
2	568.0	15,857,066	959,739
3	567.7	15,857,017	959,737
4	564.4	15,857,127	959,827

NOTE
The complete location investigation file for this project may be obtained from the Ontario Highway Research Board. This file contains all field notes and any supplementary files specifically prepared in accordance with the conditions of Section 102-2 of the R.O.C.

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

RECEIVED		DATE	BY
CASHIER			

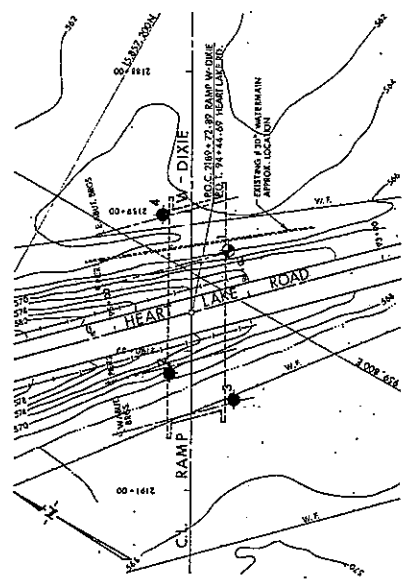
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE

BRIDGE No. 48

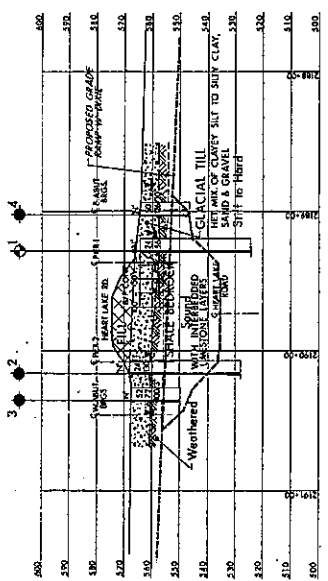
RAMP W-DIXIE OVER HEART LAKE RD.
HIGHWAY NO. 401/203 DIST. NO. 6
CITY OF MISSISSAUGA LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

STATION V.L. (CHUCKER) W.P. NO. 127-66-44 DRAWING NO.
STATION V.L. (CHUCKER) W.P. NO. 127-66-44 DRAWING NO.
DATE OCTOBER 5, 1973 SHE NO. 24-331 BRIDGE DRAWING NO.
APPROVED: 16-12-73 24-331-2 2
DRAWING NO. 16-12-73 24-331-2



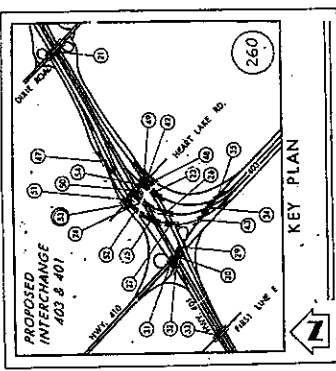
NOTE
GROUND CONDITIONS AS OF OCT. 1973



PROFILE
HORIZ. 0 20 40 60 80 FT.
VERT. 0 20 40 60 FT.

REF No: ENCLOSURE 3983-24-1

16/87-81-331-2-A



LEGEND

- ◆ Bore Hole
- ⊕ Cone Penetration Test
- ⊕ Bore Hole & Cone Test

Notes: 1. Bore holes established at time of field investigation, Aug. 1973.

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	566.8	15,857,851	959,083
2	567.3	15,857,251	959,056
3	567.3	15,857,288	959,015
4	569.5	15,857,215	958,992

NOTE

The complete foundation investigation file for this project may be obtained from the Ontario Highway Research Board, 2000 Yonge Street, Toronto, Ontario. The data presented in this file and any appendices thereto are specifically included in accordance with the conditions of Section 102-7 of Form 100.

NOTE

The boundaries between soil zones have been established only at the locations shown. It is recommended that the boundaries be confirmed from geological evidence.

NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	566.8	15,857,851	959,083
2	567.3	15,857,251	959,056
3	567.3	15,857,288	959,015
4	569.5	15,857,215	958,992

BRIDGE No. 53
RAMP E-N OVER HEART LAKE ROAD

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-DESIGN OFFICE

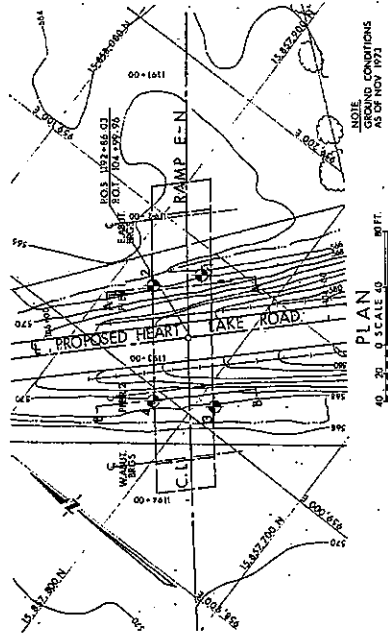
CITY OF MISSISSAUGA

PROJECT NO. 107
CONTRACT NO. 107-100

DATE NOV. 8, 1973

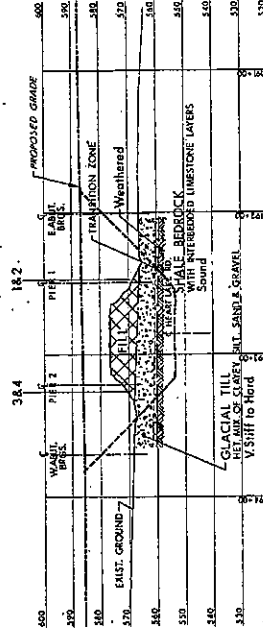
DESIGNED BY: [Signature]
CHECKED BY: [Signature]
DRAWN BY: [Signature]
DATE NOV. 8, 1973

APPROVED: [Signature]



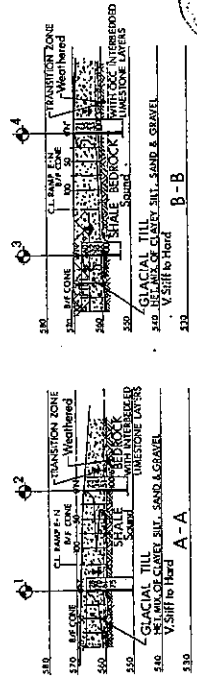
NOTE

CONTOUR CONDITIONS AS OF NOV. 1973



PROFILE

HORIZ. 1" = 20' SCALE 20' 0" FT.
VERT. 1" = 20' SCALE 20' 0" FT.



SECTIONS

HORIZ. 1" = 20' SCALE 20' 0" FT.
VERT. 1" = 20' SCALE 20' 0" FT.

REF. NO. FENCO 3983-3K-3

TOTAL 81-332-3A

DIST No. 6
CONT No. 82-108
WP No. 127-66-71

HWY. 403 E.B. EXPRESS
OVER HWY. 401 E.B. COLLECTOR
& RAMP 'W'-DIXIE (BRIDGE NO. 23)
GENERAL ARRANGEMENT

PLANMAC CONSULTANTS LTD.
CONSULTING ENGINEERS & PLANNERS

METRIC
DIMENSIONS ARE IN MILLIMETRES
OVER 1000 ARE IN METRES
ELEVATIONS ARE IN METRES
AND ALLEGATIONS ARE IN METRES
STATIONS ARE IN KILOMETRES + METRES

HORIZONTAL CURVE DATA				
CURVE	#1	#2	#3	#603
Δ	8°10'45"	14°47'55"	—	8°17'42"58"
R (m)	2323.500	1746.375	—	800.000
L (m)	332.403	461.070	—	903.896
E (m)	5.944	14.684	—	222.384
T (m)	166.485	226.799	—	502.419
Δ	—	—	—	80.960
Δ	—	—	—	100.000
Δ	—	—	—	20.321

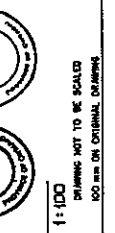
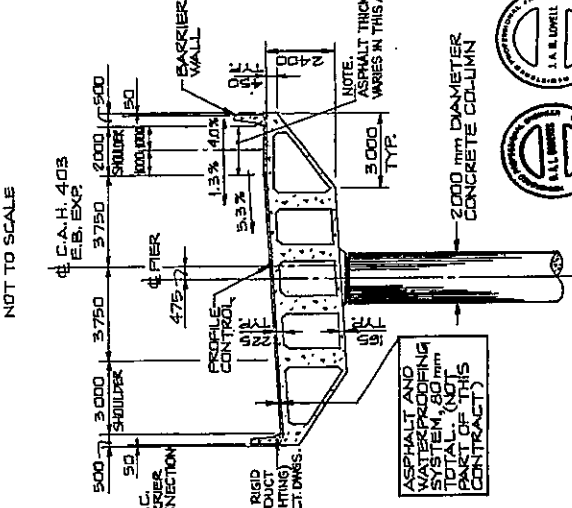
CONCRETE QUANTITIES FOR LUMP SUM TENDER ITEMS	
ABUTMENTS	174 m³
WING WALLS	68 m³
PIERS	78 m³
DECK	2517 m³
BARRIER WALLS	121 m³
APPROACH SLABS	38 m³
SLOPE PAVING	122 m³

- GENERAL NOTES**
- CLASS OF CONCRETE
 - DECK AND PIERS --- 35 MPa
 - ABUTMENTS, WING WALLS AND BARRIER WALLS --- 30 MPa
 - REMAINDER --- 20 MPa
 - CLEAR COVER TO REINFORCING STEEL
 - FOOTINGS --- 100 ± 25 mm
 - ABUTMENTS AND WING WALLS --- 80 ± 20 mm
 - FRONT FACE --- 70 ± 20 mm
 - BACK FACE --- 80 ± 20 mm
 - PIERS --- 80 ± 20 mm
 - DECK TOP SLAB --- 70 ± 20 mm
 - BOTTOM --- 40 ± 10 mm
 - 90° TOP SLAB --- 40 ± 10 mm
 - TOP --- 40 ± 10 mm
 - WING WALLS --- 40 ± 10 mm
 - BARRIER WALLS AND APPROACH SLABS --- 70 ± 20 mm
 - EXCEPT AS OTHERWISE NOTED.
 - REINFORCING STEEL
 - REINFORCING STEEL SHALL BE GRADE 400
 - WELDS OF REINFORCING STEEL SHALL BE MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS.
 - CONSTRUCTION NOTE
 - THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ± 3 mm.

LIST OF DRAWINGS

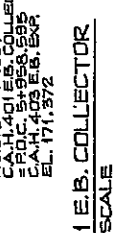
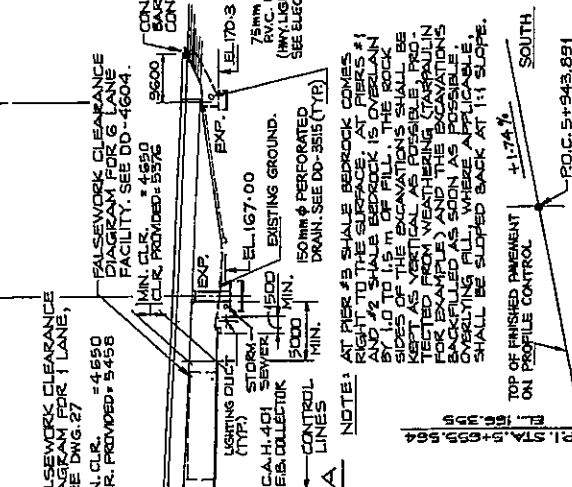
- GENERAL ARRANGEMENT
- BOREHOLE LOCATION AND SOIL STRATA
- FOOTING LAYOUT
- FOOTING REINFORCING
- NORTH ABUTMENT
- SOUTH ABUTMENT
- N.W. & S.E. WING WALLS
- N.E. & S.W. WING WALLS
- PIER AND BEARING DETAILS
- DECK DETAILS
- VOID LAYOUT
- DECK REINFORCING I
- DECK REINFORCING II
- EXPANSION ASSEMBLIES
- LONGITUDINAL POST-TENSIONING I
- LONGITUDINAL POST-TENSIONING II
- TRANSVERSE POST-TENSIONING I
- TRANSVERSE POST-TENSIONING II
- BARRIER WALL - EAST ELEVATION
- BARRIER WALL - WEST ELEVATION
- 6000 mm APPROACH SLAB
- DETAILS OF CONCRETE SLOPE PAVING
- BRIDGE DATE AND SITE NUMBER DATA
- AS CONSTRUCTED ELEV. AND DIM.
- STANDARD DETAILS

PROFILE OF C.A.H. 403 E.B. EXPRESS
NOT TO SCALE



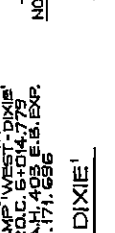
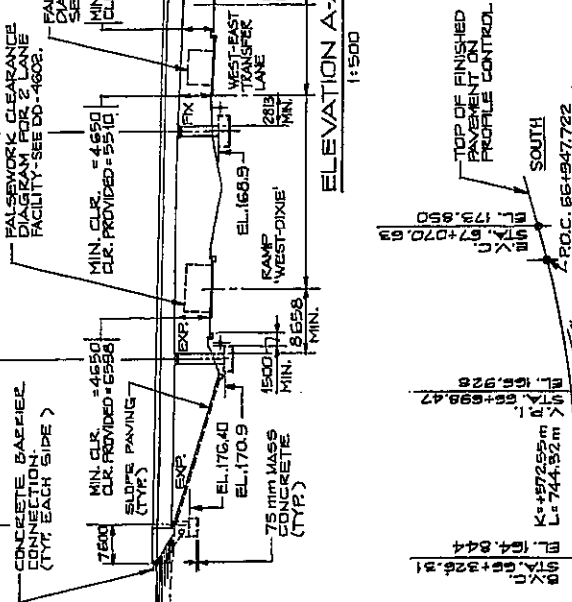
SECTION
11:00
100 mm ON ORIGINAL DRAWING

PROFILE OF C.A.H. 401 E.B. COLLECTOR
NOT TO SCALE

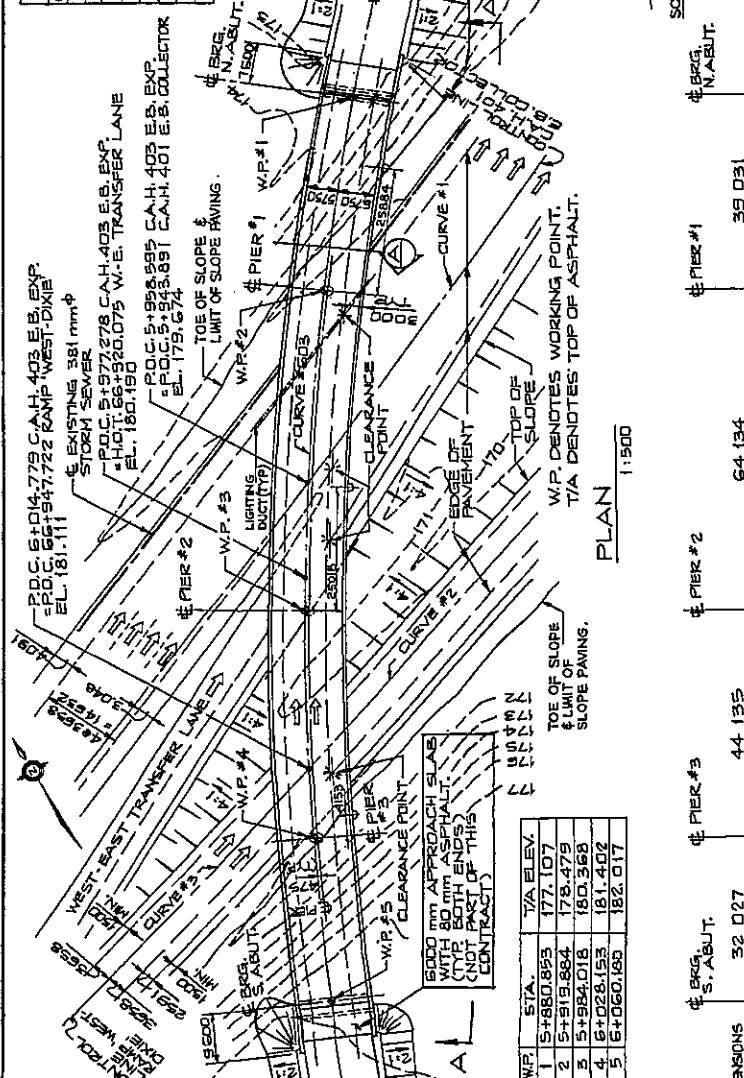


SECTION
11:00
100 mm ON ORIGINAL DRAWING

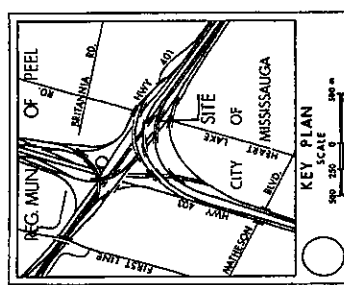
PROFILE OF RAMP 'WEST TO DIXIE'
NOT TO SCALE



SECTION
11:00
100 mm ON ORIGINAL DRAWING



W.P.	STA.	T/A ELEV.
1	5+780.055	177.107
2	5+918.884	178.478
3	5+984.018	180.368
4	6+028.153	181.402
5	6+060.180	182.017



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blow/0.3m (Std Pen Test, 475 J/blow)
- CONE Blow/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 82 02 16
- WL not encountered in Bore Holes 2, 3, 4, 5, 10 & 11

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	173.2	4 833 271-0	292 421-5
2	170.3	4 833 220-5	297 406-0
3	170.2	4 833 166-0	292 379-0
4	171.5	4 833 132-5	292 351-5
5	179.3	4 833 101-0	292 329-0
10	171.1	4 833 330-0	292 498-0
11	172.8	4 833 294-0	292 440-0

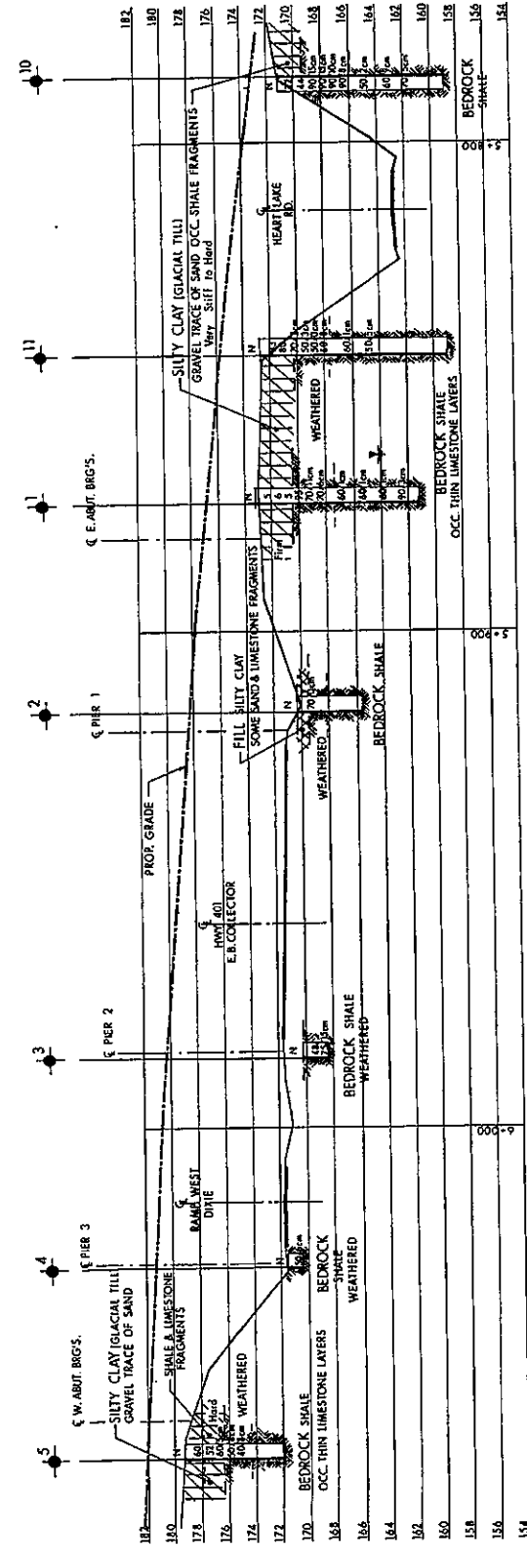
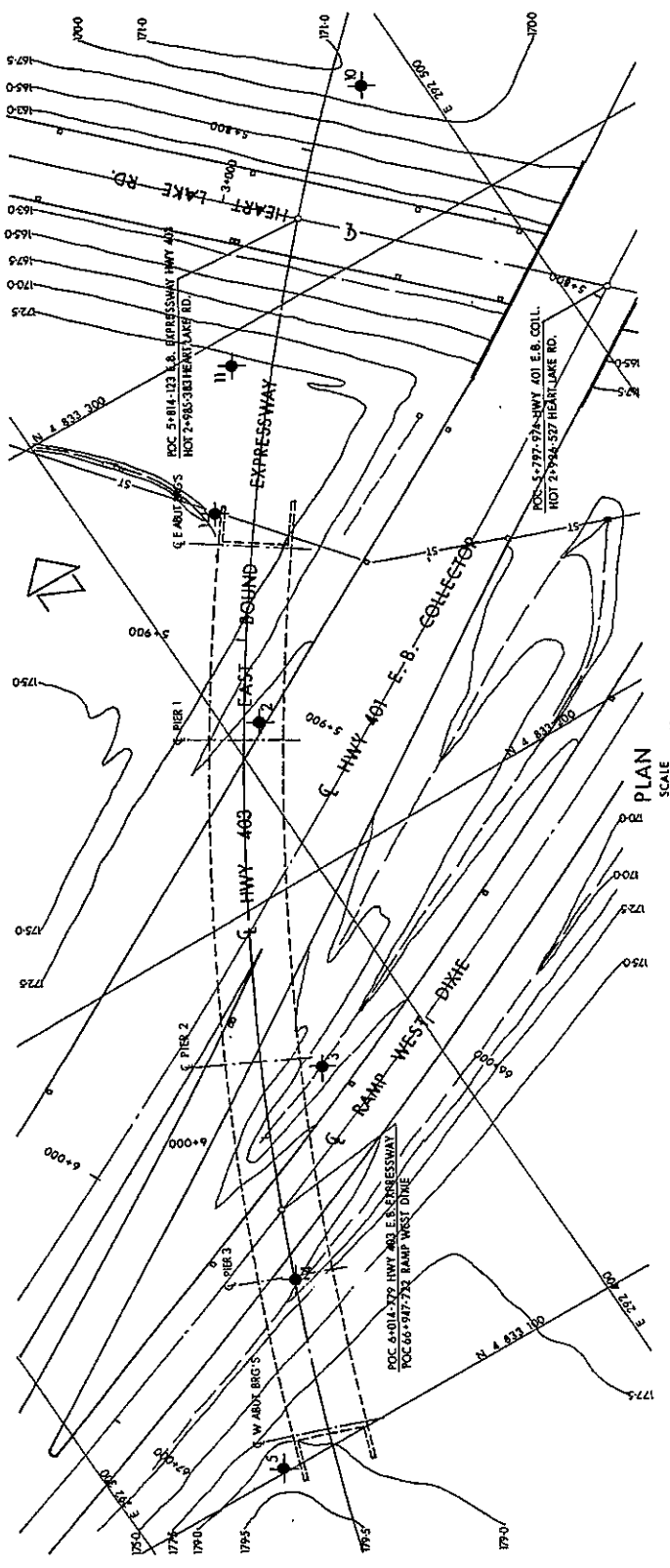
NOTE:-
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

DATE	BY	DESCRIPTION
1982	155	Geotechnical Investigation

Geotechnical Investigation
HWY No 403
DATE 82 03 18
DRAWN BY 155
CHECKED BY 155

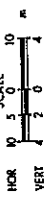
METRIC

NOTE: DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
DIMENSIONS IN KILOMETRES - METRES



NOTE:
The complete foundation investigation file for this project may be obtained from the Geotechnical Office. Information contained in this file and any supplementary file is specifically included in accordance with the conditions of Section 102-2 of Form 105

PROFILE HWY 403 E.B. EXPRESSWAY



METRIC

W.P.	STA.	T/A ELEV.
1	5+87.220	173.328
2	5+803.220	173.984
3	5+825.220	174.886
4	5+841.220	175.542

© 2010 WILEY-BLANKET INC.

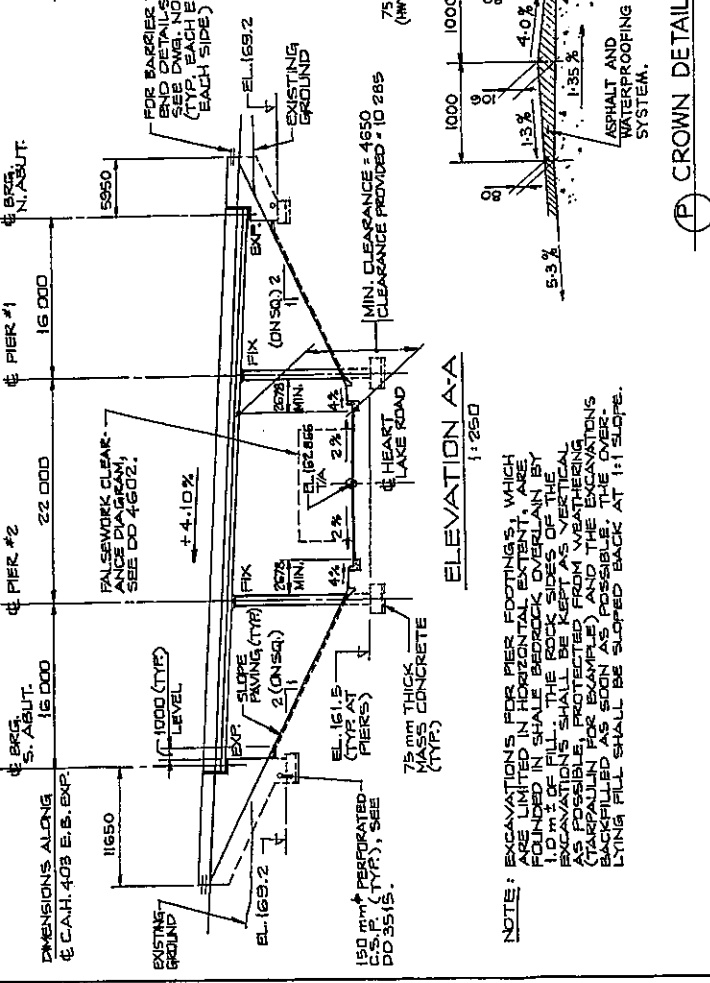
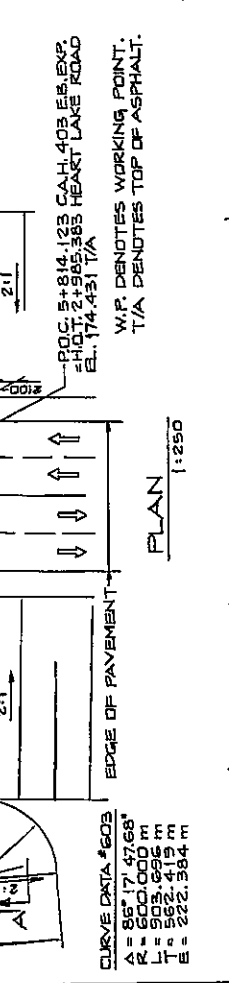
N. ABUT;
TOP OF
SLOPE

ENOTES WORKING POINT.
ENOTES TOP OF ASPHALT.

Figure 1


-
- 2 - 1000 mm ϕ
REIN. CONC.
COLUMNS.
- 100%
BARRIER WALL

-
- 1000V CABLE
- 1000V CABLE
- 1000V CABLE
- EXISTING GROUND
- EL. 169.2
- BENT
- CLEARANCE = 4650
- CLEARANCE PROVIDED = 10 285
- 75% (MAX)
- 1000
- 1000




NOTE: EXCAVATIONS FOR PIER FOOTINGS, WHICH ARE UNIFORM IN HORIZONTAL EXTENT, ARE TO BE FOUND IN SHALE BEDROCK OVERLAIN BY 1.0 m OF FILL. THE ROCK SIDES OF THE EXCAVATIONS SHALL BE KEPT AS VERTICAL AS POSSIBLE (SEE EXAMPLE). THE EXCAVATIONS SHALL BE BACKFILLED AS SOON AS POSSIBLE. THE OVERLYING FILL SHALL BE SLOPED BACK AT 1:1 SLOPE.

DIST No. 6
CONT No. 82-105
WP No. 127-66-71



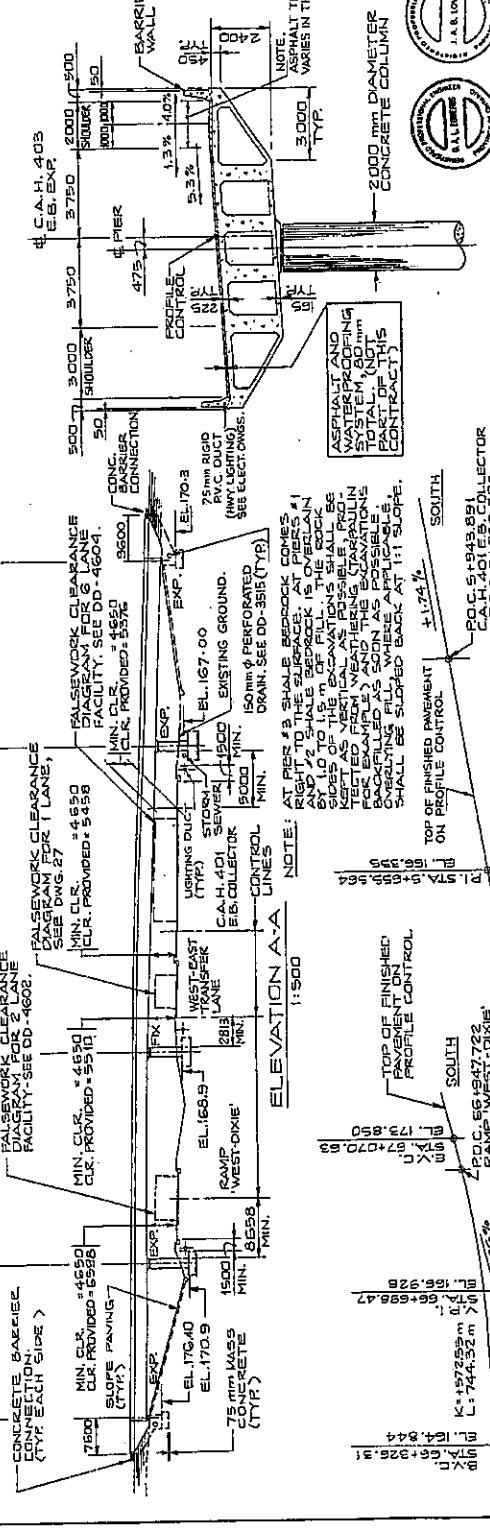
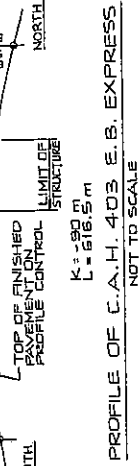
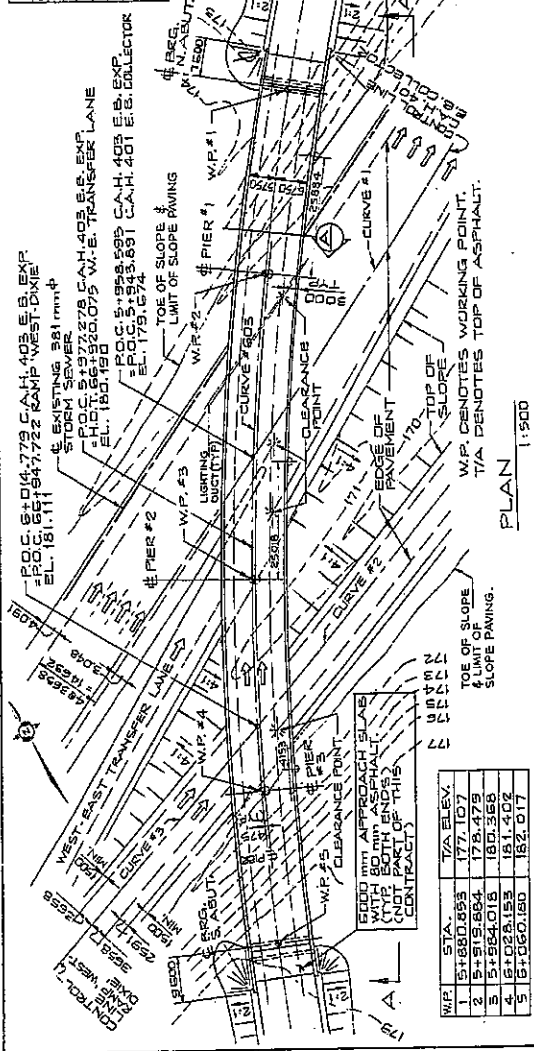
HWY 403 E.B. EXPRESS
OVER HWY 401 E.B. COLLECTOR
& RAMP 'W'-DIXIE (BRIDGE No. 23)
GENERAL ARRANGEMENT



SHEET
33


PLANIMATIC CONSULTANTS LTD.
CONSULTING ENGINEERS & PLANNERS

METRIC
 DIMENSIONS ARE IN MILLIMETRES
 UNLESS OTHERWISE STATED.
 ALL DIMENSIONS ARE TO FACE UNLESS
 STATIONS ARE IN METRES + METRES.

HORIZONTAL CURVE DATA				
CURVE	#1	#2	#3	#4
A	0+10.45	14+47.65	---	0+174.00
L (m)	330.500	174.675	---	800.000
E (m)	332.403	451.070	---	903.998
F (m)	6.944	14.664	---	222.364
T (m)	166.485	225.759	---	502.419
L _s (m)	---	---	100.000	---
S ₁ (m)	---	---	20.320	---
S ₂ (m)	---	---	20.320	---

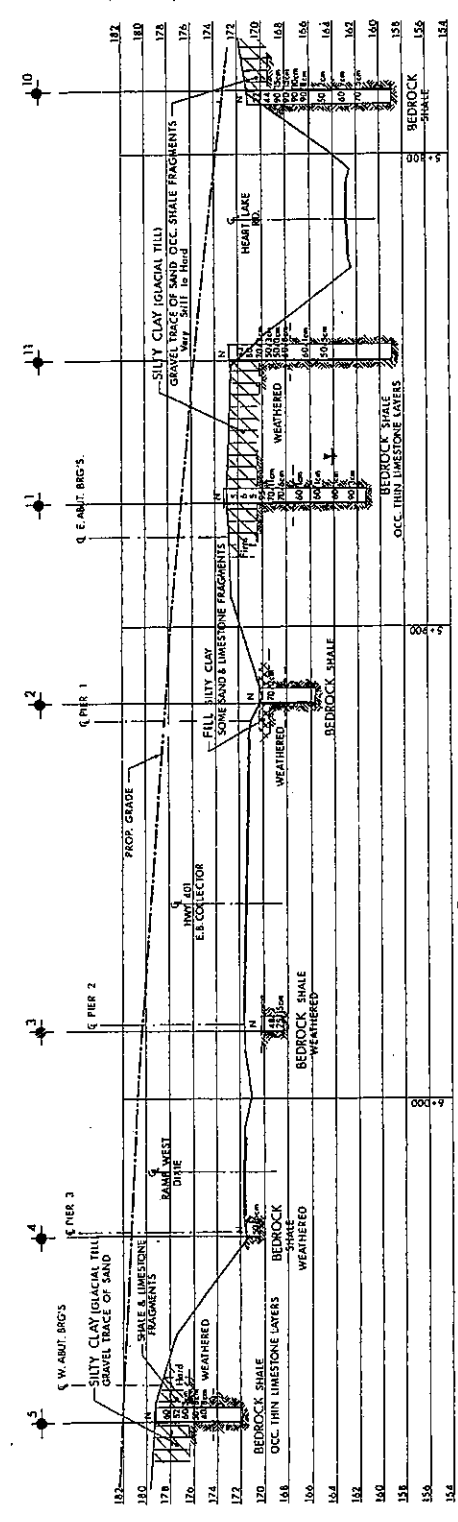
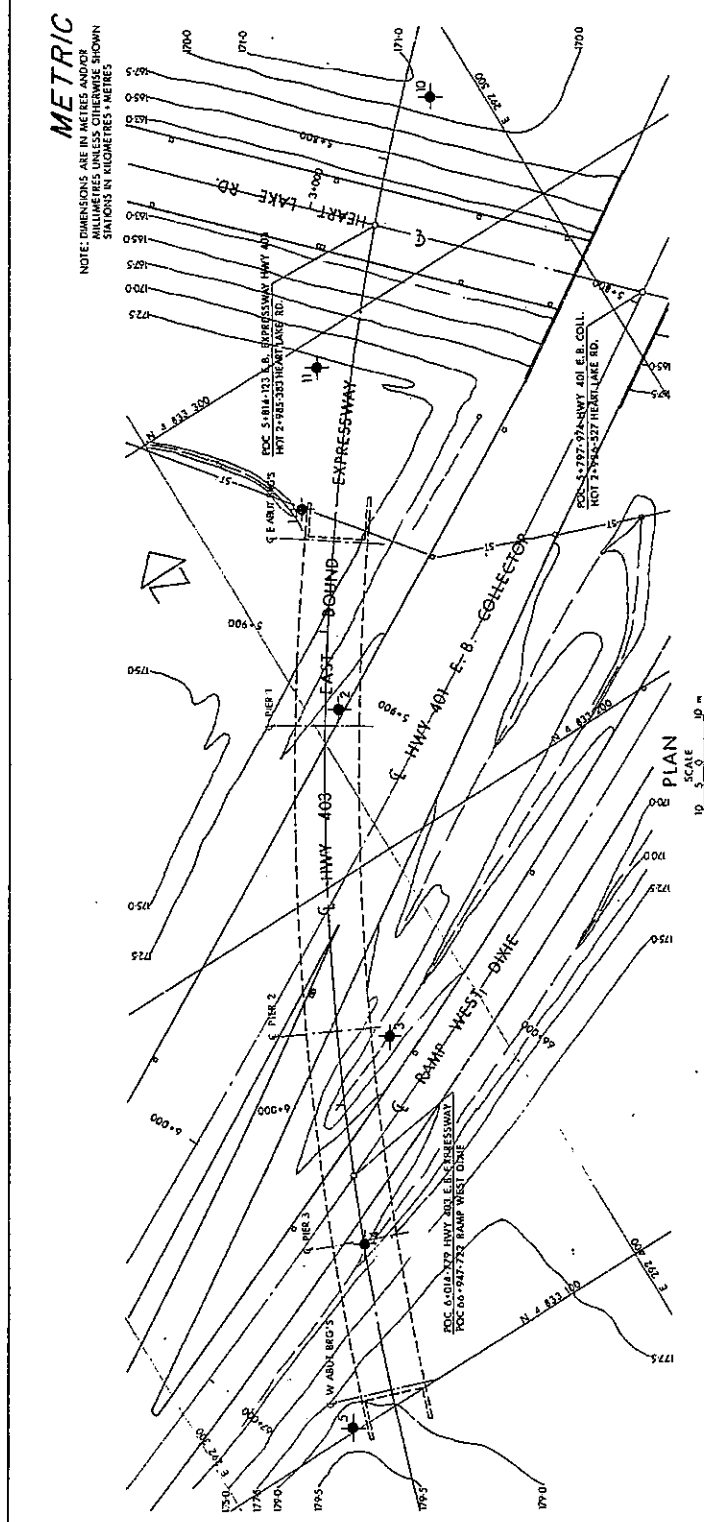


SECTION 1:100
 DRAWING NOT TO BE SCALED
 100 mm ON ORIGINAL DRAWING

PROFILE OF RAMP 'WEST TO DIXIE'
 NOT TO SCALE

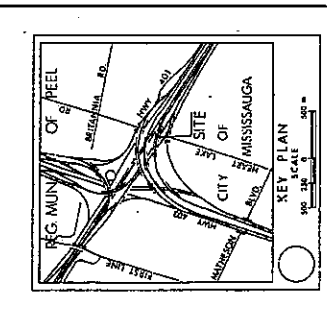
PROFILE OF C.A.H. 401 E.B. COLLECTOR
 NOT TO SCALE



PROFILE HWY 403 E. B. EXPRESSWAY

NOTE: The complete foundation investigation file for this project may be examined at the Engineering Materials Office, Downsview, Ontario, Canada. This file includes all test results and photographs of test specimens. It is recommended that this file be consulted in conjunction with the conditions of Section 100.2 of the contract.

CONT No 82-103
WP No 127-66-71
HWY 403 E.B. EXPRESSWAY CROSSING
RAMP WEST DIKE & HWY 401 E.B. COLLECTOR
BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N 10m/30m (30' Conn. 475 1/2' Blow)
- CONE Blow/30m (30' Conn. 475 1/2' Blow)
- WT at time of investigation 82 02 16

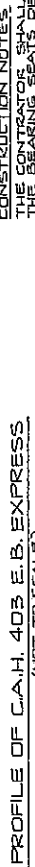
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	173.2	4 833 271.0	292 421.5
2	170.3	4 833 230.5	297 406.0
3	170.2	4 833 166.0	292 379.0
4	171.5	4 833 02.5	292 351.5
5	179.3	4 833 101.0	292 329.0
6	171.1	4 833 300.0	292 290.0
7	172.6	4 833 294.0	292 440.0

NOTE:
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geotechnical evidence.

STATION	DATE	BY	DESCRIPTION
1	1967	1	1
2	1967	1	1
3	1967	1	1
4	1967	1	1
5	1967	1	1
6	1967	1	1
7	1967	1	1

Site 24-81-46SA-A2

W.P.	STA.	T/A ELEV.
1	5+787.220	173.328
2	5+805.220	173.984
3	5+825.220	174.886
4	5+841.220	175.542

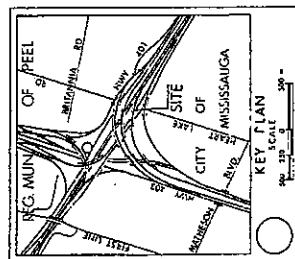


- 4950 —



(P) CROWN DETAIL

2



LEGEND	
◆	Bare Hole
⊕	Dynamic Cone Penetration Test (Cone)
⊗	Bore Hole & Cone
N	Flow/D3m [Sid Pen Test, 475 J/blow]
CONC	Flow/D3m [50° Pen Test, 475 J/blow]
→	WT at time of investigation #2 02 16 WT not encountered in Bore Holes 2, 3, 4, 5, 10 & 11

No	ELEVATION	CO. PERMANENT NO. 1-1	PERMANENT ELEV.
1	173.2	4 833 271-0	292 421.5
2	170-3	4 833 220-5	297 400-0
3	170-2	4 833 166-0	292 379-0
4	171-5	4 833 182-5	297 331-5
5	179-3	4 833 101-0	292 329-0
6	171-1	4 833 330-0	292 290-0
7	172-8	4 833 284-0	292 440-0

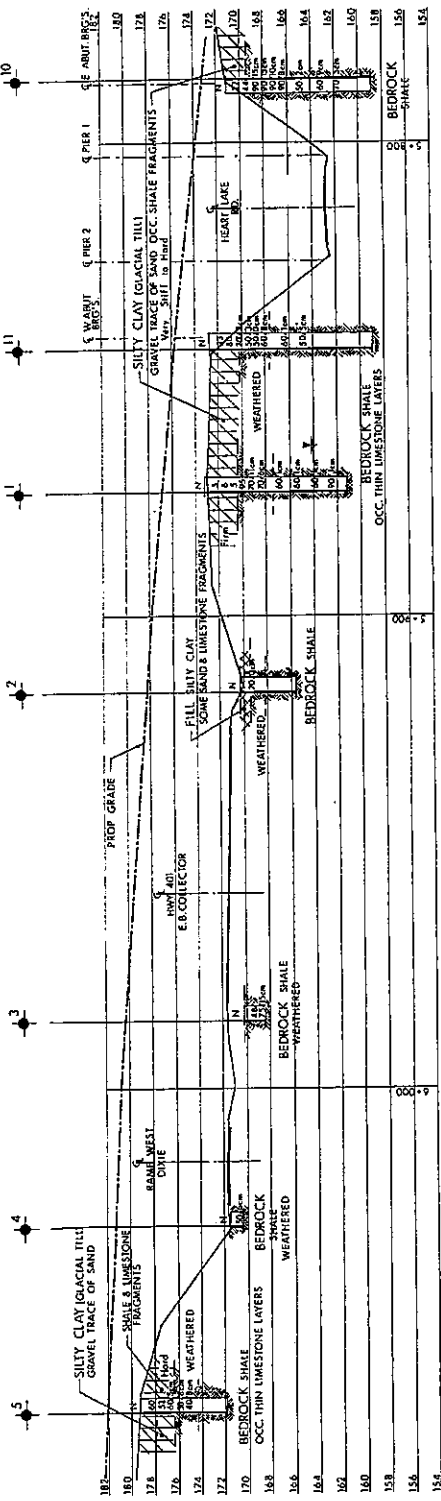
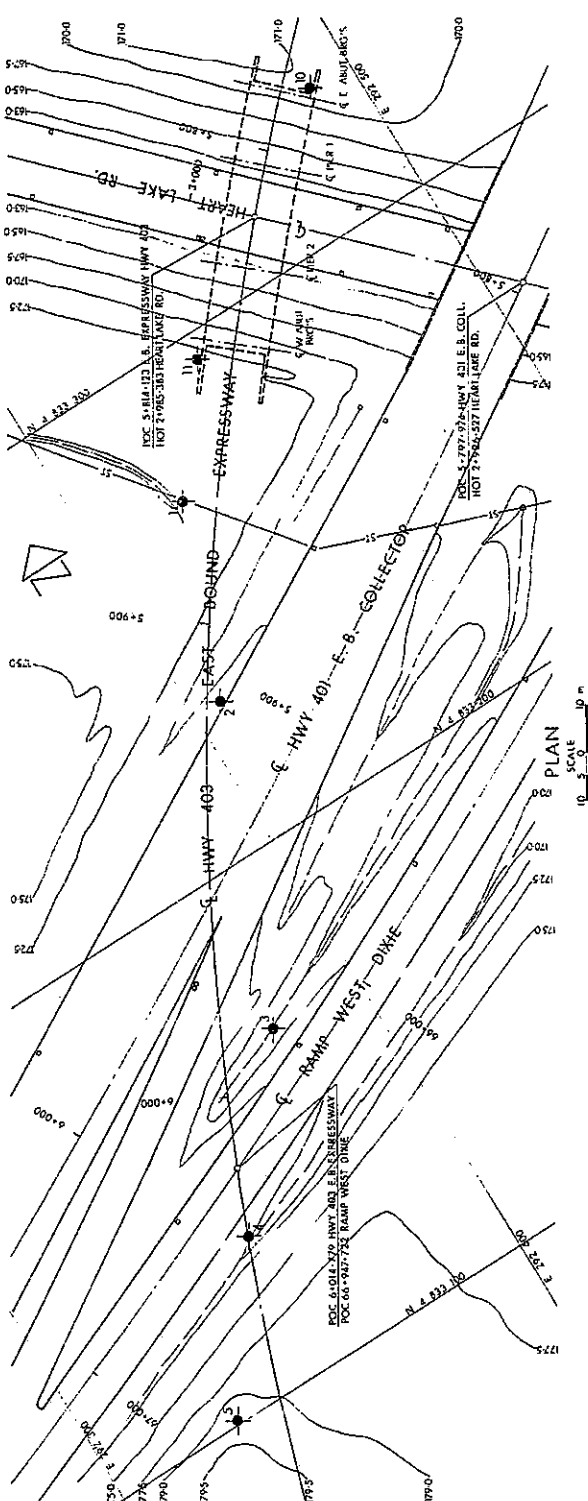
NOTE—The boundaries between soil strata have been established only at 30-cm hole locations. Between 30-cm holes the boundaries are assumed from geological evidence.

[illegible]

Site 24-B1-465B-B2

METRIC

NOTE: DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
STATIONS IN KILOMETRES • METRES



SCALE



	DIST No. 6	WP No. 127-66-73	SHEET
	HWY. 403 E.B. OVERPASS AT HEART LAKE ROAD (BRIDGE No. 54) GENERAL IMPROVEMENT		
PLANMAC CONSULTANTS LTD. CONSULTING ENGINEERS & PLANNERS			

METRIC

DIMENSIONS ARE IN MILLIMETRES
 UNLESS OTHERWISE SHOWN.
 ALL DIMENSIONS ARE TO CENTRE
 UNLESS OTHERWISE NOTED.
 STATIONS ARE IN KILOMETRES + METRES.

NOTES

- CLASS OF CONCRETE
 DECK AND COLLUMS --- 35 MPa
 ABUTMENTS, WINGWALLS --- 30 MPa
 AND BARRIER WALLS --- 20 MPa
 REMAINDER ---
- CLEAR COVER TO REINFORCING STEEL
 FOOTINGS --- 100 mm
 ABUTMENTS AND WINGWALLS --- 50 mm
 DECK --- 20 mm
 PIER --- 20 mm
 DECK --- 20 mm
 BARRIER WALLS AND APPROACH SLABS --- 40 mm
 EXCEPT AS OTHERWISE NOTED.

REINFORCING STEEL

REINFORCING STEEL SHALL BE
 SPECIFIED AND MARKED WITH
 THE SUPPLIER'S NAME AND
 GRADE.

CONSTRUCTION NOTES

THE CONTRACTOR SHALL FINISH
 THE SURFACE TO THE SPECIFIED
 ELEVATIONS TO
 A TOLERANCE OF ± 3 mm.

COUNTY: 24 TOWNSHIP: 24 RANG: 24 DRAWING TYPE: 24 SCALE: 24

ISSUED

100 17 DEC

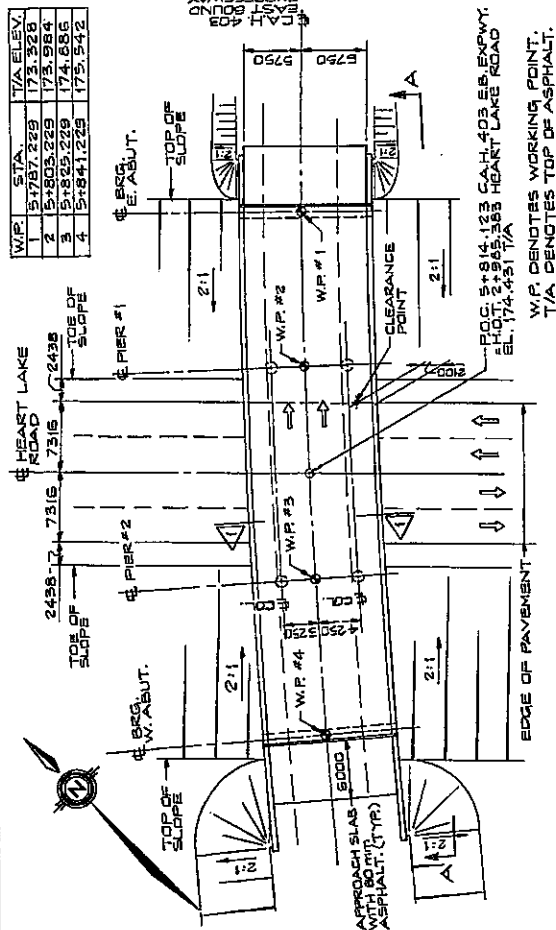
PLANMAC CONSULTANTS LTD.
 CONSULTING ENGINEERS & PLANNERS

SECTION A-A SCALE 1:100

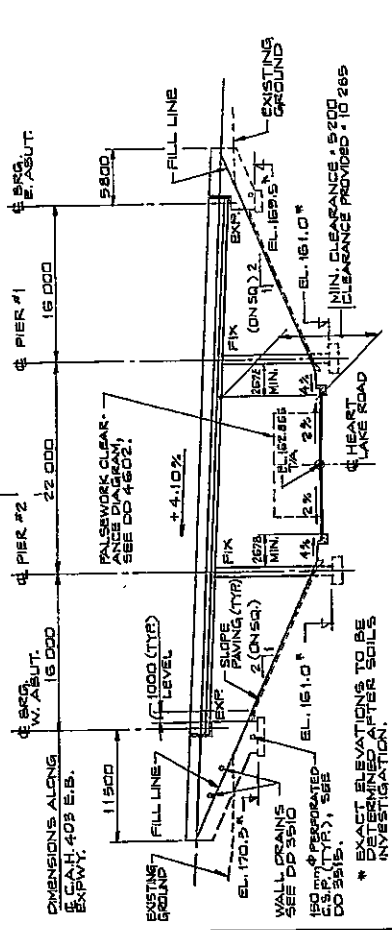
DRAWING NOT TO BE SCALED
 100 mm ON ORIGINAL DRAWING

REVISION NO. DATE BY DESCRIPTION
--

W.P.	STA.	T/A ELEV.
1	5737.228	173.328
2	5737.228	173.328
3	5737.228	173.328
4	5737.228	173.328



PLAN SCALE 1:250



ELEVATION A-A SCALE 1:250

DIST. 6	CONT No. 82-108	SHEET 111
	WP No. 127-66-74	
HWY 403 W.B. EXPRESS OVER BRIDGE NO. 24 GENERAL ARRANGEMENT		
FENCO CONSULTANTS LTD.		

METRIC

DIMENSIONS ARE IN METRES
 ELEVATIONS, COORDINATES, CURVE
 AND ALIGNMENT DATA ARE IN METRES
 STATIONS ARE IN METRES + METRES

NOTES:

CLASS OF CONCRETE

COLUMNS & DECK... 35MPa
 ABUTMENTS & BARRIER WALLS... 30MPa
 REMAINDER... 20MPa

REINFORCING STEEL

GRADE 400. BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS.

CLEAR COVER TO REINF. STEEL

FOOTINGS 100±25
 PIERS 80±20
 ABUTMENTS: FACING FACE 80±20
 BACK FACE 70±10
 DECK: TOP SLAB 80±20
 BOTTOM SLAB 40±10
 WEIR SIDES 40±10
 REMAINDER 70±20 OR AS SHOWN ON STANDARD DRAWINGS.

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR
 FINISHING THE ABUTMENT BEARING
 SEATS TO THE SPECIFIED
 ELEVATIONS WITH A TOLERANCE OF ±5 mm.

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATION & SOIL STRATA
3. PILING LAYOUT
4. SOUTH ABUTMENT SHEET I
5. NORTH ABUTMENT SHEET I
6. PIER DETAILS
7. PIER DETAILS
8. DECK LAYOUT
9. SCREED ELEVATIONS
10. LONGITUDINAL CABLE DETAILS
11. LONGITUDINAL CABLE REINFORCING DETAILS
12. TRANSVERSE CABLE DETAILS - SHEET I
13. TRANSVERSE CABLE DETAILS - SHEET II
14. DECK REINFORCEMENT - SHEET I
15. DECK REINFORCEMENT - SHEET II
16. BARRIER WALLS
17. BARRIER WALLS
18. 8000 APPROACH SLAB PAVING
19. DETAILS OF CONC. SLAB & BARRIER
20. APPROACH JOINT DETAILS
21. BRIDGE DATA (SHEET NUMBER DATA)
22. BRIDGE DATA (SHEET NUMBER DATA)
23. AS CONSTRUCTED ELEV. & DIM.
24. ELECTRICAL EMBEDDED WORK
25. ELECTRICAL STANDARDS.

CONCRETE QUANTITIES

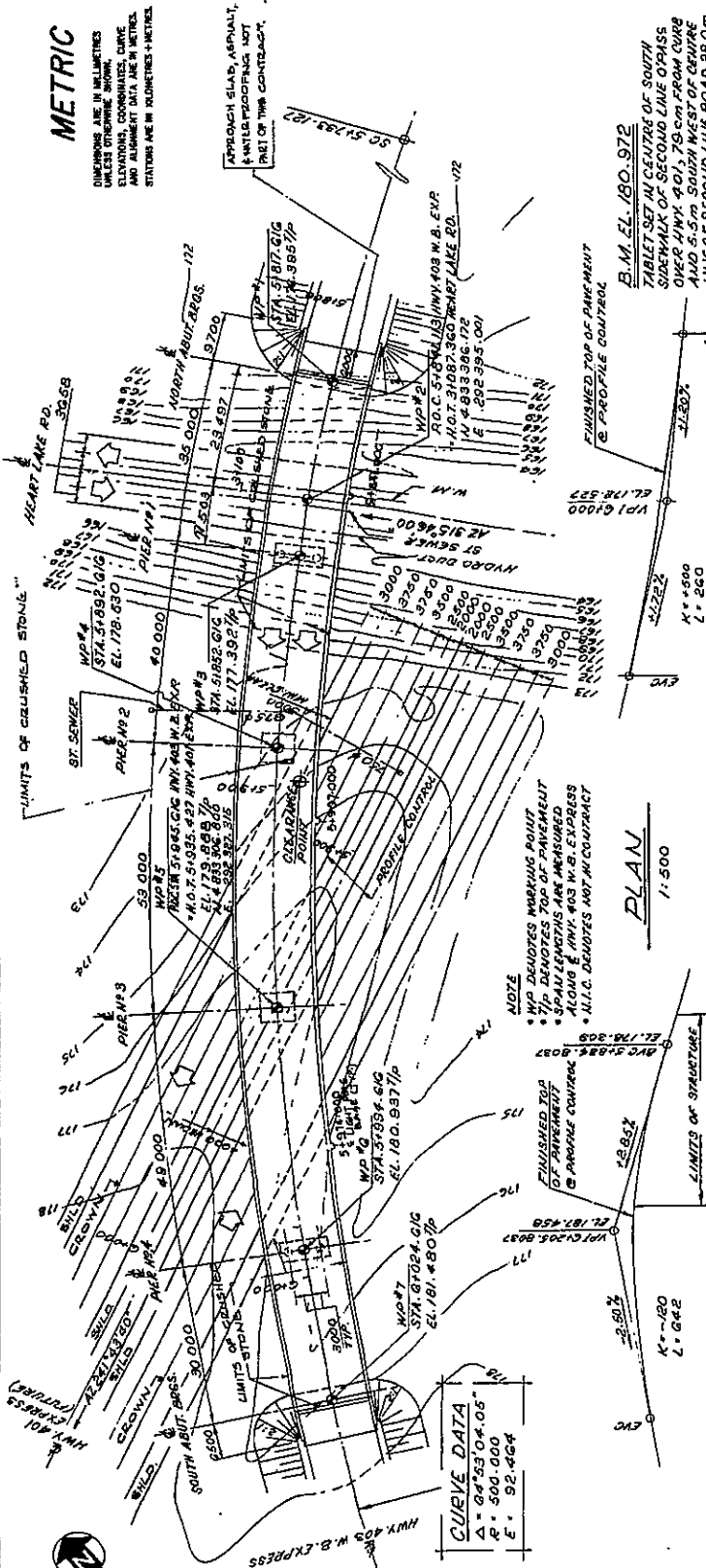
CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE LUMP SUM TENDER ITEMS.

1. CONC. IN PIERS, ABUTS. & WING WALLS
35 MPa = 291 m³
2. CONC. IN DECK
30 MPa = 107 m³
3. CONC. IN BARRIER WALLS
35 MPa = 138 m³
4. CONC. IN APPROACH SLAB
30 MPa = 29 m³
5. CONC. IN SLOPE PAVING
30 MPa = 20 m³
6. MASS CONCRETE
30 MPa = 20 m³

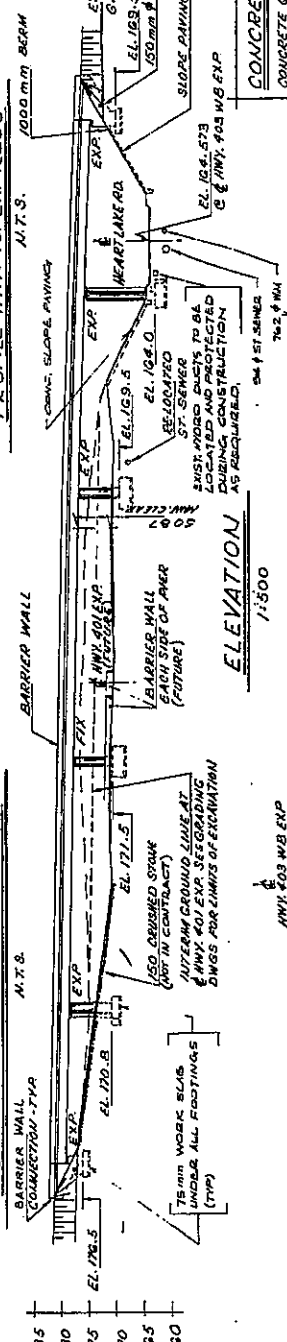


(FOR REFERENCE SEE STANDARD D-0-4-22)
 N.T.S.

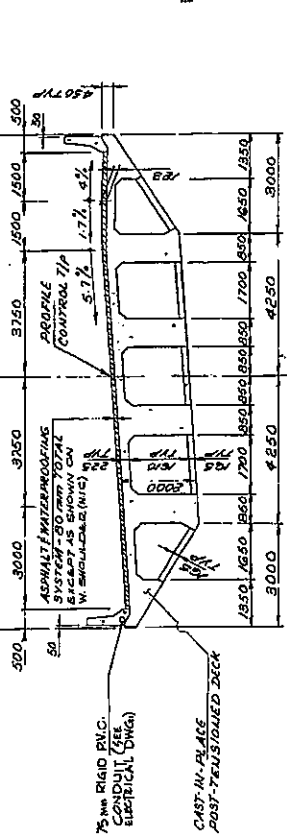
CONSTRUCTION CLEARANCE DIAGRAM



PROFILE - HWY 403 W.B. EXPRESS



ELEVATION



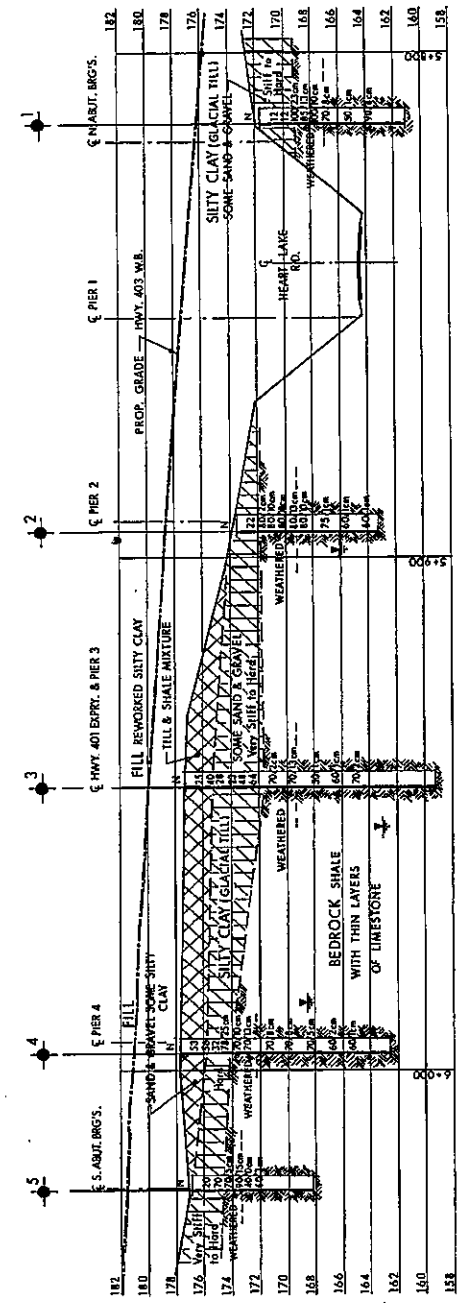
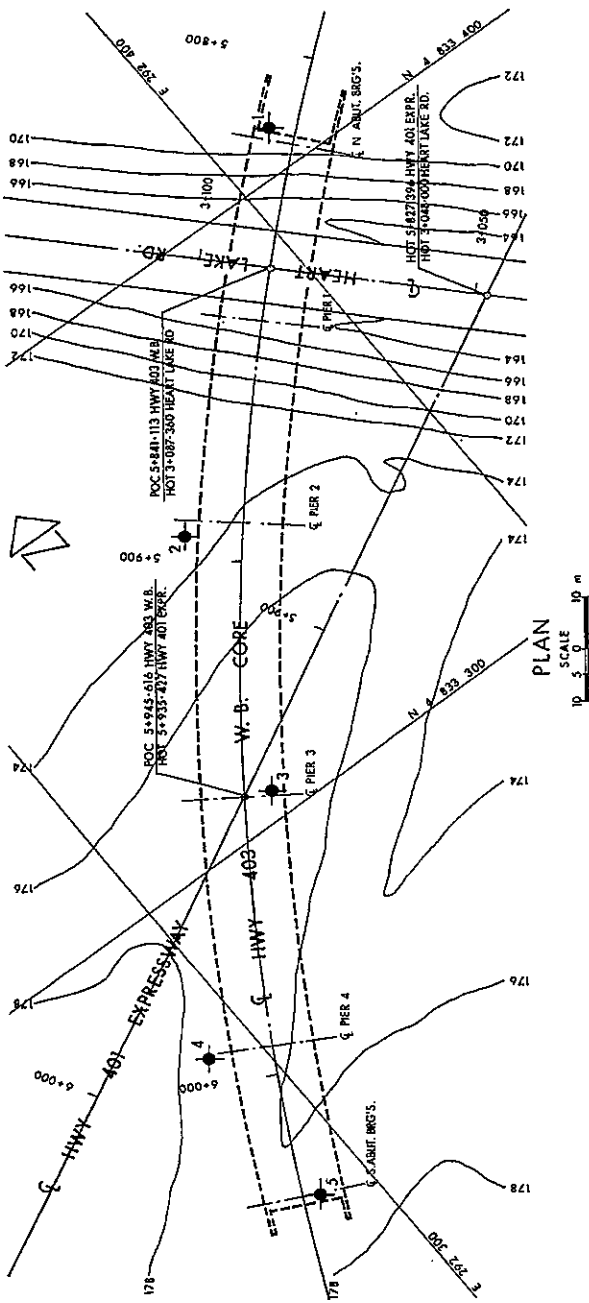
TYPICAL DECK SECTION

NOTE:
 ALL TRANSVERSE DIMENSIONS
 ARE RADIAL.



METRIC

NOTE: DIMENSIONS ARE IN METRES AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES
 * METRES



§ PROFILE HWY 403 W.B. CORE
 SCALE
 HOR 10 5 0 5 10 m
 VERT 10 5 0 5 10 m

LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blow/0.3m (Std Pen Test, 475 J/Blow)
- CONE Blow/0.3m (60° Cone, 475 J/Blow)
- W/L at time of investigation 82 (02/1)
- NO WL Established in Bt No 1 & 5

No	CO-ORDINATES	
	NORTH	EAST
1	171-7	4 833 408-5
2	173-5	4 833 333-7
3	177-4	4 833 304-8
4	177-7	4 833 270-8
5	176-9	4 833 237-4

-NOTE-
 The borehole logs and test logs have been established only at Bore Hole locations. Borehole logs (the borehole logs) are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION
1	30/11/12	158	Geocore No 30/11/12 - 158
2	01/12/12	158	HWY No 403 & 401
3	01/12/12	158	DATE 82 01 14
4	01/12/12	158	DATE 74-31-467
5	01/12/12	158	DATE 74-31-467
6	01/12/12	158	DATE 74-31-467
7	01/12/12	158	DATE 74-31-467
8	01/12/12	158	DATE 74-31-467
9	01/12/12	158	DATE 74-31-467
10	01/12/12	158	DATE 74-31-467

NOTE:
 The complete foundation investigation file for this project may be examined at the Engineering Materials Office. Information contained in this file and any supplementary files is specifically included in accordance with the conditions of Section 102.2 of the contract.

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST No 6
CONT No 93-45
WP No 54-82-14 W.B.
WP No 54-82-17 E.B.
HWY 401-TOMKEN RD. OVERPASS
(BRIDGE No 501)
GENERAL ARRANGEMENT

SHEET
107

U Wythe & Uind
consulting engineers

GENERAL NOTES:

1. CLASS OF CONCRETE
 - FRESHLY MIXED AND PLACED 35 MPa.
 - FRESHLY MIXED AND PLACED 35 MPa.
2. CLASS OF CONCRETE TO BE USED IN STRUCTURES
3. FINISHES
 - FRESHLY MIXED AND PLACED 35 MPa.
 - FRESHLY MIXED AND PLACED 35 MPa.
 - FRESHLY MIXED AND PLACED 35 MPa.
 - FRESHLY MIXED AND PLACED 35 MPa.
 - FRESHLY MIXED AND PLACED 35 MPa.
4. CONSTRUCTION DETAILS

REINFORCING STEEL

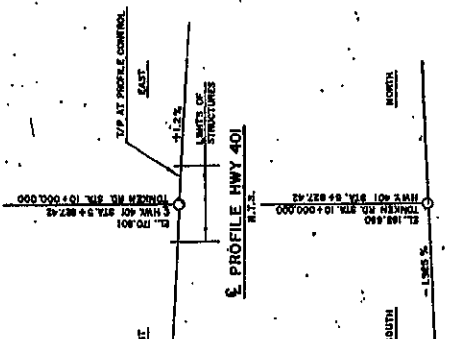
- REINFORCING STEEL SHALL BE GRADE 60 WITH MINIMUM TENSILE STRENGTH OF 420 MPa.
- REINFORCING STEEL SHALL BE GRADE 60 WITH MINIMUM TENSILE STRENGTH OF 420 MPa.
- REINFORCING STEEL SHALL BE GRADE 60 WITH MINIMUM TENSILE STRENGTH OF 420 MPa.
- REINFORCING STEEL SHALL BE GRADE 60 WITH MINIMUM TENSILE STRENGTH OF 420 MPa.
- REINFORCING STEEL SHALL BE GRADE 60 WITH MINIMUM TENSILE STRENGTH OF 420 MPa.

LIST OF MATERIALS

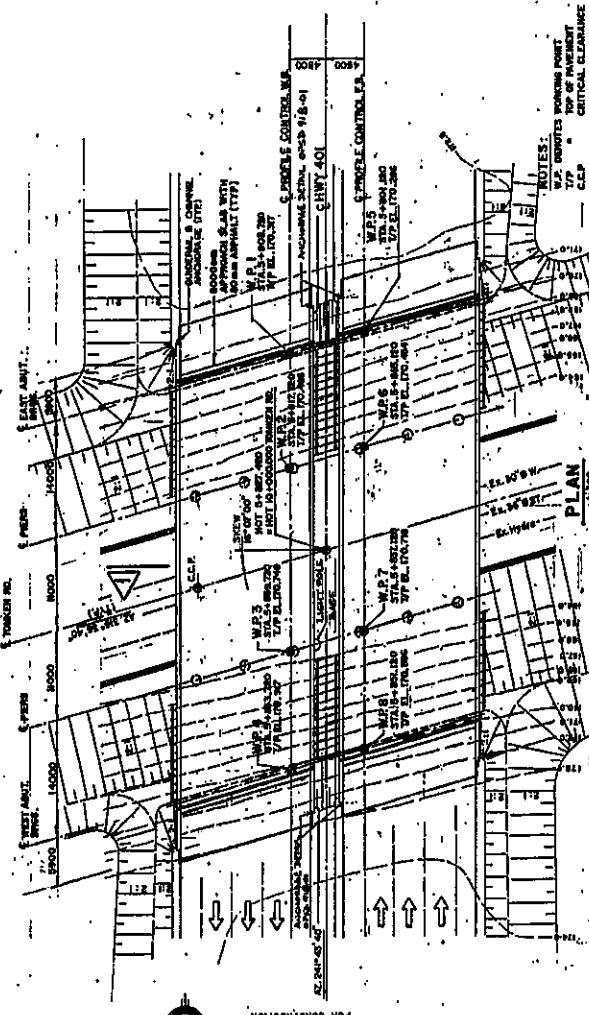
1. REINFORCING STEEL
2. REINFORCING STEEL
3. REINFORCING STEEL
4. REINFORCING STEEL
5. REINFORCING STEEL
6. REINFORCING STEEL
7. REINFORCING STEEL
8. REINFORCING STEEL
9. REINFORCING STEEL
10. REINFORCING STEEL
11. REINFORCING STEEL
12. REINFORCING STEEL
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31. REINFORCING STEEL

APPLICABLE STANDARD DRAWINGS:

DR-4008 FRESHING CLEARANCES
DR-3840 ALLOCATION TO LIGHTING POLE



§ PROFILE TOMKEN RD.
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§ PROFILE TOMKEN RD.
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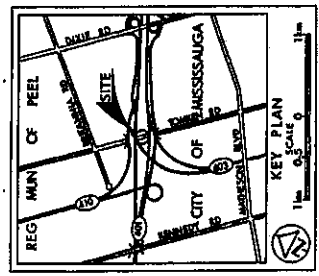
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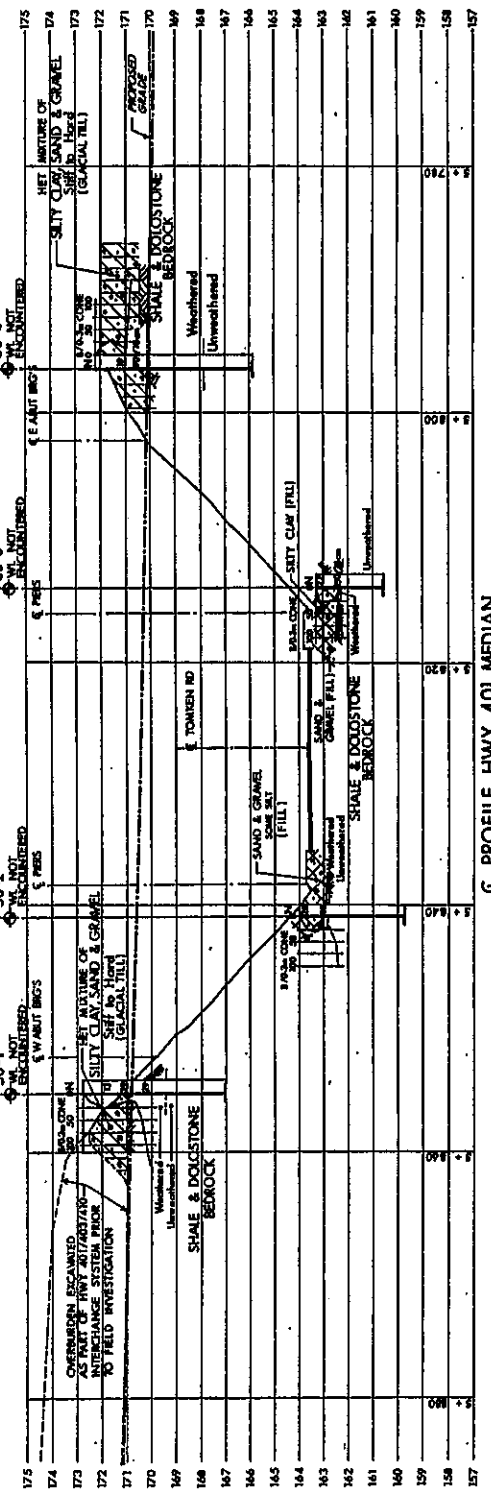
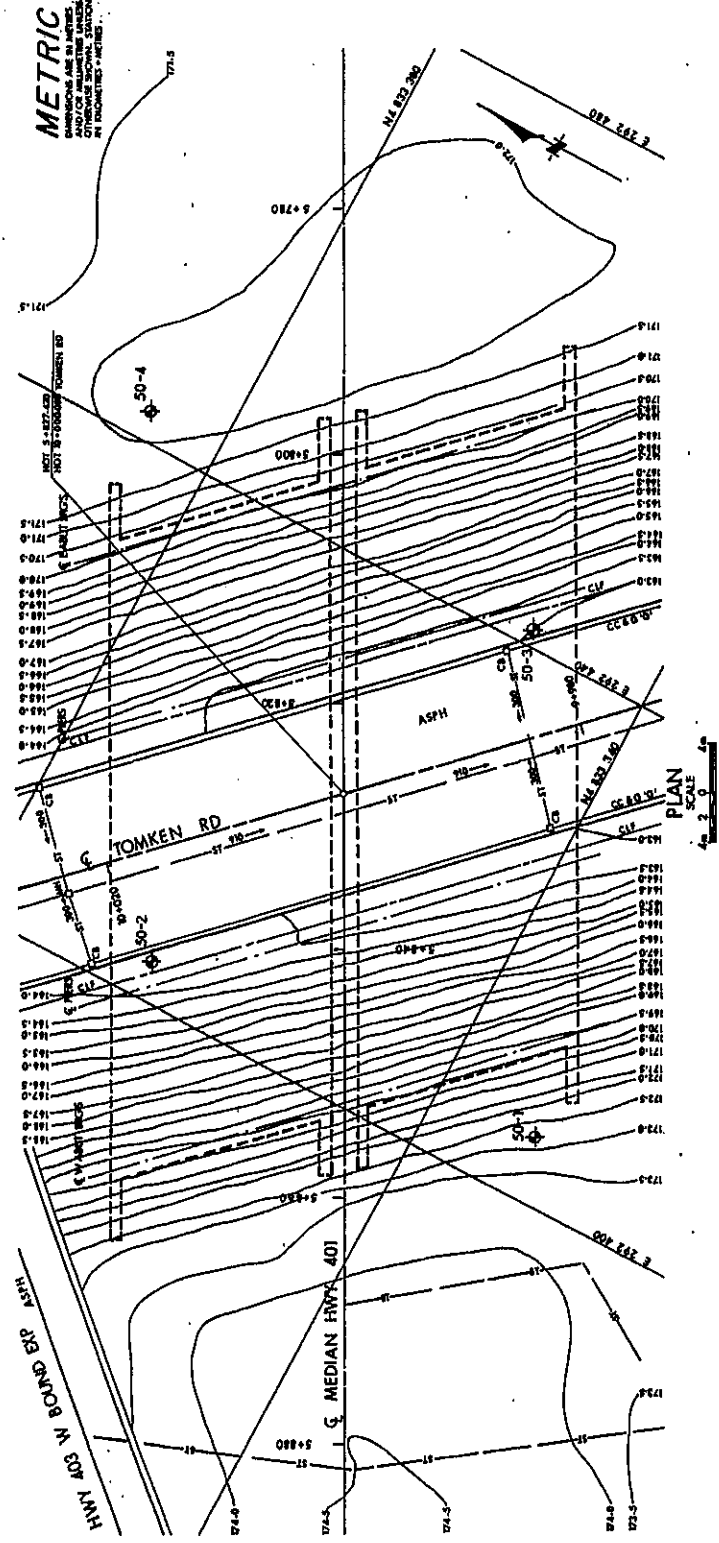
CONT No 93-45
WP No 54-82-14/7
TOMKEN RD OVERPASS
(STRUCTURE-80)
BORE HOLE LOCATIONS & SOIL STRATA
SHEET
107-1



- LEGEND**
- ◆ Bore Hole
 - ◆ Dynamic Cone Penetration Test (Cone)
 - ◆ Bore Hole & Case
 - N North 0-3m (Stat Pen Test, 475 J/ft/min)
 - CONE Meter/ft (60° Cone, 475 J/ft/min)
 - W/L at time of investigation 89 09

No	ELEVATION	CO-ORDINATES NORTH EAST
50-1	172.8	4 833 331.2 292 405.2
50-2	144.0	4 833 365.2 292 401.3
50-3	163.3	4 833 356.6 292 441.4
50-4	172.2	4 833 366.3 292 442.3

NOTE:-
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.
NOTE: The complete foundation investigation and design report for this project and other related documents may be reviewed at the Engineering Materials Office, Department of Transportation, 1000 Highway 7 East, Unit 100, Richmond Hill, Ontario L4B 1N2. For more information, contact the Engineering Materials Office at (905) 882-0900.



HP No E-81-401-1, 89 01

Appendix F

Borehole Location Plan

Drawing No. 1

A Coffey International Limited Company

NOTES:
FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

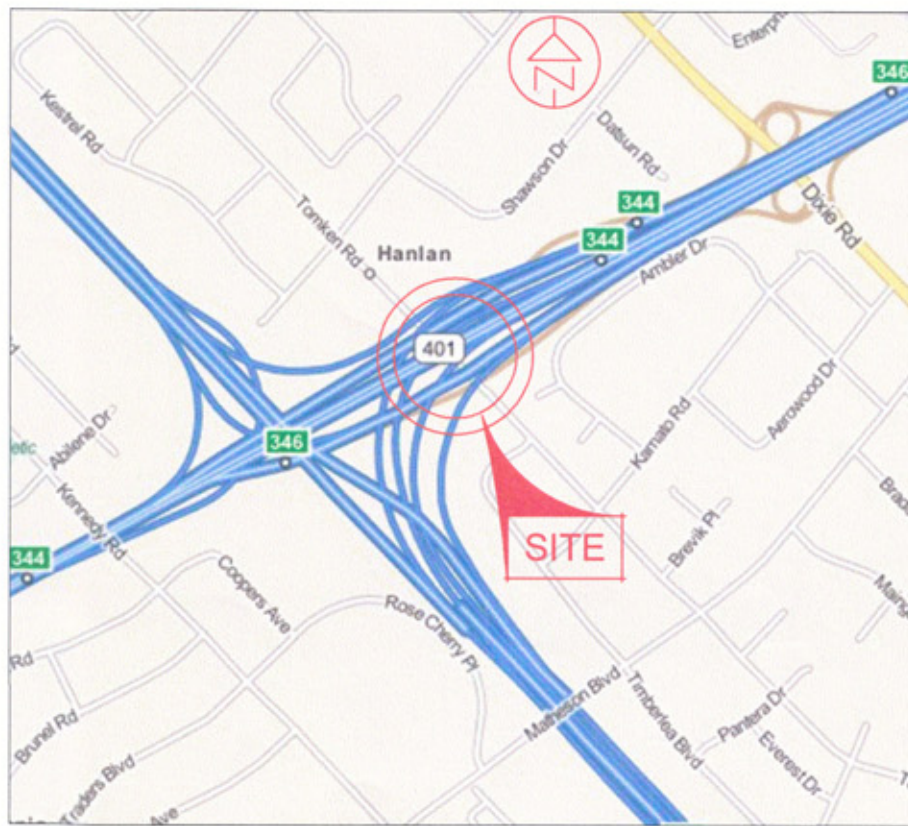
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
ARE IN KILOMETRES + METRES.

CONT No. -
GWP:
PROPOSED 2400 mm DIA. HANLAN FEEDERMAIN
AND PROPOSED 1500 mm DIA. MCC WATERMAIN
BOREHOLE LOCATION PLAN
AND SOIL STRATA



SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



KEY PLAN
N.T.S.

LEGEND

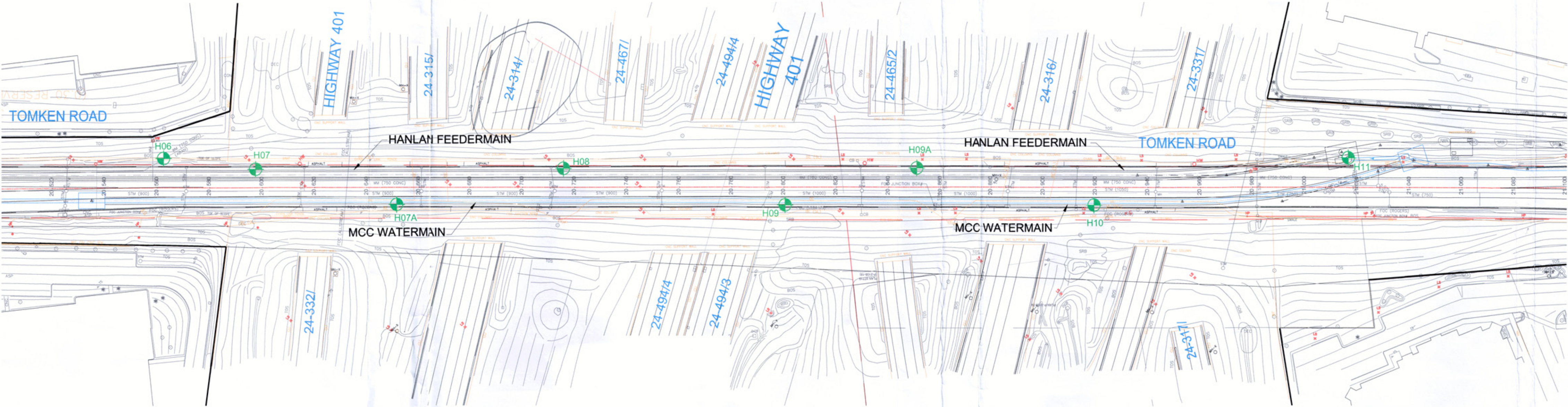
- Borehole by Coffey Geotechnics Inc.
- Blows/0.3m (Sta. Pen. Test, 475 J/blow)
- Water Level in Piezometer
- Piezometer

No.	ELEVATION	EASTING	NORTHING
H06	170.8	608479.4	4833158.1
H07	169.4	608501.4	4833130.5
H07A	167.4	608530.3	4833083.0
H08	165.1	608585.6	4833047.5
H09	163.3	608636.2	4832978.1
H09A	162.7	608681.8	4832952.6
H10	162.9	608720.8	4832894.5
H11	164.5	608802.4	4832838.9

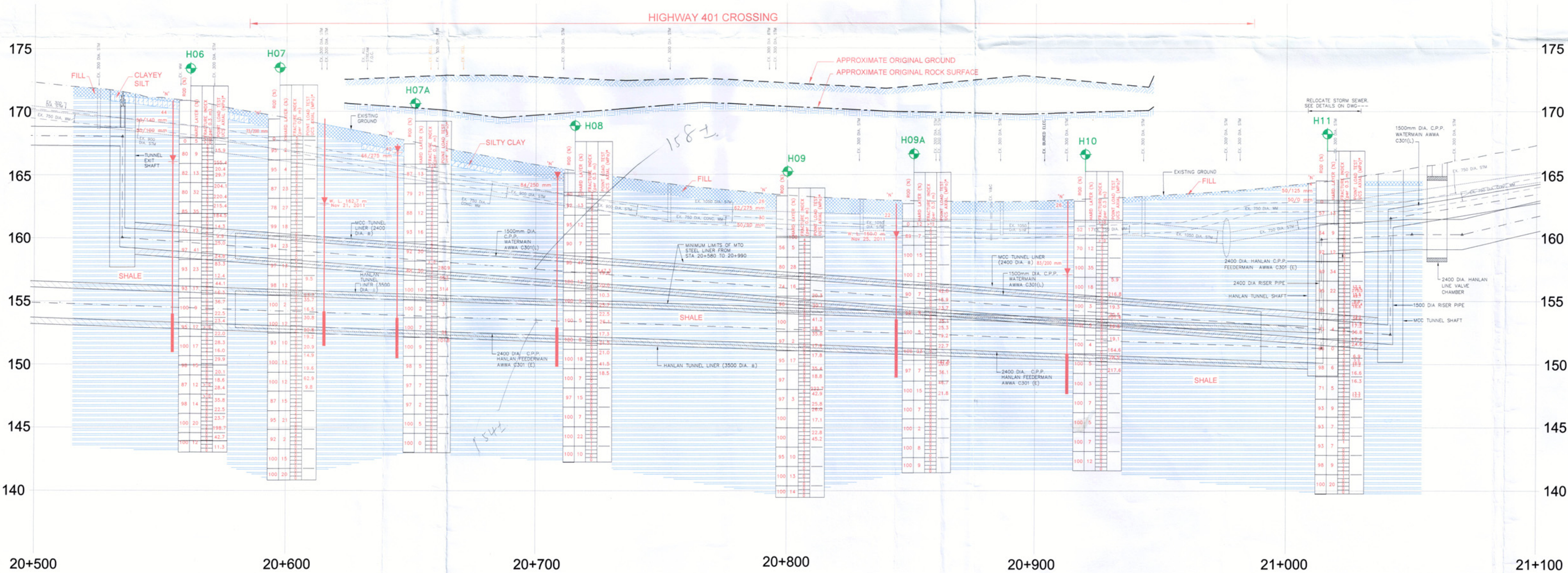
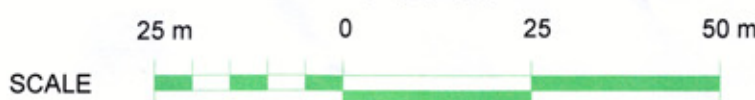
NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No			
GEOTMARK00231AA			
SUBMD	CHECKED	DATE	SITE
DRAWN	CHECKED	APPROVED	DWG
SH	JN	JN	1



PLAN



PROFILE

