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CONT. No.

W. O. No.

STR. SITE No. 10-220

HWY. No. 403

LOCATION HWY 403 & BRONTE CREEK

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Ministry of Transportation
Province of Ontario

Foundation Investigation for Proposed Structures at the Crossing of Highway 403 and Bronte Creek District #4, Burlington WP 410-85-01/02, Site 10-220

February 1991

Acres International Limited
Niagara Falls, Ontario

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1 Introduction

Acres International Limited (Acres) was retained by the Ministry of Transportation of Ontario (MTO) to undertake a foundation investigation for the proposed structures at the crossing of Highway 403 and Bronte Creek, District No. 4, Burlington, WP 410-85-01/02, Site 10-220. The work was authorized by Agreement No. 4240-9190-099 dated August 2, 1990.

The location, site plan and section of the proposed structures are shown on MTO Plan E-83-403-6.

Drilling and sampling operations were performed by Master Soil Investigations Ltd. under the full-time supervision and direction of Acres geotechnical staff. Access to some of the drill sites in the Bronte Creek ravine required minor track grading and bulldozer assistance which was undertaken by R. B. Smith Excavating Ltd. The fieldwork was carried out between October 1 and 18, 1990 and on November 21, 1990.

Plans of the site showing the borehole locations together with the stratigraphic profiles are shown on Drawings 4108501/02-A and 4108501/02-B. For the purposes of simplifying location descriptions in the text, it has been assumed that Highway 403 will run east/west and the Bronte Creek flows north/south.

Details of the investigation program are outlined in Section 2 with the site conditions being described in Section 3 of this report.

All of the data obtained during this investigation have been evaluated. Recommendations regarding the geotechnical aspects of the design and construction of the proposed bridges and associated works are presented in Section 4.

2 Exploratory Work

Prior to any fieldwork, a site meeting was held with the affected landowners and representatives from the Halton Region Conservation Authority, the MTO and the Ministry of Government Services to determine any specific constraints on the investigation program.

Sixteen boreholes, numbered BH-1, BH-2, BH-3(a) to BH-3(d) and BH-4 to BH-14 inclusive, were drilled using an MTO Class III drill equipped with hollow and solid stem augers. The total depth of drilling was 196.2 m. Prior to drilling, borehole locations were surveyed and staked in the field by the Surveys and Plans Branch of the MTO. Numbering of the boreholes drilled is the same as the borehole numbering assigned by the surveyors.

The majority of the overburden was drilled using hollow stem augers. However, the very hard or very dense soils encountered during drilling occasionally caused penetration refusal for the hollow stem augers. It became necessary to add water to the holes, use solid stem augers or use an N-size tricone bit in order to advance the deeper boreholes. Sampling of overburden was undertaken using split barrel samplers in accordance with the Standard Penetration Test (SPT) method. In the majority of the sampling attempts, the sampler met refusal (N>100) and could not be driven the full depth. The upper weathered portions of the shale bedrock were drilled and sampled by the same methods as employed for the overburden. NQ-size coring was used to sample the more competent rock and a total of 57.8 m of diamond drilling was performed.

Several days of heavy rain during the drilling program resulted in the proposed water truck access route to three borehole locations on the upper east bank (BH-1 to 3) becoming impassible. The water truck became stuck while attempting to bring water to BH-3 and had to be pulled out be a rubber-tired backhoe. As a result, the drilling of BH-1 was postponed and completed on November 21 in conjunction with investigations for the Highway 403/CNR subway.

While drilling at BH-2, the hollow stem augers met refusal at 7.8 m depth. An N-size tricone bit was used to advance the borehole to 10.7 m and the augers were then drilled with difficulty to this depth. An N-size tricone bit was used to complete the borehole from 10.7 m to 14.8 m depths.

During the drilling at the BH-3 location, the initial hole, BH-3(a), encountered auger refusal at 7.6 m depth. Auger refusal resulted in shearing of the keyway in the drill head.

A second hole, BH-3(b), was drilled within 1.5 m of BH-3(a) using solid stem augers. At 10.7 m depth, the split barrel sampler encountered a void and fell under its own weight to 15.1 m in, what is assumed to be, an open vertical joint in the mudstone bedrock. Two further holes, BH-3(c) and 3(d), were then drilled on either side of BH-3(b) and encountered the bedrock surface at 10.7 and 10.8 m respectively.

Table 1 presents a summary of all the borehole physical data.

A local contractor, R. B. Smith Excavating Ltd., was hired to bulldoze temporary trails down both sides of the Bronte Creek valley to permit drill access for BH-4 to 13 inclusive. On several occasions, bulldozer assistance was required to haul the drill up some of the steep grades. Efforts were made to minimize disturbance to the property as much as possible. Straw bales were used to construct silt dams to prevent the flow of soil from the drill sites and access routes into Bronte Creek.

Piezometers were installed in BH-1, 3(b) and 14. Details of piezometer installations are given in Table 2.

All soil samples and rock cores were returned to Acres geotechnical laboratory in Niagara Falls for detailed logging and testing.

The laboratory testing program included the following types of tests, the results of which are presented and discussed in subsequent sections of the report.

- Natural moisture content
- Liquid limit
- Plastic limit
- Sieve and hydrometer analyses
- Uniaxial compression test (bedrock)
- Direct shear test (bedrock).

Table 1

Summary of Borehole Physical Data

Borehole Number	Ground Surface Elevation (m)	Location Coordinates Highway 403 Chainage (m)	Offset (m)		Northing	Easting	Bedrock Weathered Rock Depth (m)	Weathered Rock Elev. (m)	Sound Rock Depth (m)	Sound Rock Elev. (m)	Bottom of Borehole Depth (m)	Bottom of Borehole Elev. (m)
BH 1	164.7	26+800	0.0		4 808 865	279 394	16.3	148.4	N/E	N/E	16.8	147.9
BH 2	164.0	26+730	0.0		4 808 812	279 348	13.9	150.0	N/E	N/E	14.8	149.2
BH 3(a)	162.6	26+660	0.0		4 808 758	279 304	N/E	N/E	N/E	N/E	7.6*	155.0
BH 3(b)	162.6	26+660.4	1.0	LT	4 808 759	279 303	15.1*	147.5	N/E	N/E	15.1	147.5
BH 3(c)	162.6	26+660.7	2.2	LT	4 808 760	279 302	10.7	151.9	N/E	N/E	11.6	151.0
BH 3(d)	162.6	26+659.8	0.5	T	4 808 757	279 304	10.8	151.8	N/E	N/E	10.9	151.7
BH 4	150.2	26+603.3	13.7	T	4 808 705	279 278	0.8	149.4	6.3	143.9	12.4	137.8
BH 5	150.4	26+608.3	13.0	LT	4 808 726	279 260	0.5	149.9	7.6	142.8	10.0	140.4
BH 6	149.7	26+569.2	13.3	LT	4 808 698	279 234	0.2	149.6	12.1	137.6	18.1	131.6
BH 7	135.6	26+552.2	15.0	T	4 808 667	279 246	1.3	134.3	2.7	132.9	5.7	129.9
BH 8	135.7	26+511.4	15.0	LT	4 808 655	279 197	2.8	132.9	4.6	131.1	7.6	128.1
BH 9	134.9	26+496.5	18.1	T	4 808 622	279 212	1.4	133.5	3.2	131.7	10.1	124.8
BH 10	154.5	26+455	15.0	T	4 808 592	279 183	8.0	146.5	9.1	145.3	12.2	142.3
BH 11	154.6	26+456	12.7	LT	4 808 610	279 163	7.6	147.0	9.2	145.5	12.2	142.4
BH 12	150.1	26+413.7	13.7	T	4 808 561	279 155	3.2	146.9	4.2	145.9	7.3	142.8
BH 13	154.5	26+388	18.6	LT	4 808 562	279 114	7.8	146.7	10.6	143.9	13.5	141.0
BH 14	162.1	26+331.5	10.5	T	4 808 515	279 111	N/E	N/E	N/E	N/E	10.2	151.9

Total Overburden Drilled (m)	118.7
Total Bedrock Drilled (m)	77.5
Total Drilling (m)	196.2

NE – Not encountered.

Note: BH–3(a) was drilled to 7.6 m with hollow stem augers. Due to drilling difficulties, another borehole continued as BH–3(b) with solid stem augers. It is probable that the bedrock surface level in the vicinity of BH–3(b) is at approximately elev 151.8 m. During drilling, the sampler fell freely from 10.7 to 15.1 m in what is assumed to be an open vertical joint in the bedrock. Further drilling on both sides of BH–3(b) encountered bedrock at 10.7– and 10.8–m depths.

Table 2

Summary of Piezometer Installations and Piezometric Observations

Borehole Number	Ground Surface Elev. (m)	Piezometer Tip Elev. (m)	Bentonite Seal		Date Installed	Water Level	
			Top Elev. (m)	Bottom Elev. (m)		Elevation (m)	Date
BH-1	164.7	148.6	155.7	153.2	Nov/21/90	159.9	Nov 29
						161.0	Dec 19
						161.6	Jan 9
BH-3(b)	162.6	150.4	154.4	156.3	Oct 18/90	151.5	Oct 18
						154.8	Nov 8
						155.3	Nov 29
						156.8	Dec 19
BH-14	162.1	152.1	153.8	153.3	Oct 1/90	154.1	Oct 12
						154.2	Oct 17
						154.9	Nov 8
						155.6	Nov 29

3 Site Conditions

3.1 Physiography and Topography

As outlined in the publication "The Physiography of Southern Ontario", Third Edition, by the Ministry of Natural Resources, the Highway 403/Bronte Creek area is located within the Physiographic Region referred to as the 'South Slope', being the south slope of the Oak Ridges Moraine. With the exception of the soils in the Bronte Creek floodplain, the surface deposit at the project site is the Trafalgar Moraine (till moraine-glacial till) which overlies reddish brown mudstone (shale) of the Queenston Formation. Adjacent to the Bronte Creek, the soils were probably deposited by the river or by gravity from the steep valley slopes (alluvium/colluvium).

The site is situated in a generally level area (ground surface elev 162 to 165 m approximately) into which Bronte Creek has incised a steep-sided ravine about 30 m deep. Slopes on the west side of Bronte Creek can be as high as 15 m and have an average inclination of 1H:1V. Also, on the west side of Bronte Creek, there is a tributary gully, with slopes approximately 7 m high, containing an intermittent stream. A bedrock face 8 m high, is at the downstream end of the tributary gully and a small waterfall is formed there during wet periods. On the east side of Bronte Creek at the proposed highway alignment, there is a 15-m high bedrock face rising to a small terrace area at about elev 150 m. Flat floodplain areas, up to 50 m wide and about 1 m above Bronte Creek water levels, are present on both the west and east sides of the watercourse.

Fields adjacent to the Bronte Creek ravine are presently cultivated and have a surficial layer of organic topsoil about 0.4 m thick. The valley, the tributary gully and the ridge between are tree covered.

The site area is generally well drained, apart from the portion immediately adjacent to Bronte Creek where there are some boggy areas and pools of standing water.

Topography and geotechnical conditions are shown on Drawing 4108501/02-A for the Bronte Creek bridge and west approach cut area, and on Drawing 4108501/02-B for the east approach cut. Details of the geotechnical conditions encountered at the borehole locations, together with the laboratory test results, are summarized in the Record of Borehole forms. Grain size distributions are shown in Figures 1, 1A and 2. A Plasticity Chart showing results of consistency limits testing is presented in Figure 3.

3.2 Overburden Conditions

The deposits of glacial origin generally consist of a heterogeneous mixture of sand, gravel, silt and clay sizes with occasional cobbles. The percentage composition of the various constituent particles varies throughout the deposit, however, the major soil types encountered on this site are outlined below.

3.2.1 Heterogeneous Mixture of Clayey Silt and Sand, Trace to Some Gravel (Glacial Till)

The heterogeneous mixture of clayey silt and sand, trace to some gravel comprises the major portion of the overburden deposits on the project site. It was encountered in BH-1, 2, 3(a) to (d) and 10 to 14. The maximum thickness measured on the east side of Bronte Creek was 14 m in BH-1. On the west side, BH-14 was drilled to a depth of 10.2 m and terminated in this material.

Grain size distribution tests, the results of which are presented in Figure 1, show this material to be well graded containing between 63 and 71% silt and clay sizes, 23 to 29% sand and 6 to 8% gravel. The results of four sets of Atterberg limits tests yielded average liquid and plastic limit values of 29 and 15% respectively. As shown in Figure 3, it can be classified as a clayey silt of low plasticity (CL). The color grades from brown to reddish brown progressing from the ground surface down to bedrock.

The natural moisture contents within this deposit generally range from 7 to 14% with a mean of approximately 10% being well below the corresponding plastic limits.

SPTs generally met refusal (N>100) except in the upper 1 to 4 m where 'N' values between 41 and 84 were measured. The consistency of this deposit can generally be described as 'hard'.

3.2.2 Sandy Silt to Silty Sand, Some Gravel, Trace Clay (Glacial Till)

Within and near the base of the material described in Section 3.2.1, there are pockets, lenses or layers which grade from nonplastic combinations of silt, sand and gravel (GM-SM) to low plastic mixtures of sandy silt, trace clay, trace gravel (ML). Such materials were encountered in BH-1, 2, 3(b), (c) and (d), 10, 11 and 13, and ranged in thickness from approximately 0.5 to 3 m.

Two grain size distribution curves which represent typical materials included in these zones are shown in Figure 1A. Atterberg limits tests for Sample 4, BH-11, which is typical of the sandy silt, trace clay, trace gravel, yielded liquid and plastic limits of 17% and 15% respectively placing the material in the ML classification.

The natural moisture contents within these layers average about 10%. SPTs generally met refusal (N>100), however, some lower values in the range of 47 to 90 were measured indicating that the cohesionless materials exist in a very dense condition and the cohesive in a hard consistency.

3.2.3 Mixture of Clayey Silt, Sand and Gravel (Alluvium/Colluvium)

The major portion of the overburden materials within the Bronte Creek floodplain consist of a mixture of clayey silt, sand and gravel. Where encountered in BH-7, 8 and 9, the deposit varies in thickness from 1.3 to 1.4 m and, with the exception of BH-8, overlies the mudstone bedrock (Queenston Shale). The results of a grain size distribution test performed on a composite sample from BH-8 and 9 is presented in Figure 1B and shows a percentage composition of 39% gravel, 27% sand, 28% silt and 6% clay sizes. Atterberg limits tests performed on the particles finer than 425 microns from this sample yielded liquid and plastic limit values of 25 and 17% respectively. While approximately two-thirds of the material consists of coarse-grained particles, the fine-grained particles result in it being cohesive.

On the basis of the Atterberg limits, this material is classified as CL.

The color is generally brown or reddish brown, but is sometimes mottled. An organic odor was present and organic material was noted in some samples.

'N' values in this material ranged from 13 to 36 indicating a stiff to hard consistency.

3.2.4 Gravelly Sand, Some Silt (Alluvium/Colluvium)

In BH-8, a 1.4-m thick pocket of reddish brown gravelly sand, some silt was encountered. A single SPT carried out in this material gave and 'N' value of 25 indicating a compact state. On the basis of visual inspection, the soil is classified as GM.

This deposit is also considered to be of alluvial or colluvial origin as outlined in Section 3.1.

3.3 Bedrock Conditions

The bedrock in the area is a mudstone of the Queenston Formation frequently referred to as the Queenston Shale. Bedrock surface levels are approximately elev 147 m on the west side of Bronte Creek and approximately elev 150 m on the east side. At the bottom of the present creek valley, the bedrock has been eroded down to approximately elev 134 m.

The upper surface of the Queenston Shale has been completely weathered and disturbed to give sand- and gravel-sized angular fragments in a very stiff clay matrix. The boundary between this material and the overlying till is difficult to determine during drilling due to the similarity in their composition and consistency. As the boreholes progress deeper from the bedrock surface, the bedrock gradually becomes more competent; initially with alternating weathered and unweathered layers, eventually becoming slightly weathered or fresh throughout the rock mass with only occasional, thin, weathered or brecciated zones. Core recovery and RQD (Rock Quality Designation) values generally increase with depth into the rock mass, as do rock strength and bedding plane spacing.

The Queenston Shale is generally reddish brown, however, there are occasional gray bands in the deposit.

For the purposes of this report, 'sound' bedrock has been used to describe those zones where a core recovery of at least 90% and an RQD of at least 30% are consistently achieved. Bedrock with these qualities has been assumed to require typical rock excavation techniques.

The thickness of weathered bedrock as measured in the boreholes is generally between 1.1 and 2.8 m with an average of 1.6 m. However, in BH-4, 5 and 6, the thickness of weathered bedrock is 5.5, 7.1 and 11.9 m respectively. The substantially greater thickness of weathered bedrock at these boreholes is likely due to stress relief caused by the downcutting of the adjacent Bronte Creek.

A single uniaxial compressive strength test on the 'sound' Queenston Shale from BH-8 gave a result of 43.2 MPa.

Laboratory testing was performed on a typical brecciated zone within the bedrock. Testing of a breccia band from BH-9 showed the breccia to consist of sand- (19%) and gravel- (25%) sized angular fragments in a low plasticity (CL-ML) clayey silt to silt matrix (silt sizes 43%, clay sizes -13%) (see Figures 2 and 3). The natural moisture content was below the plastic limit. A single direct shear test was also performed on a breccia sample from BH-8 and this yielded a peak friction angle of 29.1 deg. The friction angle at the completion of shearing (12-mm displacement) was 18.8 deg, although the residual friction angle may be slightly less than this.

In BH-3(b), a void was encountered at the bedrock surface extending 4.4 m into the bedrock. Further, closely spaced boreholes drilled within 1.5 m of this borehole showed that the void is of limited areal extent. The void is likely due to an open, major vertical joint within the bedrock.

3.4 Groundwater Conditions

Groundwater level observations from the three piezometers, including their installation details, are summarized in Table 2. Near the junction of the west approach cut and the tributary gully, the groundwater level appears to be in the elevation range of 154 to 156 m. In the east approach cut, the groundwater level slopes down from approximately elev 161.6 m near the CN tracks to about elev 155 m at the ravine crest. These levels will probably fluctuate with precipitation. Several readings taken in BH-1 following completion of the investigations have indicated a continued rise in water levels. The last reading (January 9, 1991) indicated a level above the ditch level along the nearby CNR tracks.

4 Geotechnical Design and Construction Considerations

4.1 General Configuration of Structures

The proposed structures involved in the Highway 403/Bronte Creek crossing consist, in general, of the following major elements.

- Two 2-lane bridge structures, one eastbound and one westbound, across the Bronte Creek ravine.

- Approach embankments leading to the east and west bridge abutments.

- A culvert under the west side approach embankment located in a shallow gully which contains an intermittent tributary stream.

- Approach cuts on both the east and west sides of the Bronte Creek ravine.

The preferred locations (chainages) for the various bridge elements, based primarily on structural considerations, are as follows.

	Westbound Roadway	**Eastbound Roadway**
East Abutment	26+610 (*E)	26+605 (F)
East Pier	26+570 (F)	26+550 (*E)
West Pier	26+510 (*W)	26+495 (*W)
West Abutment	26+455 (F)	26+455 (F)

The items marked with an (F) are considered to be final, whereas those noted with *W or *E) may be subject to minor adjustments in the direction indicated (MTO Minutes of Meeting dated August 15, 1990).

Recommendations regarding the foundations of the various bridge elements are based on locating them at the above positions.

The road grade in the east approach cut, where it exits from the ravine east wall, is at approximately elev 155 m and slopes down to about elev 153 m, approximately 200 m

east of the ravine. The road grade at the west ravine wall is approximately elev 158 m and rises up to the existing grade between the ravine and Appleby Line.

4.2 Bridge Foundations

4.2.1 Bridge Piers

The structure configuration, as outlined in Section 4.1, locates three of the bridge piers down at floodplain level and one, the westbound east pier, up on a bedrock promontory which projects into the ravine.

BH-7, 8 and 9, located in the floodplain, as shown on Drawing 4108501/02-A encountered 'sound'* bedrock at elev 132.9, 131.1 and 131.7 m, respectively. It is recommended that the piers at these locations be founded on spread footings on the 'sound' bedrock at elev 131 m and be designed using a factored bearing capacity of 1300 kN at Ultimate Limit State (ULS). The bearing capacity at Serviceability Limit State, Type II, (SLS) will not govern the design since the anticipated settlements under the design pressure will be small, that is significantly less than 25 mm.

During construction, if any weak and weathered layers of rock are exposed at the founding elevation, it is recommended that they be removed. A 75-mm thick concrete mud slab should be placed immediately over the complete foundation surface. This concrete layer is required to seal the bedrock surface and prevent the softening and slaking of the bedrock.

A soil friction strength at ULS along a weak horizontal sliding plane within the bedrock is recommended as tan 26° = 0.49. If reasonable configurations of the foundation fail to provide an adequate margin of safety using this sliding value, it is recommended that inclined rock anchors be included to obtain the additional capacity. Since it will not be practical to inspect such anchors after installation, it is recommended that they be adequately protected against long-term corrosion.

As the bridge piers will be founded directly on 'sound' bedrock, it is not anticipated that they will be undermined due to scour. Material selected for backfilling around and above the footing level should be resistant to scour or alternatively be protected against scour using appropriately sized riprap. In any case, periodic inspections of the footing areas should be carried out to check for scour and appropriate remedial measures taken, if necessary.

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*For the definition of 'sound' bedrock as used in this report, refer to Section 3.3.

The excavations for the bridge pier foundations will be about 3 m deep. If they are to be undertaken with sloped excavation walls, such walls should be cut back no steeper than 1H:1V.

The east pier of the westbound roadway is located adjacent to a very steep bedrock slope which extends down to the Bronte Creek. BH-6, which was drilled at this site, encountered weathered bedrock which extended to a depth of 12.1 m or to approximately elev 137.6 m. To avoid potential stability problems which might result by placing a spread foundation adjacent to the steep riverbank slope, and to minimize differential settlements between adjacent foundations, it is recommended that this pier be supported on deep foundations which would carry the loads down to the 'sound' bedrock at elev 137 m. Because the zone of weathered bedrock includes frequent layers of relatively unweathered rock, the driving of 'H' piles through the weathered bedrock would be very difficult, if not impossible. It is therefore recommended that the deep foundations comprise either 'H' piles driven into preaugered holes, or caissons. The former would likely be easier to construct because of the smaller hole which would need to be augered, i.e., 350 mm versus 1000 (±) mm in diameter.

Typically, 310x110 'H' piles driven to refusal on or into a nondeteriorating rock can be assumed to have a factored axial capacity of 1600 kN at ULS. However, due to the lower strength and slaking nature of the Queenston Shale, it is recommended that a factored axial capacity of 1400 kN at ULS be assumed for piles driven into the 'sound' bedrock. The axial capacity at SLS, Type II, will not govern since the anticipated settlements under design loads will be small, resulting primarily from the elastic shortening of the pile plus a very small amount due to consolidation of any weaker layers within the zone of influence of the pile tip. An axial capacity at SLS, Type II, of 1000 kN can, however, be assumed.

If piles driven into an augered hole are used, it is recommended that a layer of wet concrete, a minimum of 1 m thick, be placed in the bottom of the hole and have the pile driven through it. The concrete should seal the bedrock surface and prevent the deterioration of the bedrock near the pile tip. Consideration might also be given to completely grouting up the voids around the pile, depending on the requirements for lateral pile resistance.

Dewatering of temporary excavations will be required for the three bridge piers adjacent to Bronte Creek. As the alluvium/colluvium materials are generally of

relatively low permeability, seepage into these excavations should be able to be handled by normal sumping and pumping. However, for the more pervious soil encountered above the bedrock surface in BH-8, larger seepage flows may be encountered together with a tendency for the soil to flow into the excavation. It should be cautioned that lenses or pockets of pervious soils might be encountered in any excavations in the floodplain. Special measures such as the installation of close sheeting or excavation slope blanketing with appropriately graded granular filter materials may be required in such situations. Due to the proximity of these excavations to Bronte Creek, however, adequate measures should be taken to protect the excavations during construction against possible flood flows in the creek.

4.2.2 Bridge Abutments

In the area of the east abutments, BH-4 and 5 encountered weathered bedrock from close to the ground surface to depths of 6.3 and 7.6 m, respectively. To minimize settlement of these structures, it is recommended that deep foundations be used to transfer the abutment loads down to 'sound' bedrock at approximately elev 142.5 m. In addition to settlement considerations, the east abutment of the eastbound bridge is located very close to the slope extending down to the floodplain giving rise to slope stability concerns if spread footings were to be used. The use of deep foundations avoids these potential problems.

As described in Section 4.2.1, 'H' piles driven into preaugered holes are also recommended for the east abutment foundations. A factored axial capacity of 1400 kN at ULS can be assumed with an axial capacity at SLS, Type II, of 1000 kN. A layer of wet concrete, at least 1 m thick, should be placed in the augered hole prior to pile driving to seal the bedrock surface and prevent deterioration.

At the west abutments, BH-10 and 11 penetrated 8 and 7.6 m of hard or very dense glacial till overlying weathered bedrock. These abutments are currently positioned at the top of a very steep overburden slope. The bearing capacity of spread footings at this location would be significantly lower in comparison with footings on a horizontal ground surface, as a result of the proximity of the slope. Because of these slope stability concerns, deep foundations are also recommended for these structures. 'H' piles driven to 'sound' bedrock at approximately elev 145 m could be adopted. However, due to the hard nature of the glacial till and weathered bedrock, preaugering will probably be required to ensure that the piles reach the required depth. The concrete seal in the bottom of any preaugered hole, as described above, is also recommended.

Backfill of the abutment retaining wall structures should be with free-draining granular materials in accordance with OPSS - Special Provision 109 F03.

All backfill materials should be placed and compacted in layers and drained by perforated pipes, weep holes or equivalent. The lateral earth pressure on the abutment structure will depend on the type of granular backfill material used and the rigidity of the wall. If the abutment loads are carried to 'sound' bedrock and the structure is considered to be rigid and nonyielding, the at-rest pressure would be applicable. The following parameters are recommended for use in the design.

	Granular "A"	**Granular "B"**
Unit weight (kN/m^3)	22.8	21.2
Friction angle (degrees)	35	30
Active earth pressure coefficient, Ka	0.27	0.33
At-rest earth pressure coefficient, Ko	0.43	0.5

4.2.3 Frost Protection

All footings and pile caps should be placed at a minimum depth of 1.2 m below finished grade to provide adequate protection against frost action.

4.3 Culvert and Tributary Creek

The proposed structures include a culvert to be constructed in the tributary gully on the west side of Bronte Creek. If it is built to grades conforming to the existing creek bed, it will have a sloping invert grading from approximately elev 152 m at its upstream end to about elev 146.5 m downstream. Such a configuration will result in the culvert being founded in the hard heterogeneous mixture of clayey silt and sand, trace to some gravel at its inlet and either weathered or 'sound' bedrock at the outlet end. While both of these foundation materials are adequate, their load/deformation characteristics will differ which may lead to differential settlements along the culvert. If there is an abrupt change from overburden to 'sound' bedrock, it is recommended that the 'sound' bedrock be

subexcavated at the point of change and backfilled with compacted Granular "A" to create a gradual transition between the two types of foundation material. A factored bearing capacity of 900 kPa at ULS is recommended. The bearing capacity at SLS, Type II, can be assumed as 500 kPa.

During construction of the culvert, it will be necessary to provide a temporary diversion channel around the culvert location to pass any flow which may occur in the gully. Furthermore, if a concrete culvert is proposed, it is recommended that a 75-mm thick concrete mud slab be placed on the foundation within 4 hours of when the excavation has reached final grade to prevent softening of overburden or deterioration of the bedrock.

Riprap should be provided both upstream and downstream of the culvert. This should be adequately sized to prevent erosion of the stream bed and undermining of the culvert due to flows in the gully. As discussed in Section 4.4, the riprap layer should cover all areas of the embankment slope where flood flows are likely to impinge. Depending on the size of the riprap, it may be necessary to provide a granular filter layer beneath the riprap to protect the underlying soil.

Where the tributary gully joins the Bronte Creek ravine, about 100 m downstream of Highway 403 centerline, there is a waterfall about 8 m high. The water flows over slightly to moderately weathered bedrock in the creek bed and at the falls. In the vicinity of the falls, the bedrock face exhibits only a minor degree of ongoing erosion. Since the erosion in the creek bed and at the falls face has been only minor in the long term since the downcutting of Bronte Creek, significant further erosion is considered unlikely during the lifetime of these structures. This assumes, of course, that flow in the gully after construction will be similar to that which has existed to date.

4.4 Embankments

Fill embankments are required behind each of the bridge abutments. On the west side of the ravine, the embankment is generally less than 5 m in height. However, on the south side of the eastbound roadway in the vicinity of the tributary creek bed, the embankment is approximately 10 to 11 m high, being the highest slope on any part of the embankments. Behind the east abutment, the maximum embankment height is approximately 5.5 m.

Prior to constructing the embankments, it will be necessary to remove the trees and organic topsoil from the embankment foundation areas, so exposing the hard glacial soils. Assuming that the embankments will be constructed of the glacial soils from the approach cuts, no stability problems are anticipated. However, the soils must be placed

and compacted in layers at a moisture content close to optimum and to a minimum of 95% of the maximum dry density (as determined by ASTM D698, latest revision).

Except for the 10- to 11-m high portion of the embankment in the tributary creek bed, side slopes of 2H:1V are recommended for the embankments from a stability point of view. The south facing slope within the tributary creek bed should be constructed with a 5-m wide berm at elev 150 m and 2H:1V slopes above and below the berm. This will result in an overall slope of about 2.45H:1V.

The other area which will require special treatment is the south facing slope at the east abutment where the ravine bank is sloping steeply down to the floodplain. Without shaping of the riverbank, the fill will form a relatively thin veneer which will be impractical to place and compact and will probably lead to slope instability. It is recommended that a minimum 3-m wide bench be cut into the riverbank at about the lowest elevation of the fill such that the fill can be placed and compacted in horizontal layers then trimmed to form an outer slope of 2H:1V.

Embankment slopes should be covered with vegetation to provide protection against gullying and erosion. The upstream and downstream toes of the west embankment in the vicinity of the gully and culvert should be covered with riprap. This must extend to a height sufficient to protect the fill against likely flood flows in the gully.

4.5 Approach Cuts

The proposed road grades in the vicinity of the Bronte Creek will require cuts up to 6 m deep in the west approach and approximately 11 mm deep east of the ravine. These excavations will be made in the very stiff to hard glacial soils and slopes of 2H:1V will generally be stable.

The pockets, lenses or layers of sandy silt to silty sand, some gravel, trace clay, which are generally cohesionless, appear to exist below the level of excavation in the approach cuts. They should not therefore cause a problem due to sloughing or flowing of the cut slopes.

The piezometric data indicate that the groundwater level is close to the road grade just to the east of the Bronte Creek ravine, rising to about 8 m above road grade adjacent to the CN tracks. To prevent the water exiting from the cut slopes, with the associated slumping of the slope material, it is recommended that drainage trenches be installed to draw the water level down. Drainage trenches should be installed both at the road grade

level and on the cut slopes at approximately elev 157 m. A bench, 3 m wide, should be provided at elev 157 m to facilitate installation of the slope drains and provide access for future maintenance. Typical details for such drainage facilities are shown in Figure 4. Water collected from these drains can be directed towards the Bronte Creek ravine where it can be discharged into an erosion-resistant channel. As the road grade rises towards the west, the depth of drains may need to be substantial close to the ravine in order to give an adequate fall on the drain. It is anticipated that the quantity of seepage will be small because of the relatively impervious nature of the soils.

A vegetative cover must be applied to the cut slopes to prevent erosion and gullying due to precipitation. Interceptor ditches should be provided along the top of the cut slopes to collect surface runoff and conduct it away.

During excavation of the approach cuts any surface or groundwater inflow should be able to be controlled by temporary ditching and sumping.

Since BH-3(b) encountered a void of limited areal extent within the bedrock near the base of the cut, it is recommended that the base of the cut be proof-rolled with a 10-t vibratory roller prior to placing any subbase material. This will detect or at least seal such voids if present close to subgrade level. The proof-rolling should extend at least 50 m from the top of the Bronte Creek valley on the east side and 50 m from the top of the tributary gully on the west.

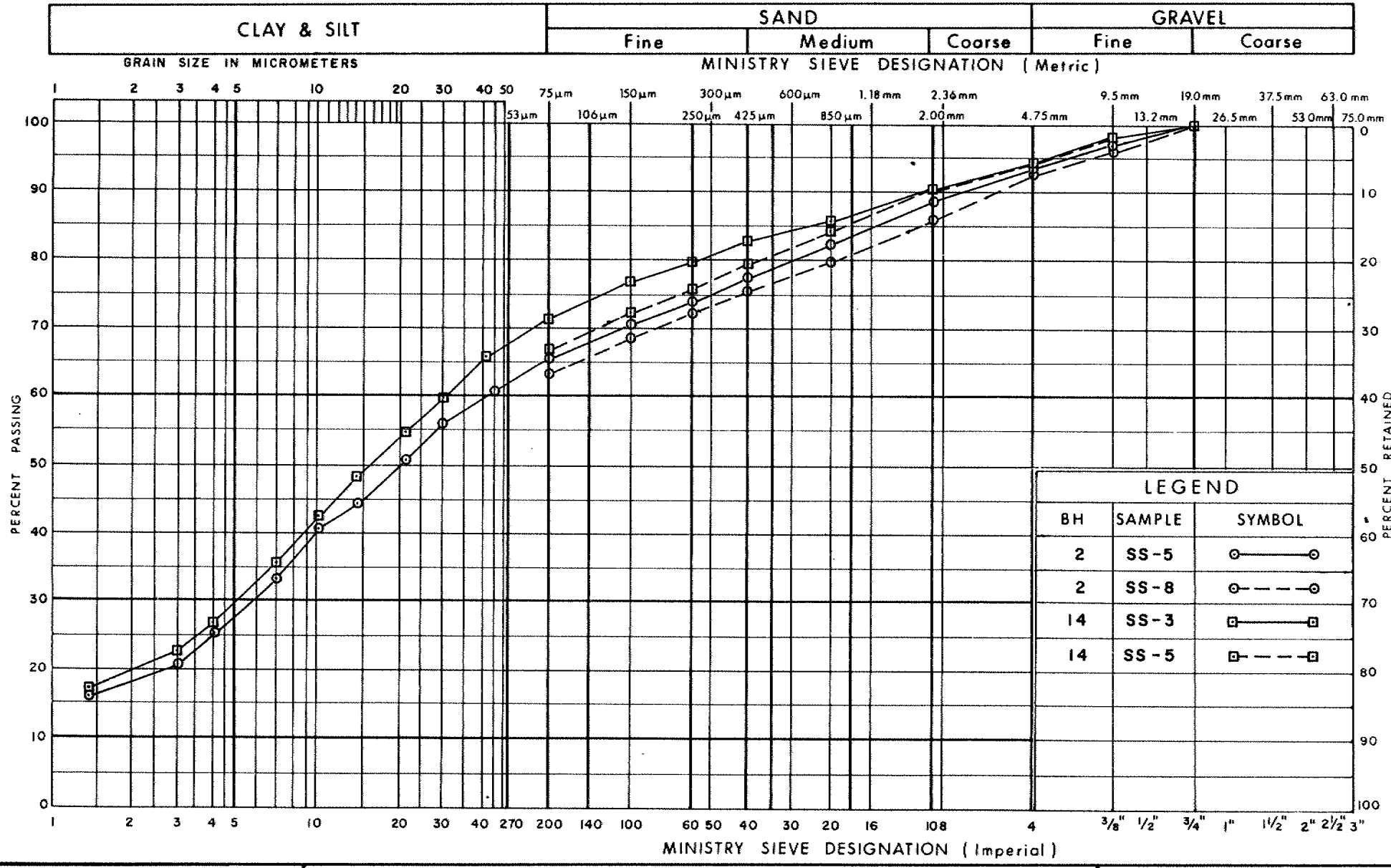
C. S. Bodimeade
Senior Geotechnical Engineer

T. J. Bradshaw
Deputy Head, Geotechnical Department

Figures

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

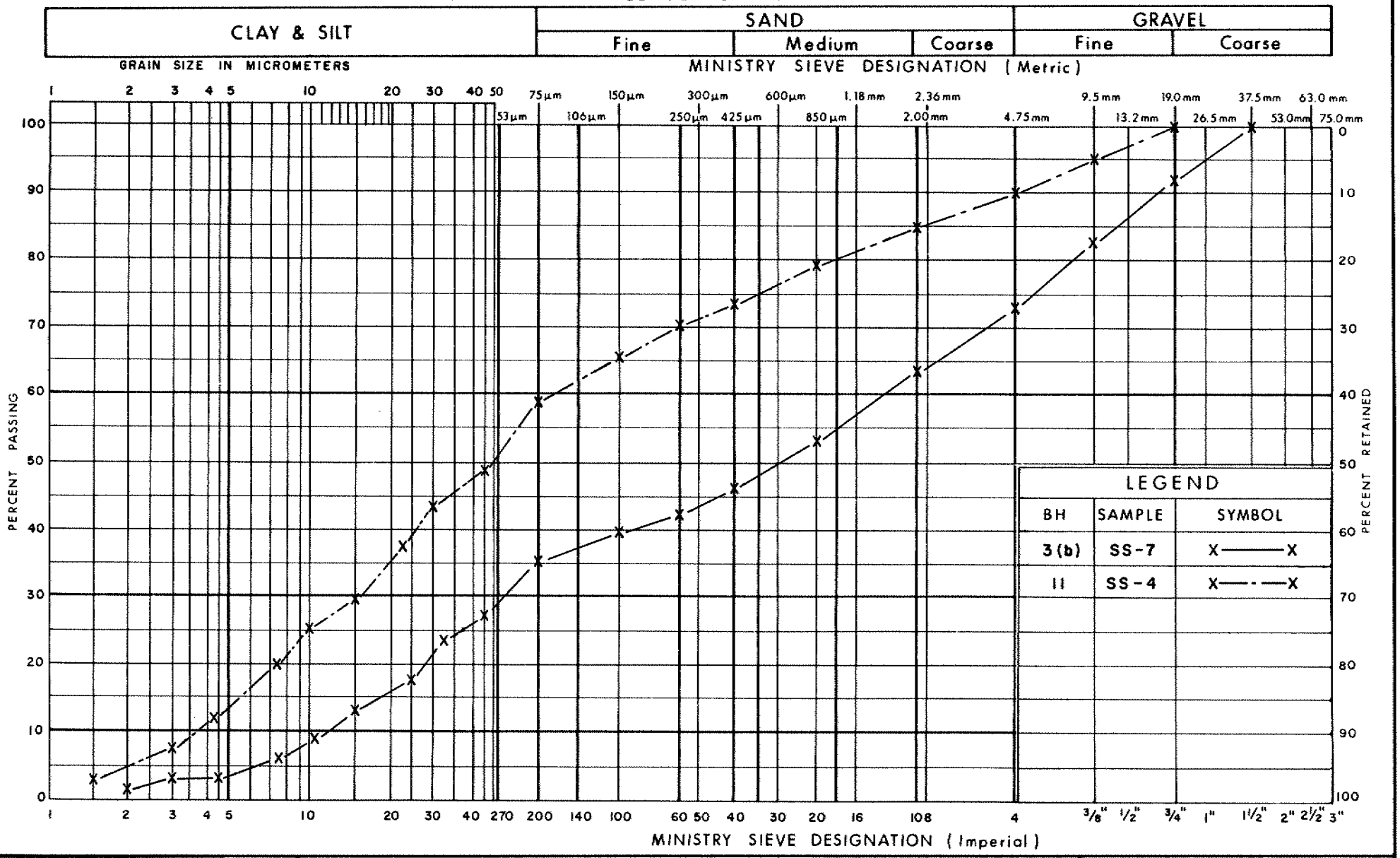
GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF CLAYEY SILT AND SAND TRACE TO SOME GRAVEL (GLACIAL TILL)

FIG No 1

W P 410-85-01/02

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

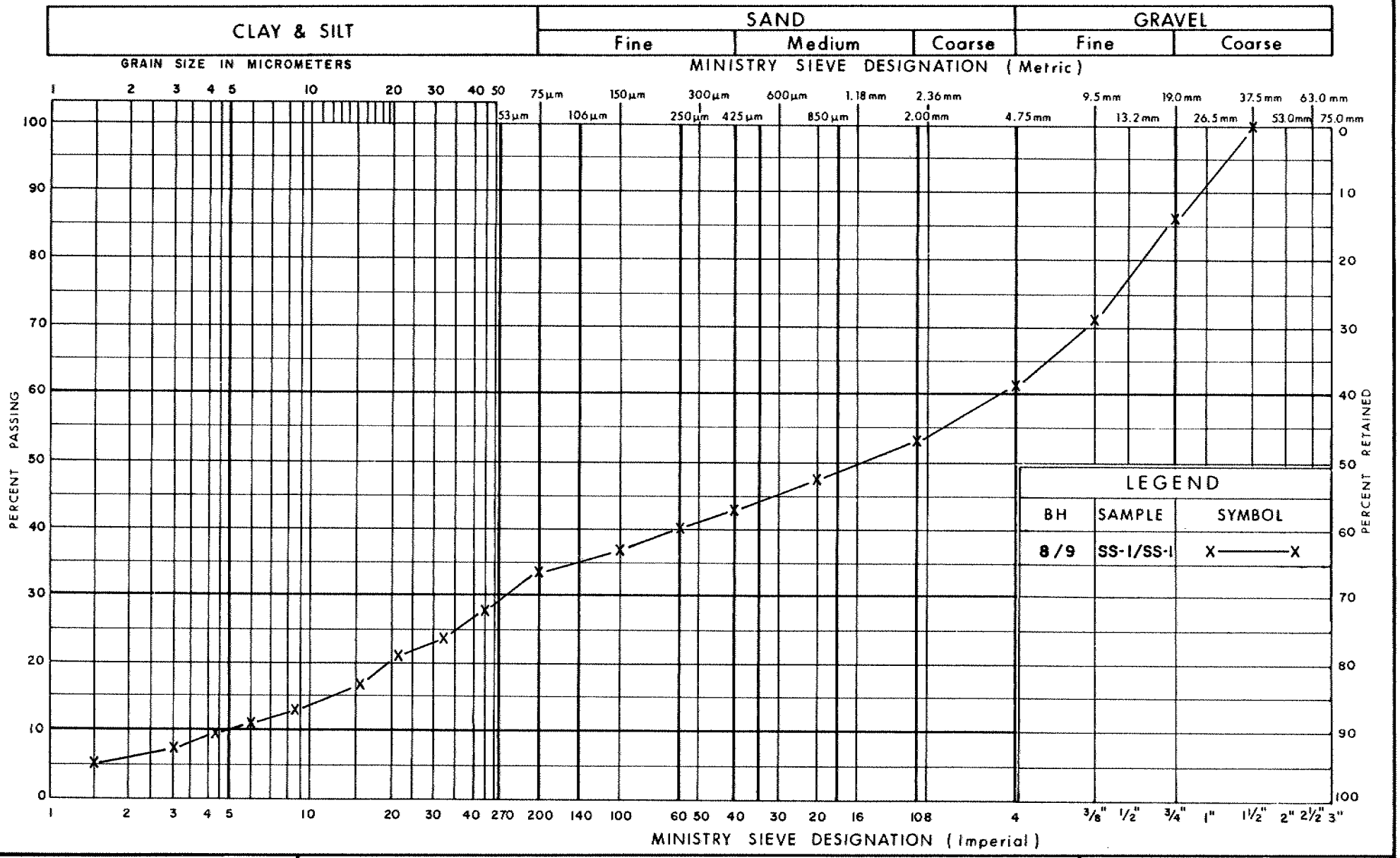
SANDY SILT TO SILTY SAND, SOME GRAVEL, TRACE CLAY
(GLACIAL TILL)

FIG No 1A

W P 410-85-01/02

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

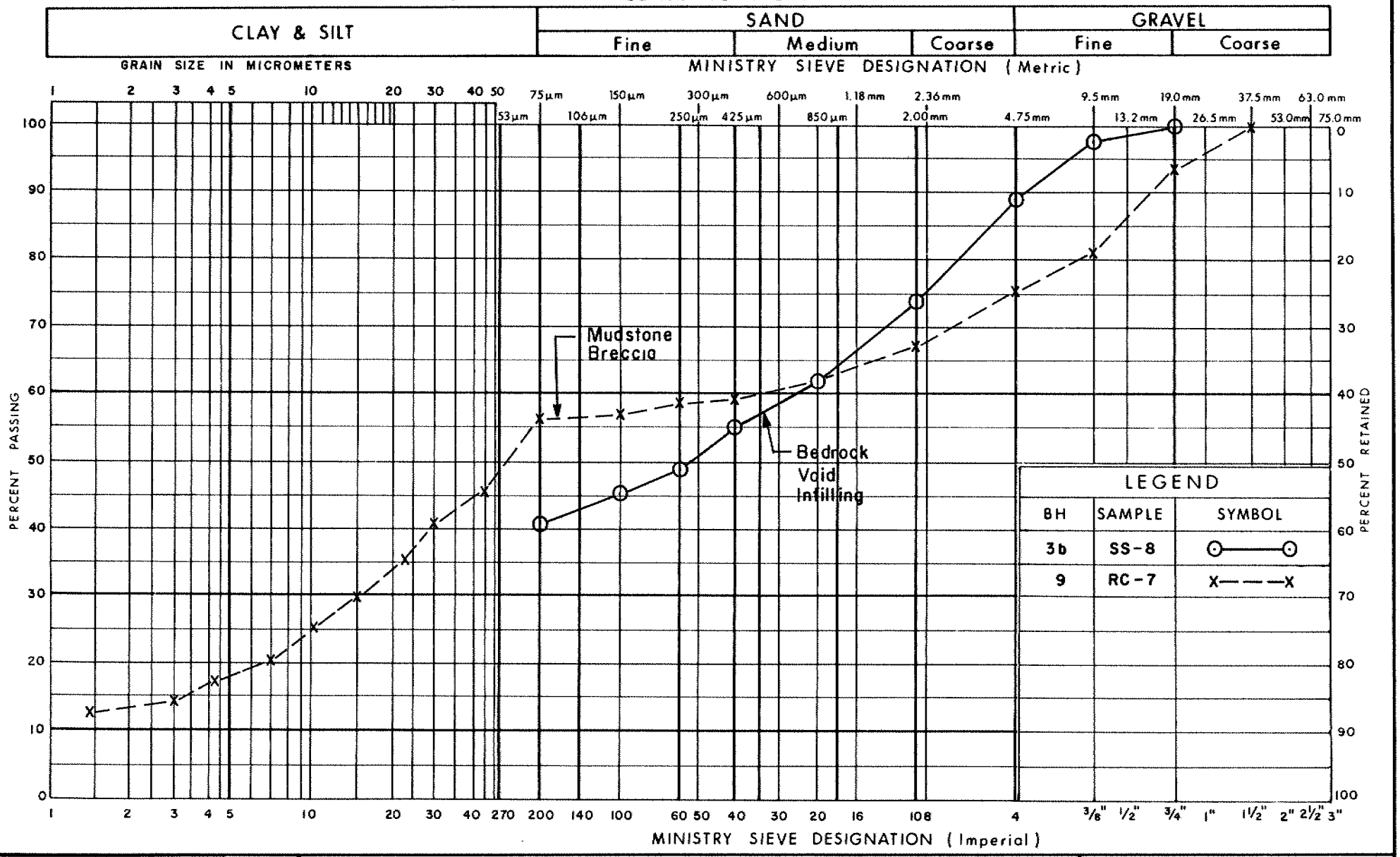
GRAIN SIZE DISTRIBUTION

MIXTURE OF CLAYEY SILT, SAND AND GRAVEL
(ALLUVIUM/COLLUVIUM)

FIG No 1B
W P 410-85-01/02

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM

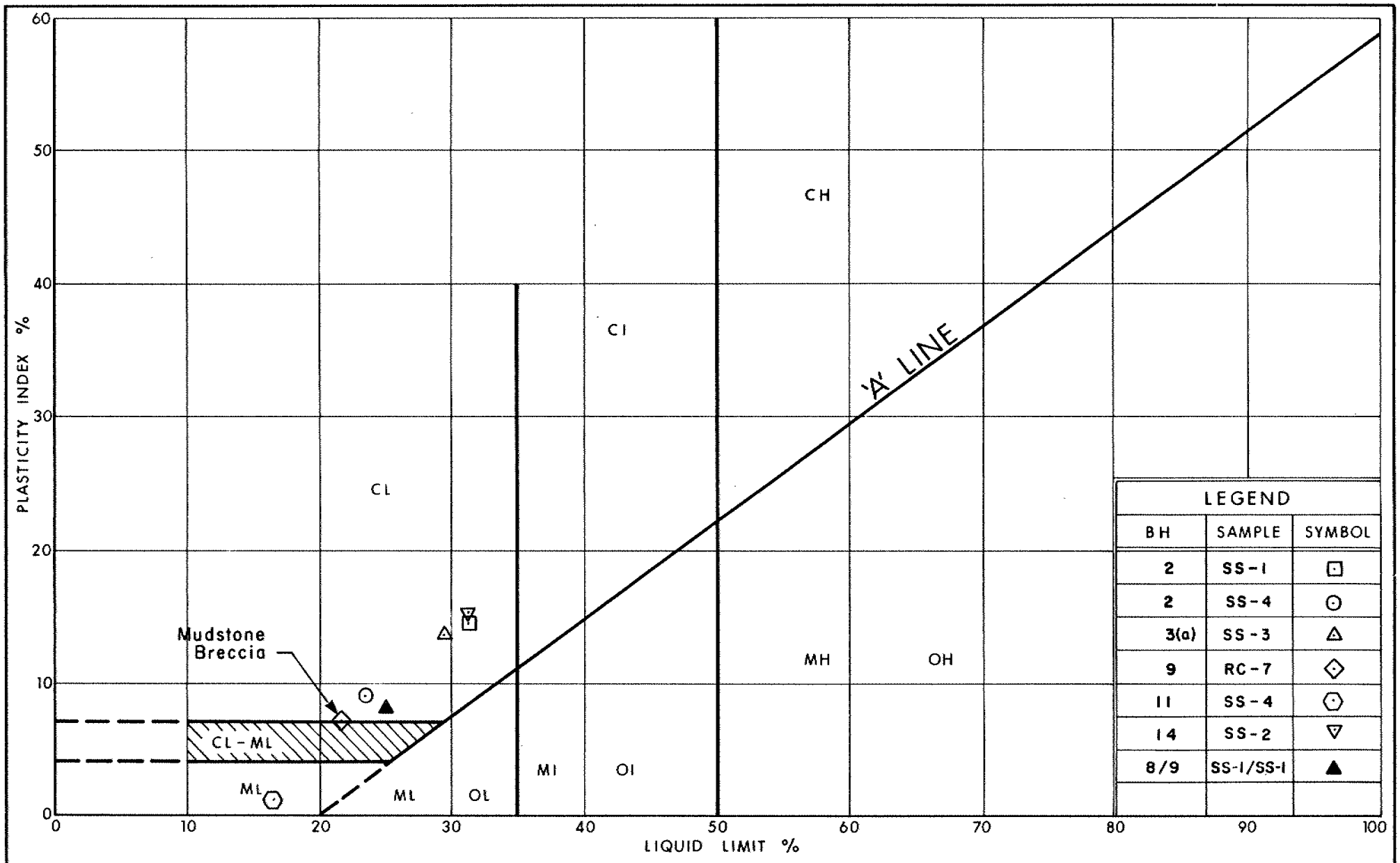


Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
MUDSTONE BRECCIA
BEDROCK VOID INFILLING

FIG No 2
W P 410-85-01/02

Oct 75, FF-S-21



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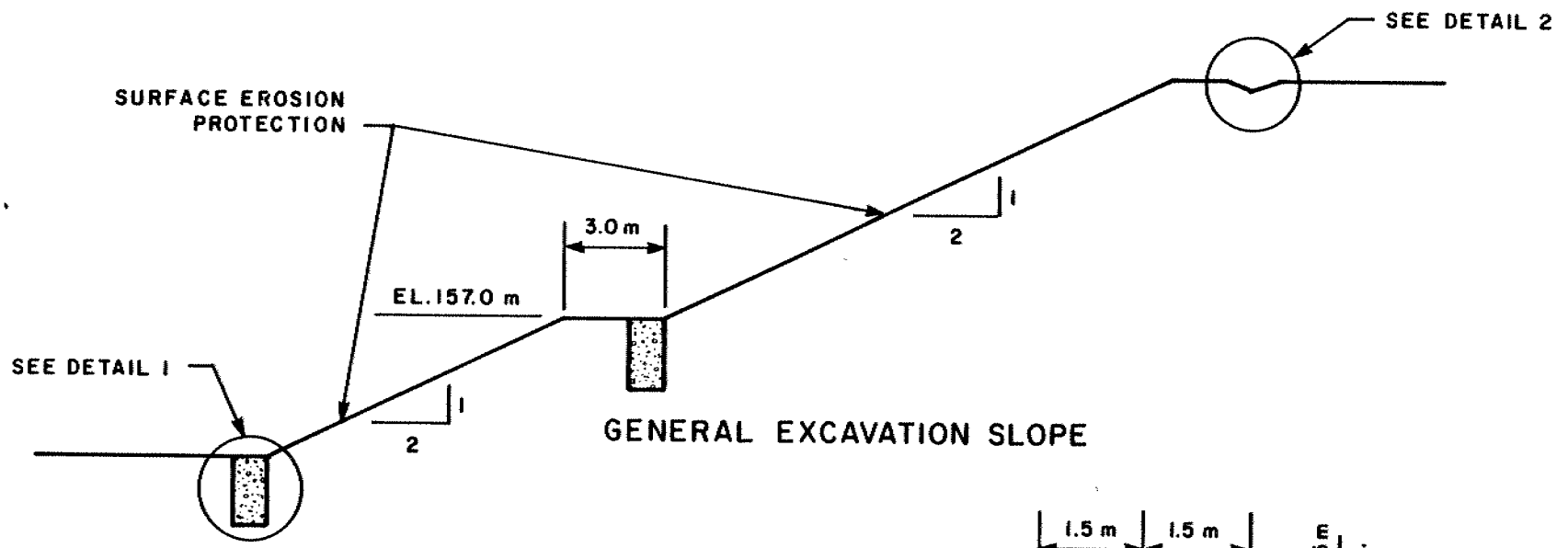
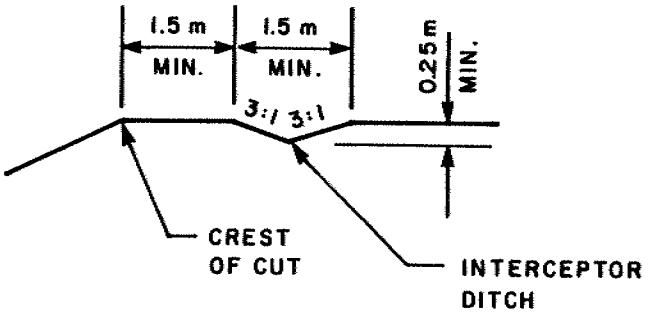
PLASTICITY CHART
VARIOUS GLACIAL TILL, ALLUVIUM/COLLUVIUM GRADATIONS AND MUDSTONE BRECCIA

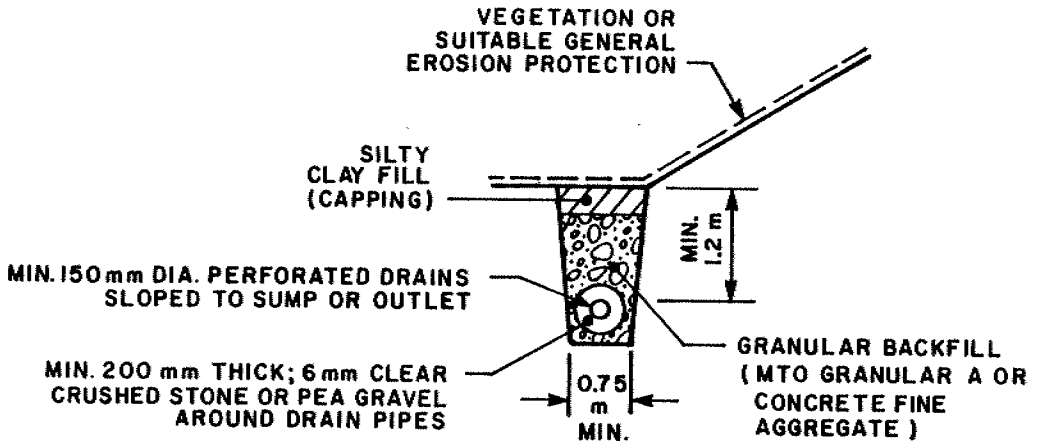
FIG No 3
W P 410-85-01/02



GENERAL EXCAVATION SLOPE



DETAIL 2



DETAIL 1

Ministry of Transportation
Ontario

RECOMMENDED DRAINAGE SYSTEM EAST APPROACH CUT

FIG No 4

W P 410-85-01/02

Drawings

MINISTRY OF TRANSPORTATION, ONTARIO PH-D-207 88 10

METRIC

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

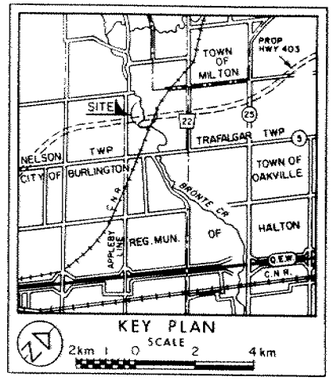
CONT No
WP No 410-85-01/02

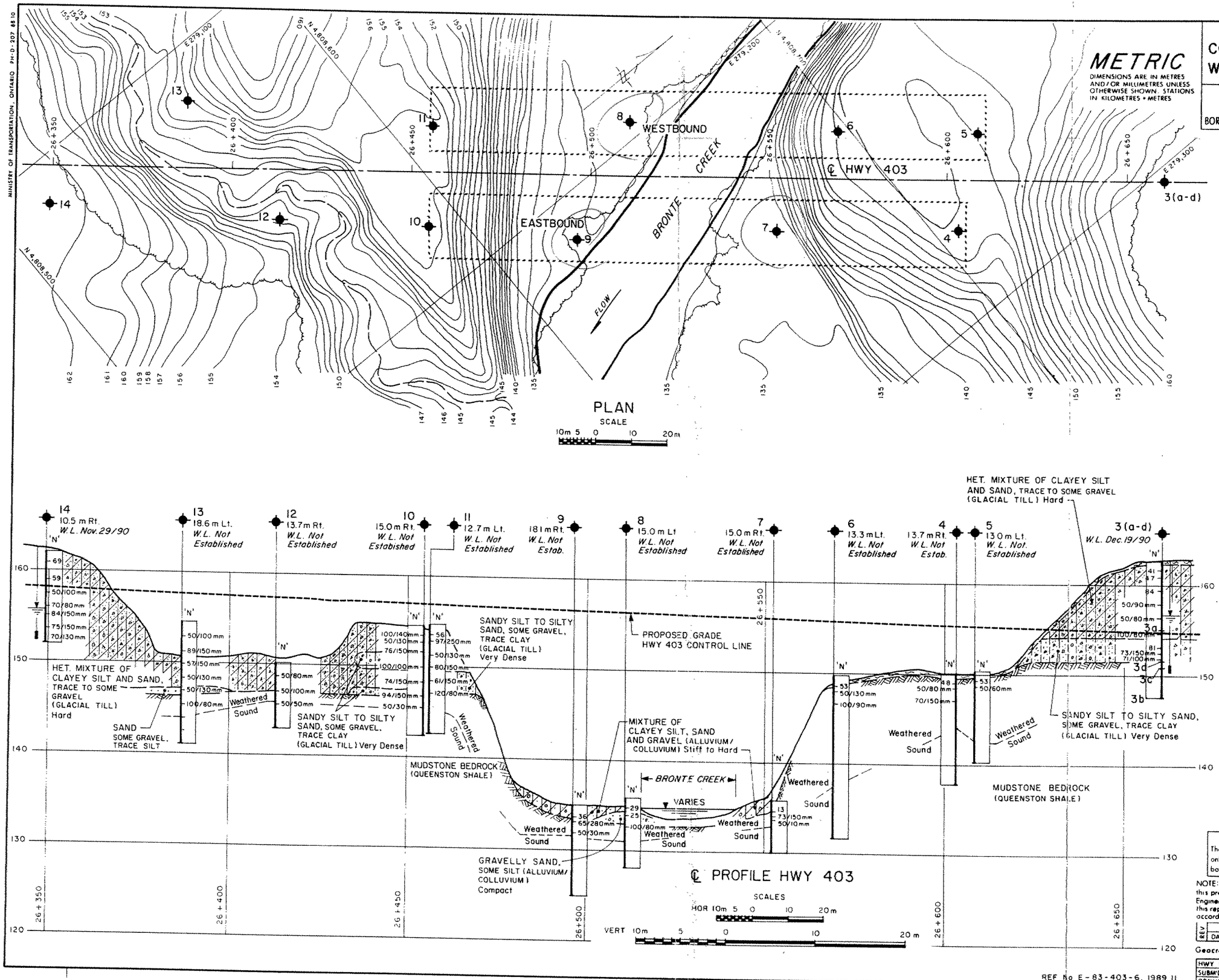
BRONTE CREEK

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

ACRES INTERNATIONAL LIMITED





LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation
- Piezometer Tip
- Rt. Offset Right of ℄
- Lt. Offset Left of ℄

No	ELEVATION	CO-ORDINATES NORTHING	EASTING
3a	162.6	4 808 758	279 304
3b	162.6	4 808 759	279 303
3c	162.6	4 808 760	279 302
3d	162.6	4 808 757	279 304
4	150.2	4 808 705	279 278
5	150.4	4 808 726	279 260
6	149.7	4 808 698	279 234
7	135.6	4 808 667	279 246
8	135.7	4 808 655	279 197
9	134.9	4 808 622	279 212
10	154.5	4 808 592	279 183
11	154.6	4 808 610	279 163
12	150.1	4 808 561	279 155
13	154.5	4 808 562	279 114
14	162.1	4 808 515	279 111

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

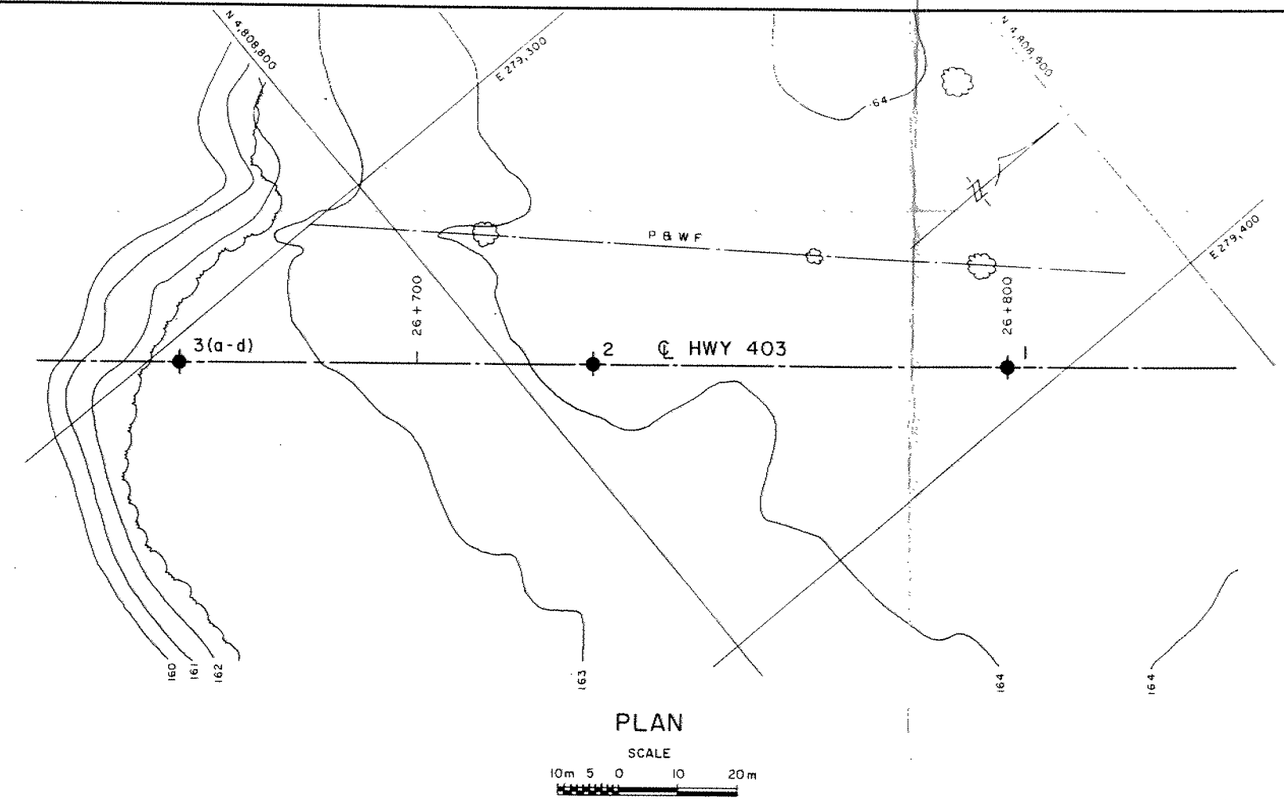
REV	DATE	BY	DESCRIPTION

Geocres No 30M5-169

REF No E-83-403-6, 1989 11

HWY No 403			DIST 4
SUBM'D	CHECKED	DATE JAN 1991	SITE 10-220
DRAWN T T	CHECKED	APPROVED	DWG 410850102-A

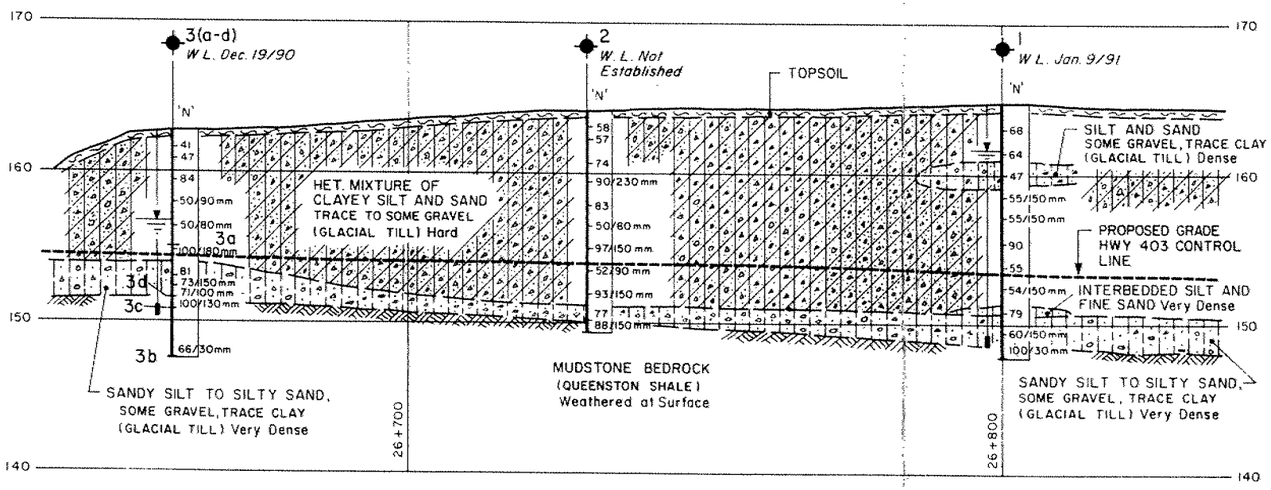
MINISTRY OF TRANSPORTATION, ONTARIO PH-0-207 88 10



PLAN

SCALE

10m 5 0 10 20m



℄ PROFILE HWY 403

SCALES

HOR 10m 5 0 10 20m

VERT 10m 5 0 10 20m

METRIC

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

CONT No

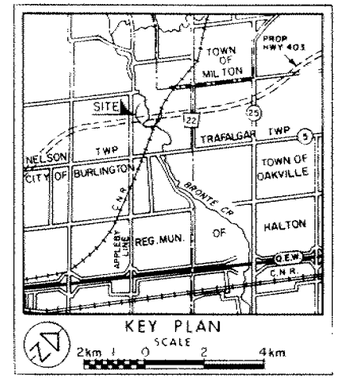
WP No 410-85-01/02

BRONTE CREEK

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

ACRES INTERNATIONAL LIMITED



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
- Piezometer Tip

No	ELEVATION	CO-ORDINATES NORTHING	EASTING
1	164.7	4 808 865	279 394
2	164.0	4 808 812	279 348
3a	162.6	4 808 758	279 304
3b	162.6	4 808 759	279 303
3c	162.6	4 808 760	279 302
3d	162.6	4 808757	279 304

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100

REV	DATE	BY	DESCRIPTION

Geocres No 30M5-169

HWY No 403			DIST 4
SUBM'D	CHECKED	DATE JAN 1991	SITE 10-220
DRAWN T T	CHECKED	APPROVED	DWG 410850102-8

REF No E-83-403-6, 1989 11

Explanation of Terms Used in Report

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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.

Strength

Term	Description	Unconfined Compressive Strength (MPa)	(psi)
Extremely weak rock	Indented by thumbnail	0.25-1.0	36-145
Very weak rock	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	1.0-5.0	145-725
Weak rock	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 rock	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	Specimen requires more than one blow of geological hammer to fracture it	50-100	7250-14500
Very strong rock	Specimen requires many blows of geological hammer to fracture it	100-250	14500-36250
Extremely strong rock	Specimen can only be chipped with geological hammer	>250	>36250

Weathering

Term	Description
Fresh	No visible sign of rock material weathering.
Faintly weathered	Discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Highly weathered	More than half of the rock is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.
Residual	All rock material is converted to soil. The mass structure and material soil fabric are destroyed. There is a large change in volume, but the soil has not be significantly transported.

Soil Description

Term	Example	%
Trace	Trace sand	1 - 10
Some	Some sand	10 - 20
Adjective	Sandy	20 - 35
And	And sand	>35
Noun	Sand	>50

Record of Boreholes

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 1

METRIC

Sta. 26 + 800 ℄ Hwy. 403
Co-ords. 4 808 865 N; 279 394 E

W P 410-85-01/02 LOCATION
DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger
DATUM Geodetic DATE 90 11 21

ORIGINATED BY REC
COMPILED BY REC
CHECKED BY TJB

OFFICE REPORT ON SOIL EXPLORATION

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● SLOPE TRIAXIAL, + FIELD VANE, × LAB VANE)	WATER CONTENT (%) Wp W Wl	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
164.7	Ground Level					90 11 29		20 40 60 80 100	10 20 30		
0.0	Topsoil						164				
	Heterogeneous mixture of clayey silt and sand some gravel, dry, low plasticity CL (Glacial Till) Hard Brown		1	SS	68						
			2	SS	64	▼	162				
	Silt and sand, some gravel, trace clay, nonplastic Dense		3	SS	47		160				
			4	SS	55/150 mm						
			5	SS	55/150 mm		158				
	Occasional patches of silty sand		6	SS	90		156				
			7	SS	55		154				
			8	SS	54/150 mm						
	Interbedded silt and fine sand						152				
150.7			9	SS	79						
14.0	Silty sand, trace to some gravel, trace clay, moist, nonplastic SM (Glacial Till) Very Dense Brown		10	SS	60/150 mm		150				
148.4	Mudstone Bedrock (Queenston Shale)					Piezometer					
16.3 147.9	Weathered Reddish Brown		11	SS	100/30 mm		148				
16.8	End of borehole										

Note:

Water level recorded January 9, 1991.

*Ground surface is cultivated to 0.4 m depth. Presently growing forage crops.

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

Ministry of Transportation Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 410-85-01/02 LOCATION Sta. 26 + 730 ℄ Hwy. 403 Co-ords. 4 808 812 N; 279 348 E ORIGINATED BY REC

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, N tricone COMPILED BY CSB

DATUM Geodetic DATE 90 10 15 to 16 CHECKED BY TJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
164.0	Ground Level										
0.0	Topsoil*										
	Heterogeneous mixture of clayey silt and sand, trace to some gravel, dry, low plasticity CL (Glacial Till)		1	SS	58						
			2	SS	57		162				
	Hard Gray Brown		3	SS	74						
			4	SS	90/	230 mm	160				
			5	SS	83		158				6 29 47 18
	Occasional cobbles as indicated by drill action		6	SS	50/	80 mm	156				
			7	SS	97/	150 mm					
			8	SS	52/	90 mm	154				8 30 (62)
	Brown		9	SS	93/	150 mm	152				
151.0											
13.0	Silt and sand, some gravel, trace clay, wet										
150.0	SM (Glacial Till)		10a 10b	SS	77		150				
14.0	Mudstone Bedrock (Queenson Shale)										
149.2	Weathered Reddish Brown		11	SS	88/	150 mm					
14.8	End of Borehole										

Note:

*Ground surface is cultivated to 0.4 m depth. Presently, growing forage crops.

Hole was advanced below 7.9 m depth by N tricone due to auger refusal.

Water used to drill below 7.9 m depth, hole full of water on completion. Groundwater level not determined.

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 3(a) METRIC

W P 410-85-01/02 LOCATION Sta. 26 + 660 ℄ Hwy. 403 Co-ords. 4 808 758 N; 279 304 E ORIGINATED BY RFC

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CSB

DATUM Geodetic DATE 90 10 16 to 17 CHECKED BY TJR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
162.6	Ground Level										
0.0	Topsoil*										
	Heterogeneous mixture of clayey silt and sand trace to some gravel, dry, low plasticity CL (Glacial Till)		1	SS	41		162				
			2	SS	47						
	Hard Brown						160				
			3	SS	84						
			4	SS	50/90 mm		158				
			5	SS	50/80 mm		156				
155.0			-	SS	30/0 mm						
7.6	End of Borehole, sampler and auger refusal. For continuation, see BH-3(b)										

Note:

*Ground surface is cultivated to 0.4 m depth. Presently, growing forage crops.

Borehole dry on completion of drilling. Groundwater level not established.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 3(b)

METRIC

W P 410-85-01/02 LOCATION Sta. 26 + 660.4 o/s 1.0 Lt. ℄ Hwy. 403 Co-ords. 4 808 759 N; 279 303 E ORIGINATED BY REC

DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger COMPILED BY CSB

DATUM Geodetic DATE 90 10 18 CHECKED BY TJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
162.6	Ground Level					90 11 29					
0.0	Heterogeneous mixture of clayey silt and sand trace to some gravel, dry, low plasticity CL (Glacial Till) Hard Brown						162				
							160				
							158				
							156				
			6	SS	100/ 180 mm						
154.0							154				
8.6	Silt and sand, some gravel, trace clay, wet										
			7	SS	81						28 37 34 1
	GM-SM (Glacial Till) Very Dense Reddish Brown										
151.9							152				
10.7	Assumed bedrock surface										
						Piezometer					
	Void, possible infilling of silt, sand and gravel, wet, very loose, brown		8	SS	0		150				11 49 (40)
							148				
147.5	Mudstone Bedrock		9	SS	66/ 30 mm						
15.1	End of Borehole										

Notes:

1. Groundwater elevation recorded December 19, 1990.
2. Sampler and drill rods fell freely from 10.7 to 15.1 m depth during drilling. Possible open vertical joint in bedrock. See nearby holes BH-3(c) and BH-3(d)

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 3 (c)

METRIC

W P 410-85-01/02 LOCATION Sta. 26 + 660.7 o/s 2.2 Lt. ℄ Hwy. 403 Co-ords. 4 808 760 N; 279 302 E ORIGINATED BY REC

DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger COMPILED BY CSB

DATUM Geodetic DATE 90 10 18 CHECKED BY TJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
162.6	Ground Level										
0.0	Heterogeneous mixture of clayey silt and sand trace to some gravel, dry, low plasticity CL (Glacial Till) Hard Brown Occasional cobbles as indicated by drill action						162				
							160				
							158				
							156				
154.0							154				
8.6	Silt and sand, some gravel, trace clay GM-SM (Glacial Till) Very Dense Reddish Brown		10	SS	73/150 mm				○		
151.9			11	SS	71/100 mm		152		○		
10.7	Mudstone Bedrock Weathered Reddish Brown		12	SS	100/130 mm				○		
151.0											
11.6	End of Borehole										

Note:

Hole drilled to determine extent of void encountered in BH-3(b).

Borehole dry on completion of drilling. Groundwater level not established.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3(d)

METRIC

Sta. 26 + 659.8 o/s 0.5 Rt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 757 N; 279 304 E ORIGINATED BY REC

DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger COMPILED BY CSB

DATUM Geodetic DATE 90 10 18 CHECKED BY TJB

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT Wl / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
162.6	Ground Level										
0.0	**Heterogeneous mixture of clayey silt and sand trace to some gravel, dry, low plasticity** CL (Glacial Till) Hard Brown **Occasional cobbles as indicated by drill action**						162				
							160				
							158				
							156				
154.0											
8.6	**Silt and sand, some gravel, trace clay, wet** GM-SM (Glacial Till) Very Dense Reddish Brown						154				
151.8											
10.8	Mudstone Bedrock Weathered Reddish Brown		13	SS	100/4	90 mm	152				
151.7											
10.9	End of Borehole										

Note:
Hole drilled to determine extent of void encountered in BH-3(b). Borehole dry on completion of drilling. Groundwater level not established.

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 4

METRIC

W P 410-85-01/02 LOCATION Sta. 26 + 603.3 o/s 13.7 Rt. ℄ Hwy. 403 Co-ords. 4 808 705 N; 279 278 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 11 to 15 CHECKED BY TJB

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT Wl / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
150.2	Ground Level										
0.0	Topsoil						150				
149.4	Boulder										
0.8	Mudstone Bedrock (Queenston Shale)		1	SS	48						
			2	SS	50/80 mm						
	Reddish brown with occasional gray bands, very weak to weak, highly to moderately weathered, very thinly to thinly bedded. Occasional fragmented zones up to 70 mm thick. 3.28-3.36: Brecciated.						148				
			3	SS	70/150 mm						
			4	NQ RC	REC 76%		146				RQD = 23%
			5	NQ RC	REC 83%						RQD = 14%
	weathered / sound (1438 ± 6mm)						144				
	Medium strong, faintly weathered, thinly to medium bedded		6	NQ RC	REC 100%						RQD = 79%
			7	NQ RC	REC 100%		142				RQD = 78%
			8	NQ RC	REC 99%		140				RQD = 82%
			9	NQ RC	REC 100%						RQD = 82%
137.8							138				
12.4	End of Borehole										

Water used during drilling. Groundwater level not established.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 5

METRIC

Sta. 26 + 608.3 o/s 13.0 Lt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 726 N; 279 260 E ORIGINATED BY REC

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 15 CHECKED BY TJR

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
150.4	Ground Level										
0.0 / 149.9	Topsoil, some cobbles										
0.5	Mudstone Bedrock (Queenston Shale)		1	SS	53		150				
			2	SS	50/ 60 mm						
	Reddish brown with occasional gray bands, very weak to medium strong, highly to slightly weathered, very thinly to medium bedded. Occasional fragmented zones up to 50 mm thick						148				
			3	NQ RC	REC 27%		146				RQD = 7%
			4	NQ RC	REC 100%						RQD = 56%
	7.13-7.58: Brecciated weathered		5	NQ RC	REC 100%		144				RQD = 29%
	sound Medium strong, faintly weathered, thinly to medium bedded. Rare fragmented zones up to 50 mm thick		6	NQ RC	REC 94%		142				RQD = 68%
140.4	8.30-8.32: Brecciated		7	NQ RC	REC 99%						RQD = 98%
10.0	End of Borehole										

Water used during drilling. Groundwater level not established.

+3, ×5 Numbers refer to Sensitivity

20 / 5 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 6

Sta. 26 + 569.2 o/s 13.3 Lt. ℄ Hwy. 403

METRIC

W P 410-85-01/02 LOCATION Co-ords. 4 808 698 N; 279 234 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 10 to 11 CHECKED BY TJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
149.7	Ground Level										
0.0 / 149.5	Topsoil										
0.2	Mudstone Bedrock (Queenston Shale)		1	SS	53						
			2	SS	50/- 130 mm		148				
	Reddish brown with occasional gray bands, very weak to weak, highly to moderately weathered, very thinly to thinly bedded. Frequent fragmented and brecciated zones		3	SS	100/- 90 mm						
			4	NQ RC	REC 26%		146				RQD = 0%
			5	NQ RC	REC 86%		144				RQD = 16%
			6	NQ RC	REC 85%						RQD = 47%
			7	NQ RC	REC 86%		142				RQD = 37%
			8	NQ RC	REC 42%		140				RQD = 0%
			9	RC	94%						RQD = 0%
	< 137.7 (12.0 ±) weathered / sound		10	NQ RC	REC 82%		138				RQD = 0% / Tricone
	Medium strong, faintly weathered, thinly to medium bedded. Rare fragmented zones up to 50 mm thick. 13.22: Brecciated, 5 mm. 14.27-14.38: Fragmented, contains 40 mm breccia band. 15.07-15.09: Brecciated.		11	NQ RC	REC 95%						RQD = 63%
			12	NQ RC	REC 100%		136				RQD = 72%
			13	NQ RC	REC 100%		134				RQD = 97%
			14	NQ RC	REC 98%		132				RQD = 81%
131.6											
18.1	End of Borehole										

Water used during drilling. Groundwater level not established.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 7

METRIC

Sta. 26 + 552.2 o/s 15.0 Rt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 667 N; 279 246 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 10 CHECKED BY TJB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
135.6	Ground Level										
0.0	**Mixture of clayey silt, sand and gravel, dry, low plasticity (CL)**										
134.3	Stiff Reddish Brown		1	SS	13						
1.3	Mudstone Bedrock (Queenston Shale)		2	SS	73/150 mm		134				
			3	SS	50/10 mm						
	weathered — sound										
	Reddish brown with occasional gray bands, medium strong, faintly weathered, very thinly to thinly bedded. Occasional fragmented zones up to 70 mm thick		4	NQ RC	REC 100%		132				RQD = 59%
	4.78-4.80: Brecciated		5	NQ RC	REC 99%		130				RQD = 86%
129.9											
5.7	End of Borehole										

Water used during drilling. Groundwater level not established.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 8

METRIC

Sta. 26 + 511.4 o/s 15.0 Lt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ordn. 4 808 655 N; 279 197 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NO Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 09 CHECKED BY TJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
135.7	Ground Level										
0.0	**Mixture of clayey silt, sand and gravel, moist, low plasticity (CL)**										
134.3	Very stiff Brown		1	SS	29						
1.4	Gravelly sand, some silt, wet GM		2	SS	25		134				
132.9	Compact Reddish Brown										
2.8	Mudstone Bedrock (Queenston Shale) weathered sound		3	SS	100+	80 mm	132				
	Reddish brown with occasional gray bands, medium strong, faintly weathered, very thinly to medium bedded 5.80-5.83: Brecciated* 6.59: Brecciated, 5 mm		4	HQ RC	REC 99%		130	Uniaxial compressive strength = 43.2 MPa; ϕ' peak = 29.1 deg. Direct shear test ϕ' (12 mm disp.) = 18.8 deg.			RQD = 54%
128.1			5	HQ RC	REC 100%						RQD = 84%
7.6	End of Borehole										

*Testing performed on breccia material

Water used during drilling. Groundwater level not established.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 9

METRIC

Sta. 26 + 496.5 o/s 18.1 Rt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 622 N; 279 212 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 09 CHECKED BY TJB

OFFICE REPORT ON SOIL EXPLORATION

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
134.9	Ground Level										
0.0	**Mixture of clayey silt, sand and gravel, moist, low plasticity (CL)**										
133.5	Hard Reddish Brown		1	SS	36		134				
1.4	Mudstone Bedrock (Queenston Shale)		2	SS	65/ 280 mm						
	weathered		3	SS	50/ 30 mm		132				
	sound		4	NQ RC	REC 91%						RQD = 33%
	Reddish brown with occasional gray bands, medium strong, faintly weathered, very thinly to thinly bedded. Occasional fragmented zones up to 60 mm thick		5	NQ RC	REC 97%		130				RQD = 57%
	3.39-3.40) 4.93-4.99) 6.06-6.15) Brecciated 6.70-6.71) 7.41-7.45)		6	NQ RC	REC 100%		128				RQD = 53%
	8.42-8.49*: Brecciated		7	NQ RC	REC 93%						RQD = 69% 24 19 43 14
124.8			8	NQ RC	REC 100%		126				RQD = 80%
10.1	End of Borehole										

*Testing performed on breccia material

Water used during drilling. Groundwater level not established.

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 10

METRIC

Sta. 26 + 455 o/s 15.0 Rt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 592 N; 279 183 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 03 to 04 CHECKED BY TJB

OFFICE REPORT ON SOIL EXPLORATION

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH cPo (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
154.5	Ground Level										
0.0	Heterogeneous mixture of clayey silt and sand some gravel, dry, low plasticity CL (Glacial Till)		1	SS	100/140 mm		154		○		
			2	SS	50/130 mm				○		
151.5	Hard Brown						152				
3.0	Sandy silt, some gravel, trace clay, dry, slow dilatancy. Occasional cobbles* ML (Glacial Till) Very dense		3	SS	76/150 mm				○		
149.5	Reddish Brown		4	SS	100/100 mm		150		○		
5.0	Heterogeneous mixture of clayey silt and sand some gravel, dry, low plasticity CL (Glacial Till)		5	SS	74/150 mm				○		
	Hard Reddish Brown						148				
	Silty sand, some gravel, trace clay		6	SS	94/150 mm				○		
146.5	Very Dense										
8.0	Mudstone Bedrock (Queenston Shale) weathered sound		7	SS	50/30 mm		146		○		
	Reddish brown with occasional gray bands, medium strong, faintly weathered, very thinly to thinly bedded. Occasional fragmented zones up to 70 mm thick 10.73: Brecciated, 5 mm		8	NQ RC	REC 92%		144				RQD = 55%
142.3			9	NQ RC	REC 96%						RQD = 55%
12.2	End of Borehole										

*Indicated by drill action

Water used during drilling. Groundwater level not established.

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 11

METRIC

Sta. 26 + 456 o/s 12.7 Lt. ℄ Rwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 610 N; 279 163 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 04 to 05 CHECKED BY TJB

OFFICE REPORT ON SOIL EXPLORATION

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
154.6	Ground Level										
0.0	Heterogeneous mixture of clayey silt and sand trace to some gravel, dry, low plasticity Occasional cobbles* CL (Glacial Till)		1	SS	56		154		○		
			2	SS	97/250 mm				○		
							152				
			3	SS	50/130 mm				○		
150.0	Hard Brown										
4.6	Sandy silt, some gravel trace clay, dry, slow dilatancy. Occasional cobbles* ML (Glacial Till)		4	SS	80/150 mm		150		● H		10 30 54 6
			5	SS	61/150 mm				○		
	Very dense						148				
147.0	Brown										
7.6	Mudstone Bedrock (Queenston Shale)		6	SS	120/80 mm				○		
							146				
	(145 9.6m) weathered / sound		7	NQ RC	REC 90%						RQD = 34%
	Reddish brown with occasional gray bands, medium strong, faintly weathered, very thinly to thinly bedded. Rare fragmented zones up to 100 mm thick 12.19-12.22: Brecciated						144				
142.4			8	NQ RC	REC 100%						RQD = 50%
12.2	End of Borehole										

*Indicated by drill action

Water used during drilling. Groundwater level not established.

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 12

METRIC

Sta. 26 + 413.7 o/s 13.7 Rt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 561 N; 279 155 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 02 to 03 CHECKED BY EJB

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
150.1	Ground Level						150				
0.0	Heterogeneous mixture of clayey silt and sand trace to some gravel, dry, low plasticity CL (Glacial Till)		1	SS	50/ 80 mm				○		
146.9	Hard Brown						148				
3.2	Mudstone Bedrock (Queenston Shale) weathered / sound		2	SS	50/ 100 mm				○		
	Reddish brown with occasional gray bands, medium strong, faintly weathered, very thinly to thinly bedded. Rare fragmented zones up to 100 mm thick		3	SS	50/ 50 mm		146				
			4	NQ RC	REC 90%						RQD = 51%
			5	NQ RC	REC 90%		144				RQD = 72%
142.8											
7.3	End of Borehole										

Water used during drilling. Groundwater level not established.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation

RECORD OF BOREHOLE No 13

METRIC

Sta. 26 + 388 o/s 18.6 Lt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 562 N; 279 114 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, NQ Rock Core COMPILED BY CSB

DATUM Geodetic DATE 90 10 01 to 02 CHECKED BY TJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
154.5	Ground Level										
0.0	Heterogeneous mixture of clayey silt and sand some gravel, dry, low plasticity CL (Glacial Till) Hard Reddish Brown		1	SS	50/- 100 mm		154		○		
			2	SS	89/- 150 mm		152		○		
			3	SS	57/- 150 mm		150		○		
			4	SS	50/- 130 mm		148		○		
146.7	Sand, some gravel, trace silt, wet, Gray SP		5	SS	50/- 130 mm				○		
7.8	Mudstone Bedrock (Queenston Shale) Reddish brown with occasional gray bands, weak, highly to moderately weathered, very thinly to thinly bedded		6	SS	100/- 80 mm		146		○		
	weathered		7	NQ RC	REC 70%		144				RQD = 40%
	sound Medium strong, faintly weathered. Occasional fragmented zones up to 60 mm thick		8	NQ RC	REC 94%						RQD = 61%
141.0			9	NQ RC	REC 100%		142				RQD = 57%
13.5	End of Borehole Water used during drilling. Groundwater level not established.										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation

RECORD OF BOREHOLE No 14

METRIC

Sta. 26 + 349 o/s 10.5 Rt. ℄ Hwy. 403

W P 410-85-01/02 LOCATION Co-ords. 4 808 515 N; 279 111 E ORIGINATED BY CSB

DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CSB

DATUM Geodetic DATE 90 10 01 CHECKED BY TJB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
162.1	Ground Level					90 112 9					
0.0	Topsoil*						162				
	Heterogeneous mixture of clayey silt and sand trace to some gravel, dry, low plasticity										
	CL (Glacial Till)		1	SS	69				○		
	Hard Brown						160				
			2	SS	59				○		
							158				
			3	SS	50/100 mm				○		5 24 51 20
			4	SS	70/80 mm		156		○		
	Reddish Brown										
	Occasional cobbles as indicated by drill action		5	SS	84/150 mm				●		6 28 (66)
							154				
			6	SS	75/150 mm				○		
151.9			7	SS	70/130 mm	Piezometer	152		○		
10.2	End of Borehole										

Note:

Groundwater elevation recorded on Nov 20/90.

*Ground surface is cultivated to 0.4 m depth. Presently growing forage crops.

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Acres Facsimile

To M. De Vata
Attention: T. Kim

At MTO - Toronto

No. (416) 235-5240

From T. J. Bradshaw

Date April 15, 1993
File No. W11415.00
Del E. Gyurkovics
No. of Pages 4

Acres International Limited
5259 Dorchester Road
Niagara Falls, Ontario
L2E 6W1

Telephone (416) 374-5200
Telex 061 5107
Facsimile (416) 374-1157

Subject **Highway 403 Excavation East of Bronte Creek**
Stability of Base of Cut
WP408-85-01 Site 10-478 and WP410-85-01/02 Site 10-220

Tae,

Further to our recent telephone conversation on the subject matter, we have reviewed our reports for the area and would offer the following comments.

The piezometers had their tips located below or slightly above the bedrock surface in the non-to-slightly cohesive till deposit. They indicate that the piezometric level near and east of the CNR crossing is close to the ground surface. West of the railway cut, the piezometric level drops toward the Bronte Creek ravine. Adjacent to the ravine, it is at a depth of approximately 6 m.

If these piezometric levels are assumed to be effective on the base of the cohesive till during excavation of the roadway cut, there is a potential to heave the base of the cut. To prevent such heave, it will be necessary to relieve the water pressure below the cohesive till.

The elevations to which the cut can be advanced and maintain a factor of safety of 1.2 against base heave have been calculated and are shown in the attached Table 1. When the excavation reaches these elevations, we would suggest that pressure relief wells be installed along the roadway between Chainages 26+650 and 27+190 to relieve the water pressure and ensure long-term stability against heave. This can be accomplished by carrying out the excavation and drain installations as outlined below.

(a) At the various chainages along the cut, excavate to the elevations shown in Table 1.

(b) Install bench drains (see Figure 1).

(c) Install relief wells down to bedrock surface. Wells would consist of 600-mm diameter holes backfilled with concrete fine aggregate at 10-m centers along the line of the finished roadside ditches.

(d) Create ditches along the lines of the wells so that any seepage water can be disposed of in a controlled manner without softening the general excavated area.

(e) Install piezometers at 50-m centers along the centerline of the proposed highway and monitor piezometric levels to ensure adequate factor of safety against uplift.

(f) Excavate down to final road grade elevations.

(g) Construct drainage system and toe drain as outlined in our reports. (See typical detail of connection between drainage trench and pressure relief wells as shown in Detail 1 in Figure 1.)

Tae, when you have had an opportunity to review the above, we would be pleased to discuss it with you. I will be out of the office next week, however, Chi Ng is familiar with the subject and can be contacted at (416) 384-5200, ext. 5302, in my absence.

Regards,

TJB:eg

T. J. Bradshaw

Table 1

Excavation Depth for Stage 1 Excavation

Chainage	Elevation (m)
27+190	159.2
27+100	159.7
27+000	157.0
26+900	155.0
26+800	157.0
26+700	155.5
26+650	154.8

ACRES

Calculations

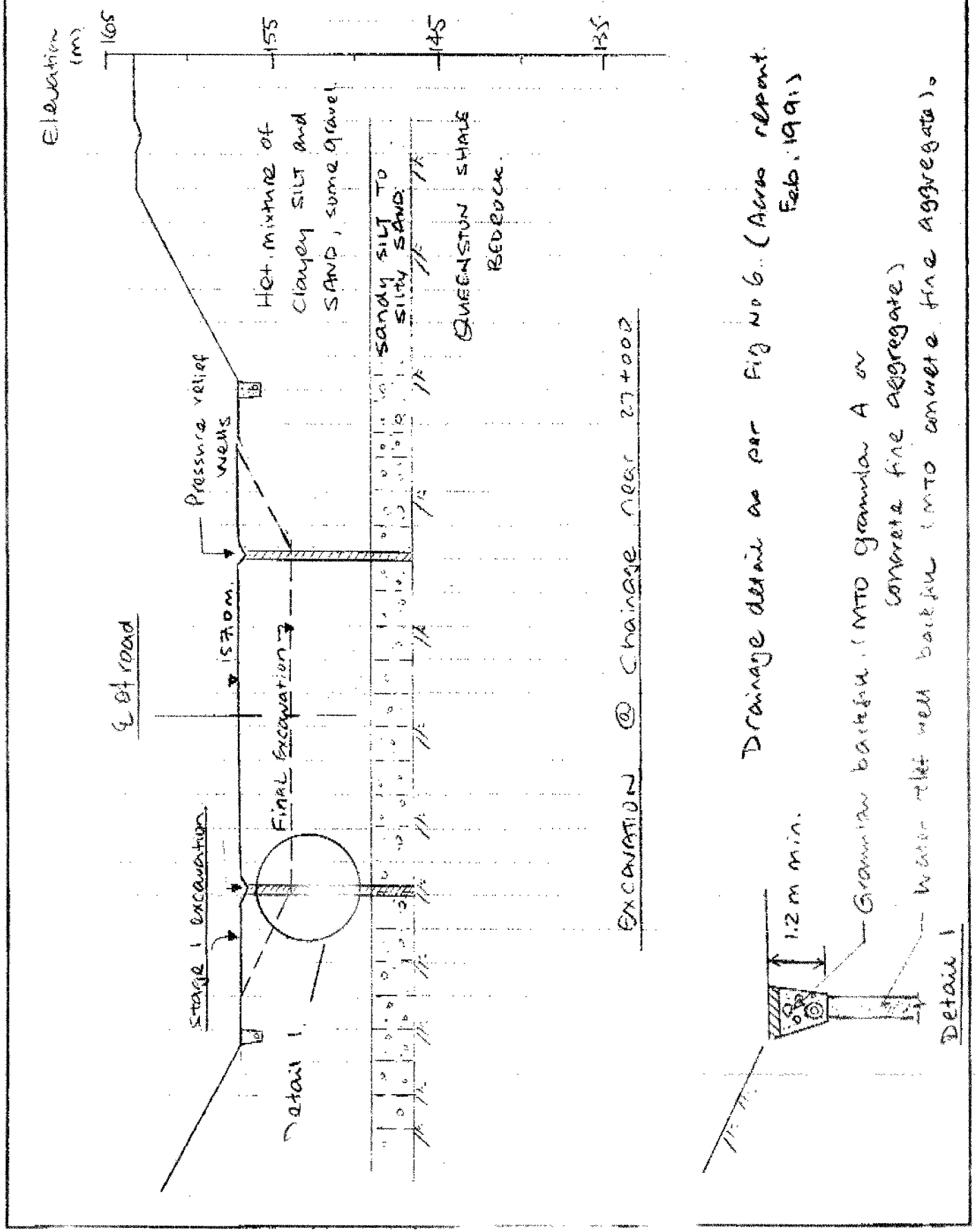
SUBJECT

FIGURE 1

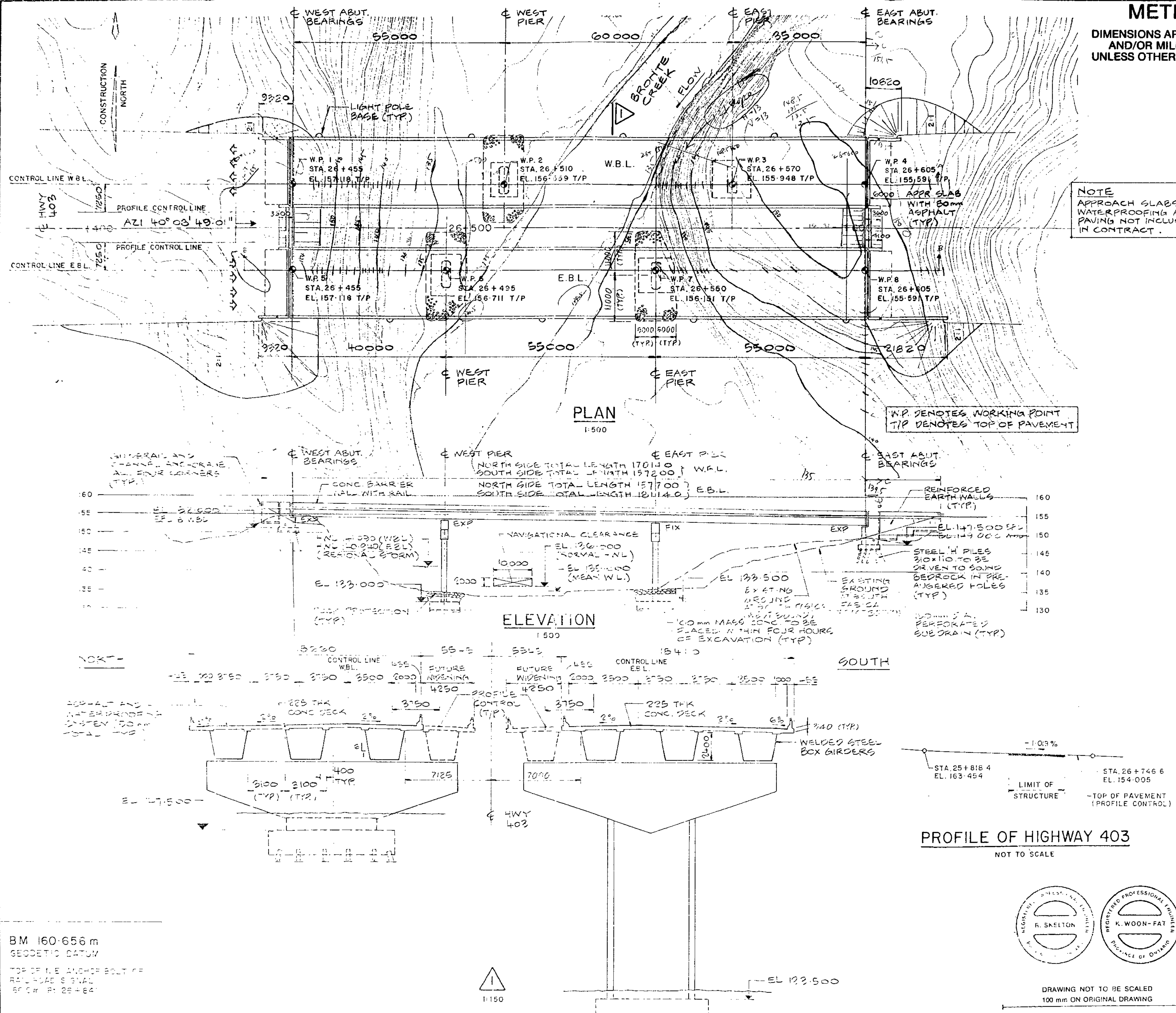
By _____ Date _____ Project No. _____

Checked _____ Date _____ Calculation No. _____

Page ____ of ____



Nov 85 Form 145



BM 160.656 m
GEODETIC DATUM

R. SKELTON
K. WOON-FAT

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DISTR No 4
CONT No
WP No 410-85-01, 410-85-02

BRONTE CREEK BRIDGES AT HWY 403
GENERAL ARRANGEMENT
STRUCTURAL STEEL SCHEME

SHEET

McCORMICK RANKIN
CONSULTING ENGINEERS

GENERAL NOTES

1. CLASS OF CONCRETE
   - PIER COLUMNS ---------- 35 MPa
   - ALL CONCRETE ---------- 30 MPa
2. REINFORCING STEEL

   REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.
3. CLEAR COVER TO REINFORCING STEEL
   - FOOTINGS ---------- 100 ± 25
   - ABUTMENTS AND WINGWALLS
     - FRONT FACE ---------- 80 ± 20
     - BACK FACE ---------- 70 ± 20
   - PIER ---------- 80 ± 20
   - DECK ---------- TOP ---------- 70 ± 20
     - BOTTOM ---------- 40 ± 10
   - REMAINDER (UNLESS OTHERWISE NOTED) 70 ± 20
4. CONSTRUCTION NOTE

   IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED BEARING HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

LIST OF DRAWINGS

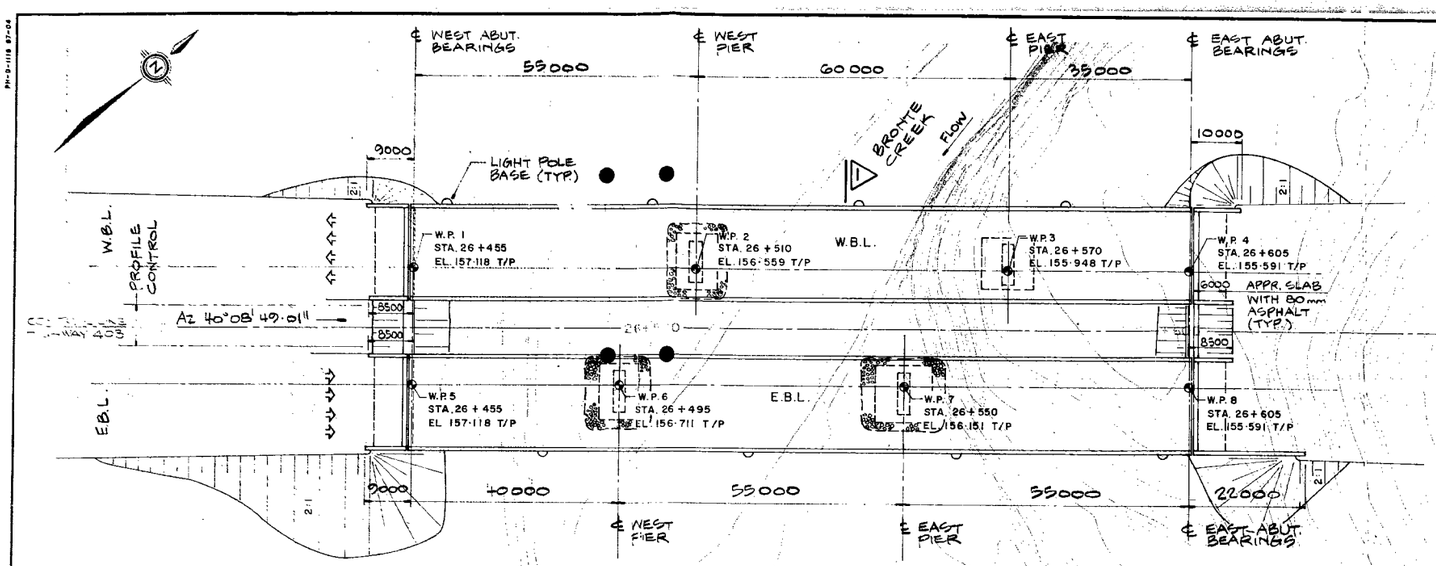
1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATIONS AND SOIL STRATA
3. WESTBOUND STRUCTURE FOOTING LAYOUT
4. EASTBOUND STRUCTURE FOOTING LAYOUT
5. WESTBOUND STRUCTURE FOOTING REINFORCING
6. EASTBOUND STRUCTURE FOOTING REINFORCING
7. WESTBOUND STRUCTURE WEST ABUTMENT
8. EASTBOUND STRUCTURE WEST ABUTMENT
9. WESTBOUND STRUCTURE WEST ABUTMENT WINGWALLS
10. EASTBOUND STRUCTURE WEST ABUTMENT WINGWALLS
11. WESTBOUND STRUCTURE EAST ABUTMENT
12. EASTBOUND STRUCTURE EAST ABUTMENT
13. WESTBOUND STRUCTURE EAST ABUTMENT WINGWALLS
14. EASTBOUND STRUCTURE EAST ABUTMENT WINGWALLS
15. REINFORCED EARTH RETAINING WALLS PLAN & DET.
16. REINFORCED EARTH RETAINING WALLS, ELEVATIONS & SECTION
17. REINFORCED EARTH RETAINING WALLS TYPICAL DETAILS
18. WESTBOUND STRUCTURE WEST PIER
19. WESTBOUND STRUCTURE EAST PIER
20. EASTBOUND STRUCTURE WEST PIER
21. EASTBOUND STRUCTURE EAST PIER
22. WESTBOUND STRUCTURE BEARING DETAILS
23. EASTBOUND STRUCTURE BEARING DETAILS
24. STRUCTURAL STEEL I
25. STRUCTURAL STEEL II
26. STRUCTURAL STEEL III
27. STRUCTURAL STEEL IV
28. STRUCTURAL STEEL V
29. STRUCTURAL STEEL VI
30. CONSTRUCTION PROCEDURE
31. DECK DETAILS
32. DECK REINFORCING I
33. DECK REINFORCING II
34. WESTBOUND STRUCTURE BARRIER WALL I
35. WESTBOUND STRUCTURE BARRIER WALL II
36. EASTBOUND STRUCTURE BARRIER WALL I
37. EASTBOUND STRUCTURE BARRIER WALL II
38. WESTBOUND STRUCTURE RAILING FOR BARRIER WALL
39. EASTBOUND STRUCTURE RAILING FOR BARRIER WALL
40. JOINT ANCHORAGE AND ARMOURING WEST ABUTMENTS
41. JOINT ANCHORAGE AND ARMOURING EAST ABUTMENTS
42. WESTBOUND STRUCTURE 6000 mm APPROACH SLAB
43. EASTBOUND STRUCTURE 6000 mm APPROACH SLAB
44. AS CONSTRUCTED ELEVATION AND DIM.
45. STANDARD DETAILS
46. ELECTRICAL EMBEDDED WORK IN STRUCTURE
47. ELECTRICAL EMBEDDED WORK - DETAILS
48. QUANTITIES - WESTBOUND STRUCTURE I
49. QUANTITIES - WESTBOUND STRUCTURE II
50. QUANTITIES - EASTBOUND STRUCTURE I
51. QUANTITIES - EASTBOUND STRUCTURE II

APPLICABLE STANDARD DRAWINGS

DD 3502 MINIMUM GRANULAR BACKFILL REQUIREMENTS

REVISIONS	DATE	BY	DESCRIPTION

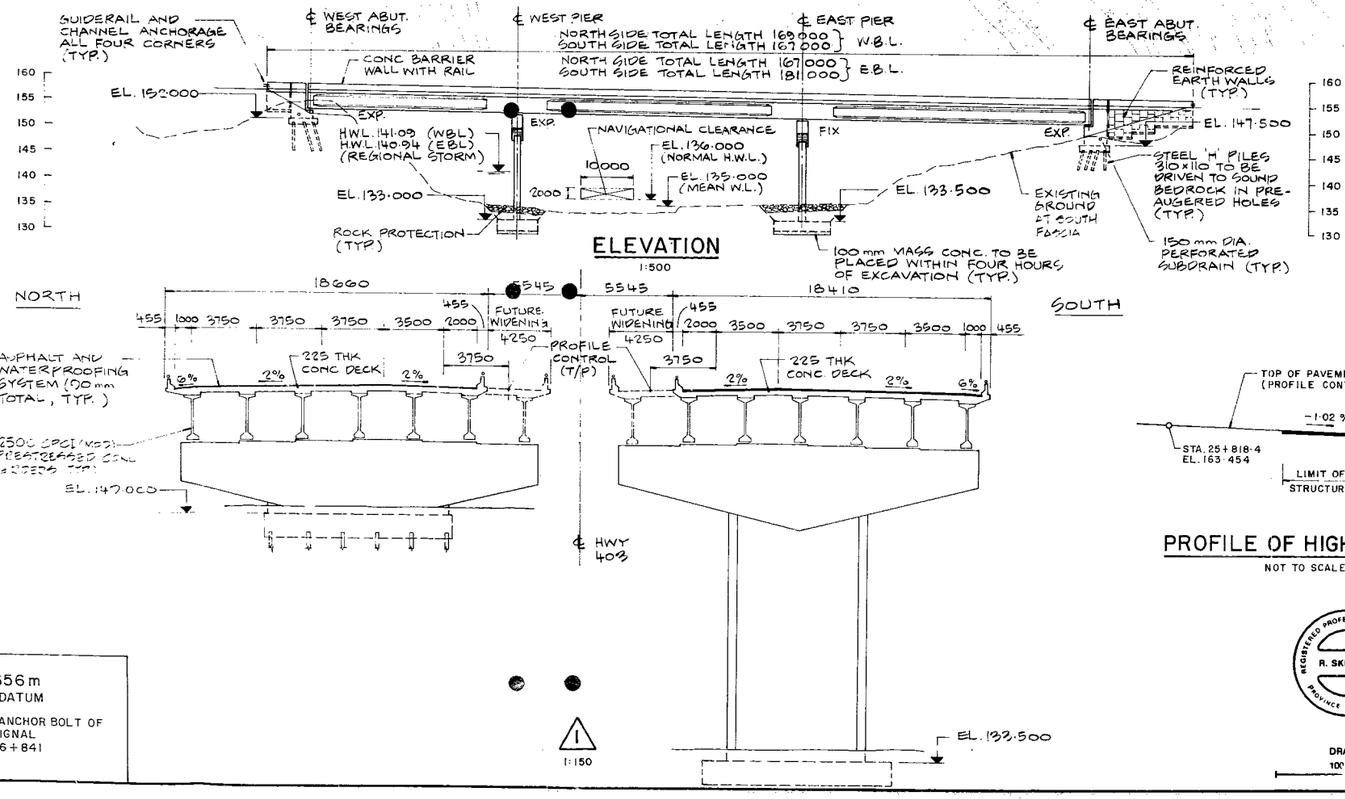
DESIGN	CHK	CODE CHBDC-83	LOAD CLASS A	DATE APR 198[illegible]
DRAWN	CHK	SITE 10-220	STRUCT SCHEME	DWG. P



PLAN
1:500

W.P. DENOTES WORKING POINT
T/P DENOTES TOP OF PAVEMENT

NOTE
APPROACH SLABS, WATERPROOFING AND PAVING NOT INCLUDED IN CONTRACT



ELEVATION
1:500

PROFILE OF HIGHWAY 403
NOT TO SCALE

BM 160·656m
GEODETIC DATUM
TOP OF N.E. ANCHOR BOLT OF RAIL ROAD SIGNAL
166·0m Rt 26+841

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

R. SKELTON — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO
K. WOON-FAT — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

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

DISTRICT Nº 4
CONT No
WP No 410-85-01
410-85-02
SHEET
BRONTE CREEK BRIDGES AT HWY 403
PRECAST GIRDER SCHEME
GENERAL ARRANGEMENT
McCORMICK RANKIN
CONSULTING ENGINEERS

GENERAL NOTES

1. **CLASS OF CONCRETE**
   - GIRDERS ---------- SEE GIRDER DWGS
   - DIAPHRAGMS ---------- MPa
   - PIER COLUMNS ---------- 35 MPa
   - REMAINDER ---------- 30 MPa
2. **REINFORCING STEEL**
   REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.
3. **CLEAR COVER TO REINFORCING STEEL**
   - FOOTINGS ---------- 100 ± 25
   - ABUTMENTS AND WINGWALLS
     - FRONT FACE ---------- 80 ± 20
     - BACK FACE ---------- 70 ± 20
   - PIER ---------- 80 ± 20
   - DECK ---------- TOP ---------- 70 ± 20
     BOTTOM -- 40 ± 10
   - REMAINDER (UNLESS OTHERWISE NOTED) 70 ± 20
4. **CONSTRUCTION NOTE**
   IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED BEARING HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

LIST OF DRAWINGS

APPLICABLE STANDARD DRAWINGS
OD 3502 MINIMUM GRANULAR BACKFILL REQUIREMENTS

REVISIONS

DATE	BY	DESCRIPTION

DESIGN K.W.F.	CHK R.S.	CODE 0HBDC-83	LOAD CLASS X	DATE MAY, 1991	
DRAWN A.M.	CHK K.W.F.	SITE 10-220	STRUCT	SCHEME	DWG. P1

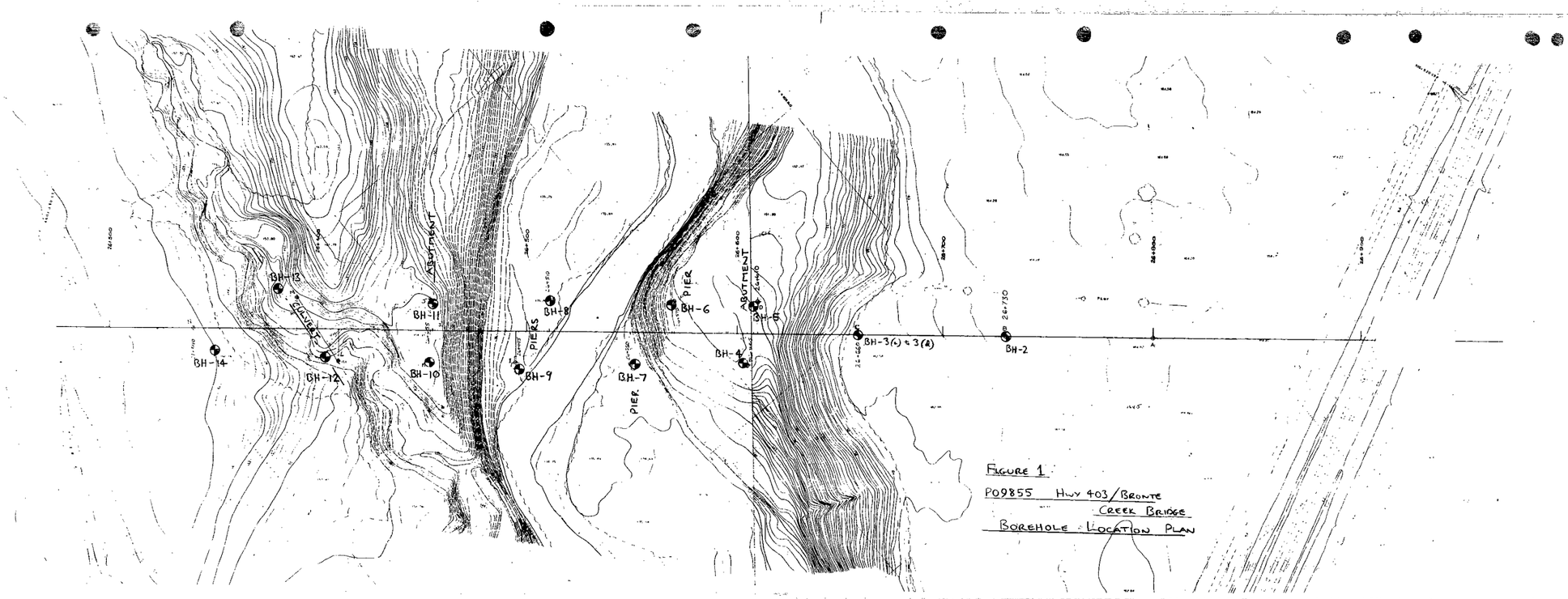


FIGURE 1

P09855 HWY 403/BRONTE CREEK BRIDGE

BOREHOLE LOCATION PLAN