GEOCRES No 40P16-17

Trow

Foundation Investigation and Design Report Highway 10 and Regional Road 24 Widening Village of Caledon, Ontario G.W.P 220-94-00

Prepared for:

SNC Lavalin Engineers & Constructors Inc.
2200 Lake Shore Blvd., West
Toronto, Ontario
M8V 1A4

Trow Consulting Engineers Ltd.

1595 Clark Boulevard
Brampton, Ontario L6T 4V1
Telephone: (905) 793-9800
Facsimile: (905) 793-0641

brge0056698a
September 13, 2000
Final: November 29, 2000

Table of Contents

Appendices

Part I Foundation Investigation Report

1. Introduction

This report summarizes the results of a foundation investigation conducted at three culvert structures in Village of Caledon, Region of Peel, Ontario. One culvert is located along Regional Road 24 at Station 9+855, west of the intersection of Highway 10 and Regional Road 24 (hereinafter called "the intersection"). The other two are located along Highway 10 at Station 18+344 (south of the intersection), and at Station 20+067.70 (north of the intersection).

This report contains factual information obtained from the geotechnical investigation. The investigation was done at the request of SNC Lavalin Engineers & Constructors Inc.

2. Site Description and Geology

The sites are located near the intersection of Highway 10 and Regional Road 24, Village of Caledon, Region of Peel.

The surrounding area consists of rolling grasslands with clusters of trees. Farms and private dwellings are scattered throughout the area. At these locations the creeks run perpendicular to Highway 10 and Regional Road 24. At the vicinity of the existing culvert outlets the surficial vegetation generally consists of marshy vegetation along the banks.

Physiographically, the sites are located at the fringes of the Oak Ridges moraine and the Hillsburgh Sandhills. The Oak Ridges moraine is generally composed of sandy or gravelly materials. Further west the sand gradually gives way to a till.

3. Investigation Procedures

3.1 Field Investigation

The investigation in the field was carried out during the period of August 23 and 24, 2000. The fieldwork consisted of four (4) sampled boreholes (Borehole Nos. BH-1, BH-4, BH-5 and BH-6) along the shoulders of the roads, one (1) sampled borehole (Borehole No. BH-3) at the north bank of Caledon Creek near east side of the existing twin cell culvert on Highway 10, and one (1) sampled borehole (Borehole No. BH-2) at west bank of the creek near north side of the existing concrete culvert on Regional Road 24. In addition, another six (6) holes (Borehole Nos. HA-1, HA-2, HA-3, HA-4, HA-5 and HA-6) were hand augered beside the creeks at the culvert extension area. The locations of the holes are shown on the attached Sheet Nos. 1 to 3 in Appendix A.

Brief descriptions of the locations are summarized in the following Table 1.

Table 1: Summary of Borehole Information

Culvert Location	Borehole on Road Shoulder	Borehole at Culvert Extension Area	Hand Augered Hole at Culvert Extension Area
RR 24 Sta. 9+855	BH-1	BH-2	HA-1, HA-2
Hwy 10 Sta. 18+344	BH-4	BH-3	HA-3, HA-4
Hwy 10 Sta. 20+067.70	BH5, BH-6	--	HA-5, HA-6

The boreholes were drilled by means of a truck mounted drill rig owned and operated by a specialist drilling contractor. In general, disturbed subsoil samples were retrieved at 0.7 m intervals for the surficial 3.0 m and at 1.5 m intervals thereafter. Soil samples were taken in conjunction with standard penetration tests.

Groundwater observations were recorded during and after the course of the fieldwork. Piezometers were installed in Borehole Nos. BH-2 and BH-5 to monitor the stabilized groundwater levels.

Prior to drilling, the locations of the underground services were cleared. Monitoring the drilling and sampling operations and logged the field borings work was supervised by an engineer from Trow Brampton office. Following the general field classification of the soils, the samples were preserved in moisture tight bags and returned to Trow's laboratory for

visual and textural classification. The locations and elevations of the boreholes were established in the field by Trow Consulting Engineers Ltd. based on the CAD profiles provided by SNC-Lavalin Engineers & Constructors Inc.

3.2 Laboratory Analysis

Geotechnical laboratory testing consisted of visual classifications of all recovered samples, natural moisture content of the soils in all samples and grain size analyses on selected samples were carried out. The results are presented on the borehole logs.

One soil sample from each culvert location at the footing elevation was tested for pH, sulphate and chloride concentration. The results are tabulated and discussed Section 6.

4. Subsurface Conditions

4.1 Subsoil Conditions

The detailed soil profiles encountered in each borehole and hand augered hole and the results of laboratory moisture content determinations are indicated on the attached logs in Appendix B.

The subsurface stratigraphy at the three sites to the depth of exploration comprised fill/topsoil overlying glacial till, in turn underlain by shale or dolomite bedrock. A detailed description of the subsurface conditions encountered in the boreholes or hand augered holes is provided in the following sections.

4.1.1 Fill, Topsoil

For those boreholes located on the shoulders of Highway 10 and Regional Road 24, fill material was encountered. Fill material was also found at Boreholes BH-2 and BH-3, which are at the creek bank area. Surficially, all the hand augered holes encountered a thin topsoil of sand with organics, trace silt and clay, ranging in thickness from 0.2 to 0.3 m.

At Boreholes BH-1 and BH-2 put down at the vicinity of the culvert on Regional Road 24 at Station 9+855, the elevation to the bottom of the fill layer at these borehole locations is 420.1 m and 420.7 m, respectively. The Standard Penetration Test "N' values obtained within the fill at these boreholes range from 5 to 33.

At Boreholes BH-3 and BH-4 put down at the vicinity of twin culvert on Highway 10 at Station 18+334, the elevation to the bottom of the fill layer at these borehole locations is 404.9 m and 405.1 m, respectively. The Standard Penetration Test "N' values obtained within the fill layer at these boreholes range from 3 to 30.

At Boreholes BH-5 and BH-6 put down at the vicinity of the culvert on Highway 10 at Station 20+067.7, the elevation to the bottom of the fill layer at these borehole location is 428.4 m and 428.0 m, respectively. The Standard Penetration Test "N' values obtained within the fill layer at these boreholes range from 8 to 26.

Grain size analysis was carried out on one (1) sample of the fill material at Borehole No. BH-3. The results indicate that this sample contains 46% gravel, 40% sand and 14% silt and clay.

4.1.2 Glacial Till

The surficial topsoil/fill is underlain by a heterogeneous mixture of silt, sand, and gravel, with cobbles and boulders (cohesionless Glacial Till). The till layer is the predominant soil

deposit encountered for the depth of the boreholes put down. This layer was loose to very dense, but generally compact to dense. The loose layer is generally confined to the upper 1.0 to 1.5 m of till stratum. The Standard Penetration Test "N' values obtained within the till layer at these boreholes range from 4 to split spoon refusal. The presence of cobbles and boulders throughout the till stratum has likely contributed to the variability of the Standard Penetration Test "N" values obtained at these sites. This deposit is generally very moist to saturated.

Grain size analyses carried out on six (6) selected auger samples of the glacial till indicated ~15 to 50 per cent of material passing the 0.075 mm sieve. The results of the grain size analysis on the glacial till samples are presented in Appendix C and summarized below.

Table 2: Grain Size Analysis Results for Glacial Till

Sample No.	Gravel (%)	Sand (%)	Silt & Clay (%)
BH-1	60	15	25
BH-2	11	39	50
BH-3	49	36	15
BH-4	46	39	15
BH-5	21	40	39
BH-6	47	28	25

4.1.3 Bedrock

Inferred shale bedrock of Cabot Head Formation was recognized in Borehole BH-4 at the twin cell culvert area on highway 10 south of the intersection. The surface of the shale bedrock in the borehole is at ~ Elevation 397.4 m. In Boreholes BH-5 and BH-6, which are located north of the intersection, inferred dolomite bedrock of Amabel Formation was encountered. The dolomite bedrock surface was contacted at ~ Elevations 422.0 and 423.8 m.

5. Groundwater Conditions

The groundwater conditions at the sites were observed in the open boreholes during and after drilling. Observation of the groundwater level was carried out by measuring the water levels in the open boreholes and piezometers installed, and the water table in the creek. The results are given in the Borehole logs.

The average groundwater levels observed in the boreholes at the three culverts are listed below:

Culvert on Highway 10 at Station 18+334:	407.1 m
Culvert on Regional Road 24 at Station 9+855:	419.9 m
Culvert on Highway 10 at Station 20+067.70:	428.8 m

It is possible that groundwater levels may be higher at wetter times of the year.

6. Soil Chemistry

Selected soil samples from each culvert foundation elevation were submitted to Entech in Mississauga for pH, soluble chloride and sulphate testing. The results of these tests are summarized below:

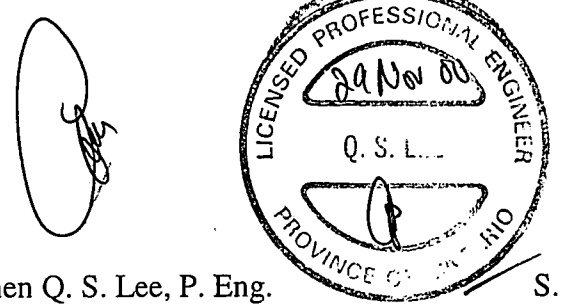
Borehole	Elevation (m)	pH	Sulphate (µg/g)	Chloride (µg/g)
BH2 SS3	420.4	8.8	5.1	73
BH4 SS5	406.4	8.8	84.7	466
BH5 SS5	428.1	8.6	7.9	186

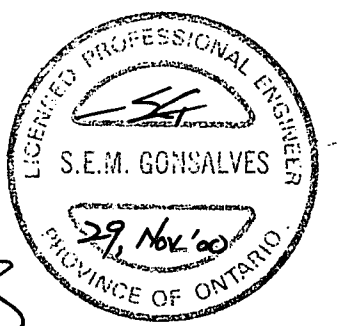
7. Closure

Field work for this investigation was carried out by Mr. Jack Zhou of Trow Consulting Engineers Ltd. Drilling services for field investigation were provided by Malones Soil Samples, North York, Ontario.

Yours truly,

Trow Consulting Engineers Ltd.





Stephen Q. S. Lee, P. Eng.
Senior Geotechnical Engineer
Geotechnical Division

S. E. Gonsalves, P. Eng.
Principal Engineer
M.T.O. Designated Contact

Part II
Foundation Design Report

Part II Foundation Design Report

8. Engineering Discussions and Recommendations

8.1 Introduction

The proposed widening and grade raise on Highway 10 necessitates extending both ends of an existing twin cell concrete rigid frame culvert or replacing the culvert. This existing twin cell culvert is a 28 m long by 8 m wide by 1.8 m high located underneath Highway 10 at Station 18+344. Replacing the existing twin cell culvert on Highway 10 with a single span bridge structure is also under consideration.

At Station 9+855 on Regional Regional 24 and Station 20+067.70 on Highway 10, road widening with possible realignment has necessitated the extension of both ends of the existing concrete culverts at these locations.

The comments and recommendations given in this report are based on the assumption that the above-described design concept will proceed into construction. If changes are made either in the design phase or during construction, this office should be retained to review these modifications. The result of this review may be a modification of our recommendations or it may require additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

8.2 Foundations

8.2.1 Concrete Culvert on Regional Road 24 at Station 9+855 (BH 1 and BH 2; Sheet 1)

Based on the proposed widening and or realignment of Regional Road 24, the 1.2 m by 1.2 m concrete culvert underneath Regional Road at Station 9+855 will be extended on both sides of the existing culvert.

Based on the data provided to us, it is estimated that the existing culverts are founded at about elevation of 419.50 m. For the purposes of this report it is assumed that the proposed extensions would also be founded at the same elevation.

The following design values can be utilized for the design of the proposed culvert extensions.

Table 3: Design Parameters for Culvert on RR 24 at Station 9+855

Option	Fill material from compacted subgrade to founding elevation	Factored Bearing Capacity at U.L.S. (kPa)	Bearing Capacity at S.L.S. (kPa)	Founding Elevation (m)
Open Culvert	Compacted Granular A	400 kPa	250 kPa	419.5

The above recommendations are based on an assumed minimum footing width of 1 m for the open culvert. Constructability, traffic staging, roadside protection, and extent of excavation requirements will have to be considered. Sub-excavation of the topsoil and soft till overburden of about 0.5 to 1.2m below the founding elevation is expected. Excavations adjacent to and below existing footings which must remain should be carried out in a manner that protect the footings. Granular A compacted in 300 mm lift to 100% Proctor Dry Density or lean concrete should be used to bring the excavated subgrade to the footing bearing elevation. Lean concrete fill can be used to raise the grade to the design level. The excavated footing subgrade must be inspected by a qualified geotechnical engineer to verify the competency of the founding material.

The unfactored horizontal resistance against sliding between concrete and approved compacted Granular A surface can be calculated using a friction angle of 35^0. An unfactored friction angle of 30^0 can be used for horizontal resistance calculation for concrete and the till surface.

Minimum frost cover of 1.2 m for the footing is assumed to be provided. The total and differential settlement will occur immediately following construction, and will be less than 25 mm, if the foundation is constructed as per the recommendations provided.

To accommodate any resulting differential settlement between the existing culvert and proposed extensions, suitable connections should be provided.

Box culvert was not considered for this existing open culvert extension to preserve the likely provision for future channel deepening that may be in the initial intent of culvert type selection.

8.2.2 Twin Cell Culvert on Highway 10 at Station 18+334 (BH 3 and BH 4; Sheet2)

8.2.2.1 Culvert Extension or Replacement

Based on the proposed widening of Highway 10, the existing twin cell culvert 28.0 m by 8.0 m by 1.8 m underneath Highway 10 would be extended on both sides of the existing culvert or this culvert may be replaced. This section provides recommendations on the culvert options.

It is understood that the proposed extensions may be designed as an open culvert or closed culvert. Foundation recommendations are provided in this report for both these options.

Based on data provided to us, it is estimated that the existing culverts are founded at or about elevations of 405.3 m. For the purposes of this report it is assumed that the proposed extensions would also be founded at the same elevation.

The following values can be utilized for the design.

Table 4: Design Parameters for Culvert on Highway 10

Option	Fill material from compacted subgrade to founding elevation	Factored Bearing Capacity at U.L.S. (kPa)	Bearing Capacity at S.L.S. (kPa)	Founding Elevation (m)
Open Culvert	Compacted Granular A	500 kPa	300 kPa	405.3
Box Culvert	Compacted Granular A	550 kPa	350 kPa	405.3

The above recommendations are based on an assumed minimum footing width of 1 m for the open culvert and a base width of 8 m for the closed culvert. Sub-excavation of the topsoil and soft till overburden of about 1.0m below the founding elevation is expected. Granular A compacted in 300 mm lift to 98% Proctor Maximum Dry Density should be used to bring the excavated subgrade to the footing bearing elevation. In areas where subgrade preparation is less than 300 mm below the founding elevation, a 300 mm bedding layer should be incorporated using Granular A compacted to 98% Proctor Maximum Dry Density. Lean concrete fill can be used to raise the grade to the design level. The excavated footing subgrade must be inspected by a qualified geotechnical engineer to verify the competency of the founding material.

The unfactored horizontal resistance against sliding between concrete and approved compacted Granular A surface can be calculated using a friction angle of 35^0. An unfactored friction angle of 30^0 can be used for horizontal resistance calculation for concrete and the till surface.

Minimum frost cover of 1.2 m for the footing must be provided for the open culvert footing. Rigid box culvert can be designed to resist the frost pressure. Cover, backfill and frost treatment for box culvert should be carried in accordance with OPSS 422 and OPSD 803. A minimum bedding material of 300 mm thick must be provided.

In either case the total and differential settlement will occur immediately following construction, and will be less than 25 mm, if the foundation is constructed with the recommendations provided.

To accommodate any resulting differential settlement between the existing culvert and proposed extensions, suitable connections should be provided.

Excavations adjacent to and below existing footings which must remain should be carried out in a manner that protect the footings.

Where culvert replacement, including removal of existing footings is proposed, detailed examination of constructibility issues including traffic staging, roadside and traffic protection, shoring must be undertaken.

8.2.2.2 Rigid Frame Bridge Replacement

Spread Footing

It is understood that replacing the existing twin cell culvert with a new single span rigid frame bridge is also under consideration. Based on the results of previous Ministry of Transportation Ontario and this investigation, competent glacial till is relatively shallow. Spread footings can be used for the proposed bridge replacement structure. The following designs values can be utilized for the design of the bridge footing.

Table 5: Design Parameters for Bridge Footing on Highway 10

Option	Fill material from compacted subgrade to founding elevation	Factored Bearing Capacity at U.L.S. (kPa)	Bearing Capacity at S.L.S. (kPa)	Founding Elevation (m)
Spread Footing	Compacted Granular A	550 kPa	350 kPa	405.3

A minimum footing width of 1 m is assumed for the bearing capacity values provided. Constructability, traffic staging, roadside protection, and extent of excavation requirements will have to be considered. Sub-excavation of the topsoil and soft till overburden of about 1.0 m below the existing founding elevation is expected. Granular A compacted in 300 mm lift to 98% Proctor Dry Density should be used to bring the excavated subgrade to the footing bearing elevation. Lean concrete fill can be used to raise the grade to the design level. The excavated footing subgrade must be inspected by a qualified geotechnical engineer to verify the competency of the founding material.

The unfactored horizontal resistance against sliding between concrete and approved compacted Granular A surface can be calculated using a friction angle of 35^0. An unfactored friction angle of 30^0 can be used for horizontal resistance calculation for concrete and the till surface.

Minimum frost cover of 1.2 m for the footing is assumed to be provided.

Deep Foundations

For piles driven to end bear on bedrock or into the glacial till, the following Limit States design values may be assumed in accordance with the Ontario Highway Bridge Design Code (O.H.B.D.C.):

Table 6 Design Pile Capacities

	HP 310x110
Factored Axial Capacity at ULS	1300 kN
Axial Capacity at SLS	950 kN
Ultimate Capacity for Hiley Formula	2900 kN

Based on the attached borehole logs the interpreted end bearing elevation of the pile is approximately at Elevation 397 m. Furthermore, based on the soil borings, the bedrock elevation at the location of the twin culvert is variable and may change over a short distance.

The approach grade at this culvert is anticipated to be raised by approximately 1.5 meters immediately adjacent to the bridge abutment. The resulting net load increase applied to the overburden soils will be approximately 23 kPa (assuming a unit weight of 18.0 kN/m^3 for the approach embankment fill). Under these conditions, settlements of the approach embankments are expected near the abutments resulting from consolidation of the subsurface soils, and consequently, down drag forces may be generated on the piles. The reduced pile load capacities listed in Table 6 have factored in the anticipated down drag forces. The minimum pile spacing should be calculated in accordance with the OHBDC requirements.

If piles should end above the bedrock surface within the glacial till stratum the Engineer must be notified immediately. Pile driving should be controlled by the Hiley Formula as per MTO standards SS103-10 or SS103-11 using the ultimate pile capacities referred to in Table 6.

The pile driving should be carried out using a hammer capable of delivering energy of about 60 kJ but not exceeding 70 kJ per blow.

Piles which have already been driven should be monitored during driving process for heaving due to driving of adjacent piles. It is recommended that 10% of the piles should be restruck the day after initial installation to determine if relaxation have occurred.

The lateral load capacity of H-piles driven to bedrock at the site is expected to be small. As such, all lateral loads at the abutment locations should be supported using battered piles.

Pile caps should have a frost cover protection of 1.2m.

8.2.3 Concrete Culvert on Highway 10 at Station 20+067.7 (BH 5 and BH 6; Sheet 3)

Based on the proposed widening and or realignment Highway 10, the 24 m by 1.8 m by 1.2 m concrete culvert underneath Highway 10 at Station 20+067.7 will be extended on both sides of the existing culvert.

Based on data provided to us, it is estimated that the existing culverts are founded at about elevations of 427.3 m. For the purposes of this report it is assumed that the proposed extensions would also be founded at the same elevation.

The following design values can be utilized for the design of the proposed culvert extensions.

Table 7: Design Parameters for Culvert on Highway 10 at Station 20+067.70

Option	Fill material from compacted subgrade to founding elevation	Factored Bearing Capacity at U.L.S. (kPa)	Bearing Capacity at S.L.S. Type II (kPa)	Founding Elevation (m)
Open Culvert	Compacted Granular A	400 kPa	250 kPa	427.3
Box Culvert	Compacted Granular A	400 kPa	250 kPa	427.3

The above recommendations are based on an assumed footing width of 1 m for the open culvert. Sub-excavation of the topsoil and soft till overburden of about 0.3 to 1.0 m below the founding elevation is expected. . Excavations adjacent to and below existing footings which must remain should be carried out in a manner that protect the footings. Granular A compacted in 300 mm lift to 98% Proctor Dry Density or lean concrete should be used to bring the excavated subgrade to the footing bearing elevation. Lean concrete fill can be used to raise the grade to the design level. The excavated footing subgrade must be inspected by a qualified geotechnical engineer to verify the competency of the founding material.

The unfactored horizontal resistance against sliding between concrete and approved compacted Granular A surface can be calculated using a friction angle of 35^0. An unfactored friction angle of 30^0 can be used for horizontal resistance calculation for concrete and the till surface.

Minimum frost cover of 1.2 m should be provided for open culvert footing. Rigid box culvert can be designed to resist the frost pressure. Cover, backfill and frost treatment for box culvert should be carried in accordance with OPSS 422 and OPSD 803. A minimum bedding material of 300 mm thick must be provided.

The total and differential settlement for either close or open culvert construction is anticipated to occur immediately following construction, and will be less than 25 mm, if the foundation is constructed as per the recommendations provided.

To accommodate any resulting differential settlement between the existing culvert and proposed extensions, suitable connections should be provided.

8.3 Approaches

8.3.1 Approach Embankments

For any new embankment construction and grade raise of up to 1.5 m above the existing grade on Highway 10, the topsoil and fill materials should be stripped from below the footprint area of the fill embankment and all subgrade soils should be proof-rolled prior to fill placement. The approach embankment will undergo some settlement due to consolidation of the till. Settlement of the subgrade soil below the embankment as a result of the 1.5 m grade raise is expected to be less than 25 mm. The major part of the settlement will occur during construction.

Trow should review any decision to remove or leave in place any existing pavement prior to fill placement. It will be necessary to key the new fill to the existing embankment as per O.P.S.S. requirements for any widening. All fill and compaction operations should be supervised by a qualified geotechnical personnel full time to ensure approved material and the specified degree of compaction are achieved.

Construction of the embankment, over prepared subgrade may be carried out using clean earth fill (in accordance with OPSS 212) or Select Subgrade Material (in accordance with OPSS 1010) depending on available material. All embankment fill should be placed in lifts with loose thickness not exceeding 300 mm, and be compacted to minimum 95 percent of its Standard Proctor maximum dry density. The final lift prior to placement of the granular subbase or base course should be compacted to 100 percent of the standard Proctor maximum dry density. Inspection and field density testing should be carried out by qualified geotechnical personnel during all fill placement operations to ensure that appropriate materials are used and that the adequate levels of compaction are achieved.

Embankment slope of less than eight meters can be constructed with a 2H to 1V side slope. Embankment should be constructed as per OPSS 206 and OPSD 202.010.

Slope protection and drainage measures should be provided as per MTO standard practice.

8.3.2 Backfilling Structure

The backfilling operations for the rigid frame bridge or closed culvert should be carried out in accordance with Ministry of Transportation Ontario (MTO) standards. Particularly, it must be ensured that at no time the difference between backfill elevations on either side is greater than 500 mm.

Back fill against abutments should consist of non-frost susceptible, free-draining granular materials in accordance with the Ontario Ministry of Transportation Standards.

Free-draining backfill materials and the provision of drain pipes and weepholes; etc., should prevent hydrostatic pressure build-up.

Frost tapers for the pavement construction and backfilling should be as per OPSS standards.

8.3.3 Culvert End Treatment

Culvert end treatment such as headwalls, wing walls, cut off and anchorage should be carried out in accordance to MTC Drainage Manual and Ontario Provincial Standards and Drawings.

Concrete cut off with minimum depth requirements as per OHBDC should be placed in the inlet end of the culvert.

In addition, consideration can be given to using a 450 mm clay seal placed over the granular material on the upstream end of the culvert. The clay seal should extend 450 mm above and 450 mm below the base of the granular backfill. The clay seal should be placed in 150 mm lift thickness compacted to 96 percent of Standard Proctor Maximum Dry Density. The clay seal material should conform to OPSS 1205.

A retained soil system (RSS) could also be employed for the abutment wall and wing walls. The founding material is anticipated to comprise of the sandy silt till. The additional lateral forces induced by compaction can be computed as per OHBDC Section 6. The designer should include the following in the contract:

- Longitudinal plan with top and bottom elevation of RSS
- Performance and appearance requirements
- The required NSSP for RSS

Erosion control requirements corresponding to a soil erosion "K" factor of 0.3 can be assumed for the till material.

The embankment slope around the culvert inlet can be protected against erosion using a 0.6 m thick rock blanket with a rock filter blanket. Erosion protection measures should also be provided inside the culvert if an open invert structure is used.

8.3.4 Lateral Earth Pressures

Computation of earth pressures should be in accordance with O.H.B.D.C. For design purposes, the following physical properties can be used.

Compacted Granular "A"
Angle of Internal Friction (∅) = 35° (unfactored)
Unit Weight = 22 kN/m^3
Coefficient of Lateral Earth Pressures:

$K_a = 0.27$
$K_b = 0.35$
$K_0 = 0.43$
$K^* = 0.45$

Compacted Granular "B"
Angle of Internal Friction (∅) = 30° (unfactored)
Unit Weight = 21 kN/m^3
Coefficient of Lateral Earth Pressures:

$K_a = 0.33$
$K_b = 0.41$
$K_0 = 0.50$
$K^* = 0.57$

NOTE: K_b is the backfill earth pressure coefficient for an unrestrained structure including compaction effects.

K^* is the earth pressure coefficient for a soil loading a fully restrained structure and includes compaction effects.

The earth pressure coefficient adopted will depend on whether the retaining structure is restrained or movements can be allowed such that the active state of earth pressure can develop. The effect of compaction should also be taken into account in the selection of the appropriate earth pressure coefficients.

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

If the structure is designed as a rigid frame (K_0) should be used to calculate lateral pressure.

9. Construction Considerations

Excavation is expected to be done by conventional equipment. Boulders and cobbles should be anticipated. The excavation for the proposed foundation could extend to about 3 m below the existing grade. Therefore in order to facilitate the construction of the proposed extension, temporary diversion of the water will be required. Dewatering requirements will be governed by the water levels in the creeks. The in situ till material above the groundwater table is classified as Type 3 soils. All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). Temporary cut slopes inclined at 1H:1V should be stable. Native soils under groundwater table are considered as Type 4, hence, temporary cut slopes should be inclined at 3H:1V. Allowance should be made for use of a 150 mm thick layer of lean concrete on the foundation bearing surfaces to protect against excessive disturbance of the founding sudgrade.

A cofferdam, together with open oversized excavation techniques can be used, along with provision to pump water from sumps located along the perimeter of the excavation.

Alternatively, perimeter ditches or stream diversion can be used to control water flow in the creek. However, it is the responsibility of the contractor to propose a suitable dewatering system based on the time of construction, groundwater levels and creek flow conditions for prior approval of the owner. The method used should not undermine the existing road. The appropriate NSSP for dewatering should be included in the contract. The dewatering method is the responsibility of the contractor and the contractor should submit his proposal for review prior to construction.

Erosion and sediment control during culvert construction should be as per the MTC Drainage Manual, Volume 2.

If bridge replacement option is selected using pile foundation, all piles should be driven to bedrock. Given the variable bedrock elevations at the site, the potential for irregular steeply sloping bedrock is considered to be moderate, consequently, problems may arise during pile seating. At some locations, the piles may have a tendency to skip over the bedrock surface resulting in alignment problems or deeper penetration. In the event that this occurs, somewhat longer piles may be required and in some cases piles may have to be added or replaced.

To minimize seating difficulties, rock injector points could be considered to facilitate proper seating. All piles must be fitted with reinforcing plates welded to the flanges as per OPSD 3301 to minimize pile damage. It is also recommended that, upon initial contact with the bedrock, the pile driving energy should be reduced and subsequently increased incrementally until the piles have been sufficiently seated.

The soluble sulphate contents indicate that the relative degree of sulphate attack on concrete in contact with the site soils at these three culvert locations is anticipated to be negligible.

The chloride content results suggest that there is the potential for corrosion of reinforcing steel in the concrete. Consideration should be given to additional concrete cover over reinforcing steel, use of epoxy coating and more impermeable concrete with silica fumes augmentation should be used.

10. Closure

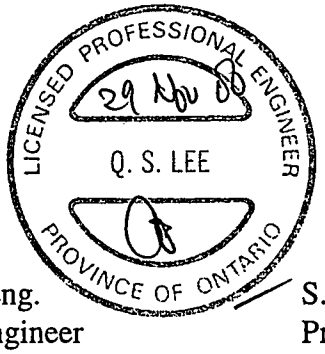
The recommendations given in this report are intended only for guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be much greater than carried out for design purpose.

More specific information, with respect to conditions between samples, or the lateral and vertical extent of the materials, may become more apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during construction.

We trust that this report is satisfactory for your purposes. Should you have any questions or comments, please do not hesitate to contact this office.

Yours truly,

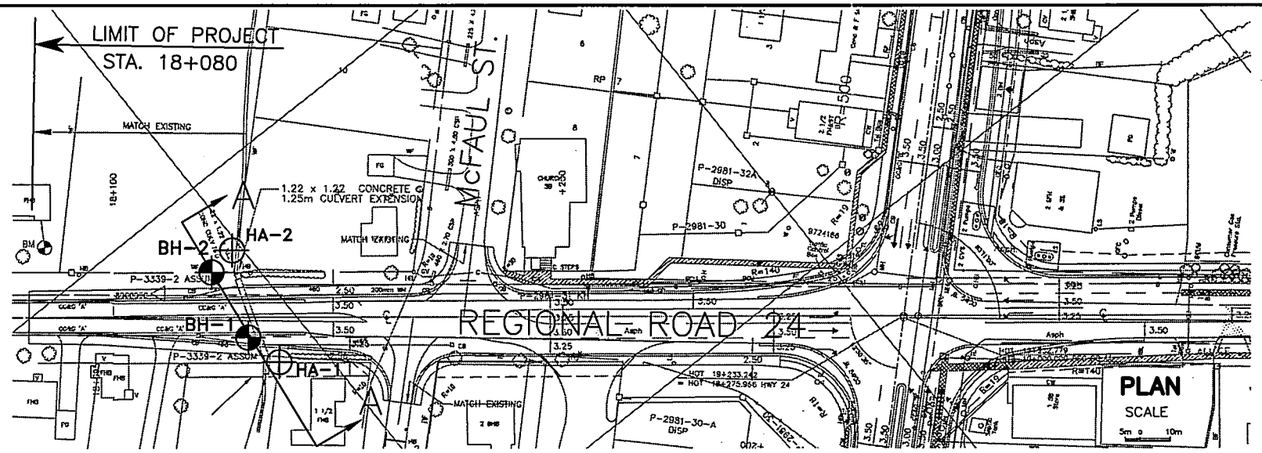
Trow Consulting Engineers Ltd.

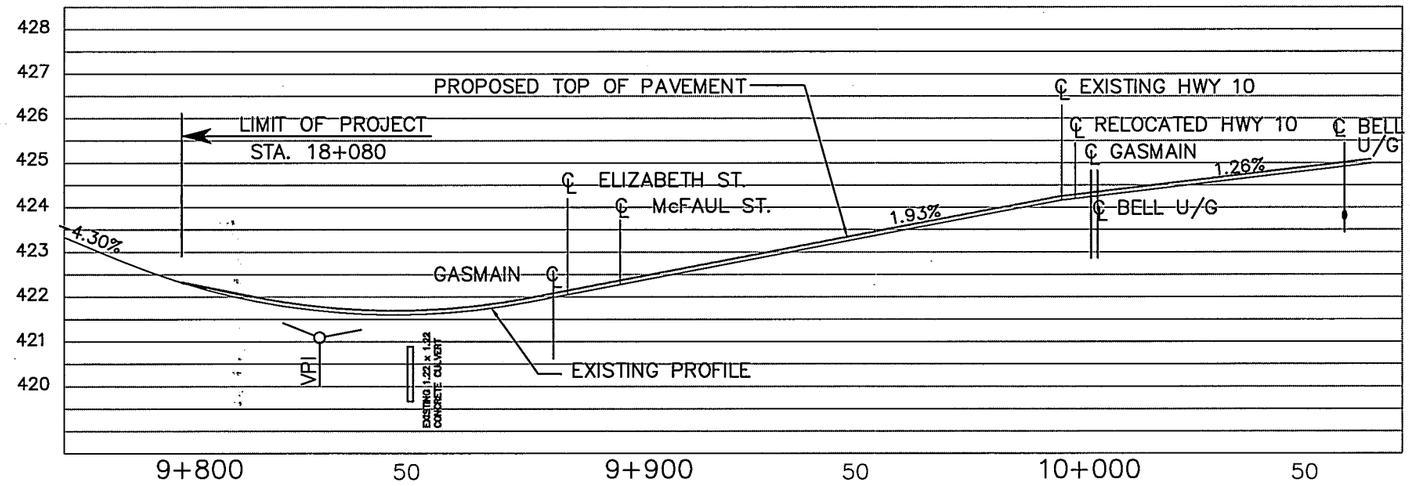


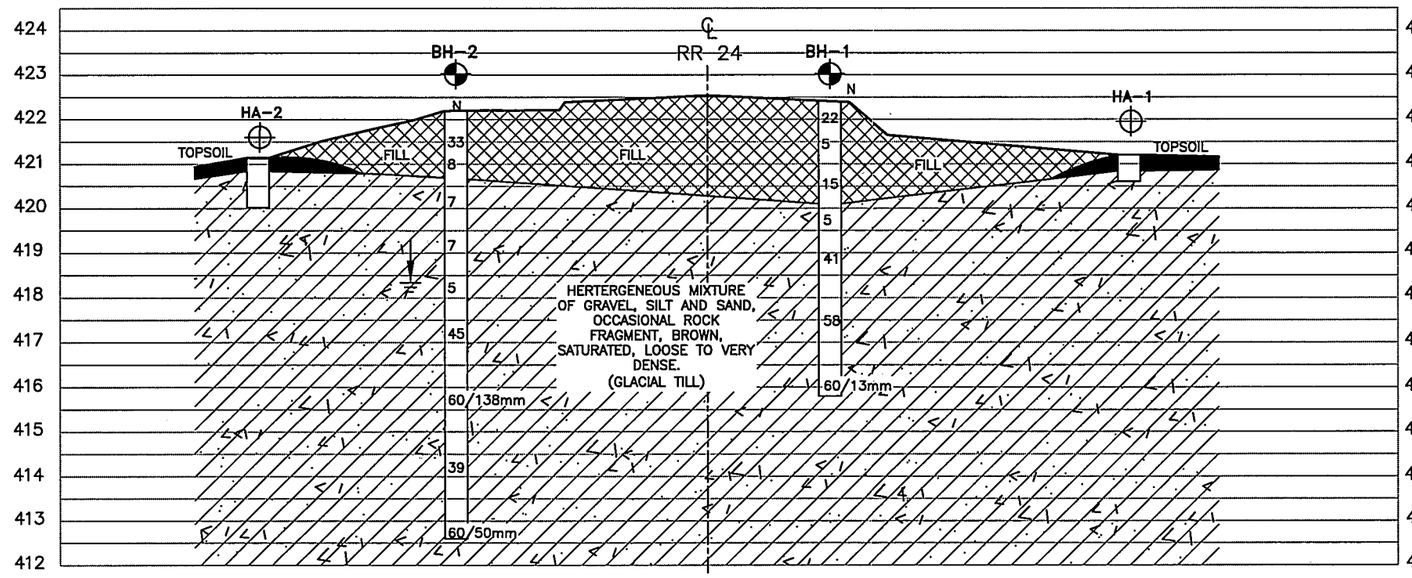
Stephen Q. S. Lee, P. Eng.
Senior Geotechnical Engineer
Geotechnical Division

S. E. Gonsalves, P. Eng.
Principal Engineer
M.T.O. Designated Contact

Appendix A: Borehole Locations & Soil Profiles







SECTION A–A

SCALE

Horizontal
NTS FOR CLARITY

0.5m 0 1.0m
Vertical

℄ PROFILE REGIONAL ROAD 24

SCALE
5m 0 10m
Horizontal
0.5m 0 1.0m
Vertical

LICENSED PROFESSIONAL ENGINEER
Q. S. LEE
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
NOV 29 '00
S.E.M. GONSALVES
PROVINCE OF ONTARIO

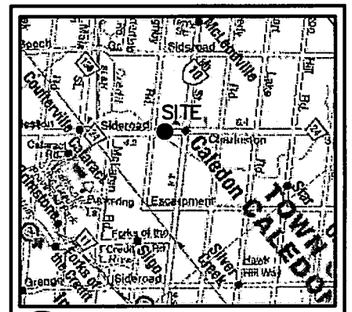
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT NO
W P NO 220-94-00

SHEET 1

HWY 10/RR 24 WIDENING
BOREHOLE LOCATION & SOIL STRATA

Trow Consulting Engineers Ltd
1595 Clark Boulevard
Brampton, Ontario L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0841
Project No. BRGE0056698A



KEY PLAN
NOT TO SCALE

LEGEND

- BH-1 — BOREHOLE LOCATION BY TROW
- HA-1 — HAND AUGURED HOLE
- WATER LEVEL AT TIME OF INVESTIGATION AUG, 2000
- WATER LEVEL IN PIZOMETER OCT, 2000
- N — BLOWS/0.3 m [STD. PEN TEST, 475 J/BLOW]
- CONE — BLOWS/0.3 m [60° CONE, 475 J/BLOW]
- PIZOMETER

No.	Elevation	Station	Offset
BH-1	422.4	18+130	4.5m of ℄
BH-2	422.2	18+122	10m of ℄
HA-1	421.2	18+137	10m of ℄
HA-2	421.4	18+126	15m of ℄

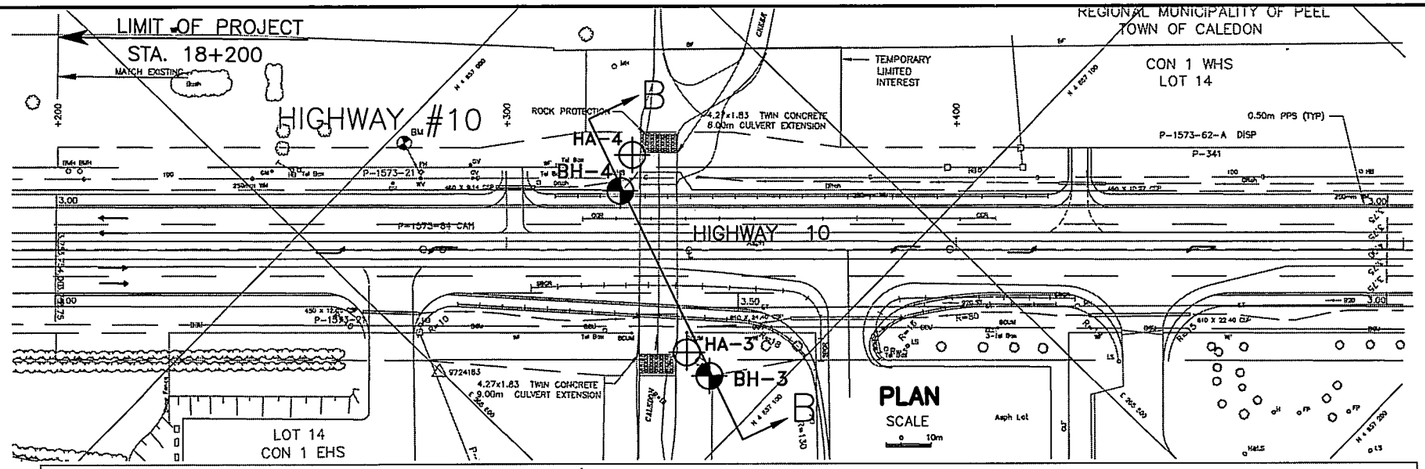
NOTE
THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.

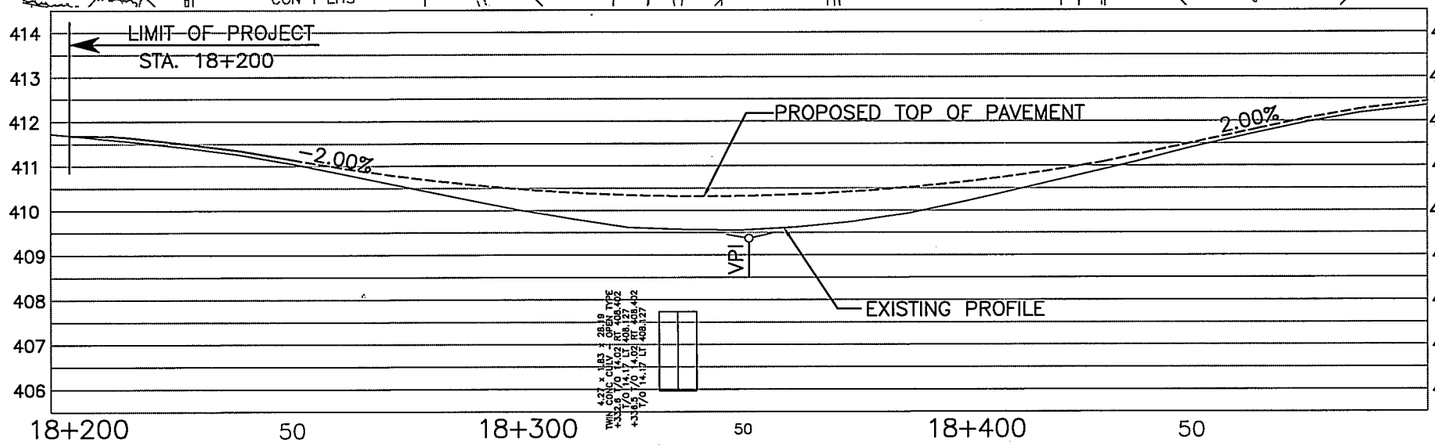
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Offic, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102.2 of Form 102.

REV	DATE	BY	DESCRIPTION

Geocres No.

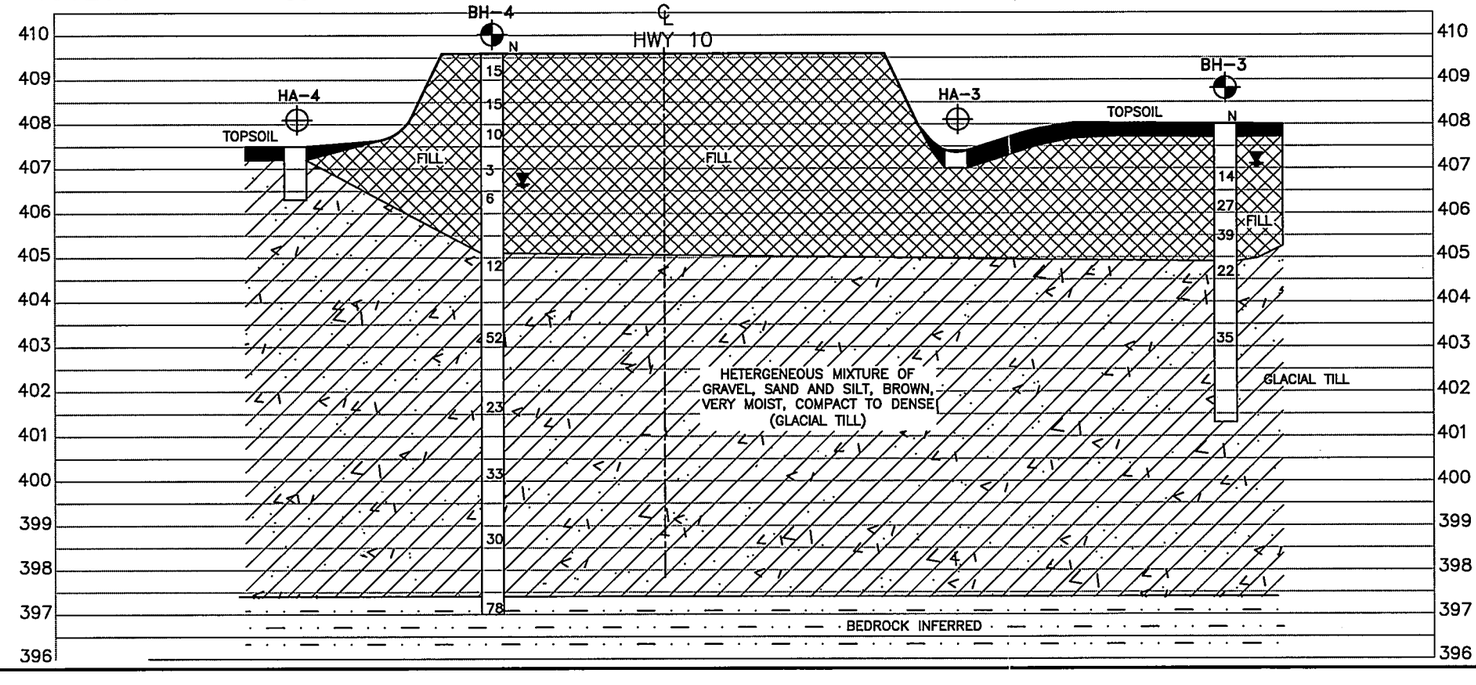
HWY NO. 10/RR 24			DIST
SUBM'D	CHECKED	DATE	SITE NO.





℄ PROFILE HWY. 10

SCALE
5m 0 10m
Horizontal
0.5m 0 1.0m
Vertical



SECTION B–B

SCALE
Horizontal
NTS FOR CLARITY
0.5m 0 1.0m
Vertical

METRIC

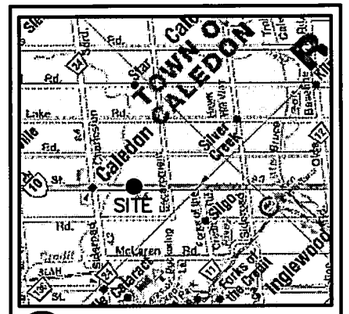
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT NO
W P NO 220–94–00

HWY 10/RR 24 WIDENING
BOREHOLE LOCATION & SOIL STRATA

SHEET 2

Trow Consulting Engineers Ltd
1595 Clark Boulevard
Brampton, Ontario L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641
Project No. BRGE0056898A



KEY PLAN
NOT TO SCALE

LEGEND

- BH-1 — BOREHOLE LOCATION BY TROW
- HA-1 — HAND AUGURED HOLE
- WATER LEVEL AT TIME OF INVESTIGATION AUG, 2000
- WATER LEVEL IN PIZOMETER OCT, 2000
- N — BLOWS/0.3 m [STD. PEN TEST, 475 J/BLOW]
- CONE — BLOWS/0.3 m [60° CONE, 475 J/BLOW]
- PIZOMETER

No.	Elevation	Station	Offset
BH–3	408.0	18+345	28m of ℄
BH–4	409.6	18+325	13m of ℄
HA–3	407.4	18+340	23m of ℄
HA–4	407.5	18+328	21m of ℄

LICENSED PROFESSIONAL ENGINEER
Q. S. LEE
Nov 29 '00
PROVINCE OF ONTARIO

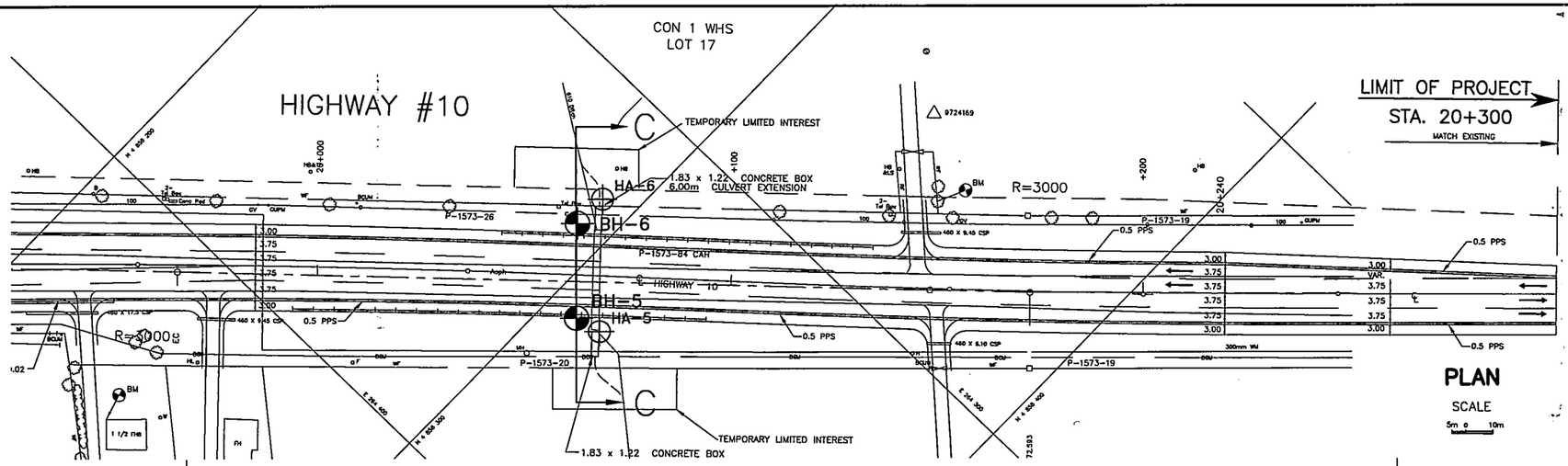
LICENSED PROFESSIONAL ENGINEER
Nov 29 '00
S.E.M. GONSALVES
PROVINCE OF ONTARIO

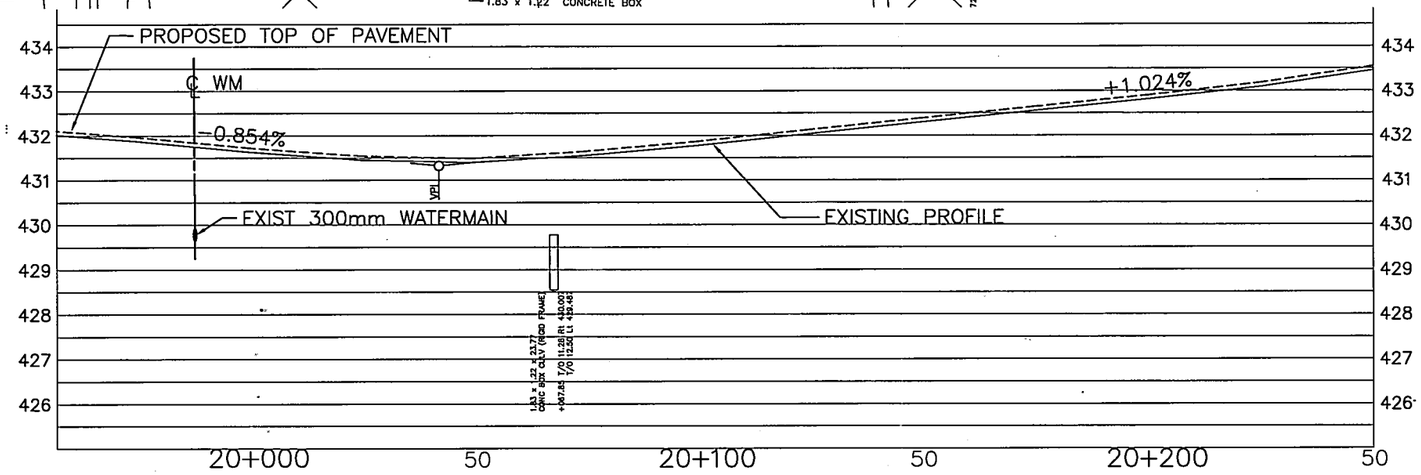
NOTE
THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.

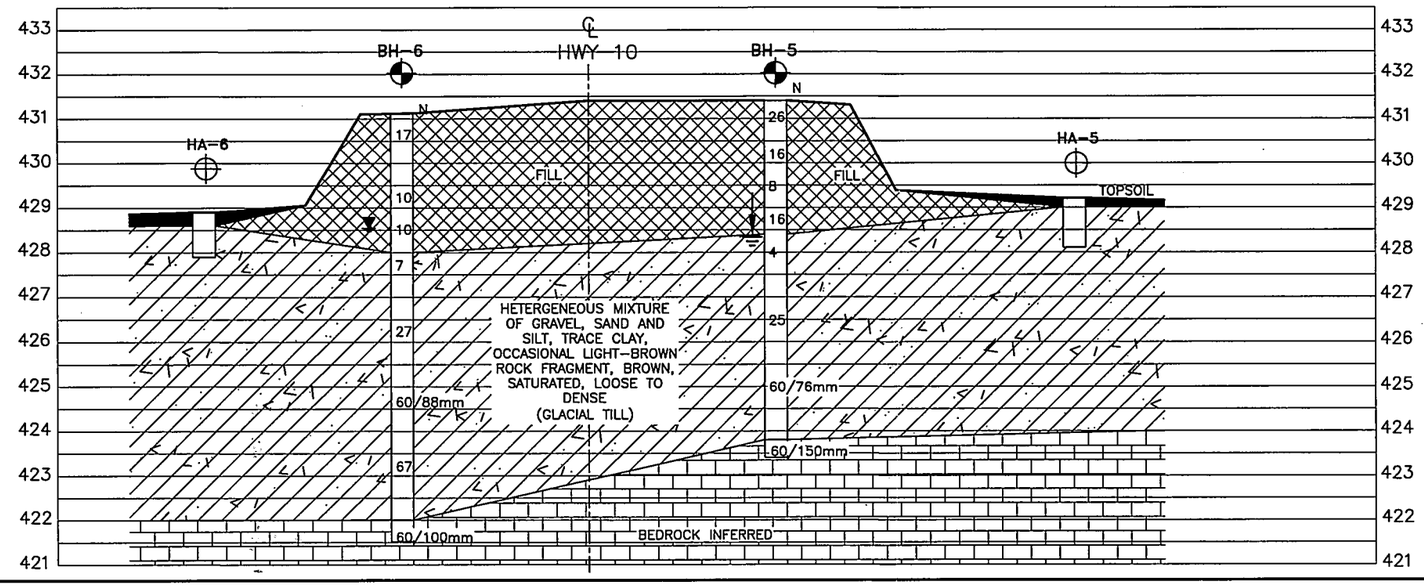
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Offic, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102–2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

REV	DATE	BY	DESCRIPTION

HWY 10/ RR 24			DIST
SUBM'D	CHECKED	DATE	SITE NO.







METRIC

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

CONT NO
W P NO 220-94-00

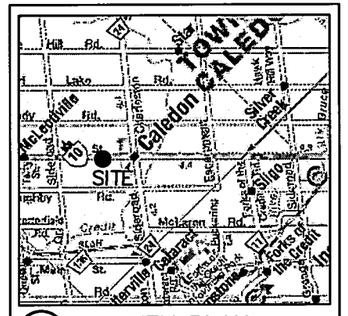
HWY 10/RR 24 WIDENING
BOREHOLE LOCATION & SOIL STRATA

SHEET 3

Trow Consulting Engineers Ltd
1595 Clark Boulevard
Brampton, Ontario L6T 4V1
Telephone: (905) 793-9800
Fax: (905) 793-0641
Project No. BRGED056698A

PLAN

SCALE
5m 0 10m



KEY PLAN
NOT TO SCALE

LEGEND

- BH-1 — BOREHOLE LOCATION BY TROW
- HA-1 — HAND AUGURED HOLE
- WATER LEVEL AT TIME OF INVESTIGATION AUG, 2000
- WATER LEVEL IN PIZOMETER OCT, 2000
- N — BLOWS/0.3 m [STD. PEN TEST, 475 J/BLOW]
- CONE — BLOWS/0.3 m [60° CONE, 475 J/BLOW]
- PIZOMETER

LICENSED PROFESSIONAL ENGINEER
Q. J. LEE
Nov 06
PROVINCE OF ONTARIO

℄ PROFILE HWY. 10

SCALE
5m 0 10m
Horizontal
0.5m 0 1.0m
Vertical

LICENSED PROFESSIONAL ENGINEER
Nov 29/06
S.E.M. GONSALVES
PROVINCE OF ONTARIO

SECTION C-C

SCALE
Horizontal
NTS FOR CLARITY
0.5m 0 1.0m
Vertical

No.	Elevation	Station	Offset
BH-5	431.4	20+062	9m of ℄
BH-6	431.1	20+062	14m of ℄
HA-5	429.2	20+067	12m of ℄
HA-6	428.9	20+068	20m of ℄

NOTE
THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES 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 Offic, 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

HWY 10/ RR 24			DIST
SUBM'D	CHECKED	DATE	SITE NO.

MINISTRY OF TRANSPORTATION, ONTARIO
RR-D-707 88-05

MODIFIED:
DRAWING NAME: BASEPLAN
CREATED: NOV/02/89

Appendix B: Borehole Logs

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

RECORD OF BOREHOLE BH-1

Page 1 OF 1

Geotechnical Investigation - Hwy. 10/ RR. 24 Widening

METRIC

PROJECT NO. brge0056698a
NORTH _____ EAST _____
DATUM Geodetic

LOCATION Hwy. 10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
EQUIPMENT TYPE Soild Auger Drill CME45C Truck Mounted
DATE August 23, 2000 to August 23, 2000

ORIGINATED BY JZ
COMPILED BY WL
CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER/ WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ○ ▲ / FIELD VANE LAB VANE ⊗ ✱) (50 100 150 200)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
422.4	GROUND SURFACE										
0.0	**FILL** - sand & gravel, brown, compact.		1	SPT	22		422	⊗	○		
	FILL - clayey silt, dark-grey, firm.		2	SPT	5			⊗	○		
							421				
	FILL - sand & gravel, brown, compact.		3	SPT	15			⊗	○		
420.1							420				
2.3	**GLACIAL TILL** - hetergeneous mixture of gravel, silt & sand, occasional rock fragments, brown, saturated, loose to very dense.		4	SPT	5			⊗	○		
			5	SPT	41		419	⊗			60 15 (25)
							418				
			6	SPT	58			⊗	○		
							417				
415.8			7	SPT	50/13mm		416	⊗			
6.6	End of Borehole Sampler Refusal Auger Refusal										

NOTES:

The creek was dry on Aug 24,2000

Water Levels

Date	Water Level (m)	Hole Depth (m)
On completion	2.44	2.59

Trow

LBPMTO 56698 10/26/00

RECORD OF BOREHOLE BH-2

Geotechnical Investigation - Hwy. 10/ RR. 24 Widening

METRIC

PROJECT NO. brge0056698a
LOCATION Hwy. 10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
ORIGINATED BY JZ
NORTH _____ EAST _____
EQUIPMENT TYPE Solid Auger Drill CME45C Truck Mounted
COMPILED BY WL
DATUM Geodetic
DATE August 23, 2000 to August 23, 2000
CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS/0.3m	GROUND WATER / WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ▲, FIELD VANE LAB VANE ⊗) (50 100 150 200)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
422.2	GROUND SURFACE										
0.0	**FILL** - consists of sandy silt, occasional gravelly sand, trace rootlets, brown, occasional mottled grey organic strain, dense to loose.		1	SPT	33		422	⊗	○		
			2	SPT	8		421	⊗	○		
420.7											
1.5	**GLACIAL TILL** - hetergeneous mixture of gravel, sand & silt, trace clay, occasional light-brown rock fragments, brown, very moist to saturated, loose to dense.		3	SPT	7			⊗	○		
			4	SPT	7		420	⊗	○		11 39 42 8
			5	SPT	5		419	⊗	○		
			6	SPT	45		418		○		
			7	SPT	60/1[illegible]mm		417	⊗			
			8	SPT	39		416		○		
							415	⊗			
412.6			9	SPT	60/50mm		414		○		
9.6	End of Borehole Sampler Refusal Auger Refusal						413	⊗			

NOTES:

Water level at the creek on Aug 24, 2000 was 421.31

Water Levels

Date	Water Level (m)	Hole Depth (m)
On Completion	4.27	4.57
Oct 13, 2000	4.0	

Trow

LBPMTO 56698 10/26/00

RECORD OF BOREHOLE BH-3

Page 1 OF 1

Geotechnical Investigation - Hwy. 10/ RR. 24 Widening

METRIC

PROJECT NO. brge0056698a | LOCATION Hwy. 10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario | ORIGINATED BY JZ

NORTH _____ EAST _____ | EQUIPMENT TYPE Solid Auger Drill CME45C Truck Mounted | COMPILED BY WL

DATUM Geodetic | DATE August 23, 2000 to August 23, 2000 | CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER/ WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ○ ▲ / FIELD VANE LAB VANE ⊗ ✖) (50 100 150 200)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl	WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR	SA	(SI & CL)
408.0	**GROUND SURFACE**														
0.0 / 407.7	**TOPSOIL** - sandy silt, trace gravel & rootlets, brown with mottled black, loose.		1	SPT	5		407	⊗			○				
0.3	**FILL** - sand & gravel, some silt, possible cobble or bounder at the lower level, brown, compact to dense.		2	SPT	14			⊗							
			3	SPT	27		406	⊗			○			46	40 (14)
			4	SPT	39				⊗		○				
404.9							405								
3.1	**GLACIAL TILL** - hetergeneous mixture of gravel, sand and silt, brown, very moist, compact to dense.		5	SPT	22			⊗			○				
							404								
			6	SPT	35		403		⊗					49	36 (15)
							402								
	- interbedded sand layers.		7	AUGER							○				
401.3															
6.7	End of Borehole Auger Refusal														

NOTES:

Water level at the creek on Aug 24, 2000 was 407.15

Water Levels

Date	Water Level (m)	Hole Depth (m)
On Completion	2.29	

Trow

LBPMTO 56698 10/26/00

RECORD OF BOREHOLE BH-4

Page 1 OF 1

Geotechnical Investigation - Hwy. 10/ RR. 24 Widening

METRIC

PROJECT NO. brge0056698a
LOCATION Hwy. 10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
ORIGINATED BY JZ
NORTH _____ EAST _____
EQUIPMENT TYPE Solid Auger Drill CME45C Truck Mounted
COMPILED BY WL
DATUM Geodetic
DATE August 23, 2000 to August 23, 2000
CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS/0.3m	GROUND WATER/ WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80); SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER, FIELD VANE, LAB VANE) (50 100 150 200)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl; WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
409.6	GROUND SURFACE										
0.0	**FILL** - gravelly sand, trace limestone fragment, brown, occasional mottled black organic strain, loose to compact.		1	SPT	15		409	⊗	○		
			2	SPT	15			⊗	○		
			3	SPT	10		408	⊗	○		
			4	SPT	3		407	⊗	○		
			5	SPT	6		406	⊗	○		
405.1											
4.6	**GLACIAL TILL** - hetergeneous mixture of gravel, silt and sand, brown, very moist to saturated, compact to very dense.		6	SPT	12		405	⊗	○		46 39 (15)
			7	SPT	52		404				
							403	⊗			
			8	SPT	23		402				
							401	⊗			
	- interbedded sand layers.		9	SPT	33		400	⊗	○		
							399				
	- hetergeneous mixture of gravel, sand and silt, light-grey, moist, dense.		10	SPT	30		398	⊗	○		
397.4											
12.2	**SHALE** - inferred bedrock.		11	SPT	78		397	⊗			
397.0											
12.7	End of Borehole Sampler Refusal Auger Refusal										

NOTES:

Water level at the creek on Aug 24, 2000 was 407.15

Water Levels

Date	Water Level (m)	Hole Depth (m)
On Completion	2.59	2.59

Trow

LBPMTO 56698 10/26/00

RECORD OF BOREHOLE BH-5

Page 1 OF 1

Geotechnical Investigation - Hwy. 10/ RR. 24 Widening

METRIC

PROJECT NO. brge0056698a
NORTH _____ EAST _____
DATUM Geodetic

LOCATION Hwy. 10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
EQUIPMENT TYPE Solid Auger Drill CME45C Truck Mounted
DATE August 23, 2000 to August 23, 2000

ORIGINATED BY JE
COMPILED BY WL
CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	GROUND WATER / WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ▲ / FIELD VANE LAB VANE ✖) (50 100 150 200)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
431.4 GROUND SURFACE												
0.0	**FILL** - sand and gravel, brown, moist to saturated, compact.		1	SPT	26		431					
			2	SPT	16		430					
			3	SPT	8		429					
428.4			4	SPT	16							
3.1	**GLACIAL TILL** - hetergeneous mixture of gravel, sand and silt, trace clay, occasional light-brown rock fragments, brown, saturated, loose to dense.		5	SPT	4		428					21 40 37 2
			6	SPT	25		427					
			7	SPT	60/75mm		426					
423.8							425					
7.6	**DOLOMITE** - inferred bedrock.		8	SPT	60/150mm		424					
423.4												
8.1	End of Borehole Sampler Refusal Auger Refusal											

NOTES:

Water level at the creek on Aug 24, 2000 was 428.89

Water Levels

Date	Water Level (m)	Hole Depth (m)
On Completion	2.74	3.05
Oct 13, 2000	3.1	

Trow

LBPMTO 56698 10/26/00

RECORD OF BOREHOLE BH-6

Page 1 OF 1

METRIC

Geotechnical Investigation - Hwy. 10/ RR. 24 Widening

PROJECT NO. brge0056698a | LOCATION Hwy. 10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario | ORIGINATED BY JZ

NORTH _____ EAST _____ | EQUIPMENT TYPE Solid Auger Drill CME45C Truck Mounted | COMPILED BY WL

DATUM Geodetic | DATE August 23, 2000 to August 23, 2000 | CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	GROUND WATER / WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ○ ▲ / FIELD VANE LAB VANE ◆ ×) (50 100 150 200)	PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR. SA (SI & CL)
431.1	GROUND SURFACE						431								
0.0	**FILL** - sand and gravel, brown, compact.		1	SPT	17			⊗			○				
	FILL - silty sand, trace clay and fine gravel, yellow-brown, occasional mottled black orgainic soil, saturated, loose.		2	SPT	10		430	⊗			○				
			3	SPT	10		429	⊗				○			
428.0							428								
3.1	**GLACIAL TILL** - hetergeneous mixture of gravel, sand and silt, trace clay, occasional light-brown rock fragments, brown, saturated, loose to very dense.		4	SPT	7			⊗			○				
			5	SPT	27		427		⊗		○				
			6	SPT	50/83mm		426		⊗		○				47 28 (25)
			7	SPT	67		425		⊗						
422.0							424								
9.1	**DOLOMITE** - inferred bedrock.		8	SPT	50/100mm		423		⊗						
421.5							422								
9.6	End of Borehole Sampler Refusal Auger Refusal														

NOTES:

Water level at the creek on Aug 24, 2000 was 428.49

Water Levels

Date	Water Level (m)	Hole Depth (m)
On Completion	2.44	3.66

Trow

LBPMTO 56698 10/26/00

RECORD OF BOREHOLE HA-1

Page 1 OF 1

METRIC

Geotechnical Investigation - Hwy.10/RR.24 Widening

PROJECT NO. brge0056698a
NORTH _____ EAST _____
DATUM Geodetic

LOCATION Hwy.10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
EQUIPMENT TYPE HAND AUGER
DATE August 24, 2000 to August 24, 2000

ORIGINATED BY JZ
COMPILED BY WL
CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER / WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ▲ FIELD VANE LAB VANE ✖) (50 100 150 200)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl / WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
421.2	GROUND SURFACE										
0.0	**TOPSOIL** - sandy silt, some rootlets, trace fine gravel, dark-brown, compact.						421				
420.9											
0.3	**GLACIAL TILL** - sandy silt, trace clay and fine subrounded gravel, dark-brown, moist, compact.										
420.6											
0.6	End of Borehole										

NOTES:

Water Levels

Date	Water Level (m)	Hole Depth (m)

Trow

LBPMTO 5669B 10/24/00

RECORD OF BOREHOLE HA-2

Page 1 OF 1

METRIC

Geotechnical Investigation - Hwy.10/RR.24 Widening

PROJECT NO. brge0056698a
NORTH _____ EAST _____
DATUM Geodetic

LOCATION Hwy.10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
EQUIPMENT TYPE HAND AUGER
DATE August 24, 2000 to August 24, 2000

ORIGINATED BY JZ
COMPILED BY WL
CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER / WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ▲, FIELD VANE LAB VANE ⊠) (50 100 150 200)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
421.4 GROUND SURFACE											
0.0 / 421.1	**TOPSOIL** - sandy silt, some rootlets, trace fine gravel, dark-brown, compact.										
0.3 / 420.2	**GLACIAL TILL** - sandy silt, trace clay and fine subrounded gravel, dark-brown, moist, compact.						421				
1.2	End of Borehole										

NOTES:

Water Levels

Date	Water Level (m)	Hole Depth (m)

Trow

LBPMTO 56698 10/24/00

RECORD OF BOREHOLE HA-3

METRIC

Geotechnical Investigation - Hwy.10/RR.24 Widening

PROJECT NO. brge0056698a
LOCATION Hwy.10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
ORIGINATED BY JZ
NORTH _____ EAST _____
EQUIPMENT TYPE HAND AUGER
COMPILED BY WL
DATUM Geodetic
DATE August 24, 2000 to August 24, 2000
CHECKED BY SL

SOIL PROFILE			SAMPLES			GROUND WATER/ WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER / FIELD VANE LAB VANE)	WATER CONTENT (%)		
407.4 GROUND SURFACE								20 40 60 80 / 50 100 150 200	wp — w — wl / 10 20 30 40	kN/m³	GR SA (SI & CL)
0.0	**TOPSOIL** - sandy silt, some rootlets and fine gravel, dark-brown, moist, compact.										
407.1 0.3	End of Borehole Auger Refusal										

NOTES:

Water Levels

Date	Water Level (m)	Hole Depth (m)

Trow

LBPMTO 56698 10/24/00

RECORD OF BOREHOLE HA-4

Page 1 OF 1

Geotechnical Investigation - Hwy.10/RR.24 Widening

METRIC

PROJECT NO. brge0056698a | LOCATION Hwy.10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario | ORIGINATED BY JZ

NORTH _____ EAST _____ | EQUIPMENT TYPE HAND AUGER | COMPILED BY WL

DATUM Geodetic | DATE August 24, 2000 to August 24, 2000 | CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER / WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ▲ FIELD VANE LAB VANE ✖) (50 100 150 200)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
407.5	GROUND SURFACE										
0.0 / 407.2	**TOPSOIL** - consists of sandy silt, some rootlets, dark-brown, compact.										
0.3 / 406.3	**GLACIAL TILL** - silty sand, some fine to coarse subrounded gravel, dark-brown, saturated, compact.						407				
1.2	End of Borehole										

NOTES:

Water Levels

Date	Water Level (m)	Hole Depth (m)

Trow

LBPMTO 56698 10/24/00

RECORD OF BOREHOLE HA-5

Page 1 OF 1

Geotechnical Investigation - Hwy.10/RR.24 Widening

METRIC

PROJECT NO. brge0056698a
LOCATION Hwy.10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
ORIGINATED BY JZ
NORTH _____ EAST _____
EQUIPMENT TYPE HAND AUGER
COMPILED BY WL
DATUM Geodetic
DATE August 24, 2000 to August 24, 2000
CHECKED BY SL

SOIL PROFILE			SAMPLES			GROUND WATER/ WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ▲ / FIELD VANE LAB VANE ✖) 50 100 150 200	WATER CONTENT (%) 10 20 30 40	kN/m³	GR SA (SI & CL)
429.2 GROUND SURFACE											
0.0 / 429.0	**TOPSOIL** - sandy silt, trace rootlets and fine gravel, dark-brown, compact.						429				
0.2 / 428.1	**GLACIAL TILL** - silty sand, some clay, trace fine subangular gravel, brown, saturated, compact.										
1.1	End of Borehole										

NOTES:

Water Levels

Date	Water Level (m)	Hole Depth (m)

Trow

LBPMTO 56698 10/24/00

RECORD OF BOREHOLE HA-6

Geotechnical Investigation - Hwy.10/RR.24 Widening

METRIC

PROJECT NO. brge0056698a
LOCATION Hwy.10 & Regional Road 24, Town of Caledon, Region of Peel, Ontario
ORIGINATED BY JZ
NORTH _____ EAST _____
EQUIPMENT TYPE HAND AUGER
COMPILED BY WL
DATUM Geodetic
DATE August 24, 2000 to August 24, 2000
CHECKED BY SL

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER / WELL LOG	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED TRIAXIAL PENETROMETER ▲ FIELD VANE LAB VANE ✖) (50 100 150 200)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl / WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR. SA (SI & CL)
428.9 GROUND SURFACE											
0.0 / 428.6	**TOPSOIL** - sandy silt, trace rootlets and fine gravel, dark-brown, compact.										
0.3 / 427.9	**GLACIAL TILL** - silty sand, trace clay and fine subangular gravel, brown, saturated, compact.						428				
1.0	End of Borehole										

NOTES:

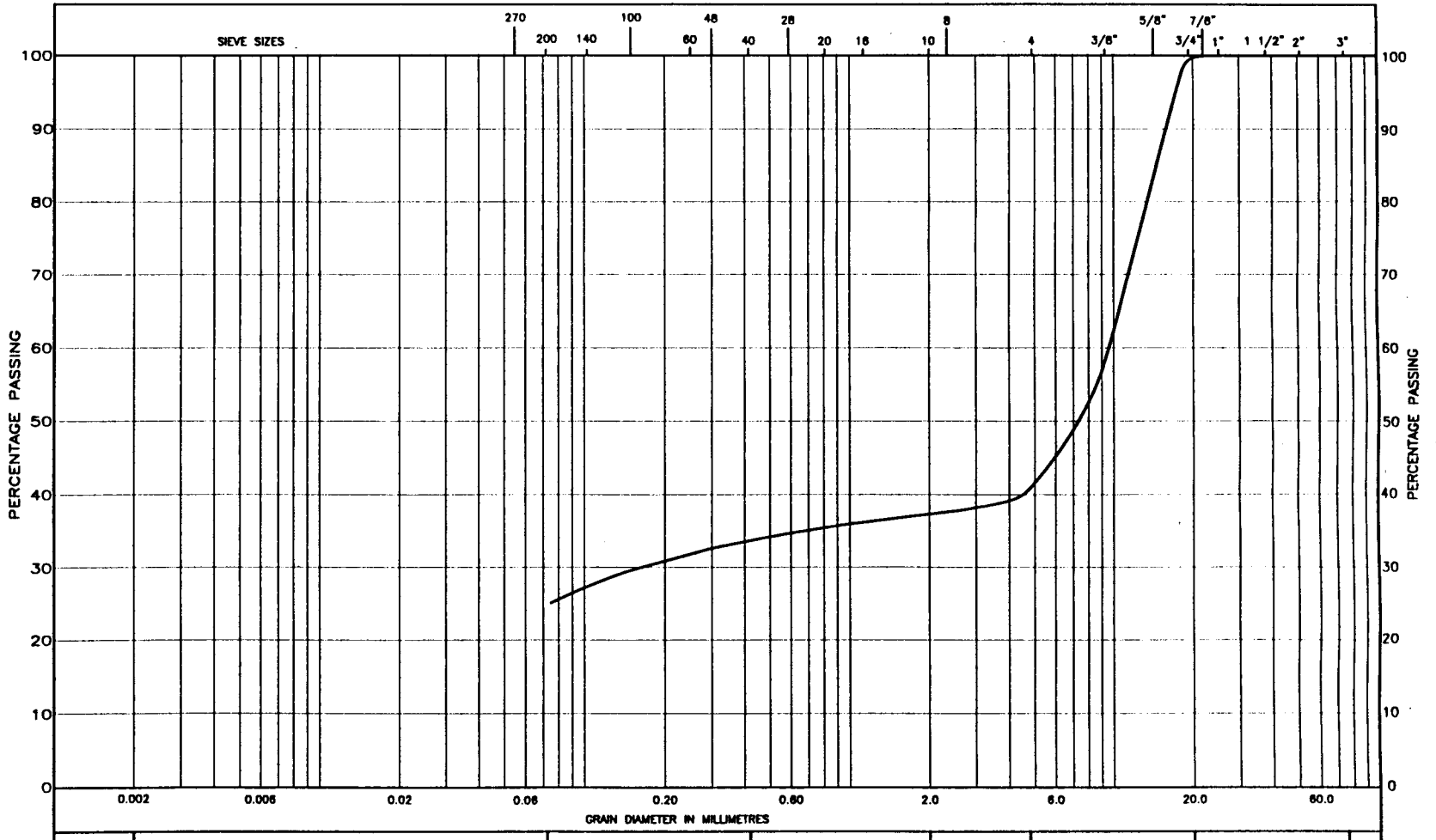
Water Levels

Date	Water Level (m)	Hole Depth (m)

Trow

Appendix C: Grain Size Analysis Results

UNIFIED SOIL CLASSIFICATION

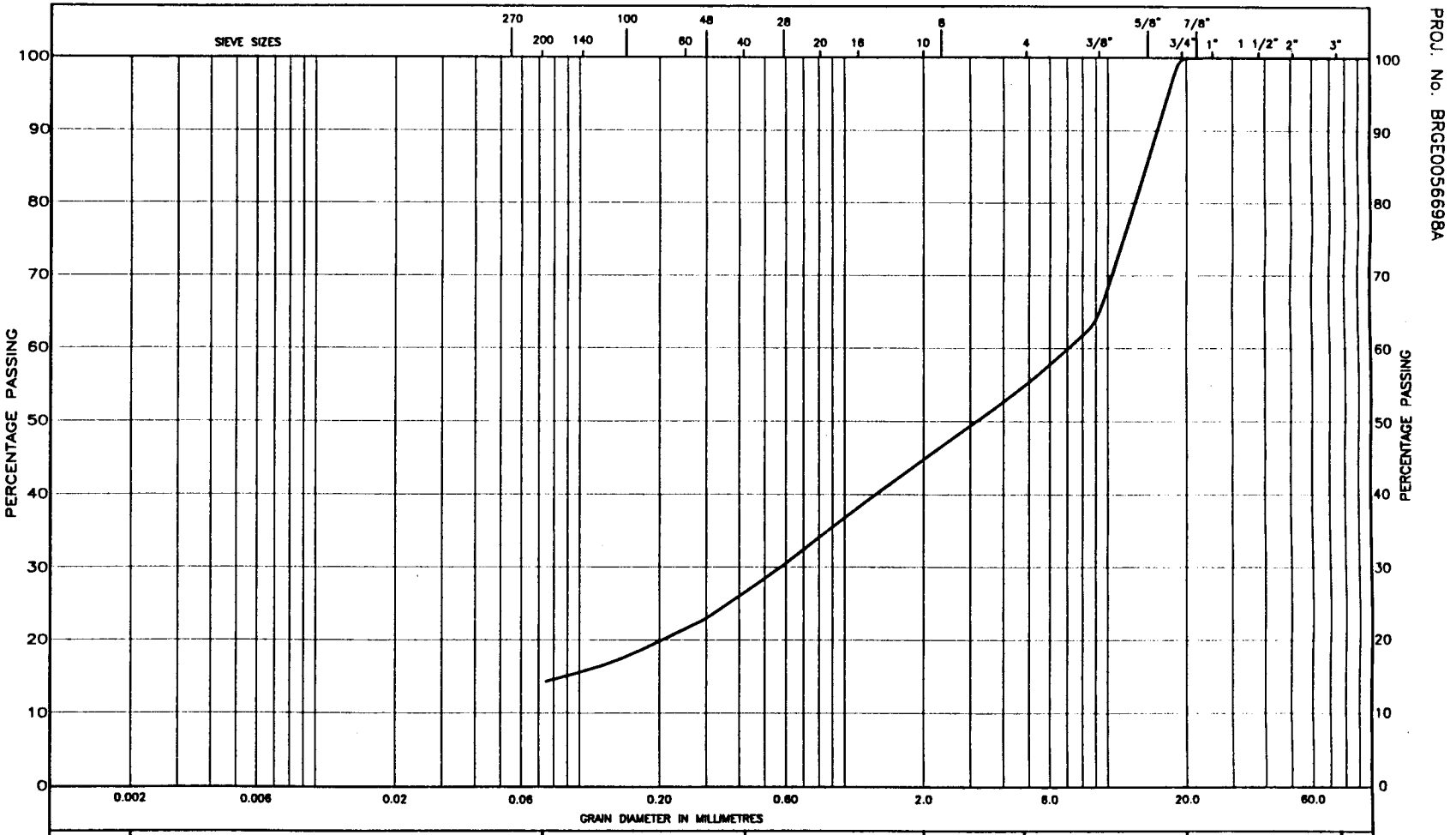


PROJ. No. BRGE0056698A

Project Name: Hwy.10 / RR.24 Widening
Sample ID: 14070
Sample Location: BH-1 SS-5, depth 3.0-3.5m

TROW

UNIFIED SOIL CLASSIFICATION

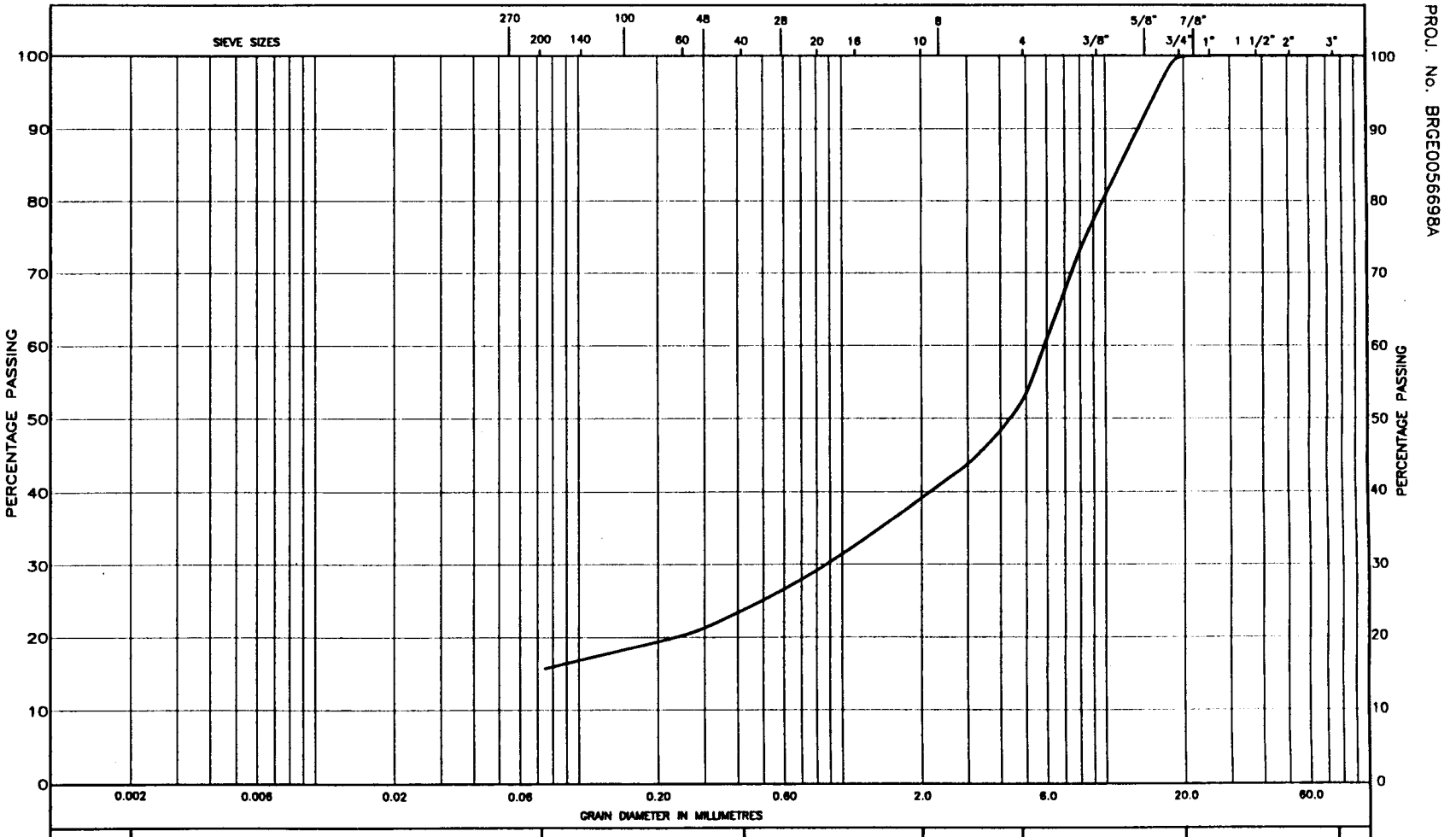


PROJ. No. BRGE0056698A

Project Name: Hwy.10 / RR.24 Widening
Sample ID: 14071
Sample Location: BH-3 SS-3, depth 1.5-2.0m

TROW

UNIFIED SOIL CLASSIFICATION

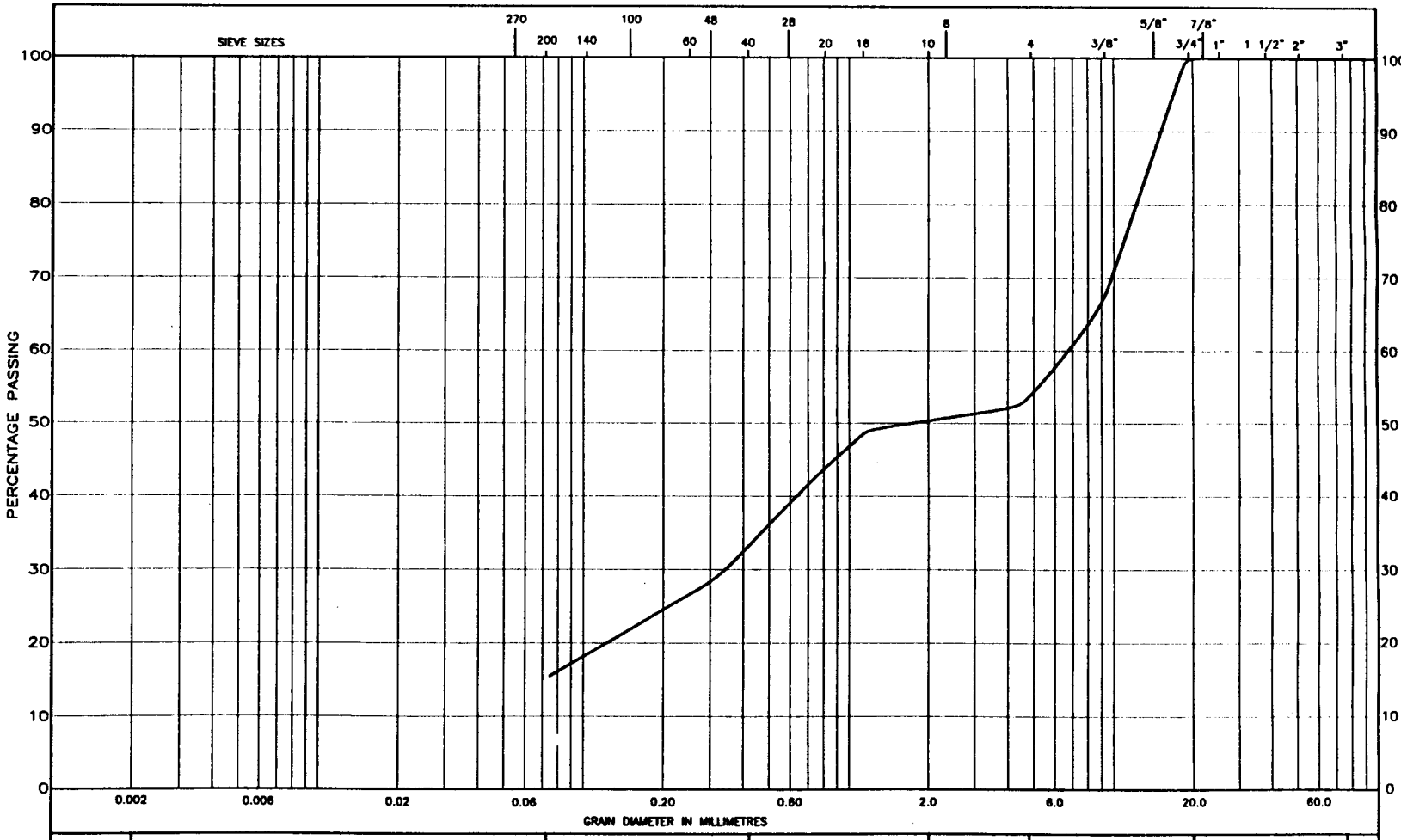


PROJ. No. BRGE0056698A

Project Name: Hwy.10 / RR.24 Widening
Sample ID: 14072
Sample Location: BH-3 SS-6, depth 4.5-5.0m

TROW

UNIFIED SOIL CLASSIFICATION

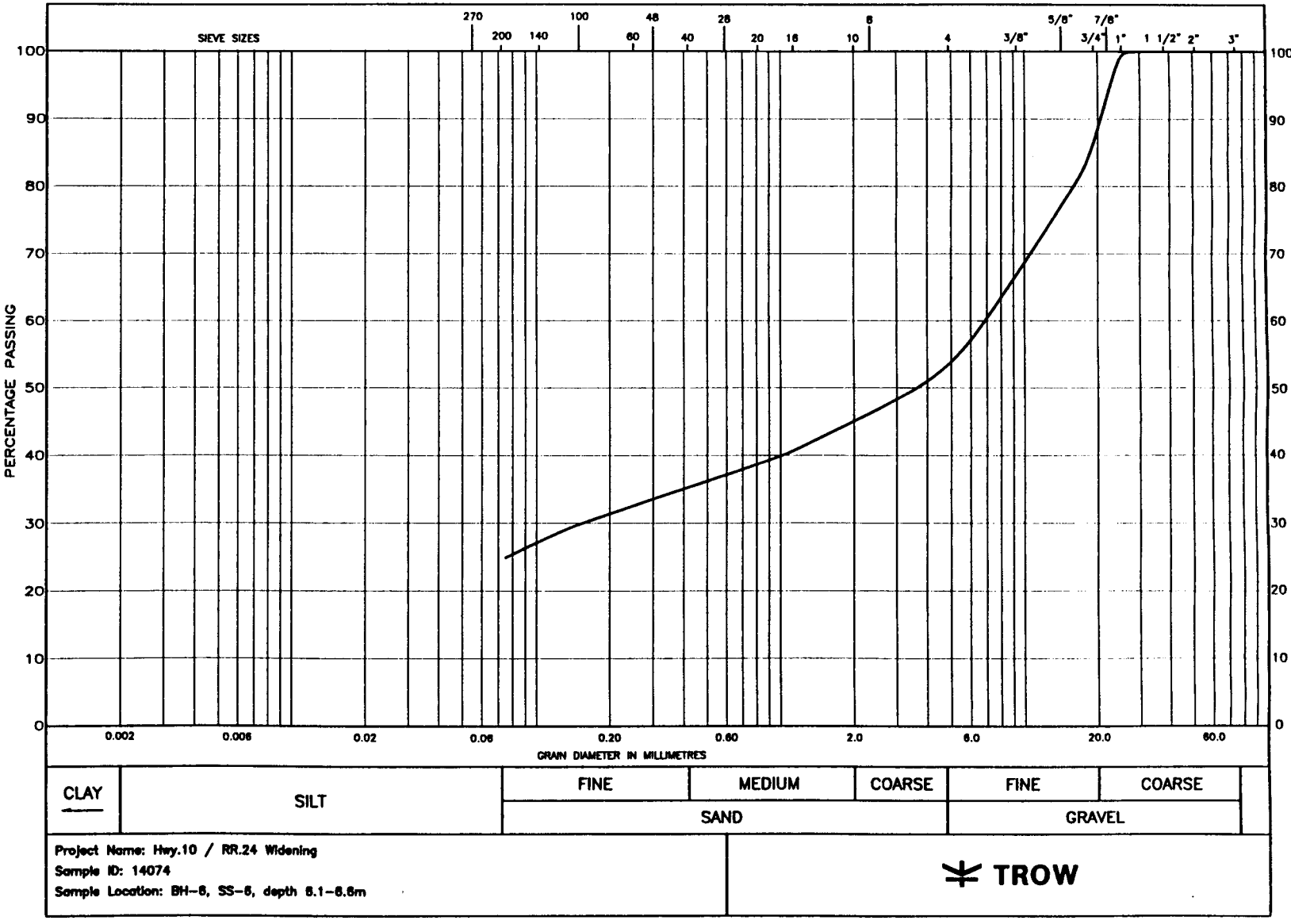


PROJ. No. BRGE0056698A

Project Name: Hwy.10 / RR.24 Widening
Sample ID: 14073
Sample Location: BH-4 SS-6, depth 4.5-5.0m

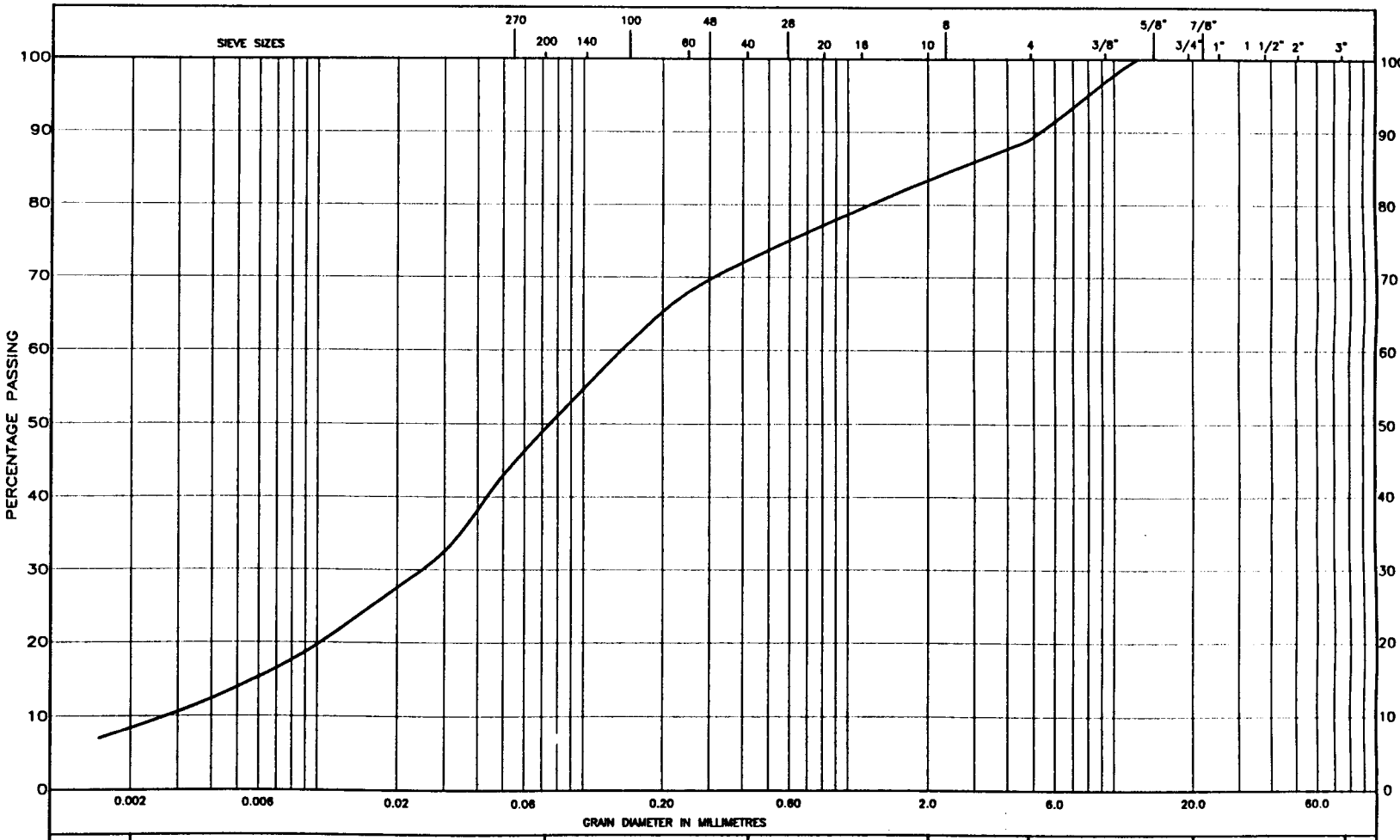
TROW

UNIFIED SOIL CLASSIFICATION



PROJ. No. BRGE0056698A

UNIFIED SOIL CLASSIFICATION

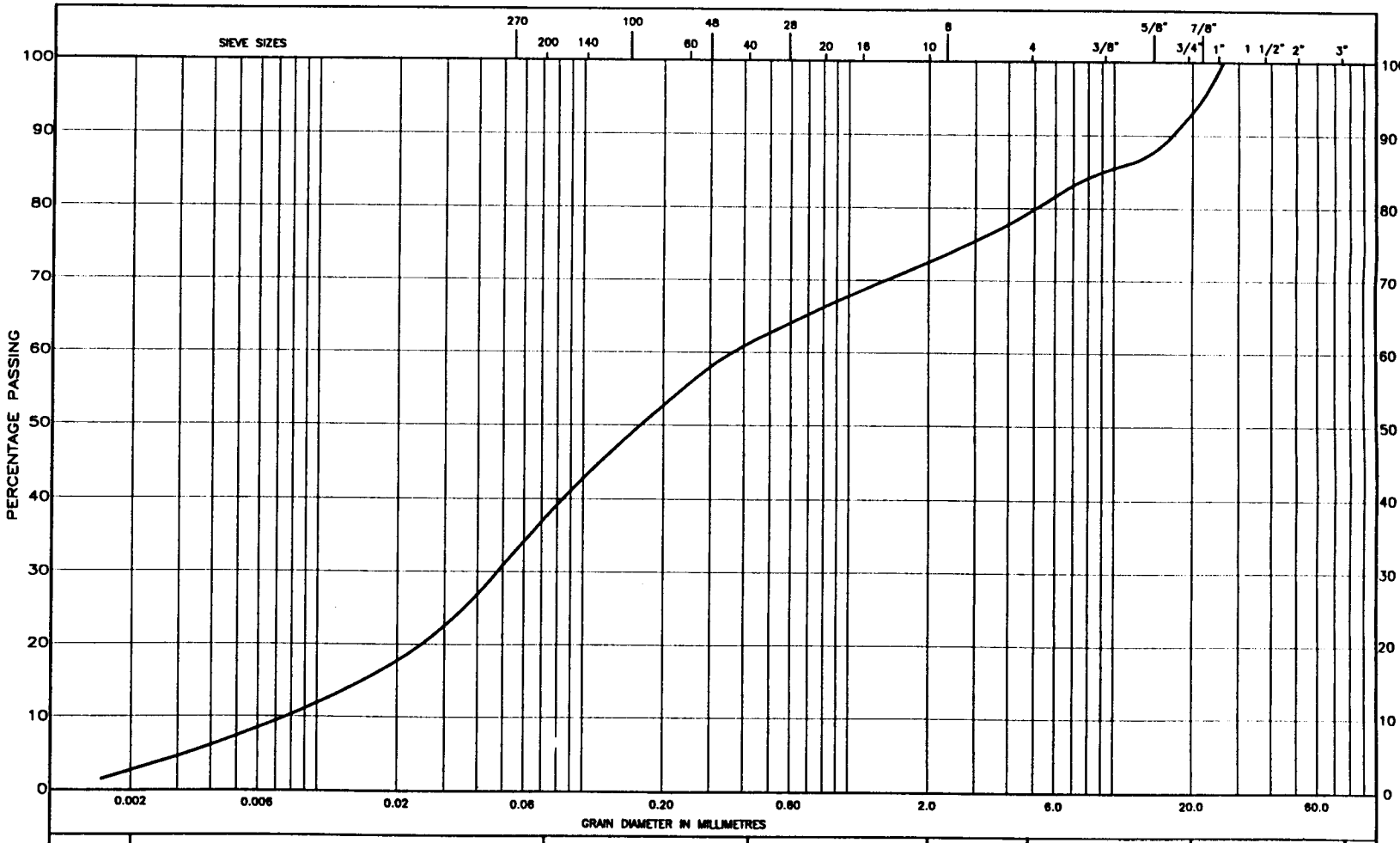


PROJ. No. BRGE0056698A

Project Name: Hwy.10 / RR.24 Widening
Sample ID: G1171
Sample Location: BH-2 SS-4, depth 2.3-2.7m

TROW

UNIFIED SOIL CLASSIFICATION



PROJ. No. BRGE005669BA

Project Name: Hwy.10 / RR.24 Widening
Sample ID: G1172
Sample Location: BH-5 SS-5, depth 3.0-3.5m

TROW

Bennett, Betty (MTO)

From: Bennett, Betty (MTO)
Sent: December 5, 2001 3:21 PM
To: Ng, Raymond (MTO)
Subject: WP 220-94-00 Hwy 10 Contract Package Review

Ray

I have reviewed the contract documents provided for the Hwy 10 widening project through Caledon and forward the following comments:

1. Because there are foundation drawings prepared for each of the 3 culverts, they should be included in the contract drawings.

2. Regarding SP 109F10, please advise who will be preparing the Foundation Reports for CPS. (The word foundations is spelled incorrectly in both report titles.)

3. Sheet 48: For the wall detail for RR 24, the retaining wall is indicated as being the edge of the paved boulevard. Not clear what is meant. The wall detail for Hwy 10 suggests the minimum bearing capacity required for the wall is 150 kPa. How will this determined and who is responsible for confirming it? (Miscellaneous spelled with 3 "L"s.) I understand from Nick Garland that a number of larger issues regarding this retaining wall surfaced at the meeting and that it will likely be re-designed...so I will abstain from further comment.

4. Sheet 308: Under the notes, the DSM number should read 9.70.56. I suggest that the attributes for this site should be Medium Performance, High Appearance and Vertical. This would permit the construction of a block wall which has been used successfully for culverts on Hwy 9. The values for soil bearing should not be provided. The RSS company determines for themselves what parameters to use based on the foundation report.

5. Sheet 320, Note 2 and 325, Note 1: The excavation would have to inspected by a certified QVE, not a foundation engineer.

6. Sheets 320 and 326: The note describing the subexcavation and replacement with granular material or concrete can be carried out only in a dry excavation.

That's all for now.

Betty