Foundation Investigation and Recommendations Report
Left Turning Lane, Lake Huron Drive
Desbarats River Culvert Replacement and Proposed Retaining Walls
Desbarats, ON
G.W.P. 6013-03-00
Geocres No. 41J-70

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Part 1 Foundation Investigation

1.1 Introduction

This submission presents the results of a geotechnical investigation completed by Trow Associates Inc. (Trow) for the proposed eastbound left turn lane and runout lane along Highway 17 at Lake Huron Drive along with culvert replacements and proposed retaining walls at the Desbarats River on Highway 17 and Lake Huron Drive south, located within Johnson Township. Photographs are included in Appendix F.

The purpose of this geotechnical investigation was to determine the existing soil conditions within the proposed construction limits by field investigation and laboratory testing.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The proposed left hand turn lane, runout lane and culvert replacements are located in the town of Desbarats between approximately Stations 13+000 and 13+410 along Highway 17. The left hand turn lane and runout lane is proposed for Lake Huron Drive and the culvert replacements along with the proposed retaining walls located at the Desbarats River on Highway 17 and Lake Huron Drive south.

The overall terrain in the area is moderately undulating consisting of rock outcrops of Cobalt bedrock separated by intervening marshy zones and wooded areas.

1.2.2 Geological Setting

According to the Ontario Geological Survey (OGS) Maps 2544 and 2556, the site is located in what is known as the Huronian Supergroup, specifically the Cobalt subgroup. As previously noted, the topography in the area is undulating consisting of bedrock outcrops. As such, the surface soils in the area consist of intervening shallow organic deposits (peat), with glaciolacustrine and till deposits consisting of gravel, sand, silt and clay.

1.3 Investigative Procedures

1.3.1 General

The fieldwork for this project was carried out from June 18th to June 28th, 2004, April 12th to April 18th and May 5th 2005. A total of 21 boreholes were advanced.

The June 18th to June 28th, 2004 investigation consisted of 15 boreholes (BH-4 to BH-18), boreholes BH-1, BH-2 and BH-3 were conducted for the Anderson Creek Culvert Rehabilitation, and are included in a separate report. Eleven boreholes (BH-5 to BH-15) were advanced on the south side of Highway 17. These boreholes were advanced to profile the existing soil conditions for the:

- Proposed Highway widening to the south
- Proposed Gabion Basket retaining wall
- Existing Twin Corrugated Steel Pipes (CSP) outlet in Desbarats River through Highway 17 (BH-8)

The remaining 4 boreholes were advance for the culvert investigation, one of which, was located at the inlet of the existing twin CSP culverts in Desbarats River through Highway 17 (BH-4) and 3 of which were advanced at the inlet, outlet and centre line for the existing single and twin CSP culverts through Lake Huron Drive south (BH-16 to BH-18). The boreholes were advanced to power auger refusal and/or terminated between 0.0 m (bedrock was observed at ground surface at the BH-5 location) and 6.7 m.

The April 12th to April 18th, 2005 and the May 5th, 2005 investigation consisted of 6 boreholes (BH-1B to BH-6B). Boreholes BH-1B and BH-2B were advanced on the north shoulder along Highway 17 at Stations 13+325 and Station 13+375, to determine the existing embankment construction. Borehole BH-3B was advanced at the proposed inlet location of the new culvert. Boreholes BH-4B, BH-5B and BH-6B were advanced 1 m north of the centreline of Highway 17 for the proposed roadway protection between Stations 13+308 to 13+323. The boreholes were advanced to refusal between 5.2 m and 10.4 m below existing grade.

All boreholes were advanced using a Mobile B-57 track mounted drill rig equipped with continuous flight hollow stem augers and standard soil sampling equipment.

From the drilling program, soil samples were obtained using a 51 mm (2 inch) outside diameter split spoon sampler in conjunction with Standard Penetration Tests (ASTM D 1586), at 0.75 m intervals for the upper 3.0 m and at 1.5 m intervals thereafter. The Standard Penetration Test "N" values were recorded and used to provide an assessment of the in-situ relative density of the overburden soils. Laboratory shear vanes were performed on the clay and silty clay samples to estimate the undrained shear strength.

All fieldwork was supervised by a member of Trow's engineering staff who directed the drilling and sampling operations, logged the factual borehole data, and retrieved soil samples for subsequent laboratory testing and identification. All borehole elevations were determined in the field by Trow. The borehole elevations were established from a temporary geodetic benchmark, located approximately 23 m north of the centre line of Highway 17 at Station 13+148 (southwest bolt of light standard with elevation 178.651 m).

The locations of the boreholes and the elevations are shown on Drawing 1 in Appendix A. Conventional rock coring was not required by the Ministry.

In addition to the boreholes drilled by Trow, a total of four (4) boreholes (BH-2, BH-3, BH-7 and BH-9) performed by Geocon in February 1965 (W.P. No. 904-64) were utilized along with test pits performed in August 1995 (W.P. No. 264-90-00). The boreholes and test pit locations are shown on Drawing 1 in Appendix A, with the summary logs included in Appendix B.

1.4 Laboratory

The soil samples obtained in the field were examined in the laboratory for further verification and classification. A laboratory testing program for the selected soil samples consisted of Natural Moisture Content Determination (LS 701), Particle Size Analyses (LS 702), Atterberg Limits (LS 703 and LS 704).

The laboratory test results are summarized on the attached borehole logs in Appendix B, as well as in Appendix C.

1.5 Subsurface Conditions

1.5.1 General

The subsurface conditions encountered during the field investigation at the sites are summarized on the borehole logs in Appendix B. The following is a description of the subsurface conditions encountered during the field investigation.

1.5.2 Stratigraphy South Side Highway 17

The stratigraphy for the south side of Highway 17 is interpreted from all boreholes located on the south side of Highway 17 (BH-5 to BH-15) including the drilling for the proposed Gabion Basket retaining wall and the south end of the twin CSP culvert through Highway 17.

In general, the stratigraphy within the boreholes consisted of sand fill, sand and gravel fill, and sand and boulder fill, overlying interlayered sand, silty sand, silty clay and clayey silt.

The fill material (i.e. sand, sand and gravel and sand and boulders) was approximately 0.6 to 1.5 m thick, brown in colour, dry to damp, loose to very dense, poor to well graded fine to coarse grained and contained trace to some silt with cobbles. Uncorrected “N” values from SPT tests within the fill material ranged from 8 to 56 blows per 300 mm. The sand and silty sand was brown to grey in colour, damp to wet, very loose to compact, poor to well graded, fine to medium grained and contained trace to some clay and gravel. Uncorrected “N” values from SPT tests within the sand range from 4 to 18 blows per 300 mm. The silty clay was grey in colour, moist to wet, very soft to firm, low to medium

plasticity and contained trace to some sand and trace organics and gravel. Undrained shear strengths within the silty clay ranged from 12 to 60 kPa. A 0.7 m thick layer of clayey silt was encountered in borehole BH-13 from Elevation 176.1 m to 175.4 m. The clayey silt was grey in colour, damp, loose and was of low plasticity. Uncorrected "N" values from one SPT test performed on the clayey silt were 8 blows per 300 mm. The boreholes were advanced to power auger refusal and/or terminated between 0.0 and 6.7 m below existing grade or Elevations178.3 and 171.6.

1.5.3 Stratigraphy Twin CSP Culverts Through Highway 17

In general, the stratigraphy as determined from boreholes BH-4 and BH-8 consisted of a thin layer of topsoil overlying sand and boulder fill and sand and silty sand.

A 125 mm thick layer of topsoil was encountered in borehole BH-4. Underlying the topsoil in borehole BH-4 and from the ground surface in borehole BH-8 was a 0.8 to 1.4 m thick layer of sand and boulder fill. The sand and boulder fill was brown in colour, damp, loose, poorly graded, with gravel and cobbles. Underlying the sand and boulder fill in borehole BH-4 was a 0.6 m thick layer of silty sand overlying suspected bedrock. The silty sand was brow to grey in colour, damp, very loose, poorly graded and contained some gravel and clay with trace organics. Uncorrected "N" values from Standard Penetration Tests (SPT tests) within the silty sand were 3 blows per 300 mm. Underlying the sand and boulder fill in borehole BH-8 was a 1.5 m thick layer of sand fill. The sand fill was brown in colour, damp, compact, well graded, fine to medium grained and contained some gravel and trace silt. Uncorrected "N" values from SPT tests within the sand fill were 10 blows per 300 mm. Underlying the sand fill was a 2.0 m thick layer of sand overlying suspected bedrock. The sand was brown in colour, wet, very loose to compact, well graded, fine to medium grained and contained trace to some gravel. Uncorrected "N" values from SPT tests within the sand ranged from 4 to 12 blows per 300 mm Auger refusal on suspected bedrock was encountered between approximately 2.1 and 4.3 m below existing grade or Elevations 176.0 to 174.1 m.

1.5.4 Stratigraphy Single and Twin CSP Culverts Through Lake Huron Drive South

In general the stratigraphy as determined from boreholes BH-16 to BH-18 consisted of sand and gravel fill overlying boulders and/or suspected bedrock. Borehole BH-18 had an initial 75 mm thick layer of asphalt.

The sand and gravel fill was brown in colour, damp, loose to dense, well graded, fine to medium grained, and contained some silt and trace cobbles. Uncorrected "N" values from SPT tests within the sand and gravel were 20 to 50 blows per 300 mm. Auger refusal on suspected bedrock was encountered between approximately 0.8 and 2.1 m below existing grade or Elevations 177.7 to 176.2 m.

1.5.5 Stratigraphy Proposed Gabion Basket Retaining Walls

In general, the stratigraphy as determined from boreholes BH-7 to BH-11 consisted of fill material overlying sand, silty sand and silty clay. Borehole BH-11 encountered an initial 150 mm thick layer of topsoil.

The fill in boreholes BH-7, BH-9 and BH-11 consisted of a 0.6 to 1.5 m thick layer of sand fill. The sand fill was brown in colour, dry to damp, loose to dense, poor to well graded, fine to medium grained, with gravel and some to with boulders. Uncorrected "N" values from SPT tests within the sand fill were 39 blows per 300 mm. Underlying the sand fill in borehole BH-7 was interlayered silty sand and silty clay, silty clay in borehole BH-9 and refusal on boulders and/or suspected bedrock in borehole BH-11. The silty sand was brown to grey in colour, damp, loose to compact, poorly graded, fine grained, and contained some clay, with trace gravel. Uncorrected "N" values from SPT tests within the silty sand were 6 to 10 blows per 300 mm. The silty clay was brown to grey, moist to wet firm to stiff, of low to medium plasticity, and contained trace to some sand, organics and trace gravel. The undrained shear strength of the silty clay was estimated to be 25 to 60 kPa based upon laboratory torvane and SPT results. The fill in borehole BH-8 consisted of a 0.8 m thick layer of sand and boulder fill. The sand and boulder fill was brown, damp, loose, poorly graded, with gravel and cobbles. Underlying the sand and boulder fill was a 1.5 m thick layer of sand fill overlying approximately 2.0 m of sand. The sand fill and sand was brown in colour, damp to wet, very loose to compact, well graded, fine to medium grained and contained trace to some gravel and trace silt. Uncorrected "N" values from SPT tests within the sand and sand fill were 4 to 12 blows per 300 mm. Auger refusal was encountered in all boreholes between 0.6 and 6.0 m below existing grade or elevations 176.7 to 172.2 m.

1.5.6 Stratigraphy North Shoulder along Highway 17

In general, the stratigraphy as determined from Boreholes BH-1B and BH-2B consisted of 60 to 100 mm of asphalt overlying 1.1 to 1.7 m of Granular "B", rock fill, and gravel and till material overlying suspected bedrock.

The Granular "B" was brown in colour, damp, compact to very dense and contained a trace to some cobbles. Uncorrected "N" values from SPT tests ranged from 31 to 65 blows per 300 mm. Underlying the Granular "B" was a 2.5 to 3.8 m thick layer of rock fill. The rock fill was dense and was approximately 300 mm in diameter. A 800 mm thick layer of wood (probably old timer cribbing) was encountered in Borehole BH-2B within the rock fill from 2.7 to 3.5 m below grade or Elevation 176.70 m to 176.00 m.

A 3.0 m thick layer of gravel was encountered in Borehole BH-1A from Elevation 174.90 m to 171.80 m underlying the rock fill. The gravel was red to grey in colour, wet, compact and contained some sand, and some silt. Uncorrected "N" values from SPT tests within the gravel ranged from 14 to 15 blows per 300 mm. Underlying the gravel in boreholes BH-1A and the rock fill in Borehole BH-2A was a till material, which ranged from predominately sand to cobbles. The till material was red to grey in colour, wet, loose to very dense, poorly graded, and fine to coarse grained. Uncorrected "N" values

from SPT tests ranged from 8 to 100 blows per 300 mm. Refusal was encountered between 6.7 and 8.5 m below existing grade or Elevations 172.80 m and 170.60 m.

1.5.7 Stratigraphy Proposed Inlet New Culvert Location

In general, the stratigraphy as determined from Borehole BH-3B consisted of a 2.0 m thick layer of sand fill, overlying cobble fill, and native sand overlying bedrock.

The sand fill was brown in colour, damp to wet, compact, well graded, fine to coarse grained and contained some cobbles and trace to some silt. Uncorrected "N" values from SPT tests within the sand ranged from 16 to 25 blows per 300 mm. underlying the sand fill was a 700 mm thick layer of cobble fill. The cobble fill was brown in colour, wet, dense and contained some sand, and some gravel. Underlying the cobble fill was native sand. The native sand was brown in colour, wet, very loose to compact, well graded, fine to medium grained and contained a trace of silt. Uncorrected "N" values from SPT tests ranged from 1 to 19 blows per 300 mm. Refusal was encountered 7.3 m below grade, or Elevation 171.50.

1.5.8 Stratigraphy Proposed Roadway Protection Centerline Highway 17 Station 13+325 to Station 13+375.

In general, the stratigraphy as determined from Boreholes BH-4B to BH-6B consisted of 280 mm of asphalt overlying a 0.9 to 3.5 m thick layer of Granular "B", interlayered sand, and clayey silt, rock fill and a till material.

The Granular "B" was brown in colour, damp to wet, compact to very dense, and contained some cobbles. Uncorrected "N" values from SPT tests ranged from 23 to 69 blows per 300 mm. Underlying the Granular "B" in Boreholes BH-4B and BH-6B was interlayered sand material and clayey silt. The sand was 2.2 to 2.8 m thick, brown to grey in colour, wet, loose to compact, poorly graded, fine to coarse grained, and contained a trace to some silt, trace to some gravel and trace cobbles. Uncorrected "N" values from SPT tests ranged from 4 to 17 blows per 300 mm. The clayey silt was grey in colour, wet, very loose, of low plasticity, and contained a trace to some sand, and trace gravel. Underlying the clayey silt in borehole BH-6B was a till material, which ranged from predominately sand to silt. The till material was 2.1 m thick, grey in colour, wet and compact to dense and overlaid suspected bedrock. A 5.8 m thick layer of rock fill was encountered underlying the Granular "B" in Borehole BH-5B. The rock fill was approximately 450 mm in diameter, dense and overlaid a 600 mm thick layer of dense, cobble till. The cobble till overlaid suspected bedrock 7.6 m below existing grade or Elevation 171.20 m. Refusal was encountered between 5.2 m and 10.4 m below grade or Elevation 173.70 and 168.50 m.

1.6 Groundwater Conditions

Groundwater was encountered between elevations 177.6 m (BH-6) and 175.5 m (BH-13) (1.2 and 2.9 m below grade respectively). Where rock fill was present groundwater levels were difficult to establish since the boreholes were cased.

Seasonal variations in the water table should be anticipated, with higher levels occurring during wetter periods of the year (such as spring thaw and late fall) and lower levels during drier periods.

Part 2 Engineering Discussions and Recommendations

2.1 Introduction

The following subsections address the geotechnical design and construction considerations for the proposed left turn lane and runout lane along Highway 17 at Lake Huron Drive along with culvert replacements and proposed retaining walls at the Desbarats River on Highway 17 and Lake Huron Drive south, located within Johnson Township. Photographs are included in Appendix F.

2.2 Retaining Wall Design

The Greer Galloway Group along with Trow Associates Inc., evaluated four different retaining wall options, which included a concrete cantilever wall, mechanically stabilized earth wall, steel sheet pile wall and gabion basket wall. The gabion basket wall was selected based upon cost, construction time, environmental concerns regarding fish habitat and construction restraints relative to the other types of retaining walls. For further discussion of the four alternatives and the rationale for the selection of the gabion basket wall, refer to Greer Galloway's Structural Design Report Section 9.3.

Two separate Gabion Basket retaining wall designs are proposed for the Highway 17 widening along with general construction recommendations. Retaining wall design No. 1 will include the proposed retaining wall located immediately west of Lake Huron Drive between Stations 13+185 and 13+225 (see photographs 3, 4 and 5, Appendix F). Retaining wall design No. 2 will include the proposed retaining wall located to the east of Lake Huron Drive at the culvert locations between Stations 13+280 and 13+315 (see photograph 6, Appendix F).

2.2.1 Retaining Wall Design No. 1 Foundation (Station 13+185 to 13+225)

The proposed Gabion Wall will vary in height from approximately 2.5 to 3.0 m and will have a stepped front face. The base of the wall will be 2.0 m wide and each 0.5 to 1.0 m step will be offset 0.5 m. The detailed Drawing No. 3 showing the wall design from Station 13+185 to Station 13+225 is included in Appendix A.

It is recommended that the retaining wall be founded on the underlying boulder till material and/or suspected bedrock between elevations 175.00 and 175.50 m.

For Gabions founded directly on the boulder till material, a Factored Bearing Resistance at ULS of 750 kPa and a Factored Bearing Resistance at SLS of 500 kPa is recommended in accordance with the Canadian Highway Bridge Design Code (C.H.B.D.C).

To place Gabions directly on the boulder till, any loose overburden material and debris must be removed, exposing the underlying dense till. Prior to the placement of the Gabions, the exposed till is to be relatively level and visually inspected by a qualified

geotechnical engineer. Granular "A" material may be used as a leveling course beneath the footings provided it is compacted to 100% of the Standard Proctor Maximum Dry Density.

The anticipated maximum total settlement for Gabions founded on boulder till is not expected to exceed 25 mm.

For gabions founded directly on unweathered to slightly weathered bedrock, a Factored Bearing Resistance at ULS of 5000 kPa is recommended in accordance with the C.H.B.D.C. and subject to inspection by a qualified geotechnical engineer. To place Gabions directly on bedrock the overburden material along with any loose debris and rock shatter must be removed, exposing sound bedrock. Prior to the placement of Gabions the exposed bedrock is to be visually inspected by a qualified geotechnical engineer to verify the integrity of the rock. In the event that a footing is likely to bear on steeply sloping bedrock (steeper than 10H:1V), the rock surface must be leveled to provide a step-like footing base.

The above Factored Bearing Resistance at ULS applies to the Gabion baskets placed directly on bedrock with a good Rock Mass Quality (RQD>75). The bearing capacity at SLS will not govern for Gabions founded on bedrock as the loads required to produce unacceptable settlements of the structure will be much larger than the recommended values for the factored resistance at ULS.

The ULS and SLS capacity of the Gabion footings must be reduced for the effects of inclined loads. The appropriate reduction factors are given on Figure 6.7.4 in the C.H.B.D.C. The reduction factors for non-cohesive soil or rock would be appropriate for the footings at this site. It should be noted that Figure 6.7.4 in the C.H.B.D.C. is for ø′=30º

2.2.2 Retaining Wall Design No. 2 Foundation (Station 13+280 to 13+315)

The proposed Gabion Wall will vary in height from 2.0 to 3.5 m and will have a stepped front face. The base of the wall will be 2.5 m wide and each 0.5 to 1.0 m step will be offset 0.5 m. The detailed Drawing No. 3 showing the wall design from Station 13+280 to Station 13+315 is included in Appendix A.

It is recommended that the retaining structure wall be founded on the underlying sand and silty sand material between elevations 175.00 and 176.50 m.

For Gabions founded on sand and silty sand material, a Factored Bearing Resistance at ULS of 100 kPa and a Factored Bearing Resistance at SLS of 80 kPa is recommended in accordance with C.H.B.D.C. To place Gabions on the sand and silty sand material, all loose overburden and deleterious material must be removed. Prior to the placement of the Gabions, the sand and silty sand is to be relatively level and visually inspected by a qualified geotechnical engineer. A 300 mm thick layer of Granular "A" material is to be used as a leveling course beneath the footings and is to be compacted to 100% of the Standard Proctor Maximum Dry Density.

The anticipated maximum total settlement for Gabions founded on sand and silty sand is not expected to exceed 25 mm.

The ULS and SLS capacity of the Gabion footings must be reduced for the effects of inclined loads. The appropriate reduction factors are given on Figure 6.7.4 in the C.H.B.D.C. The reduction factors for non-cohesive soil or rock would be appropriate for the footings at this site. It should be noted that Figure 6.7.4 in the C.H.B.D.C. is for ø´=30º

2.2.3 Design Parameters

The design of the Gabion wall Structure is based on the following soil parameters:

Material Types and Strength Parameters

Material	Friction Angle ø´	Cohesion c'	Unit Weight γ (kN/m^3)
Granular A	38º	0	22
Granular B Type I	30º	0	21
Granular B Type II	35º	0	21
Gabion	42º	0	17.5(1)
Sand & Gravel	38º	0	22
Sand	35º	0	21
Silty Sand	32º	0	21
Silty Clay	20°	5	18

Note 1: The effective unit weight of the gabion (γ = 17.5 kN/m^3), is based on the rock fill (diabase) having a unit weight of γ = 25 kN/m^3 and the gabion porosity n = 30%. A friction angle of 30º was used for sliding resistance between the gabion stone and Granular "A" contact.

2.2.4 Design Results

The model GawacWin 2003 was used to analyze a variety of Gabion wall designs, and to determine the overturning and sliding factor of safety. The slope stability model Slope/W Version 4.20 was used to evaluate the global stability. The final gabion wall design for retaining wall No. 1 and No. 2 achieved the following estimated safety factors.

Stability Type	Retaining Wall No. 1	Retaining Wall No. 2
Sliding	3.73	3.36
Overturning	7.16	6.74
Global Stability	1.62	1.51

Based the above analysis, the proposed Gabion wall designs provide adequate safety factors against sliding, overturning and global stability.

The summary output plots from both models are included in Appendix D.

2.2.5 Excavations

The excavations for the Gabion basket retaining walls for this project will likely be below the surface water elevation of the river channel, depending upon the water elevation at the time of construction. It is anticipated that the required excavations will terminate less than 0.5 m into the existing soils. Surface and groundwater control will likely be difficult with the use of steel sheet piles, as penetration of the sheeting will be difficult given the relatively shallow power auger refusal.

Dewatering requirements will be governed by the river water levels. It is the responsibility of the Contractor to propose a suitable dewatering system based on the time of construction, groundwater levels, and river flow conditions for prior approval.

All excavations must be conducted in accordance with the Occupational Health and Safety Act and Regulations for Construction. The underlying non-cohesive soils such as the sand and silty sand may be classified as "Type 3" soil, and the cohesive soils such as the clay and silty clay may be classified as a "Type 4" soil, in conformance with the Ontario Health and Safety Act and Regulations.

2.2.6 Lateral Earth Pressure

The analysis performed to estimate the appropriate safety factors for the Gabion basket retaining walls has been based upon the Coulomb's theory of earth pressure as outlined in Section 6.9 of the C.H.B.D.C. Several design assumptions were made for each of the two retaining wall heights, which include:

1. Full active earth pressure will be developed along the back face of the walls. The allowance for passive resistance of the toe of the retaining wall has been assumed to be negligible.

2. No allowance for extra forces due to backfill compaction has been included in this design, as it has been assumed that the top layers of the Gabion basket wall would displace to allow for compaction pressure dissipation.

3. The river water level at the toe of the retaining walls has been conservatively estimated at 0.3 m above the base of the wall. The phreatic surface along the back of the walls has not been included in the analysis as the Gabion basket materials are very free draining.

2.2.7 Construction Recommendations

- A 300 mm thick layer of Granular "A" should be used as a leveling course below all Gabion Basket walls and compacted to 100% SPMDD. The Granular "A" base should extend a minimum of 300 mm from the edge of the Gabion wall.

- Any soft areas encountered below the retaining wall should be excavated down to a firm base, as confirmed by a qualified geotechnical professional, and replaced with Granular "A" engineered fill. The Granular "A" should be placed in lifts not exceeding 150 mm and compacted to 100% of the SPMDD.

- A non woven geotextile (MacTex MX225 or equivalent) is to be used as a separator between the native material and Gabion baskets to prevent fines from migrating into the Gabion stone.

- Gabions shall be installed using the correct batter angle as shown on the drawings in Appendix A.

- Gabions shall be constructed and maintained during construction to slope as shown on the drawings in Appendix A. Individual Gabion deformations shall be limited to 64 mm at the top and a bulge of 51 mm measured from the base of the Gabion. The contractor shall provide alignment control for each course of Gabions and make alignment corrections as necessary.

- The extreme ends of all retaining walls should be protected with a layer of non-woven geotextile and rock fill riprap to prevent the migration of fine materials. The geotextile should be placed from the bottom of the gabion basket wall up to a minimum of 0.3 m above the high water level. The rock fill riprap should consist of a well graded material with a median particle size of 0.3 m, and should extend from the top of the geotextile to the channel bottom at a slope of 1H:1V.

A qualified geotechnical engineer should be on-site during the installation of the Gabion basket retaining walls to verify the construction recommendations.

2.2.8 Construction Materials

- Gabion baskets shall be Galvanized or PVC coated, 80 x 100 mm hexagonal double twist wire mesh type as per Ontario Provincial Standard and Specification (OPSS) 1430.

- Gabion stones shall be clean, hard, 100 mm (minimum) to 200 mm (maximum) rock diameter.

- MacTex MX225 Geotextile, with a filtration opening size of 111 μm and an apparent opening size of 0.212 mm.

- All gabion installation is to at a minimum meet the requirements of OPSS 512.

2.2.9 Lateral Earth Pressure

The Gabion retaining walls have been designed to resist the lateral earth pressure generated from the wall geometry shown on Drawing 3 and 4 in Appendix A.

2.3 Culvert Replacements at Desbarats River Highway 17 and Lake Huron Drive South

It is understood by Trow that the existing Structural Plate Corrugated Steel Pipes (SPCSP) and the Corrugated Steel Pipes (CSP) for Desbarats River through Highway 17 and Lake Huron Drive South will be replaced with two 5.49 x 2.44 m concrete box culverts (see Photographs 6, 7, 8, 9, 10, 11 and 12, Appendix F). The culvert through Highway 17 will be placed with and upstream invert of 175.36 m and a downstream invert of 175.00 m. The culvert through Lake Huron Drive South will be placed with an upstream invert of 175.00 m and a downstream invert of 174.60 m.

The box culvert through Highway 17 will be founded on sand and silty sand material at the above proposed elevations. For concrete box culverts founded on sand and silty sand, a Factored Bearing Resistance at ULS of 250 kPa and a Factored Bearing Resistance at SLS of 40 kPa is recommended in accordance with the C.H.B.D.C. Prior to the placement of the culvert, the exposed sand and silty sand is to be relatively level and visually inspected by a qualified geotechnical engineer. Any loose areas are to be sub-excavated and replaced with Granular "A" compacted to a minimum of 100% SPMDD.

The culvert through Lake Huron Drive South will be founded on compact sand and gravel fill and or boulder till material at the above proposed elevations. For concrete box culverts founded on compact sand and gravel fill and or boulder till, a Factored Bearing Resistance at ULS of 300 kPa and a Factored Bearing Resistance at SLS of 100 kPa is recommended in accordance with the C.H.B.D.C. To place the concrete box culverts on the sand fill and or boulder till material, all loose overburden and deleterious material must be removed. Prior to the placement of the culvert, the sand and gravel fill and boulder till is to be relatively level and visually inspected by a qualified geotechnical engineer. Any loose areas are to be sub-excavated and replaced with Granular "A" compacted to a minimum of 100% SPMDD.

The anticipated maximum total settlements for the concrete box culverts are not expected to exceed 25 mm, for construction done in accordance with design parameters and assuming good construction practice.

2.3.1 Culvert Bedding

The culvert bedding should consist of Granular "A" (OPSS 1010) with a minimum thickness of 300 mm beneath the culvert and extend a minimum of 600 mm on either side. The granular bedding should be compacted to 100% of the Standard Proctor Maximum Dry Density (SPMDD). If construction proceeds during the winter months, the base of the trench should not be allowed to freeze prior to placing the bedding material. In areas where the base of the trench experiences loose/soft material the area may have to be sub-excavated and the Granular "A" thickness increased to stabilize the trench base.

The underlying non-cohesive soils such as the sand and silty sand may be classified as "Type 3" soil, and the cohesive soils such as the clay and silty clay may be classified as a

"Type 4" soil, in conformance with the Ontario Occupational Health and Safety Act and Regulations.

2.3.2 Culvert Backfill

All deleterious material should be excavated as outlined in OPSD 803.010, attached in Appendix E. The culvert backfill should consist of stone free Granular "B", Type I or Granular "A" (OPSS 1010) placed in maximum 150 mm lifts kept at the same elevation on both sides of the culvert. The granular backfill should be compacted to 100% of SPMDD.

The compacted materials should extend above the culvert a minimum of 450 mm or the height of the culvert divided by 6 whichever is greater. Typical backfill diagrams are presented in Appendix E, OPSD 803.010. The minimum height of fill over the top of the culvert for heavy equipment during construction shall be a minimum of 1000 mm, unless otherwise noted by the structural engineer.

2.3.3 Lateral Earth Pressure

Culvert walls and temporary shoring that may be required for excavation should be designed to resist lateral earth pressure. The expression for calculating lateral earth pressure is given by

$$p = K (\gamma h + q)$$

where p = Lateral earth pressure (kPa).

K = Coefficient of earth pressure.

γ = Unit weight of backfill.

h = Depth to point of interest (m).

q = Surcharge load acting adjacent to the wall at the ground surface (kPa).

The above expression does not take into account hydrostatic pressure, which must be included for the groundwater level at existing ground surface.

The table below lists various earth pressure properties for given materials.

Material Types and Earth Pressure Properties

Material	Friction Angle ø´ (unfactored)	Coefficient of Active Earth Pressure (k_a)	Coefficient of Passive Earth Pressure (k_p)	Coefficient of Earth Pressure at Rest (k_o)	Unit Weight γ (kN/m^3)
Granular A	38º	0.24	4.17	0.38	22
Granular B Type I	30º	0.33	3	0.50	21
Granular B Type II	35º	0.27	3.7	0.43	21
Rock Fill	42º	0.2	5	0.33	20

Note: Values given for horizontal earth pressures are for horizontal backfill. For sloping backfill, the design requirements outlined in Sec C6.9.1(c) of the C.H.B.D.C. should be used. A unit weight of γ=20 kN/m^3 is based on well graded rock fill.

The mobilization of full active or passive resistance requires a measurable and perhaps significant wall movement or rotation. Therefore, unless the structural element can tolerate these deflections, the at-rest earth pressure should be used in design.

The effects of compaction surcharge should be taken into account in the calculations of active and at rest earth pressures. The lateral pressure due to compaction should be taken as at least 12 kPa at the surface, and its magnitude should be assumed to diminish linearly with depth to zero at the depth where the active (or at rest) pressure is equal to 12 kPa. This pressure distribution should be added to the calculated active (or at rest) pressure. Notwithstanding, lighter compaction equipment and smaller lifts should be used adjacent to walls to prevent overstressing.

2.3.4 Sliding Resistance

A friction angle, ø´, of 30 degrees can be used for sliding resistance along the Granular "A" and the pre-cast concrete culvert and 32 degrees for cast in place concrete culvert.

2.3.5 Erosion Protection Outlet

Rip-rap protection should be provided where the culvert discharges into the open creek. The rip rap should extend approximately 10 m beyond the end of the culvert and line the embankment slope to the spring line of the culvert. The size of the rip-rap is a function of the hydraulic assessment. As a rule of thumb the thickness of the rip-rap is twice the median particle size, and is 300 mm thick as a minimum. The rip-rap configuration at the creek bed should generally follow the OPSD 810.010, which is included in Appendix E of this report. Rip-rap placed at 1V:1H will be stable.

2.3.6 Erosion Protection Inlet

The existing rip-rap at the inlet of the culvert should be verified by a hydraulic assessment. Additional rip-rap is to be provided on the creek bed proceeding the installation of the exterior grout. The rip-rap should extend approximately 10 m beyond the end of the pipe and generally follow the configuration of the OPSD 810.010, included in Appendix E. Rip-rap placed at 1V:1H will be stable.

Where rip-rap is not present the side slopes are to be vegetated with sodding, seeding or planting as necessary depending on the flow rate and volume. Should seeding be utilized, a 100 mm thick layer of topsoil should be placed along with a degradable erosion blanket to help minimize erosion until the seeds begin to grow.

2.3.7 Frost Protection

A frost penetration depth of up to 2.0 m can occur in open areas in the Sault Ste. Marie region without snow cover. The underlying material can be considered reasonably frost susceptible, with a Frost Group rating of F3 to F4 based upon the U.S. Corps of Engineers Frost Design Soil Classification. There is a potential for frost heave near the inlet and outlet of the pipe. To minimize potential movements, the frost protection treatment as outlined in OPSD 803.030 and 803.031 included in Appendix E of this report may be applied.

2.3.8 Excavations

In accordance with the Occupational Health and Safety Act Regulations for Construction Projects, excavation procedures of the existing non-cohesive material for Type 3 soils and cohesive materials for Type 4 soils will be adequate. Excavations should not exceed 1H:1V above the groundwater table and 2H:1V below the groundwater table. There is a potential for sloughing to occur if the trench remains open for an extended period of time. Therefore, it is recommended that the excavations be supported with a trench box if they are open for an extended period of time. It should be noted that it will be difficult to use sheet piles as penetration into the rock fill and underlying dense till material will be difficult.

2.3.9 Dewatering

The soils encountered below the groundwater table consisted of sand and gravel, silty sand, silt and clay. The estimated hydraulic conductivity, “k” of these materials is outlined below.

Estimated Hydraulic Conductivity

Materials	Hydraulic Conductivity "k" (m/s)
Sand and Gravel	$10^{-2} – 10^{-4}$
Silty Sand	$10^{-4} – 10^{-6}$
Silt	$10^{-6} – 10^{-7}$
Silty Clay and Clay	$10^{-7} – 10^{-10}$

Dewatering requirements will be governed by the water levels in the river at the time of construction. It is the responsibility of the Contractor to propose a suitable dewatering system based on the time of construction, groundwater levels and river flow conditions for prior approval by the owner. The method used should not undermine the existing road. 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.

2.4 Shoulder Widening

The proposed widening will extend approximately 4.0 to 5.0 m beyond the original shoulder. The side slope is to be constructed at 3H:1V.

It is recommended that a granular fill material be used to construct the shoulder widenings and embankment sideslopes. The fill materials should consist of Granular "A" (OPSS 1010), Granular "B" Type I or II (OPSS 1010), and Select Subgrade Material (SSM) (OPSS 1010). For preliminary design purposes, the following structure may be used subject to a detailed pavement design.

*150 mm Granular "A"
750 mm Granular "B" Type I or II
Remainder of fill to consist of SSM

* Allow for a minimum of 50 mm of asphalt for undrivable fully paved shoulders.

Compaction of the granular material below any asphalt material is to be placed in maximum 150 mm thick lifts and compacted to a minimum of 100% of the materials Standard Proctor Maximum Dry Density (SPMDD) within 2% of the optimum moisture content. The granular material placed outside the limits of the asphalt may be compacted to 95% SPMDD.

Where the embankment is to be widened all organic and other deleterious material are to be removed. The existing fill should be excavated to provide a bench in order to ensure adequate compaction of the new granular fill material. The placement and compaction of

fill material should be completed according to OPSD drawing 208.010 in Appendix E. All shoulder widenings are to follow OPSD drawing 209.01 and 213.02 in Appendix E.

2.5 Construction Recommendations

2.5.1 Staged Construction

In order to minimize the disruption to traffic, it is recommended that the replacement of the culverts through Highway 17, be conducted in two construction stages. Each stage will consist of removing and replacing the culverts on one side of the Highway at a time as to provide a throughway lane at all times.

3.0 CLOSURE

This report has been prepared by M. Corriveau, B.Eng., and reviewed by T. Crilly M.Sc., P.Eng. and S. Gonsalves, M.Eng., P.Eng. Designated MTO Foundation Contact. The field investigation was conducted by Liz Cooke.

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

Trow Associates Inc.

Maurice Corriveau, B.Eng.
Geotechnical Department

Tom Crilly, M. Sc., P.Eng.
Branch Manager/Sr. Geotechnical Engineer

S.E. Gonsalves, M.Eng., P.Eng.
Principal Engineer
Designated MTO Foundation Contact

Encl.
Dist: The Greer Galloway Group Inc.

APPENDIX A

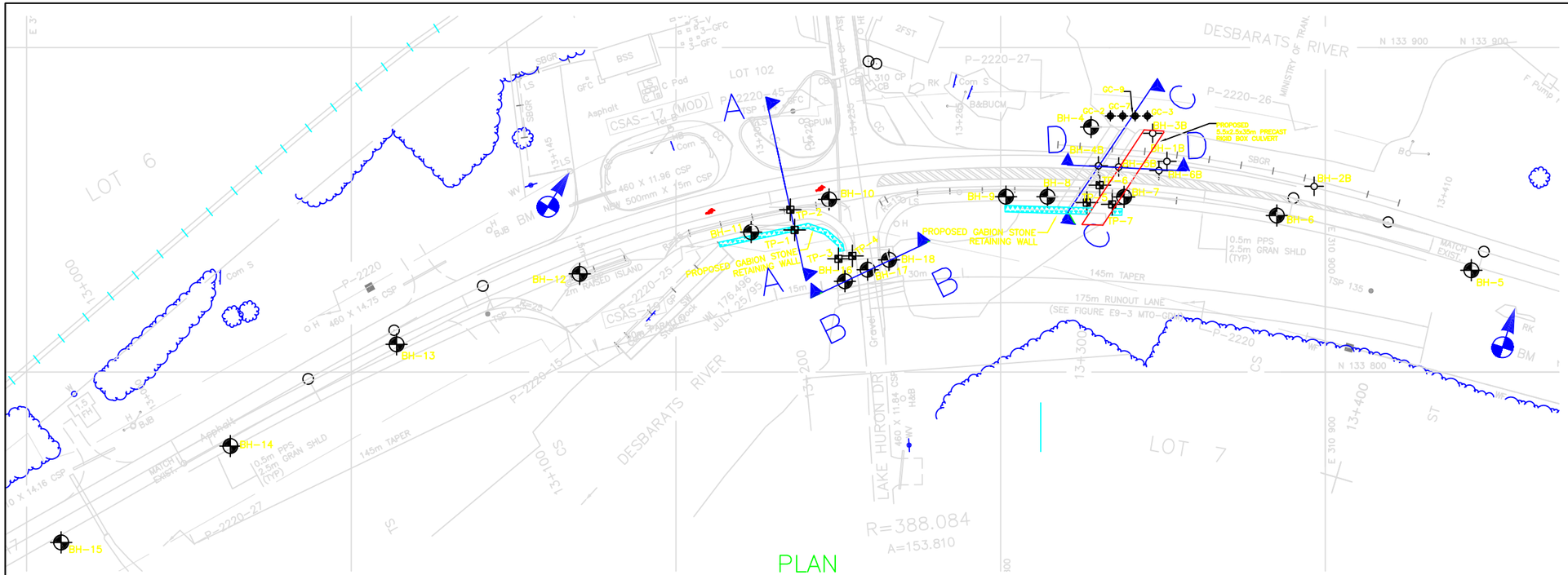
Drawings

DIST ALGOMA HWY 17
GEOCRES NO.41J-23
WP No 6013-03-00

STA 13+210 HWY 17
TOWNSHIP OF JOHNSON
BORE HOLE LOCATIONS
AND SOIL STRATA

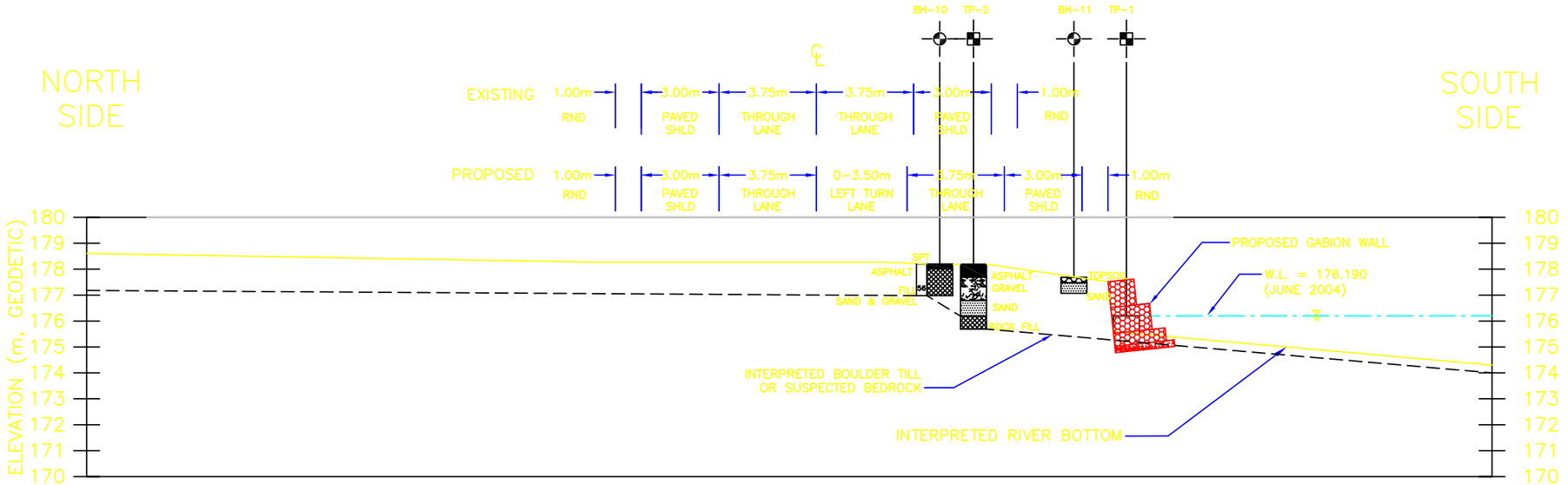
SHEET
1 OF 1

TROW ASSOCIATES INC.
SUDBURY, ONTARIO
Trow PROJ. No. S09737G/B DWG. No. 1



PLAN
0 10 20 30 40 50 m
(APPROXIMATE SCALE 1:1500)

* See Dwg. No. 3 for larger plan and profile of D-D.



PROFILE A-A
AT STATION 13+210

PROFILE
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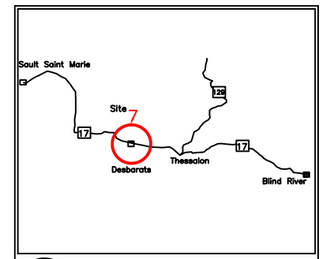
APPROXIMATE SCALE 1:200



KEY PLAN
NOT TO SCALE

LEGEND

- TROW BOREHOLE (JUNE 2004)
- TROW BORHOLE (APRIL 2005)
- M.T.O. TEST PITS W.P. 264-90-00 (AUG 1995)
- GC-2 GEOCON BOREHOLE W.P. 904-64 (FEB 1965)
- ℄ HIGHWAY CENTERLINE
- SPT STANDARD PENETRATION TEST
- RND ROUNDING
- BM GEODETIC BENCHMARK

No.	ELEVATION	No.	ELEVATION
BH-4	178.100	TP-1	176.190
BH-5	178.300	TP-2	178.083
BH-6	178.800	TP-3	176.200
BH-7	178.200	TP-5	177.900
BH-8	178.300	TP-6	178.200
BH-9	178.500		
BH-10	178.200	BH-1B	179.161
BH-11	178.300	BH-2B	179.471
BH-12	178.400	BH-3B	178.791
BH-13	178.400	BH-4B	178.811
BH-14	178.600	BH-5B	178.841
BH-15	179.200	BH-6B	178.921
BH-16	178.200		
BH-17	178.300		
BH-18	178.500		

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 GC 2-01 of OPS Gen. Cond.

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

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	T.C.	CHK T.C.	CODE .	LOAD .	DATE	JUNE 2005	
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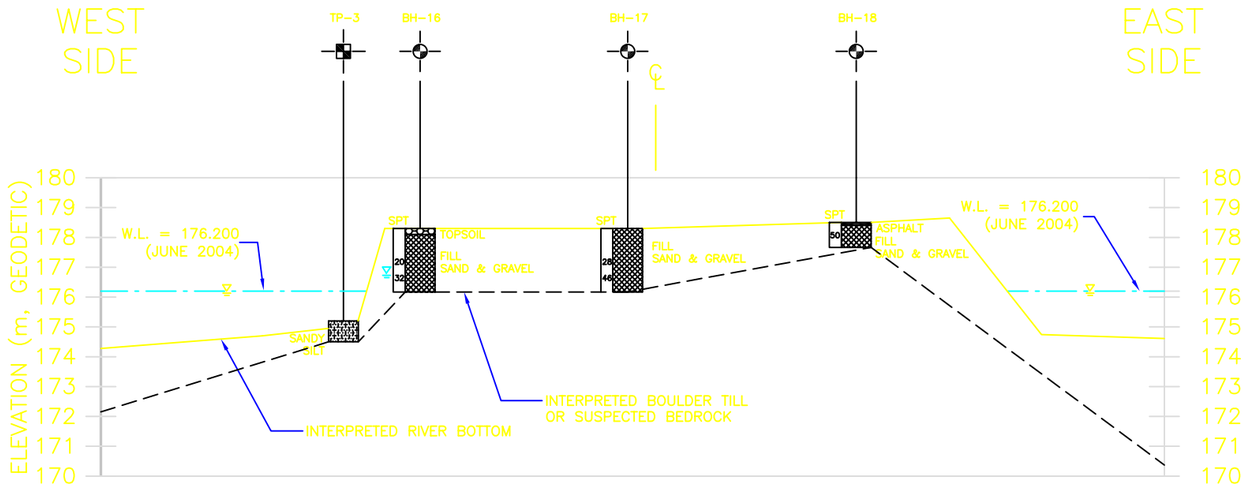


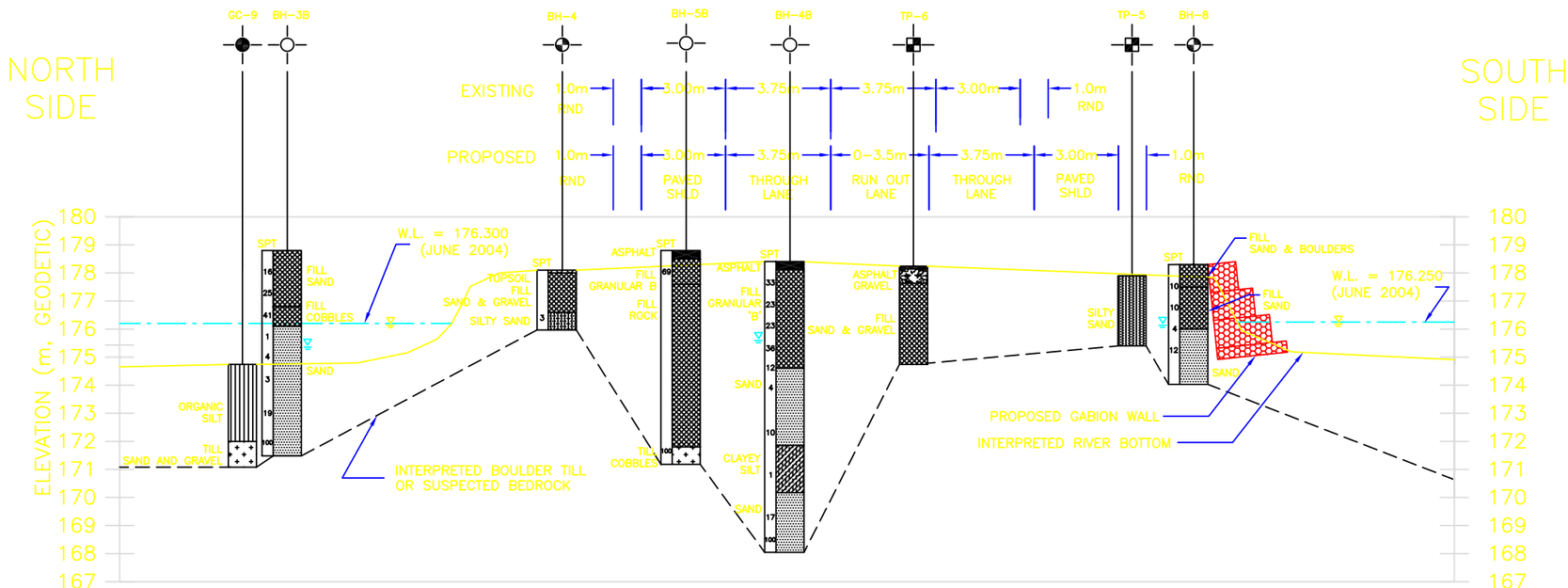
PROFILE B–B

AT LAKE HURON DRIVE SOUTH

PROFILE

0 5 10

APPROXIMATE SCALE 1:200



PROFILE C–C

HIGHWAY 17 AT STATION 13+300

PROFILE

0 5 10

APPROXIMATE SCALE 1:200

METRIC

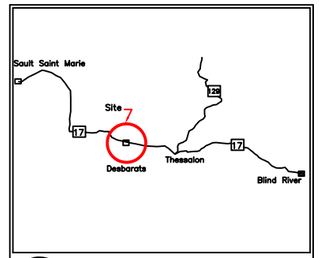
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST ALGOMA HWY 17
GEOCRES NO.41J–23
WP No 6013–03–00

HWY 17
TOWNSHIP OF JOHNSON
SOIL STRATA

SHEET 1 OF 1

TROW ASSOCIATES INC.
SUDBURY, ONTARIO
Trow PROJ. No. S09737G/B DWG. No. 2



KEY PLAN
NOT TO SCALE

LEGEND

- TROW BOREHOLE (JUNE 2004)
- TROW BORHOLE (APRIL 2005)
- M.T.O. TEST PITS W.P. 264–90–00 (AUG 1995)
- GC–2 GEOCON BOREHOLE W.P. 904–64 (FEB 1965)
- ℄ HIGHWAY CENTERLINE STANDARD
- SPT PENETRATION TEST
- RND ROUNDING

No.	ELEVATION	No.	ELEVATION
BH–4	178.100	TP–1	176.190
BH–5	178.300	TP–2	178.083
BH–6	178.800	TP–3	176.200
BH–7	178.200	TP–5	177.900
BH–8	178.300	TP–6	178.200
BH–9	178.500		
BH–10	178.200	BH–1B	179.161
BH–11	178.300	BH–2B	179.471
BH–12	178.400	BH–3B	178.791
BH–13	178.400	BH–4B	178.811
BH–14	178.600	BH–5B	178.841
BH–15	179.200	BH–6B	178.921
BH–16	178.200		
BH–17	178.300		
BH–18	178.500		

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REVISIONS		
NO.	DATE	BY
		DESCRIPTION

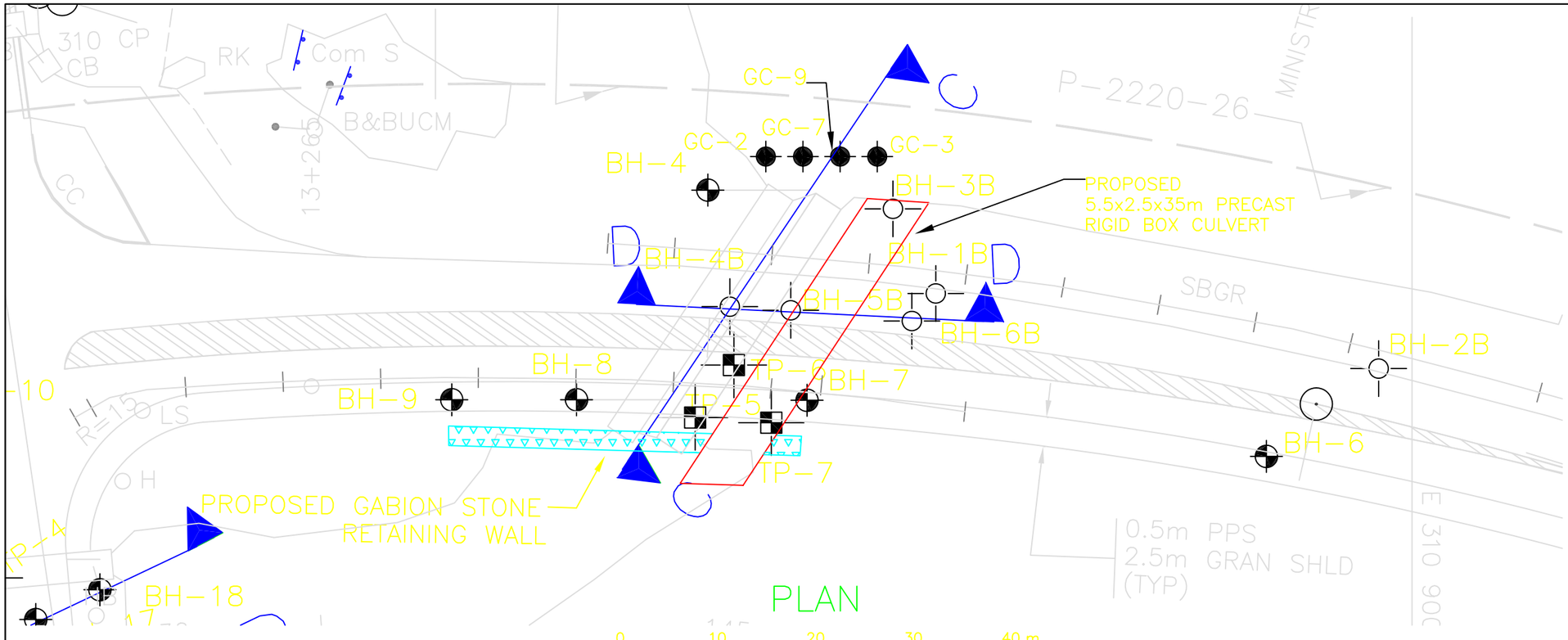
DESIGN	T.C.	CHK	T.C.	CODE .	LOAD .	DATE	JUNE 2005
DRAWN	D.S.	CHK	M.C.	SITE .	STRUCT .	SCHEME .	DWG 2

DIST ALGOMA HWY 17
GEOCRES NO.41J-23
WP No 6013-03-00

HWY 17
TOWNSHIP OF JOHNSON
BORE HOLE LOCATIONS
AND SOIL STRATA

SHEET
1 OF 1

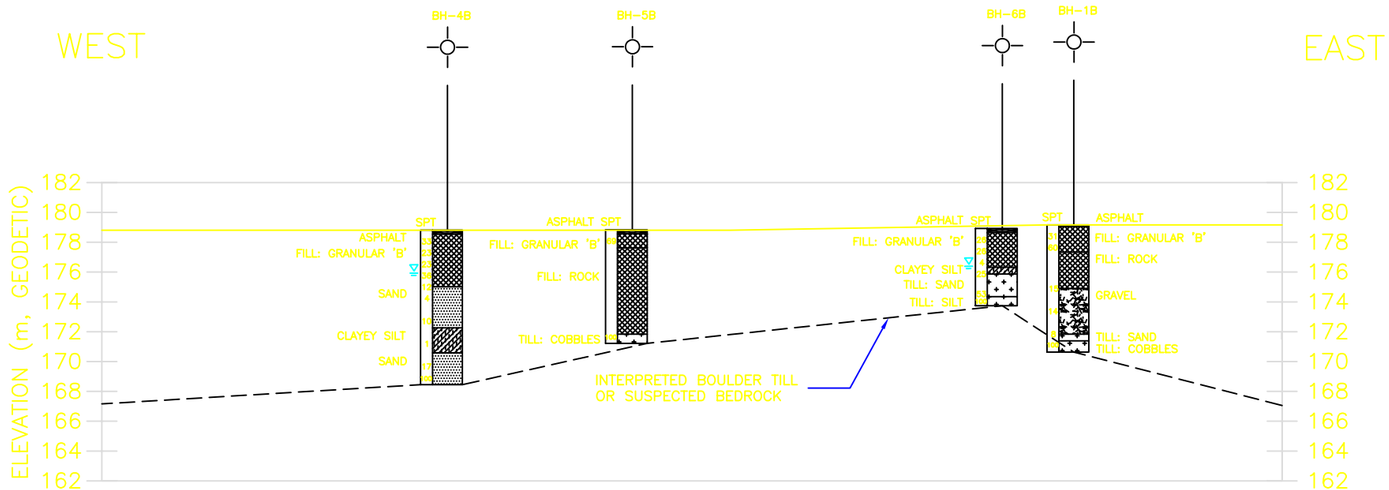
TROW ASSOCIATES INC.
SUDBURY, ONTARIO
Trow PROJ. No. S09737G/B DWG. No. 3



PLAN

0 10 20 30 40 m

APPROXIMATE SCALE 1:500



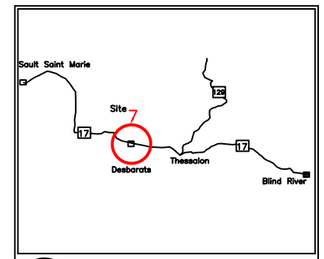
PROFILE D-D

HIGHWAY 17 FROM STATION 13+300 TO 13+321

PROFILE

0 5 10

APPROXIMATE SCALE 1:200



KEY PLAN
NOT TO SCALE

LEGEND

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- TROW BORHOLE (APRIL 2005)
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- ℄ HIGHWAY CENTERLINE
- SPT STANDARD PENETRATION TEST
- RND ROUNDING
- BM GEODETIC BENCHMARK

No.	ELEVATION	No.	ELEVATION
BH-4	178.100	TP-1	176.190
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BH-6	178.800	TP-3	176.200
BH-7	178.200	TP-5	177.900
BH-8	178.300	TP-6	178.200
BH-9	178.500		
BH-10	178.200	BH-1B	179.161
BH-11	178.300	BH-2B	179.471
BH-12	178.400	BH-3B	178.791
BH-13	178.400	BH-4B	178.811
BH-14	178.600	BH-5B	178.841
BH-15	179.200	BH-6B	178.921
BH-16	178.200		
BH-17	178.300		
BH-18	178.500		

NOTE

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

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	T.C.	CHK	T.C.	CODE .	LOAD .	DATE	JUNE 2005
DRAWN	D.S.	CHK	M.C.	SITE .	STRUCT .	SCHEME .	DWG 3

TYPICAL DRAWING
RETAINING WALL DESIGN NO. 1
(STATION 13+185 TO 13+225)

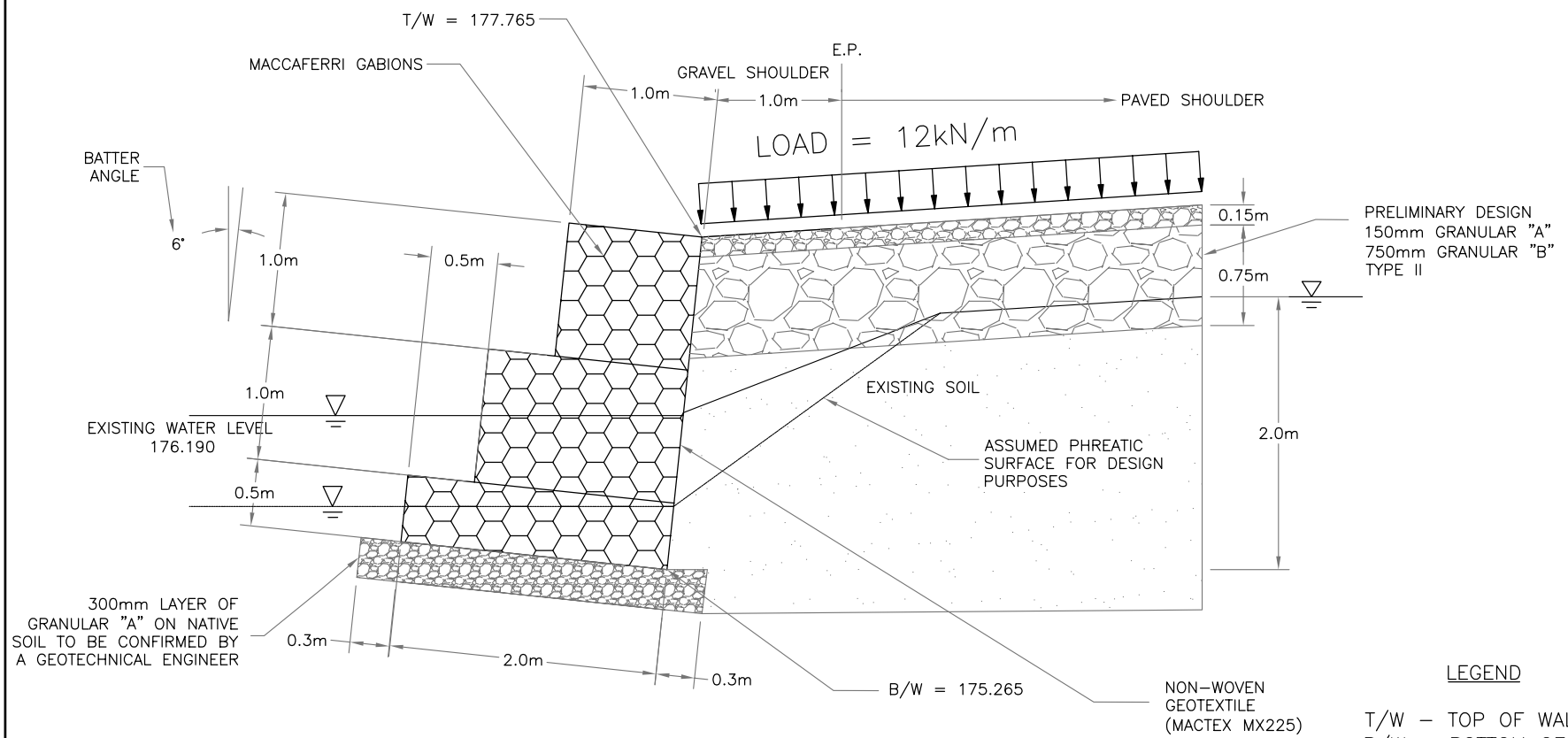
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST ALGOMA HWY 17
WP No 6013-03-00

HWY 17 – GABION WALL
CROSS SECTION @ STA 13+210
TOWNSHIP OF TARBUTT

SHEET 1 OF 1

TROW ASSOCIATES INC.
SUDBURY, ONTARIO
Trow PROJ. No. S09737G DWG. No. 3



PLAN

0 1 2 3 4 m

APPROXIMATE SCALE 1:50

LEGEND

T/W – TOP OF WALL
B/W – BOTTOM OF WALL
E.P. – EDGE OF PAVEMENT

NOTE
1) READ DETAIL IN CONJUNCTION WITH CONSTRUCTION NOTES PROVIDED WITH THIS DRAWING
2) DESIGN PARAMETERS USED IN THIS DETAIL ARE TO FOLLOW THE CONSTRUSTION RECOMENDATIONS AS OUTLINED IN SECTION 2.2.6.

REVISIONS			
	DATE	BY	DESCRIPTION

DESIGN	M.C.	CHK	T.C.	CODE .	LOAD .	DATE	SEPT 2004
DRAWN	D.S.	CHK		SITE .	STRUCT .	SCHEME .	DWG 4

PLOTTED: 2005/07/05 – 10:30

TYPICAL DRAWING
RETAINING WALL DESIGN NO. 2
(STATION 13+280 TO 13+315)

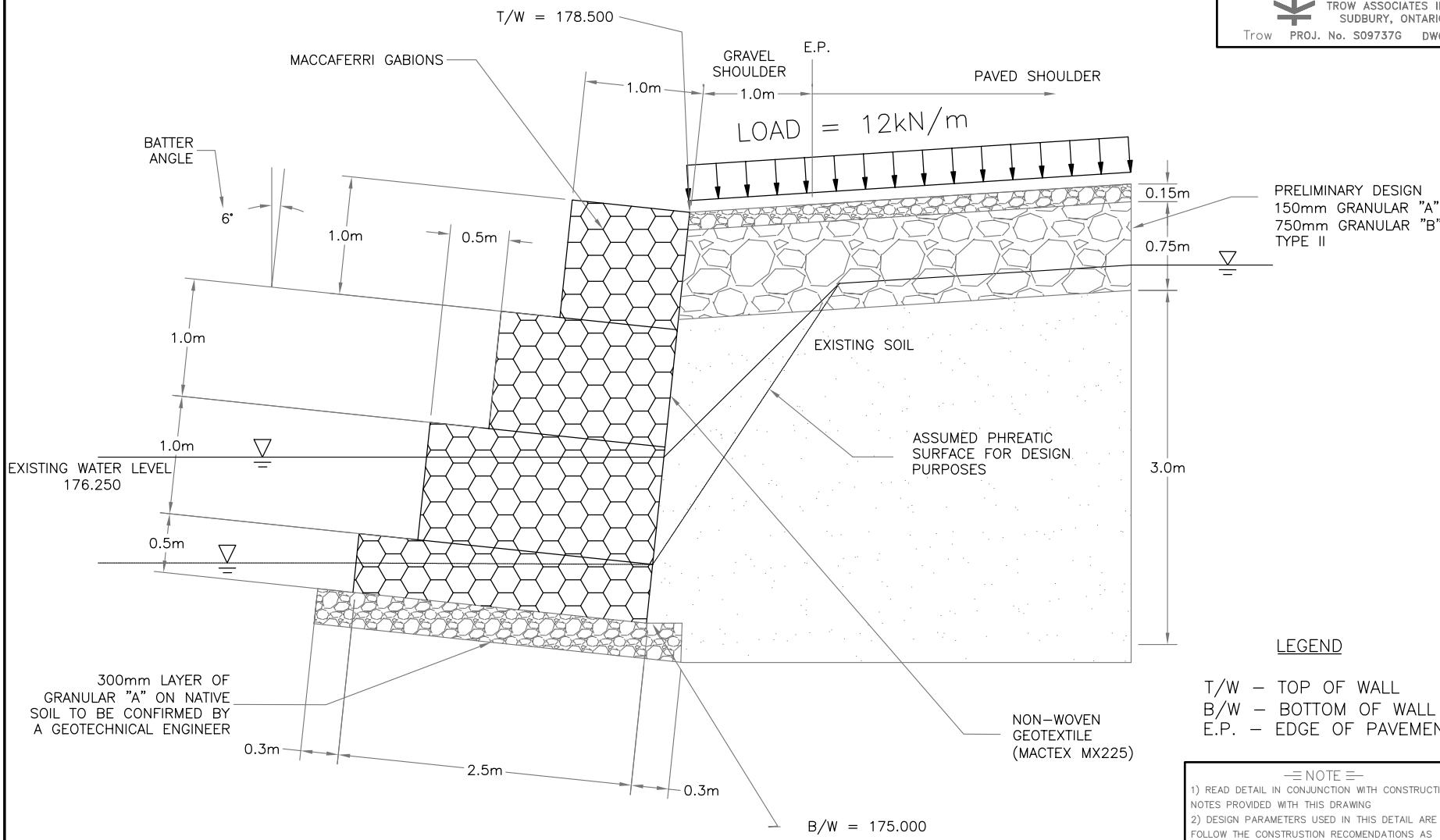
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST ALGOMA HWY 17
WP No 6013-03-00

HWY 17 – GABION WALL
CROSS SECTION @ STA 13+300
TOWNSHIP OF TARBUTT

SHEET 1 OF 1

TROW ASSOCIATES INC.
SUDBURY, ONTARIO
Trow PROJ. No. S09737G DWG. No. 4



PLAN

0 1 2 3 4 m

APPROXIMATE SCALE 1:50

LEGEND

T/W – TOP OF WALL
B/W – BOTTOM OF WALL
E.P. – EDGE OF PAVEMENT

NOTE
1) READ DETAIL IN CONJUNCTION WITH CONSTRUCTION NOTES PROVIDED WITH THIS DRAWING
2) DESIGN PARAMETERS USED IN THIS DETAIL ARE TO FOLLOW THE CONSTRUSTION RECOMENDATIONS AS OUTLINED IN SECTION 2.2.6.

REVISIONS			
	DATE	BY	DESCRIPTION
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DRAWN D.S.	CHK	SITE .	STRUCT .	SCHEME .	DWG 5

PLOTTED: 2005/07/05 – 10:30

APPENDIX B

Borehole Logs

APPENDIX B-1

Trow Borehole Logs, June 2004

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-4

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 21, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL; FIELD VANE POCKETPENETROMETER) (20 40 60 80)	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
178.1	GROUND SURFACE														
178.0 / 0.1	**TOPSOIL,** 125mm thick						178								
	FILL:SAND AND BOULDERS, brown, damp, loose, poorly graded, fine to medium grained														
							177								
176.6 / 1.5	**SILTY SAND,** brown to grey, damp, very loose, poorly graded, some gravel, some clay, trace organics		1	SS	3			×		○			12	43	28	17
176.0 / 2.1	AUGER REFUSAL ON SUSPECTED BEDROCK AT 2.13m DEPTH						176								

NOTES:

- Borehole located at north inlet of twin CSP culverts in Desbarats river through Hwy. 17
- Station 13+310
- No free water observed at completion of drilling

MTO-WP 9737-DES.GPJ 07/21/05

RECORD OF BOREHOLE BH-5

1 OF 1

METRIC

G.W.P. 6013-03-00 LOCATION Desbarats River, Johnson Township ORIGINATED BY M. Corriveau

DIST Algoma HWY 17 BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig COMPILED BY D. Smith

DATUM Geodetic DATE June 24, 2004 CHECKED BY T. Crilly

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	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 QUICK TRIAXIAL; FIELD VANE; POCKET PENETROMETER)	WATER CONTENT (%)		
178.3 / 0.0	GROUND SURFACE						178	20 40 60 80	wp — w — wl; 10 20 30 40	kN/m 3	GR SA SI CL
	No drilling attempted surface bedrock **NOTES:** - Borehole located south side of Hwy. 17, proposed widening Station 13+425										

MTO-WP 9737-DES.GPJ 07/21/05

RECORD OF BOREHOLE BH-6

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 24, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE, POCKET PENETROMETER)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI CL
178.8	GROUND SURFACE										
0.0	**FILL: SAND AND GRAVEL,** brown, damp, loose to compact, well to poorly graded, fine to coarse grained, trace to some silt		1	SS	20	▼	178				
177.3											
1.5	**GRAVEL,** brown, wet, compact, poorly graded, fine to coarse grained, some sand		2	SS	13		177				
176.4											
2.4	AUGER REFUSAL ON SUSPECTED BEDROCK AT 2.44m IN DEPTH **NOTES:** - Borehole located south side of Hwy. 17, proposed widening Station 13+370										

SPT TEST (N-Value) / CONE PENETRATION TEST: 20 40 60 80

SHEAR STRENGTH: Cu, KPa — UNCONFINED QUICK TRIAXIAL ○ ● | FIELD VANE + | POCKET PENETROMETER ⊗: 20 40 60 80

PLASTIC LIMIT wp | NATURAL MOISTURE CONTENT w | LIQUID LIMIT wl

WATER CONTENT (%): 10 20 30 40

MTO-WP 9737-DES.GPJ 07/21/05

RECORD OF BOREHOLE BH-7

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 24, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL; FIELD VANE; POCKET PENETROMETER) (20 40 60 80)	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
178.2	GROUND SURFACE															
0.0	**FILL: SAND,** brown, damp, loose to dense, well graded, fine to medium grained, some boulders		1	SS	39		178		×							
176.7							177									
1.5	**SILTY SAND,** brown to grey, damp, loose to compact, poorly graded, fine grained, some clay, trace gravel		2	SS	10	▼		×			○					
			3	SS	6		176	×								
175.2																
3.1	**SILTY CLAY,** grey, wet, soft to firm, low to intermediate plasticity, some sand, trace organics and gravel		4	SS	4		175	×			○			5	18	32	45
174.2																
4.0	**SAND,** grey, wet, loose to compact, poorly graded, fine to medium grained, trace silt, some clay		1	SH			174									
173.1																
5.1	**SILTY SAND**						173									
172.2																
6.0	AUGER REFUSAL ON SUSPECTED BEDROCK AT 6.01m DEPTH															

NOTES:

- Borehole located south side of Hwy. 17, for proposed retaining wall and widening Station 13+315

MTO-WP 9737-DES.GPJ 07/21/05

RECORD OF BOREHOLE BH-8

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 24, 2004 | CHECKED BY T. Crilly

ELEV. DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE, POCKET PENETROMETER) (20 40 60 80)	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
178.3	GROUND SURFACE													
0.0	**FILL: SAND AND BOULDERS,** brown, damp, loose, poorly graded, with gravel and cobbles						178							
177.6														
0.8	**FILL: SAND,** brown, damp, compact, well graded, fine to medium grained, some gravel, trace silt		1	SS	10		177	×						
			2	SS	10	▼		×			15	82	3	
176.0							176							
2.3	**SAND,** brown, wet, very loose to compact, well graded, fine to medium grained, trace to some gravel		3	SS	4			×						
			4	SS	12		175	×						
174.1														
4.3	AUGER REFUSAL ON SUSPECTED BEDROCK AT 4.27m DEPTH													

NOTES:
- Borehole located south side of Hwy. 17, at outlet of twin CSP culverts in Desbarats river through Hwy. 17
- Borehole also used for proposed retaining wall and Hwy. widening
- Station 13+295

MTO-WP 9737-DES.GPJ 07/21/05

RECORD OF BOREHOLE BH-9

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 24, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE, POCKET PENETROMETER)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI CL
178.5	GROUND SURFACE										
0.0 / 177.8	**FILL: SAND,** brown, damp, loose to compact, well graded, fine to medium grained, with gravel						178				
0.8 / 177.0	**SILTY CLAY,** brown, moist, stiff, low plasticity, some organics, trace sand and gravel - boulders at ~ 1.22m in depth		1	SS	24			× ⊗			
1.5	AUGER REFUSAL ON SUSPECTED BOULDERS AT 2.29m DEPTH										

NOTES:

- Borehole located south side of Hwy. 17, for proposed retaining wall and Hwy. widening
- Station 13+280
- No free water observed at completion of drilling

SPT TEST (N-Value) / CONE PENETRATION TEST: 20 40 60 80

SHEAR STRENGTH: Cu, KPa — UNCONFINED QUICK TRIAXIAL; FIELD VANE; POCKET PENETROMETER: 20 40 60 80

PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl

WATER CONTENT (%): 10 20 30 40

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RECORD OF BOREHOLE BH-10

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE POCKET PENTROMETER)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR	SA	SI	CL
178.2	GROUND SURFACE							20 40 60 80	10 20 30 40					
178.1 0.0	**ASPHALT,** ~ 150mm thick						178							
0.2	**FILL: SAND AND GRAVEL,** brown, dry to damp, dense to very dense, well graded, fine to medium grained													
177.0			1	SS	56			×			31	69		
1.2	AUGER REFUSAL ON SUSPECTED BOULDERS AT 1.22m DEPTH													

NOTES:

- Borehole located south side of Hwy. 17, for proposed retaining wall and Hwy. widening
- Station 13+220
- No free water observed at completion of drilling

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RECORD OF BOREHOLE BH-11

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ○● / FIELD VANE POCKET PENTROMETER ⊗+) (20 40 60 80)	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
177.3	GROUND SURFACE											
177.2 / 0.2	**TOPSOIL,** 150mm thick											
	SAND, brown, dry to damp, loose, poorly graded, fine to medium grained, with gravel and boulders						177					
176.7 / 0.6	AUGER REFUSAL ON SUSPECTED BOULDERS AT 0.61m IN DEPTH											

NOTES:
- 4 Attempts
- Borehole located south side of Hwy. 17, for proposed retaining wall and Hwy. widening
- Station 13+200
- No free water observed at completion of drilling

RECORD OF BOREHOLE BH-12

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE POCKET PENTROMETER)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI CL
178.4	GROUND SURFACE										
178.1 / 0.0	**ASPHALT,** ~ 100mm thick										
0.1 / 177.6	**FILL: SAND AND GRAVEL,** brown, damp, loose to compact, well graded, fine to coarse grained										
0.8	**SILTY CLAY,** grey, moist, soft to firm, low to intermediate plasticity, with organics, trace sand		1	SS	9						
			2	SS	2				109.8		
			3	SS	1	▼			79.2		
			1	SH							
173.8											
4.6	**CLAY,** brown, moist, firm, high plasticity		4	SS	4				66		
			2	SH							
171.6											
6.7	END OF BOREHOLE AT 6.71m DEPTH										

NOTES:
- Borehole located south side of Hwy. 17, for proposed Hwy. widening
- Station 13+140

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RECORD OF BOREHOLE BH-13

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE, POCKET PENTROMETER)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI CL
178.4	GROUND SURFACE										
178.3 / 0.0	**ASPHALT,** ~ 100mm thick										
0.1 / 177.7	**FILL: SAND AND GRAVEL,** brown, damp, loose, well graded, fine to coarse grained						178				
0.8 / 176.9	**SILT,** dark grey, damp, dense, some boulders		1	SS	50		177	× at 40			
1.5 / 176.1	**SILTY CLAY,** dark grey, moist, firm, low to intermediate plasticity, some sand		2	SS	5			× at 20; ○ at 30			
2.3 / 175.4	**CLAYEY SILT,**grey, damp, loose, low plasticity		3	SS	8	▼	176	× at 20; ⊗ at 30; ○ at 30			
3.1 / 174.8	**SILTY CLAY AND SAND,** grey, wet, compact to dense, low to intermediate plasticity, fine to medium grained, trace gravel		4	SS	45		175	× at 40			
3.6	AUGER REFUSAL ON SUSPECTED BOULDERS AT 3.63m DEPTH										

NOTES:
- Borehole located south side of Hwy. 17, for proposed Hwy. widening
- Station 13+080

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RECORD OF BOREHOLE BH-14

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE, POCKET PENTROMETER)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI CL
178.6	GROUND SURFACE							20 40 60 80	10 20 30 40		
178.5 0.0	**ASPHALT,** 100mm thick										
0.1	**FILL: SAND AND GRAVEL,** brown, damp, loose, well graded, fine to medium grained						178				
			1	SS	8			×			
177.0							177				
1.5	**SILTY CLAY,** grey, moist to wet, firm, intermediate plasticity, with sand		2	SS	5	▼		× ⊗			
			3	SS	6		176	× ⊗	○		
175.5											
3.1	**SILTY CLAY AND SAND,** brown, wet, loose to compact, low plasticity, fine to medium grained		4	SS	7			×	⊖		
							175				
174.0							174				
4.6	**SILTY SAND,** brown, wet, very loose, poorly graded, fine to medium grained, trace clay		5	SS	4			×			
173.5 5.0	END OF BOREHOLE AT ~ 5.03m IN DEPTH										

NOTES:
- Borehole located south side of Hwy. 17, for proposed Hwy. widening
- Station 13+020

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RECORD OF BOREHOLE BH-15

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE, POCKET PENTROMETER)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR	SA	SI	CL
179.2	GROUND SURFACE													
179.1 / 0.0	**ASPHALT,** ~ 100mm thick													
0.1 / 178.4	**FILL: SAND AND GRAVEL,** brown, damp, compact, well graded, fine to coarse grained													
0.8 / 177.7	**SAND,** brown, damp to wet, loose to compact, poorly graded, medium grained, some gravel		1	SS	18		179 / 178	× at 20			18	82		
1.5 / 176.9	**SANDY GRAVEL,** brown, wet, dense, poorly graded, fine to coarse grained		2	SS	32	▼	177	× at 40						
2.3 / 176.1	**SILTY CLAY,** grey, wet, firm, low to intermediate plasticity, trace sand		3	SS	4			× at 20, ⊗ at 40, ○ at 72.8						
3.1 / 174.6	**SANDY SILT,** grey, wet, very loose, poorly graded, fine grained		4	SS	4		176 / 175	× at 20						
4.6 / 174.1	**SILTY CLAY,** grey, wet, firm, intermediate to high plasticity		5	SS	6			× at 20, ⊗ at 40						
5.0	END OF BOREHOLE AT ~ 5.03m DEPTH													

NOTES:
- Borehole located south side of Hwy. 17, for proposed Hwy. widening
- Station 12+960

MTO-WP 9737-DES.GPJ 08/15/05

RECORD OF BOREHOLE BH-16

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE POCKET PENTROMETER) (20 40 60 80)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT (wp, w, wl) / WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR	SA	SI	CL
178.3	GROUND SURFACE													
178.1 0.0	**TOPSOIL,** ~ 200mm thick													
0.2	**FILL: SAND AND GRAVEL,** brown, damp, loose to comapct, well graded, fine to medium grained, some silt, trace cobbles		1	SS	20		178	×			37	51	12	
						▼	177							
	- compact to dense, poorly graded, some to with boulders below ~ 1.52m in depth		2	SS	32			×						
176.2 2.1	AUGER REFUSAL ON SUSPECTED BOULDER AT ~ 2.13m DEPTH													

NOTES:
- Borehole located at west outlet, for the single and twin CSP culverts through Lake Huron Drive South.
- Station 13+225

MTO-WP 9737-DES.GPJ 08/15/05

RECORD OF BOREHOLE BH-17

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE POCKET PENTROMETER)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI CL
178.3	GROUND SURFACE										
0.0	**FILL: SAND AND GRAVEL,** brown, damp, compact, well graded, fine to medium grained, some silt, trace cobbles						178				
			1	SS	28			×			
	- dense with some boulders below ~ 1.2m in depth						177				
			2	SS	46			×			
176.2											
2.1	AUGER REFUSAL ON SUSPECTED BOULDER AT ~ 2.13m DEPTH										

NOTES:

- Borehole located at CL of single and twin CSP culverts through Lake Huron Drive South
- Station 13+235
- No free water observed at completion of drilling

RECORD OF BOREHOLE BH-18

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY M. Corriveau

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B - 57 Drill Rig | COMPILED BY D. Smith

DATUM Geodetic | DATE June 28, 2004 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE, POCKET PENTROMETER)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI CL
178.5 0.0	GROUND SURFACE							20 40 60 80	10 20 30 40		
178.4 0.1	**ASPHALT,** ~ 75mm thick										
	FILL: SAND AND GRAVEL, brown, damp, loose to dense, well graded, fine to medium grained, with cobbles, trace boulders		1	SS	50		178				
177.7 0.8	AUGER REFUSAL ON SUSPECTED BOULDER AT ~ 0.835m DEPTH										
	NOTES: - Borehole located at east inlet of single and twin CSP culverts through Lake Huron Drive South - Station 13+245 - No free water observed at completion of drilling										

MTO-WP 9737-DES.GPJ 08/15/05

APPENDIX B-1

Trow Borehole Logs, April and May 2005

RECORD OF BOREHOLE BH-1B

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY S. McAuliffe

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B-57 Drill Rig | COMPILED BY C. Green

DATUM Geodetic | DATE April 19, 2005 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ○●, FIELD VANE +, LAB SHEAR ⊗) (20 40 60 80)	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
179.2	GROUND SURFACE															
179.1 / 0.0 / 0.1	**ASPHALT,** ~100 mm thick.						179									
	FILL: GRANULAR B, brown, damp, compact to very dense, trace to some cobbles.		1	SS	31			×		○			10%	81%	9%	0%
							178									
177.3			2	SS	60				×							
1.8	**FILL: ROCK,** dense, 600 mm minus.						177									
							176									
174.9							175									
4.3	**GRAVEL,** red to grey, wet, compact, some sand, some silt.		3	SS	15			×								
							174									
			4	SS	14		173	×								
171.8							172									
7.3 / 171.4	**TILL: SAND,** red to brown, wet, loose to compact, some cobbles.		5	SS	8			×								
7.8	**TILL: COBBLES,** dense.						171									
170.6			6	SS	100					×						
8.5	SPT REFUSAL ON SUSPECTED BEDROCK AT 8.53 m DEPTH															

MTO-WP 9737-DE2.GPJ 07/21/05

RECORD OF BOREHOLE BH-2B

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY S. McAuliffe

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B-57 Drill Rig | COMPILED BY C. Green

DATUM Geodetic | DATE April 18, 2005 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, kPa (UNCONFINED QUICK TRIAXIAL ○●, FIELD VANE + , LAB SHEAR ⊗) (20 40 60 80)	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
179.5 GROUND SURFACE																
179.4 / 0.0	**ASPHALT,** ~ 60 mm thick.															
0.1	**FILL: GRANULAR B,** brown, damp, compact to very dense.		1	BAG			179			○			37%	57%	6%	0%
			2	BAG						○			41%	50%	9%	0%
178.3			1	SS	65				×	○			25%	64%	11%	0%
1.2	**FILL: ROCK,** dense, 300 mm minus.						178									
176.7							177									
2.7	**WOOD**		2	SS	25				×							
176.0							176									
3.5	**FILL: ROCK,** dense, 300 mm minus.															
174.5							175									
5.0	**TILL: SAND & COBBLES,** red to grey, wet, compact, poorly graded, fine to coarse grained, trace silt.		3	SS	11		174	×								
173.4																
6.1	**TILL: GRAVEL,** grey, wet, dense.		4	SS	40		173		×							
172.8			5	SS	100						×					
6.7	SPT REFUSAL ON SUSPECTED BEDROCK AT 6.71 m DEPTH															

MTO-WP 9737-DE2.GPJ 07/21/05

RECORD OF BOREHOLE BH-3B

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY S. McAuliffe

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B-57 Drill Rig | COMPILED BY C. Green

DATUM Geodetic | DATE May 05, 2005 | CHECKED BY T. Crilly

ELEV. DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL; FIELD VANE LAB SHEAR) (20 40 60 80)	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
178.8	GROUND SURFACE														
0.0	**FILL: SAND,** brown, damp, compact, well graded, fine to coarse grained, some cobbles, trace to some silt. - wet below ~ 0.28 m.		1	SS	16		178								
			2	SS	25		177								
176.8															
2.0	**FILL: COBBLES,** brown, wet, dense, some sand, some gravel.		3	SS	41										
176.1							176								
2.7	**SAND,** brown, wet, very loose, well graded, fine to medium grained, trace silt.		4	SS	1	▼									
			5	SS	4		175								
			6	SS	3		174								
	- compact below ~ 5.60 m. - trace to some cobbles.		7	SS	19		173								
							172								
171.5			8	SS	100										
7.3	SPT REFUSAL ON SUSPECTED BEDROCK AT 7.32 m DEPTH														

MTO-WP 9737-DE2.GPJ 07/21/05

RECORD OF BOREHOLE BH-4B

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY S. McAuliffe

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B-57 Drill Rig | COMPILED BY C. Green

DATUM Geodetic | DATE April 12, 2005 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, kPa (UNCONFINED QUICK TRIAXIAL ○●, FIELD VANE + , LAB SHEAR ⊗) (20 40 60 80)	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
178.8	GROUND SURFACE															
0.0 / 178.5	**ASPHALT,** ~ 280 mm thick.															
0.3	**FILL: GRANULAR B,** brown, damp, compact to dense.		1	BAG									39%	58%	3%	0%
			2	BAG									37%	52%	11%	0%
			1	SS	33		178						16%	76%	8%	0%
	- some cobbles below ~ 1.20 m.															
			2	SS	23		177						18%	75%	7%	0%
			3	SS	23	▼	176						18%	76%	6%	0%
	- wet below ~ 2.74 m.															
175.0			4	SS	36		175						12%	79%	9%	0%
3.8	**SAND,** brown to grey, wet, loose to compact, poorly graded, fine to coarse grained, trace silt, trace gravel, trace cobbles.		5	SS	12								10%	86%	4%	0%
			6	SS	4		174						3%	89%	8%	0%
							173									
	- some to with silt below ~ 6.10 m.		7	SS	10								5%	72%	23%	0%
172.3							172									
6.6	**CLAYEY SILT,** grey, wet, very loose, low plasticity, some sand, trace gravel, organic stained.		8	SS	1		171					91	2%	20%	58%	20%
170.6																
8.2	**SAND,** grey, wet, compact, poorly graded, fine to coarse grained, some silt, some gravel, trace cobbles.						170									
			9	SS	17		169						24%	60%	16%	0%
168.5			10	SS	100											
10.4	SPT REFUSAL ON SUSPECTED BEDROCK AT 10.36 m DEPTH															

MTO-WP 9737-DE2.GPJ 07/21/05

RECORD OF BOREHOLE BH-5B

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY S. McAuliffe

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B-57 Drill Rig | COMPILED BY C. Green

DATUM Geodetic | DATE April 19, 2005 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ○●, FIELD VANE + , LAB SHEAR ⊗) (20 40 60 80)	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
178.8	GROUND SURFACE												
0.0 / 178.6	**ASPHALT,** ~280 mm thick.												
0.3	**FILL: GRANULAR B,** brown, damp, compact to very dense, some cobbles.		1	SS	69		178						
177.6							177						
1.2	**FILL: ROCK,** dense, 450 mm minus.						176						
							175						
							174						
							173						
171.8							172						
7.0	**TILL: COBBLES,** dense.		2	SS	100								
171.2													
7.6	SPT REFUSAL ON SUSPECTED BEDROCK AT 7.62 m DEPTH												

MTO-WP 9737-DE2.GPJ 07/21/05

RECORD OF BOREHOLE BH-6B

1 OF 1

METRIC

G.W.P. 6013-03-00 | LOCATION Desbarats River, Johnson Township | ORIGINATED BY S. McAuliffe

DIST Algoma | HWY 17 | BOREHOLE TYPE Hollow Stem Augers B-57 Drill Rig | COMPILED BY C. Green

DATUM Geodetic | DATE April 12, 2005 | CHECKED BY T. Crilly

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR	SA	SI	CL
178.9	GROUND SURFACE													
0.0 / 178.6	**ASPHALT,** ~ 280 m thick.													
0.3	**FILL: GRANULAR B,** brown, damp, compact, some cobbles.		1	SS	26		178							
			2	SS	26		177							
176.3	- wet below ~ 2.40 m.		3	SS	4	▼					19%	53%	28%	0%
2.6 / 175.9	**CLAYEY SILT,** grey, wet, very loose, trace sand.						176							
3.1	**TILL: SAND,** grey, wet, compact to dense, some clay, trace silts, some cobbles.		4	SS	25									
174.4							175							
4.6	**TILL: SILT,** grey, wet, dense, some cobbles, trace sand.		5	SS	53		174							
173.7			6	SS	100									
5.2	SPT REFUSAL ON SUSPECTED BEDROCK AT 5.18 m DEPTH													

APPENDIX B-2

Borehole Logs From Others

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT I7723 BORING # 1 And PT. 2 DATUM GEODETIC CASING BX.
BORING DATE FEB 1- 3/65 REPORT DATE FEB. 22, 1965 COMPILED BY A.E.L. CHECKED BY B.T.D.
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES
A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

ELEVN. / DEPTH	WATER CONDITIONS	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	ELEVATION SCALE
576.9	RIVER LEVEL			
576.0 / 0.0	0.9' ICE			
	RIVER BOTTOM			580
	VERY SOFT DARK BROWN ORGANIC SILT			
570.4 / 5.6				570
565.9 / 10.1		SOUND REDDISH BROWN RHYOLITE BEDROCK		
556.9 / 19.1		END OF HOLE		560
				550

SHEAR STRENGTH - PSF
LAB. VANE x (NAT.) ⊗ (REM.) V_L
50 100 150 200
WATER CONTENT W% ____ ⊙ NAT. ⊡ L_W △ P_W
20 40 60 80
DYNAMIC PENETRATION TEST BLOWS PER FOOT
20 40 60 80

1 (BOREHOLE)

PUSH

68 BLOWS FOR LAST 6 INS
100 BLOWS FOR 1 INCH - NO ADVANCE
END OF PENETRATION TEST AT EL. 567.5

DENSE TO VERY DENSE REDDISH BROWN SAND AND GRAVEL TILL WITH BOULDERS

OTHER TESTS: M, R.C. RECOV. 100%, 98%

SAMPLES

CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
	2" DO	1	1
	3" TO	2	PUSH
	2" DO	3	>100
	2" DO	4	>100
	BXL. RC	5	-
	-	6	-

2 (PENETRATION TEST)

ELEVN. / DEPTH	WATER CONDITIONS	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	ELEVATION SCALE
576.7	RIVER LEVEL			
	5.8' ICE	PROBABLY VERY SOFT ORGANIC SILT		580
573.4 / 0.0	RIVER BOTTOM			
570.7 / 2.7		PROBABLY DENSE TO VERY DENSE SAND & GRAVEL TILL		570
564.7 / 8.7		END OF PEN TEST		560

75 BLOWS - NO ADVANCE
END OF PENETRATION TEST AT EL. 564.7

APPENDIX I

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7723 BORING # 3 And TP 4 DATUM GEODETIC CASING BX.
BORING DATE FEB. 4-5/65 REPORT DATE FEB. 22, 1965 COMPILED BY A.E.L. CHECKED BY B.T.D.
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION: DISTURBED; FAIR; GOOD; LOST

SAMPLE TYPES
A.S. - AUGER SAMPLE; S.T. - SLOTTED TUBE; W.S. - WASHED SAMPLE; D.O. - DRIVE-OPEN; D.F. - DRIVE-FOOT VALVE; C.S. - CHUNK SAMPLE; F.S. - FOIL SAMPLE; S.O. - SLEEVE-OPEN; S.F. - SLEEVE-FOOT VALVE; T.O. - THIN WALLED OPEN; R.C. - ROCK CORE

ABBREVIATIONS
V - IN-SITU VANE TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Qc - TRIAXIAL CONSOLIDATED UNDRAINED; Q - TRIAXIAL UNDRAINED; S - TRIAXIAL DRAINED; γ - WET UNIT WEIGHT P.C.F.; K - PERMEABILITY; C - CONSOLIDATION; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	SHEAR STRENGTH - PSF ▲ UNCONFINED COMP. (U) LAB. VANE X (NAT.) ⊗ (REM.) V_L, FIELD VANE + (NAT.) ⊗ (REM.) V_F (50, 100, 150, 200); WATER CONTENT W% ⊙ NAT. ⊡ Lw ▲ Pw (20, 40, 60, 80); DYNAMIC PENETRATION TEST BLOWS PER FOOT (20, 40, 60, 80)	OTHER TESTS	SAMPLES: CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
576.8		RIVER LEVEL		580	3 (BOREHOLE)				
574.8 0.0		RIVER BOTTOM			ICE				
	BENTONITE PLUG	VERY SOFT DARK BROWN ORGANIC SILT		570	WT. OF HAMMER; γ=77; M		2" DO	1	PUSH
562.5 14.3	SAND						3" TO	2	"
	PIEZOMETER						TO	3	"
		DENSE TO VERY DENSE REDDISH-BROWN SAND & GRAVEL TILL WITH BOULDERS		560	RC. RECOV. 31%		2" DO	4	>100
					34 BLOWS - NO ADVANCE		BXL RC	5	-
					END OF PENETRATION TEST AT EL. 562.5	M	2" DO	6	>100
				550			DO	7	>100
541.8 35.0	WELL TIP						DF	8	>100
							DF	9	>100
		SOUND REDDISH BROWN RHYOLITE BEDROCK		540		88%	BXL RC	10	-
532.1 42.8						100%	"	11	-
		END OF HOLE		530					
					4 (TEST PIT)				
				590					
570.0 6.8		RIVER LEVEL							
563.2 13.6		RIVER BOTTOM			ICE				
		REDDISH BROWN RHYOLITE BEDROCK		570					

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7723 BORING # 5 And PT. 6 DATUM GEODETIC CASING BX.
BORING DATE FEB. 6-8/65 REPORT DATE FEB. 23, 1965 COMPILED BY A.E.L. CHECKED BY B.T.D.
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION: DISTURBED; FAIR; GOOD; LOST

SAMPLE TYPES: A.S. - AUGER SAMPLE; S.T. - SLOTTED TUBE; W.S. - WASHED SAMPLE; D.O. - DRIVE-OPEN; D.F. - DRIVE-FOOT VALVE; C.S. - CHUNK SAMPLE; F.S. - FOIL SAMPLE; S.O. - SLEEVE-OPEN; S.F. - SLEEVE-FOOT VALVE; T.O. - THIN WALLED OPEN; R.C. - ROCK CORE

ABBREVIATIONS: V - IN-SITU VANE TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Qc - TRIAXIAL CONSOLIDATED UNDRAINED; Q - TRIAXIAL UNDRAINED; S - TRIAXIAL DRAINED; γ - WET UNIT WEIGHT PCF; K - PERMEABILITY; C - CONSOLIDATION; WL - WATER LEVEL IN CASING; WT - WATER TABLE IN SOIL

SOIL PROFILE | SHEAR STRENGTH - PSF. ▲ UNCONFINED COMP. (U) LAB. VANE ×(NAT.) ⊗(REM.) V_L, FIELD VANE +(NAT.) ⊕(REM.) V_F | SAMPLES

ELEVN. / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	OTHER TESTS	CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
576.4		RIVER LEVEL		580					
574.4 2.0		1.5 ICE							
	BENTONITE PLUG / SAND	RIVER BOTTOM VERY SOFT DARK BROWN ORGANIC SILT		570	C γ=76		2" TO DF	1	PUSH
	WL @ EL. 578.2 FEB. 8, 1965						3" TO	2	"
				560			2" TO	3	"
					γ=81		" TO	4	"
551.4 22.9	PIEZOMETER	DENSE TO VERY DENSE REDDISH BROWN SAND & GRAVEL TILL WITH BOULDERS	T	550			" DO	5	62
							" DO	6	73
539.4 34.9		END OF HOLE		540	M		" DO	7	21
536.1		END OF PEN. TEST							

(BOREHOLE) 5

BR BLOWS = LAST 2 INS.
125 BLOWS = NO ADVANCE
END OF PENETRATION TEST AT EL. 538.2

(PENETRATION TEST) 6

576.6		RIVER LEVEL		580					
573.8 2.8		2.0 ICE							
		RIVER BOTTOM PROBABLY VERY SOFT ORGANIC SILT							
567.6				570					
565.7			T						
5.1		END OF PEN. TEST PROBABLY DENSE TO VERY DENSE SAND & GRAVEL TILL		560					

PUSH
63 BLOWS = LAST 10 INS.
125 BLOWS = NO ADVANCE
END OF PENETRATION TEST AT EL. 565.7

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7723 PEN. TEST # 7, 8 And 9 DATUM GEODETIC CASING —

BORING DATE FEB 8-9/65 REPORT DATE MAR. 1, 1965 COMPILED BY A.E.L. CHECKED BY B.T.D.

HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION

DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES

A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Qc - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

SOIL PROFILE ELEVN./DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	WATER CONTENT W% ● NAT. ⊡ LW ▲ Pw / DYNAMIC PENETRATION TEST BLOWS PER FOOT 20 40 60 80	OTHER TESTS	SAMPLES CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
576.6	▼	RIVER LEVEL		580	7 (PENETRATION TEST)					
		1.5 ICE								
575.1		RIVER BOTTOM								
0.0		PROBABLY VERY SOFT ORGANIC SILT			PUSH					
567.6				570						
5.1		PROBABLY SENSE TO VERY DENSE SAND & GRAVEL TILL								
562.1										
10.6		END OF PEN. TEST		560	125 BLOWS - LAST 6 INS. 125 BLOWS NO ADVANCE END OF PENETRATION TEST AT EL 562.1					
576.6	▼	RIVER LEVEL		580	8 (PENETRATION TEST)					
		1.9 ICE								
572.1		RIVER BOTTOM								
0.0		PROBABLY VERY SOFT ORGANIC SILT		570	PUSH					
566.1										
6.0		END OF PEN. TEST			6 BLOWS - LAST 6 INS. 105 BLOWS NO ADVANCE END OF PENETRATION TEST AT EL 566.1					
				560						
576.6	▼	RIVER LEVEL		580	9 (PENETRATION TEST)					
		1.3 ICE								
573.3		RIVER BOTTOM								
0.0		PROBABLY VERY SOFT ORGANIC SILT		570	PUSH					
567.6										
6.1										
561.3					128					
12.4		END OF PEN. TEST		560	88 BLOWS - LAST 3 INS. END OF PENETRATION TEST AT EL 561.3					
		PROBABLY DENSE TO VERY DENSE SAND & GRAVEL TILL								

M.T.O. Test Pits
W.P. 264-90-00
August 1995

TP-1 STATION 13+210 – 13.0m RT (D-2.0)

0	-	1.2	Water
		1.2	NFP RF

TP-2 STATION 13+210 – 6.8m RT

0	-	240	Asph
240	-	490	Cr Gr (Cl Sm @ 600)
490	-	1.4	Br F-M Sa with Gr Occ Cob (Moist & Clean) (Wet @ 1.2)
1.4	-	2.0	Gry Si(y) Cl (Wet & Stiff) (Fr Wat @ 1.7)
2.0	-	2.5	RF (Wet)
		2.5	NFP RF

TP-3 STATION 13+220 – 23.0 RT (D-1.6) (Culv)

0	-	1.0	Water
1.0	-	1.7	Gry Sa(y) Si with Cl (Wet & Stiff)
		1.7	NFP Blds

TP-4 STATION 13+226 – 23.0 RT (D-2.0) (Culv)

0	-	1.3	Water
		1.3	NFP

TP-5 STATION 13+300 – 14.0 RT (D-2.4) (Culv)

0	-	300	Water
300	-	2.5	Gry Si(y) Sa with Cl (Wet & Soft)
		2.5	NFP Blds

TP-6 STATION 13+305 – 5.4 RT (Culv)

0	-	90	Asph
90	-	610	Cr Gr
610	-	3.5	Br F Sa(y) with Gr Occ Cob (Moist & Clean) (Wet @ 2.0+)
		3.5	NFP Hole Sloughing

TP-7 STATION 13+308 – 14.0 LT (D-2.3) (Culv)

0	-	1.2	Water
		1.2	NFP Blds

APPENDIX C

Laboratory Testing Results

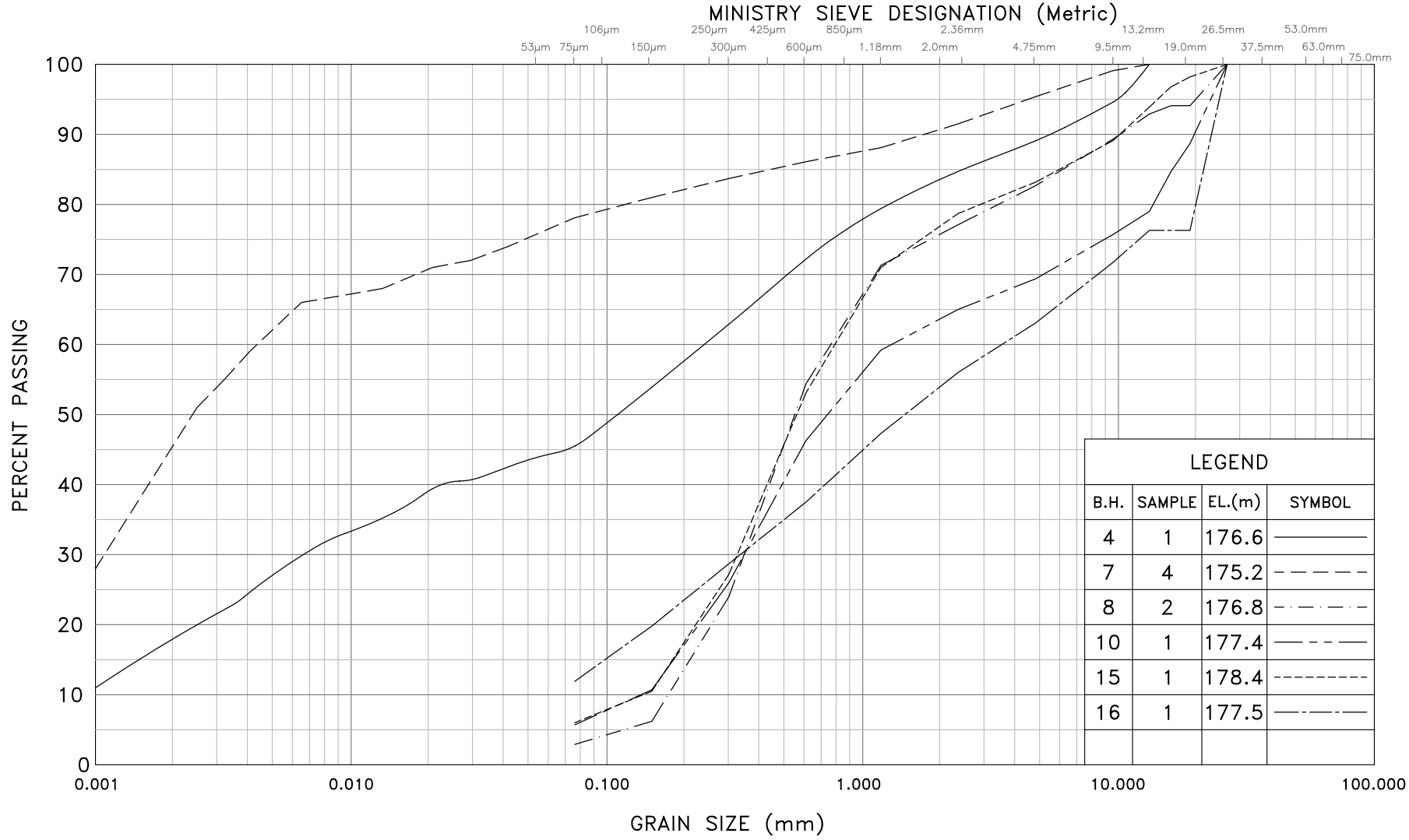
APPENDIX C

Laboratory Testing Results – June 2004

PLOTTED: 2004/07/27 – 10:15

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



Ministry of Transportation
Ontario

METRIC

GRAIN SIZE DISTRIBUTION

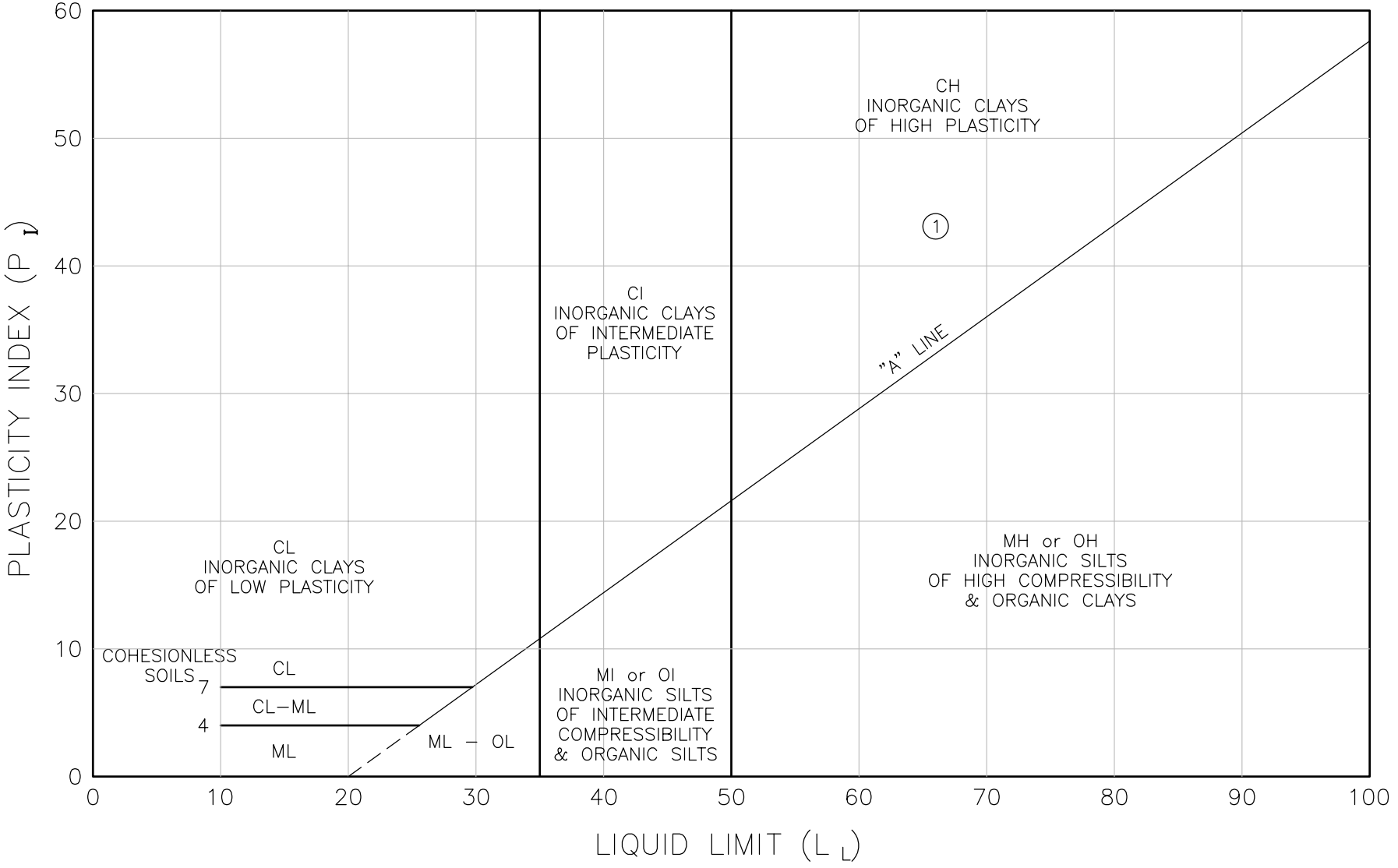
FIGURE No. 1

W.P. 6013-03-00

REF. S09737G

ATTERBERG LIMITS – PLASTICITY CHART

① BH–12 SS–4 (4.57m – 5.03m)



W.P. 6013–03–00

FIGURE 2

TROW

APPENDIX C

Laboratory Testing Results – April 2005

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

MINISTRY SIEVE DESIGNATION (Metric)

53µm 75µm 106µm 150µm 250µm 300µm 425µm 600µm 850µm 1.18mm 2.36mm 2.0mm 4.75mm 9.5mm 13.2mm 19.0mm 26.5mm 37.5mm 53.0mm 63.0mm 75.0mm

PERCENT PASSING

100 90 80 70 60 50 40 30 20 10 0

0.001 0.010 0.100 1.000 10.000

GRAIN SIZE (mm)

LEGEND				
B.H.	SAMPLE	DEPTH (mm)	ELEV. (m)	SYMBOL
2B	BS1	60–300	179.411	
2B	BS2	300–760	179.171	
4B	BS1	280–460	178.531	
4B	BS2	460–760	178.351	
OPSS "A"				
OPSS "B" TYPE I				

Ontario

Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

GRANULAR 'B' TYPE I

FIGURE No. 1

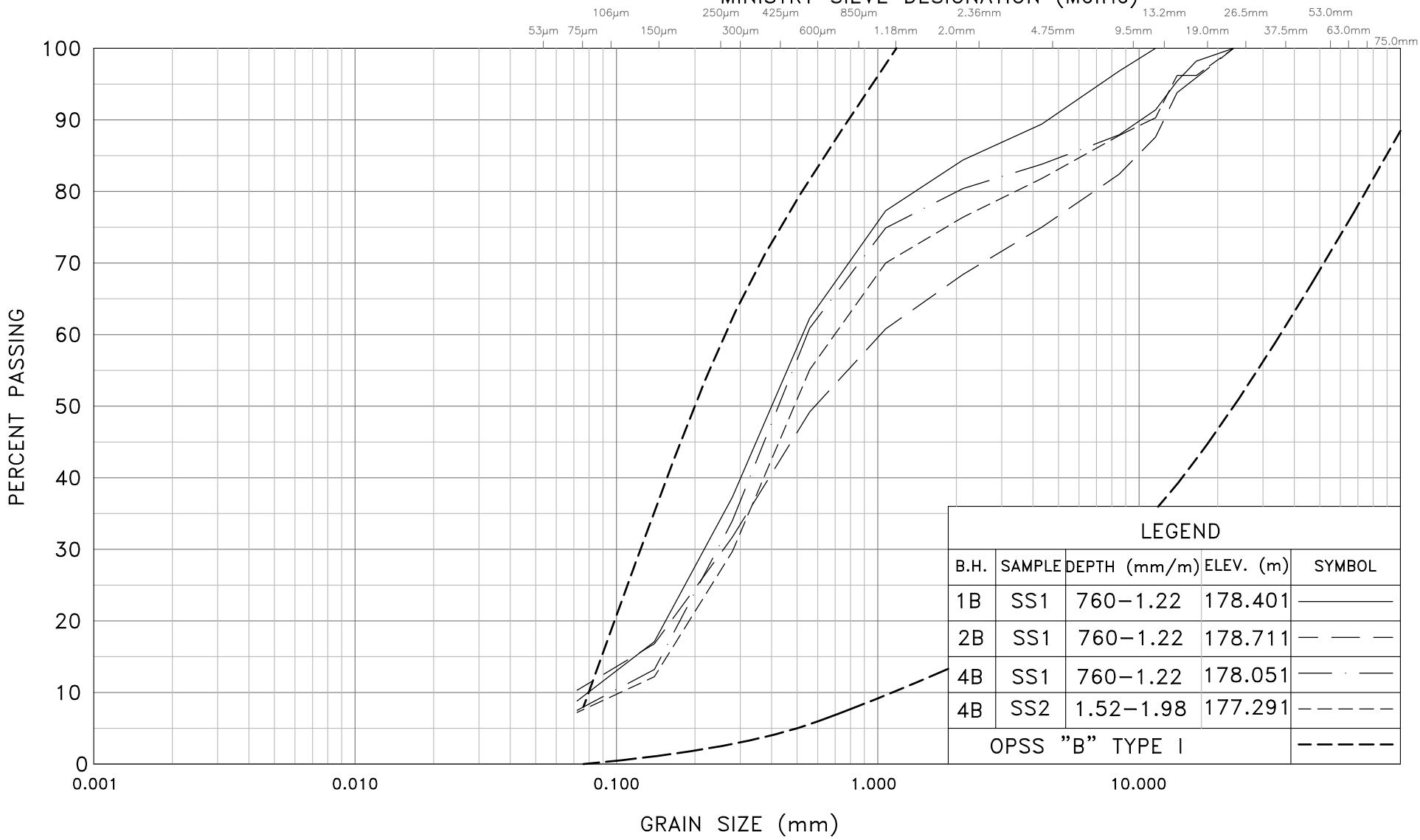
W.P. 6013-03-00

REF. S09737G/B

PLOTTED: 2005/06/14 – 3:15

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



Ministry of Transportation
Ontario

METRIC

GRAIN SIZE DISTRIBUTION

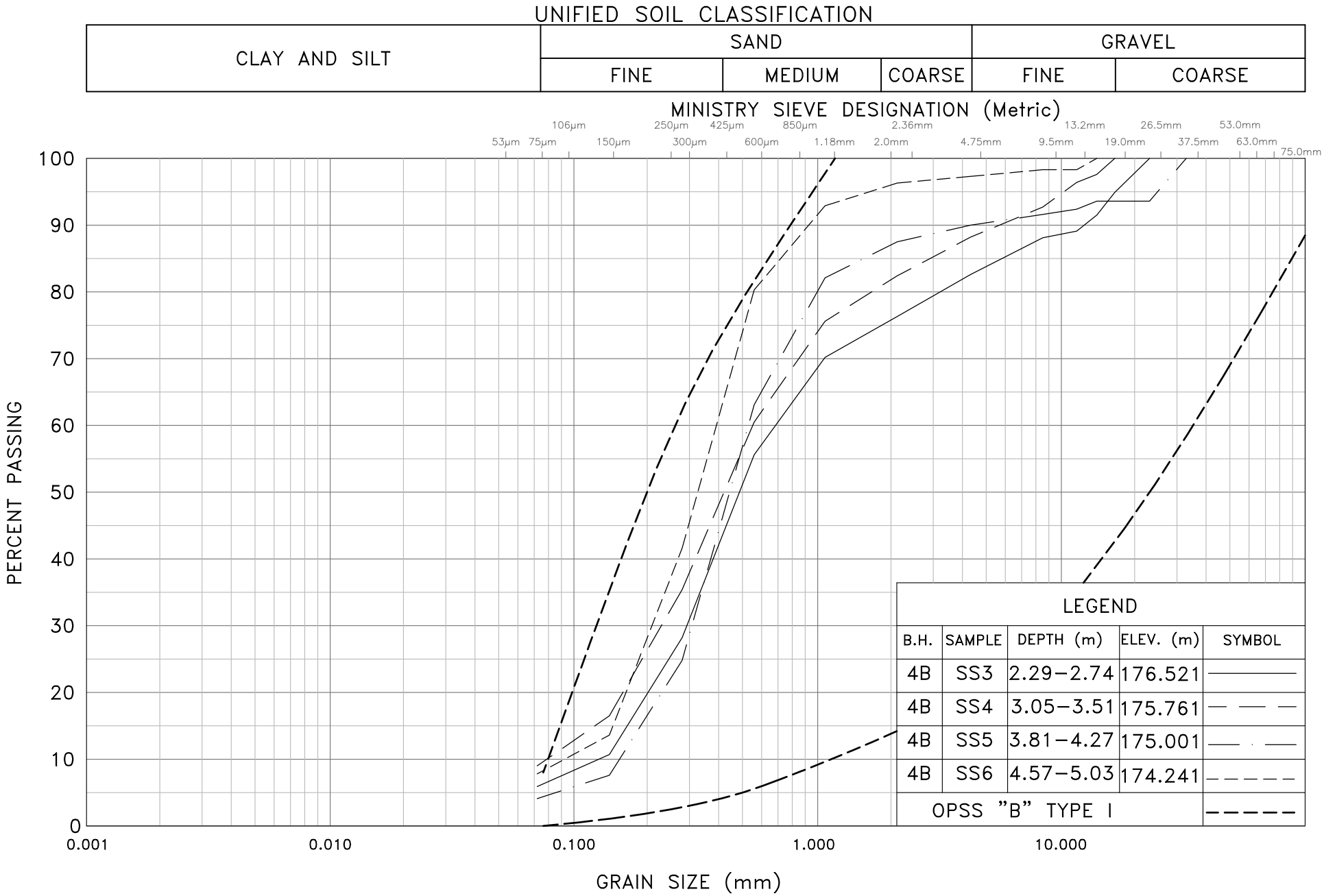
GRANULAR 'B' TYPE I

FIGURE No. 2

W.P. 6013–03–00

REF. S09737G/B

PLOTTED: 2005/06/14 – 3:30



Ministry of Transportation
Ontario

METRIC

GRAIN SIZE DISTRIBUTION
GRANULAR 'B' TYPE I

FIGURE No. 3

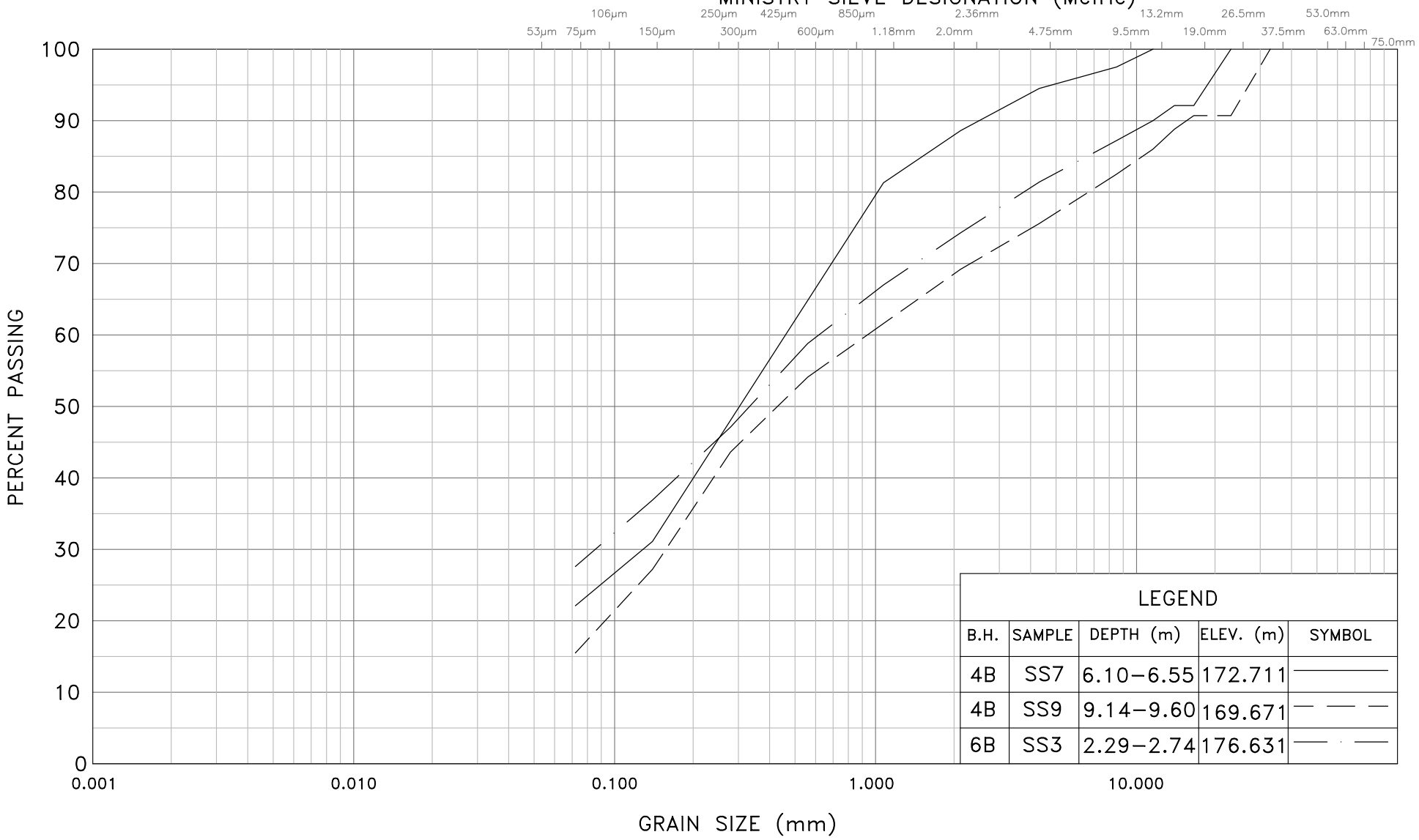
W.P. 6013–03–00

REF. S09737G/B

PLOTTED: 2005/06/14 – 3:45

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



Ministry of Transportation
Ontario

METRIC

GRAIN SIZE DISTRIBUTION
SILTY SAND

FIGURE No. 4

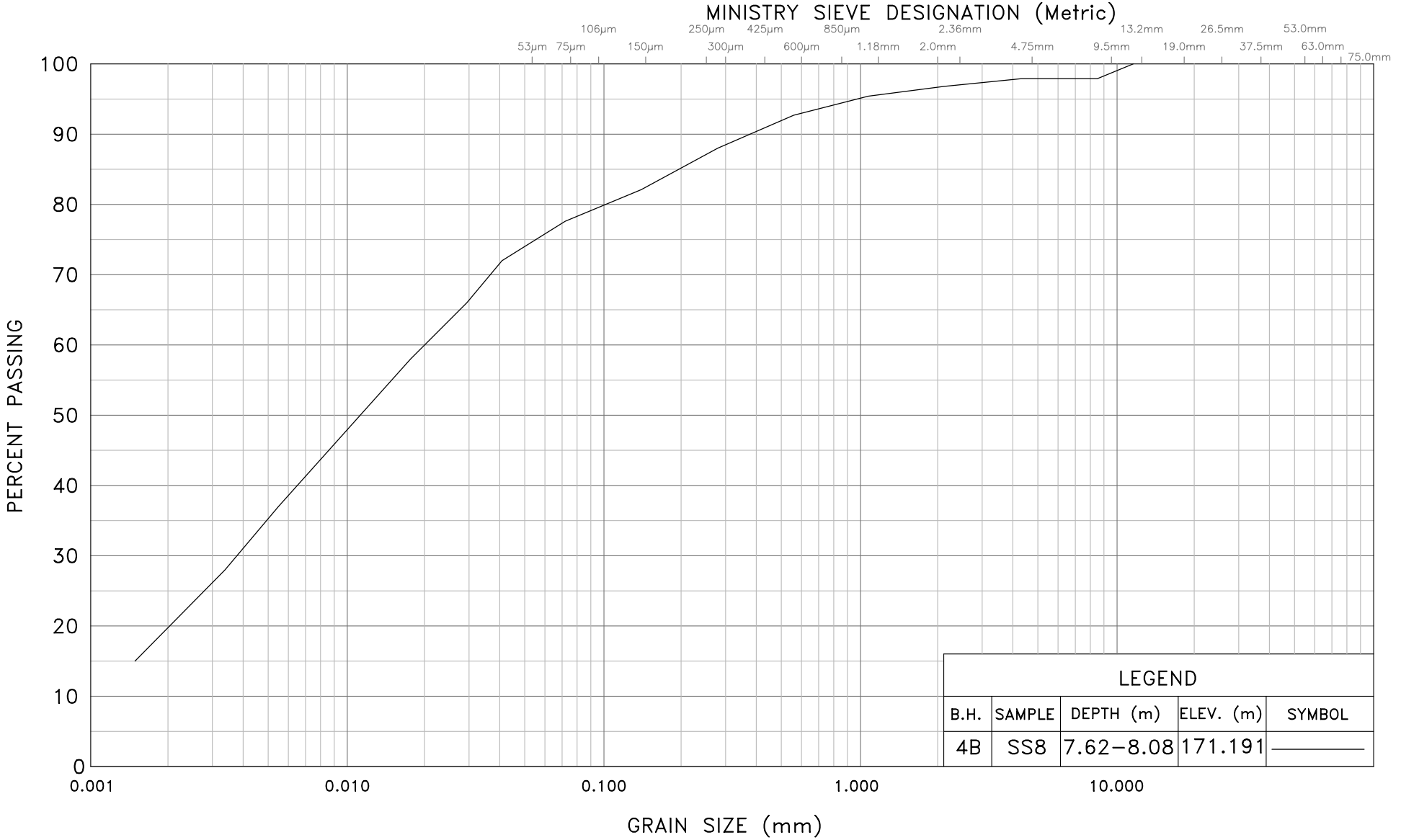
W.P. 6013–03–00

REF. S09737G/B

PLOTTED: 2005/06/14 – 4:00

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



Ministry of Transportation
Ontario

METRIC

GRAIN SIZE DISTRIBUTION
CLAYEY SILT

FIGURE No. 5

W.P. 6013-03-00

REF. S09737G/B

APPENDIX D

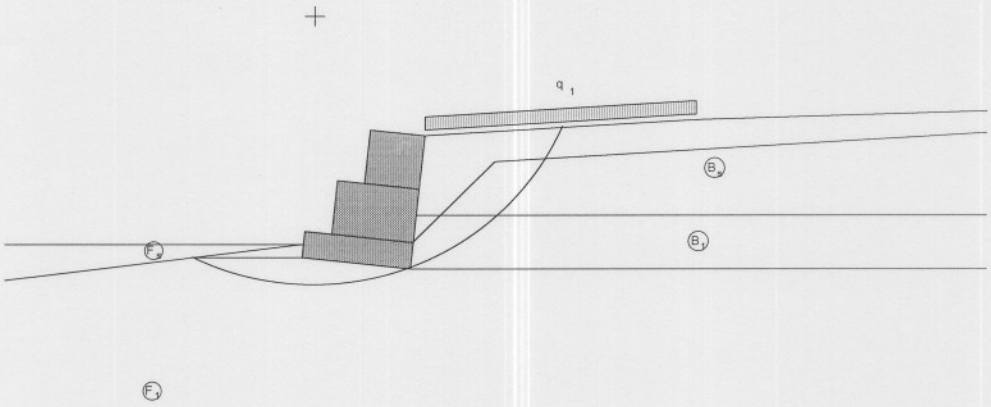
Computer Model Output

APPENDIX D-1

Model Output – Retaining Wall No. 1
(Stations 13+185 to 13+225)

Program released in license to: Trow Associates

Project: SO9737G Gabion Stone RSS
File: Left Hand Turning Lane Hwy 17 Retaining Wall No 1 Date: 10/18/2004



SOIL DATA

Soil	γ kN/m³	c kN/m²	ϕ deg	Soil	γ kN/m³	c kN/m²	ϕ deg
B_s	21.00	0.00	35.00	F_s	18.00	5.00	20.00
B_1	18.00	5.00	20.00	F_1	20.00	0.00	45.00

LOADS

Load	Value kN/m²	Load	Value kN/m
q_1	12.00		

STABILITY CHECKS

Sliding Safety Coefficient	3.73	Base normal stress (left)	8.07kN/m²
Overturning Safety Coefficient	7.16	Base normal stress (right)	65.44kN/m²
Overall Stability Safety Coefficient	1.54	Max. allowable stress	1137.96kN/m²

Program released in license to: Trow Associates

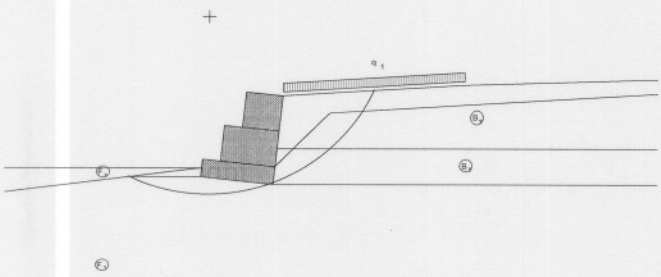
Project: SO9737G Gabion Stone RSS
File: Left Hand Turning Lane Hwy 17 Retaining Wall No 1 Date: 10/18/2004

INPUT DATA

Wall data

Wall batter	:	6.00 deg
Rockfill unit weight	:	25.00 kN/m³
Porosity of gabions	:	30.00 %
Geotextile in the backfill	:	Yes
Friction reduction	:	5.00 %
Geotextile on the base	:	No
Friction reduction	:	%
Mesh and the wire diam.:		: 8x10, ø 2.70 mm

Layer	Length m	Width m	Offset m
1	2.00	0.50	-
2	1.50	1.00	0.50
3	1.00	1.00	1.00



Backfill soil data

Inclination of Stretch 1	:	3.40 deg
Length of stretch 1	:	5.00 m
Inclination of Stretch 2	:	1.70 deg
Soil unit weight	:	21.00 kN/m³
Soil friction angle	:	35.00 deg
Soil cohesion	:	0.00 kN/m²

Additional Backfill Layers

Layer	Initial height m	Incl. angle deg	Unit weight kN/m³	Cohesion kN/m²	Friction angle deg
1	0.80	0.00	18.00	5.00	20.00

Foundation data

Top surface height	:	0.25 m
Top surface init. length	:	0.00 m
Top surface incl. angle	:	7.00 deg
Soil unit weight	:	18.00 kN/m³
Soil friction angle	:	20.00 deg
Soil cohesion	:	5.00 kN/m²
Foundation allowable pressure	:	kN/m²
Water table height	:	0.25 m

Additional Foundation Layers

Layer	Depth m	Unit weight kN/m³	Cohesion kN/m²	Friction angle deg
1	0.00	20.00	0.00	45.00

Water profile data

Initial height	:	0.30 m
Inclination of the 1st stretch	:	45.00 deg
Length of the 1st stretch	:	1.50 m
Inclination of the 2nd stretch	:	3.40 deg
Length of the 2nd stretch	:	10.00 m

Loads data

Distributed loads on backfill			First stretch	:	12.00 kN/m²
			Second stretch	:	kN/m²
Distributed loads on wall			Load	:	kN/m²
Line loads on backfill					
Load 1	:	kN/m	Distance from wall face	:	m
Load 2	:	kN/m	Distance from wall face	:	m
Load 3	:	kN/m	Distance from wall face	:	m
Line load on wall					
Load	:	kN/m	Distance from wall face	:	m

Seismic action data

Horizontal coefficient	:	Vertical coefficient	:

STABILITY ANALYSIS RESULTS

Active and Passive Thrust

Active Thrust	:	26.91 kN/m
Point of application ref. to X axis	:	2.08 m
Point of application ref. to Y axis	:	0.63 m
Direction of the thrust ref. to X axis	:	27.25 deg
Passive Thrust	:	4.17 kN/m
Point of application ref. to X axis	:	0.01 m
Point of application ref. to Y axis	:	0.12 m
Direction of the thrust ref. to X axis	:	-7.00 deg

Sliding

Normal force on the base	:	72.65 kN/m
Point of application ref. to X axis	:	1.26 m
Point of application ref. to Y axis	:	-0.13 m
Shear force on the base	:	12.26 kN/m
Resisting force on the base	:	77.68 kN/m
Sliding Safety Coefficient	**:**	**3.73**

Overturning

Overturning Moment	:	15.03 kN/m x m
Restoring Moment	:	107.67 kN/m x m
Overturning Safety Coefficient	**:**	**7.16**

Stresses Acting on Foundation

Eccentricity	:	-0.27 m
Normal stress on outer border	:	8.07 kN/m²
Normal stress on inner border	:	65.44 kN/m²
Max. allowable stress on the foundation	:	1137.96 kN/m²

Program released in license to: Trow Associates

Project: SO9737G Gabion Stone RSS
File: Left Hand Turning Lane Hwy 17 Retaining Wall No 1 Date: 10/18/2004

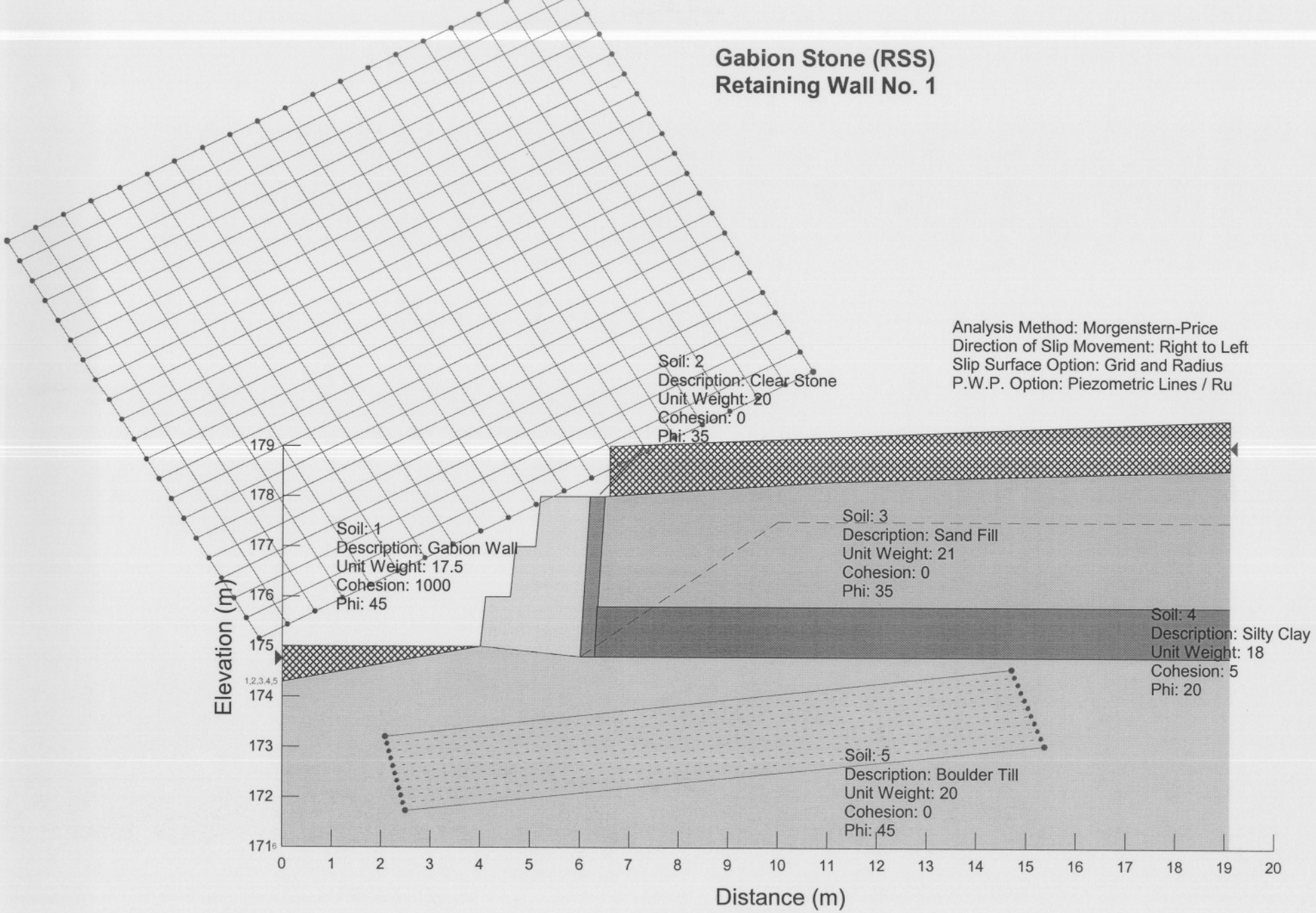
Overall Stability

Initial distance at pivot leftside	:	m
Initial distance at pivot rightside	:	m
Initial depth referred to base	:	m
Max depth allowed in calculation	:	m
Center of the arch referred to X axis	:	0.23 m
Center of the arch referred to Y axis	:	4.50 m
Radius of the arch	:	5.03 m
Number of search surfaces	:	44
Overall Stability Safety Coefficient	**:**	**1.54**

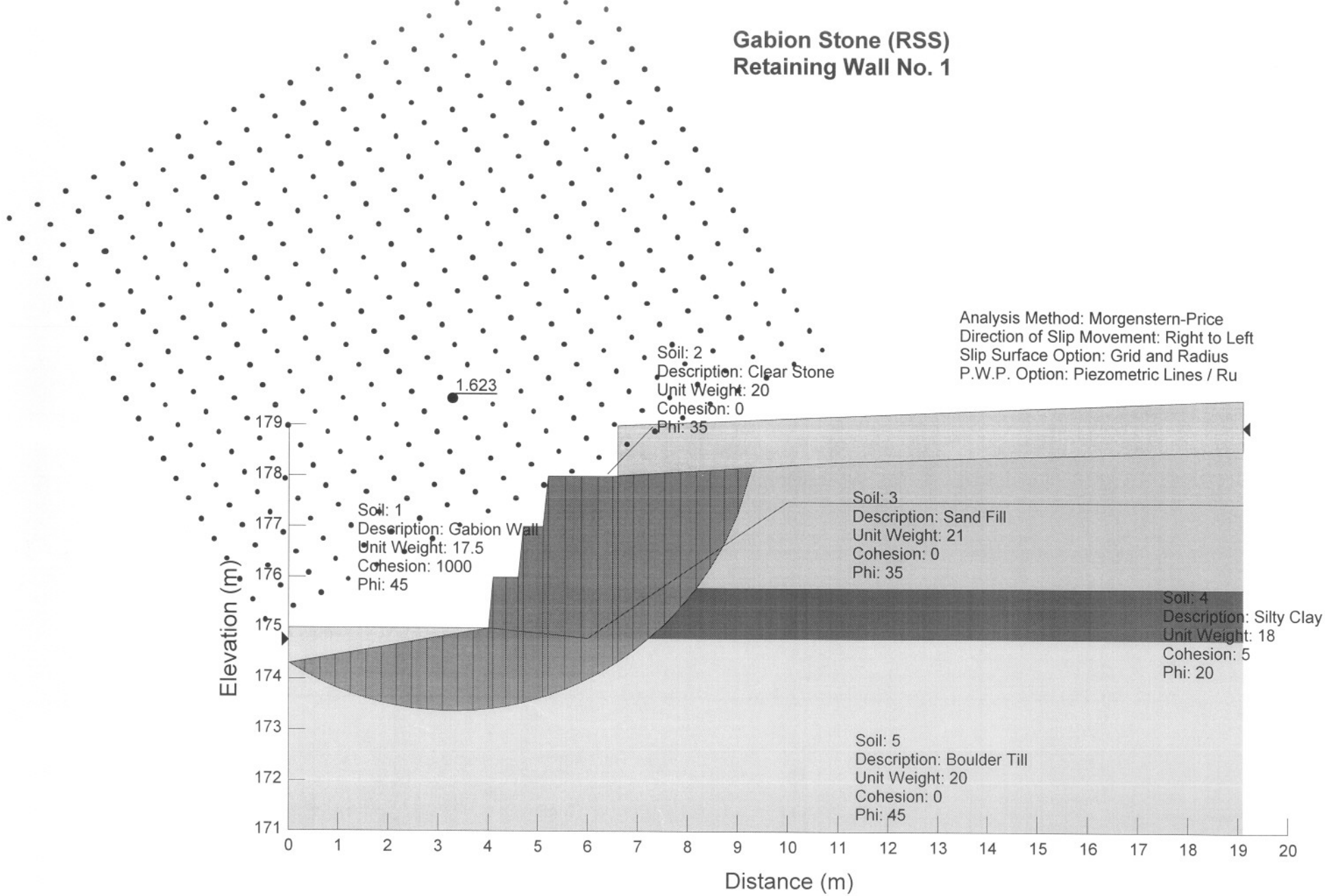
Internal Stability

Layer	H	N	T	M	τ_{Max}	τ_{All}	σ_{Max}	σ_{All}
	m	kN/m	kN/m	kN/m x m	kN/m²	kN/m²	kN/m²	kN/m²
1	1.99	51.76	8.01	44.06	5.34	43.63	30.40	580.79
2	0.99	20.02	2.16	10.55	2.16	33.63	19.00	

Gabion Stone (RSS)
Retaining Wall No. 1



Gabion Stone (RSS)
Retaining Wall No. 1

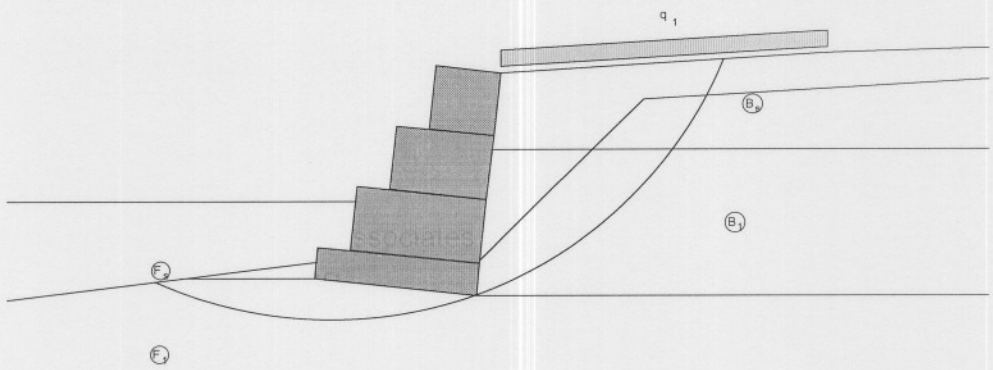


APPENDIX D-2

Model Output – Retaining Wall No. 2
(Stations 13+280 to 13+315)

Program released in license to: Trow Associates

Project: SO9737G Gabion Stone RSS
File: Left Hand Turning Lane Hwy 17 Retaining Wall No 2 Date: 10/18/2004



SOIL DATA

Soil	γ kN/m³	c kN/m²	ϕ deg	Soil	γ kN/m³	c kN/m²	ϕ deg
B_s	21.00	0.00	35.00	F_s	18.00	5.00	20.00
B_1	21.00	0.00	35.00	F_1	21.00	0.00	35.00

LOADS

Load	Value kN/m²	Load	Value kN/m
q_1	12.00		

STABILITY CHECKS

Sliding Safety Coefficient	3.36	Base normal stress (left)	7.23kN/m²
Overturning Safety Coefficient	6.74	Base normal stress (right)	79.84kN/m²
Overall Stability Safety Coefficient	1.36	Max. allowable stress	260.38kN/m²

Program released in license to: Trow Associates

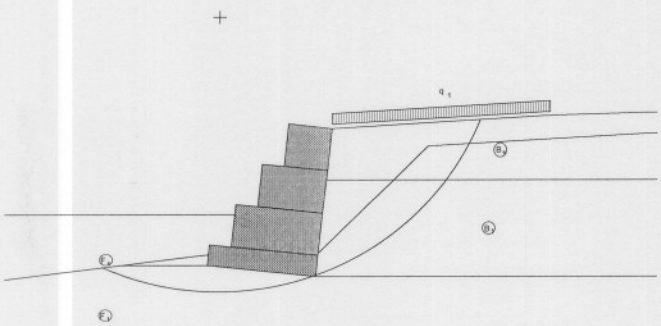
Project: SO9737G Gabion Stone RSS
File: Left Hand Turning Lane Hwy 17 Retaining Wall No 2 Date: 10/18/2004

INPUT DATA

Wall data

Wall batter	:	6.00 deg
Rockfill unit weight	:	25.00 kN/m³
Porosity of gabions	:	30.00 %
Geotextile in the backfill	:	Yes
Friction reduction	:	5.00 %
Geotextile on the base	:	No
Friction reduction	:	%
Mesh and the wire diam.:	:	8x10, ø 2.70 mm

Layer	Length m	Width m	Offset m
1	2.50	0.50	-
2	2.00	1.00	0.50
3	1.50	1.00	1.00
4	1.00	1.00	1.50



Backfill soil data

Inclination of Stretch 1	:	3.40 deg
Length of stretch 1	:	5.00 m
Inclination of Stretch 2	:	1.70 deg
Soil unit weight	:	21.00 kN/m³
Soil friction angle	:	35.00 deg
Soil cohesion	:	0.00 kN/m²

Additional Backfill Layers

Layer	Initial height m	Incl. angle deg	Unit weight kN/m³	Cohesion kN/m²	Friction angle deg
1	2.00	0.00	21.00	0.00	35.00

Program released in license to: Trow Associates

Project: SO9737G Gabion Stone RSS
File: Left Hand Turning Lane Hwy 17 Retaining Wall No 2 Date: 10/18/2004

Foundation data

Top surface height	:	0.25 m
Top surface init. length	:	0.00 m
Top surface incl. angle	:	7.00 deg
Soil unit weight	:	18.00 kN/m³
Soil friction angle	:	20.00 deg
Soil cohesion	:	5.00 kN/m²
Foundation allowable pressure	:	kN/m²
Water table height	:	1.20 m

Additional Foundation Layers

Layer	Depth m	Unit weight kN/m³	Cohesion kN/m²	Friction angle deg
1	0.00	21.00	0.00	35.00

Water profile data

Initial height	:	0.30 m
Inclination of the 1st stretch	:	45.00 deg
Length of the 1st stretch	:	2.50 m
Inclination of the 2nd stretch	:	3.40 deg
Length of the 2nd stretch	:	10.00 m

Loads data

Distributed loads on backfill			First stretch	:	12.00 kN/m²
			Second stretch	:	kN/m²
Distributed loads on wall			Load	:	kN/m²
Line loads on backfill					
Load 1	:	kN/m	Distance from wall face	:	m
Load 2	:	kN/m	Distance from wall face	:	m
Load 3	:	kN/m	Distance from wall face	:	m
Line load on wall					
Load	:	kN/m	Distance from wall face	:	m

Seismic action data

Horizontal coefficient	:	Vertical coefficient	:	

STABILITY ANALYSIS RESULTS

Active and Passive Thrust

Active Thrust	:	32.01 kN/m
Point of application ref. to X axis	:	2.63 m
Point of application ref. to Y axis	:	1.06 m
Direction of the thrust ref. to X axis	:	27.25 deg
Passive Thrust	:	4.17 kN/m
Point of application ref. to X axis	:	0.01 m
Point of application ref. to Y axis	:	0.12 m
Direction of the thrust ref. to X axis	:	-7.00 deg

Sliding

Normal force on the base	:	107.97 kN/m
Point of application ref. to X axis	:	1.60 m
Point of application ref. to Y axis	:	-0.17 m
Shear force on the base	:	13.11 kN/m
Resisting force on the base	:	80.38 kN/m
Sliding Safety Coefficient	**:**	**3.36**

Overturning

Overturning Moment	:	30.31 kN/m x m
Restoring Moment	:	204.17 kN/m x m
Overturning Safety Coefficient	**:**	**6.74**

Stresses Acting on Foundation

Eccentricity	:	-0.36 m
Normal stress on outer border	:	7.23 kN/m²
Normal stress on inner border	:	79.84 kN/m²
Max. allowable stress on the foundation	:	260.38 kN/m²

Program released in license to: Trow Associates

Project: SO9737G Gabion Stone RSS
File: Left Hand Turning Lane Hwy 17 Retaining Wall No 2 Date: 10/18/2004

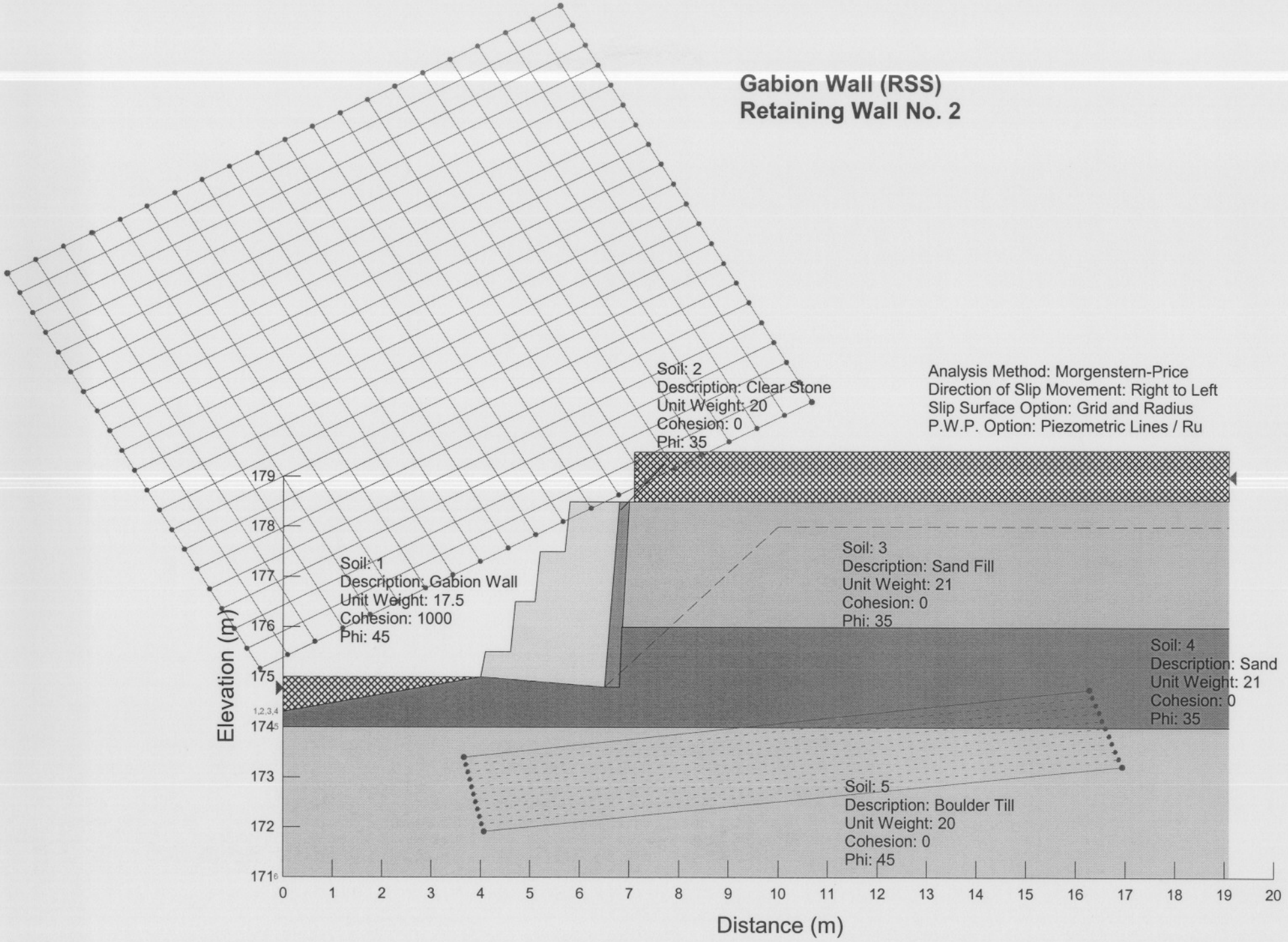
Overall Stability

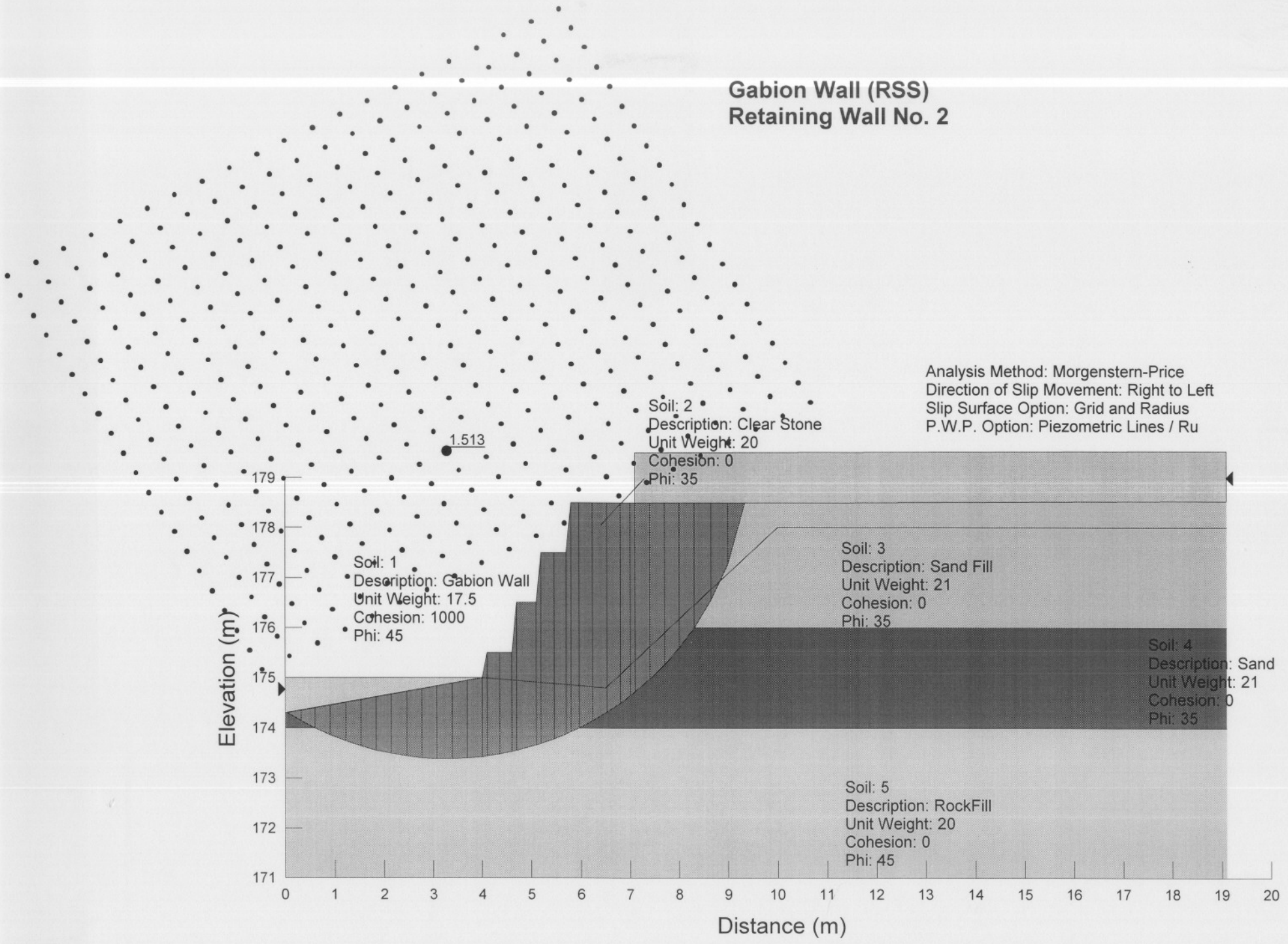
Initial distance at pivot leftside	:	m
Initial distance at pivot rightside	:	m
Initial depth referred to base	:	m
Max depth allowed in calculation	:	m
Center of the arch referred to X axis	:	0.28 m
Center of the arch referred to Y axis	:	5.81 m
Radius of the arch	:	6.46 m
Number of search surfaces	:	41
Overall Stability Safety Coefficient	**:**	**1.36**

Internal Stability

Layer	H	N	T	M	τ Max	τ All	σ Max	σ All
	m	kN/m	kN/m	kN/m x m	kN/m²	kN/m²	kN/m²	kN/m²
1	2.98	86.12	11.91	103.05	5.96	49.53	35.99	580.79
2	1.99	51.16	7.10	43.37	4.73	43.35	30.18	
3	0.99	20.02	2.16	10.55	2.16	33.63	19.00	

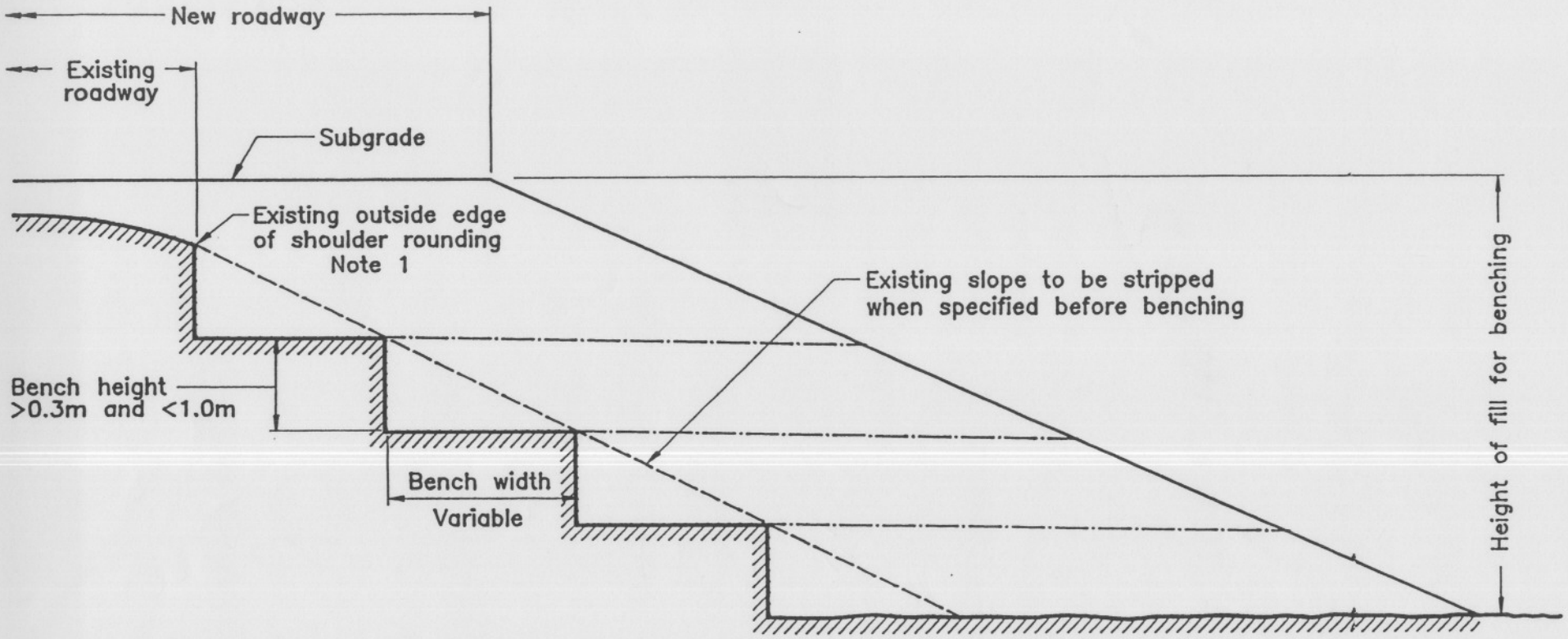
Gabion Wall (RSS)
Retaining Wall No. 2




Gabion Wall (RSS)
Retaining Wall No. 2
Analysis Method: Morgenstern-Price
Direction of Slip Movement: Right to Left
Slip Surface Option: Grid and Radius
P.W.P. Option: Piezometric Lines / Ru
1.513
Soil: 1
Description: Gabion Wall
Unit Weight: 17.5
Cohesion: 1000
Phi: 45
Soil: 2
Description: Clear Stone
Unit Weight: 20
Cohesion: 0
Phi: 35
Soil: 3
Description: Sand Fill
Unit Weight: 21
Cohesion: 0
Phi: 35
Soil: 4
Description: Sand
Unit Weight: 21
Cohesion: 0
Phi: 35
Soil: 5
Description: RockFill
Unit Weight: 20
Cohesion: 0
Phi: 45
Elevation (m)
179
178
177
176
175
174
173
172
171
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Distance (m)

APPENDIX E

OPSD Specifications



NOTES:

1 When the subgrade is below the existing outside edge of shoulder rounding, benching shall be carried out below the point where the subgrade intersects the existing slope.

A Benching is not required on existing slopes flatter than 3:1 or where specified.

B Benches are to be excavated one level at a time and the compacted fill brought up before the next benching level is excavated.

C All dimensions are in millimetres or metres unless otherwise shown.

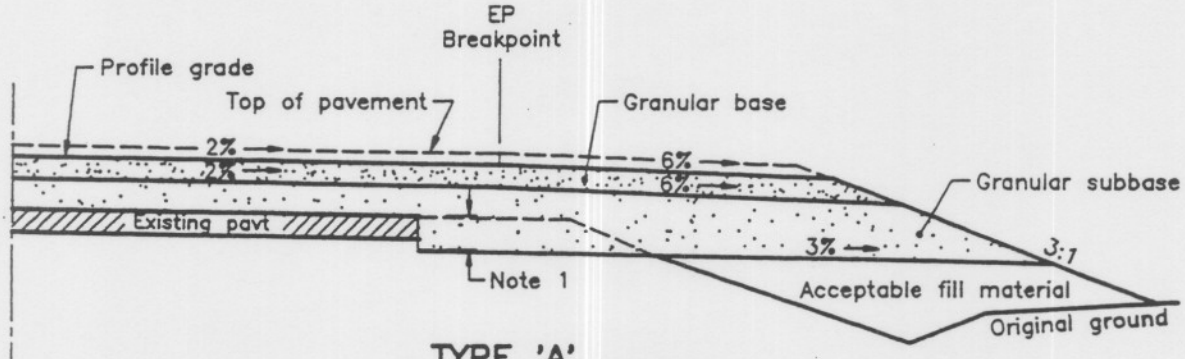
ONTARIO PROVINCIAL STANDARD DRAWING

BENCHING OF EARTH SLOPES

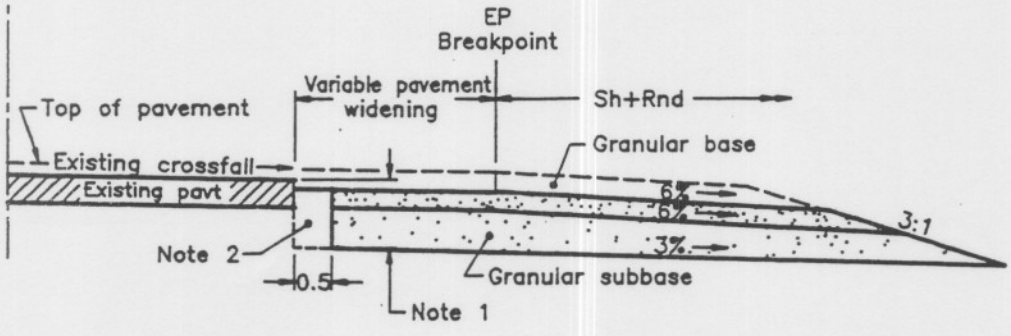
1996 02 01 | Rev

Date

OPSD – 208.010



TYPE 'A'
HALF GRADING SECTION
HOT MIX WITH GRANULAR GRADE RAISE



TYPE 'B'
HALF GRADING SECTION
RESURFACING AND GRANULAR WIDENING

NOTES.

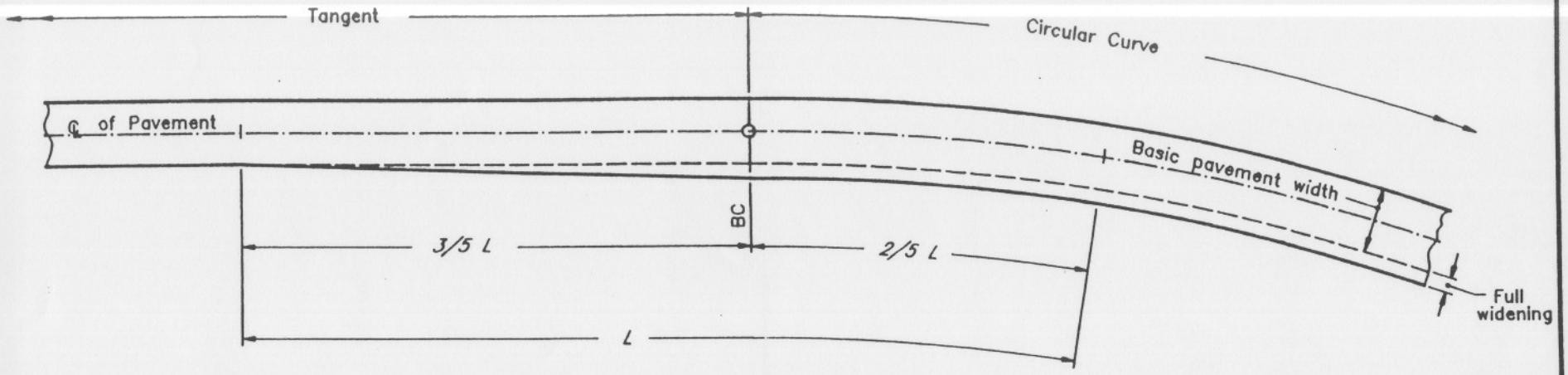
1 Depth of excavation as specified.

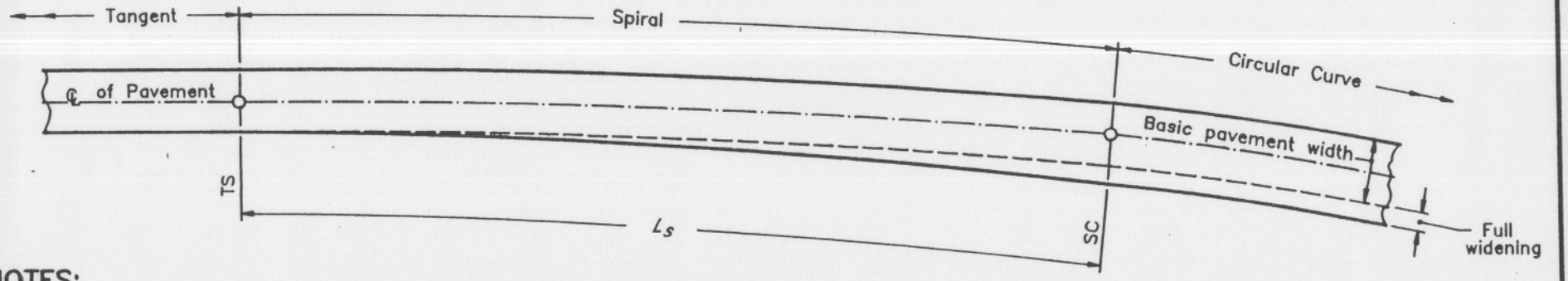
2 If there is no granular material within 1.0m of edge of existing pavement, excavation shall begin at pavement edge.

A Where steel beam guide rail is indicated, the distance from edge of pavement to granular courses rounding breakpoint shall be shoulder width plus 0.50m.

B All dimensions are in metres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Date	1988 12 01	Rev	2
WIDENING **GRANULAR BASE**	Date _____			
	OPSD – 209.01			



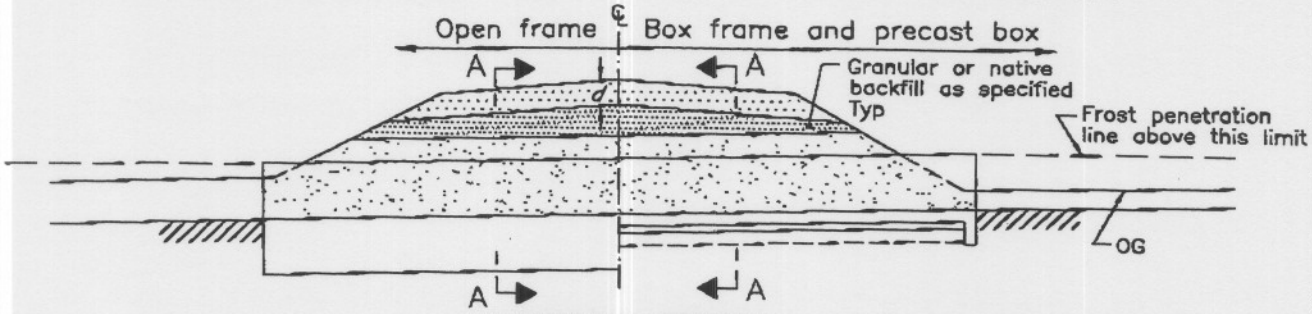


NOTES:

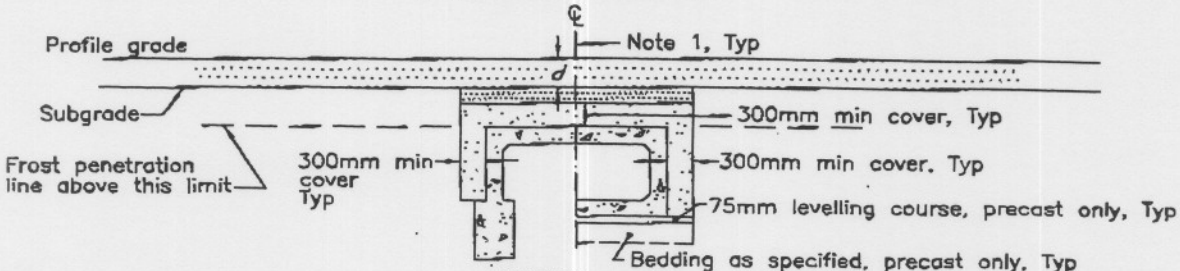
A $L = L_s$ – Length of spiral curve or equivalent spiral.
B Full widening to be attained over spiral curve or equivalent spiral.
C Widening at intermediate points to be proportioned to produce a smooth edge of pavement.
D All dimensions are in millimetres or metres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Date	1983 12 01	Rev	
PAVEMENT WIDENING ON CURVES WIDENING ON INSIDE OF CURVES WITH OR WITHOUT SPIRALS	Date _____			
	OPSD – 213.02			

FROST PENETRATION LINE AT OR ABOVE TOP OF CULVERT

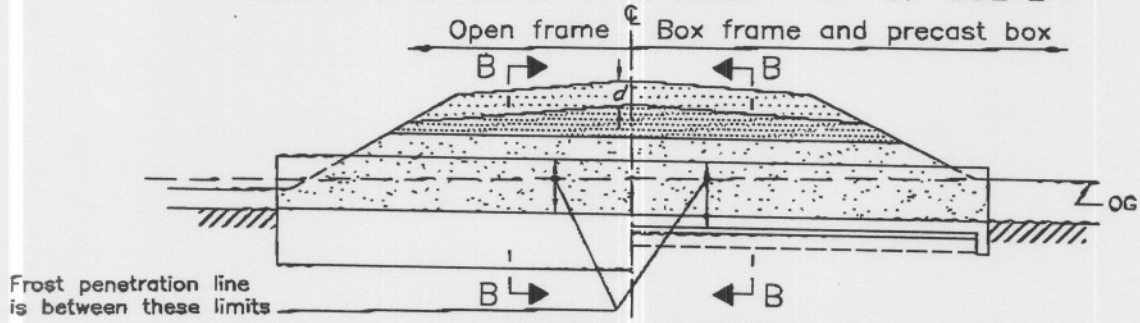


LONGITUDINAL SECTION

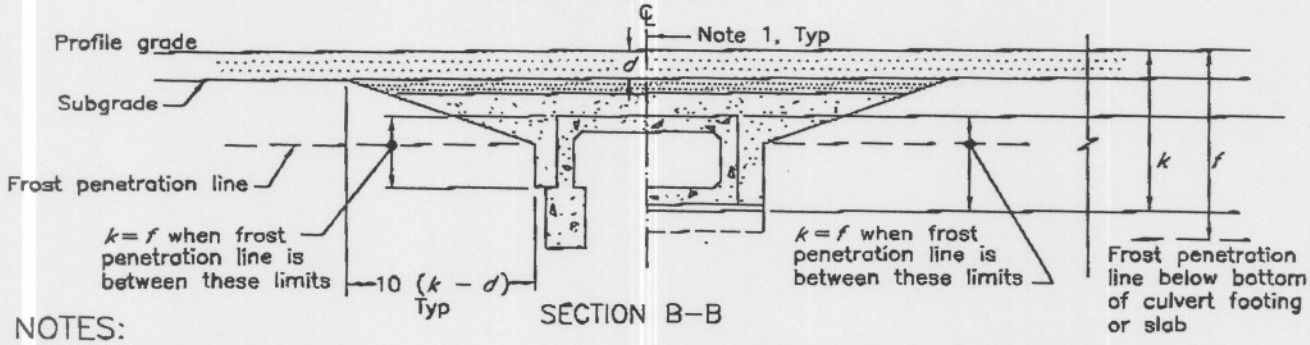


SECTION A–A

FROST PENETRATION LINE BELOW TOP OF CULVERT



LONGITUDINAL SECTION



SECTION B–B

NOTES:

1 Condition of frost treatment symmetrical about centreline of culvert.

A Bedding, levelling and cover material to be granular as specified.

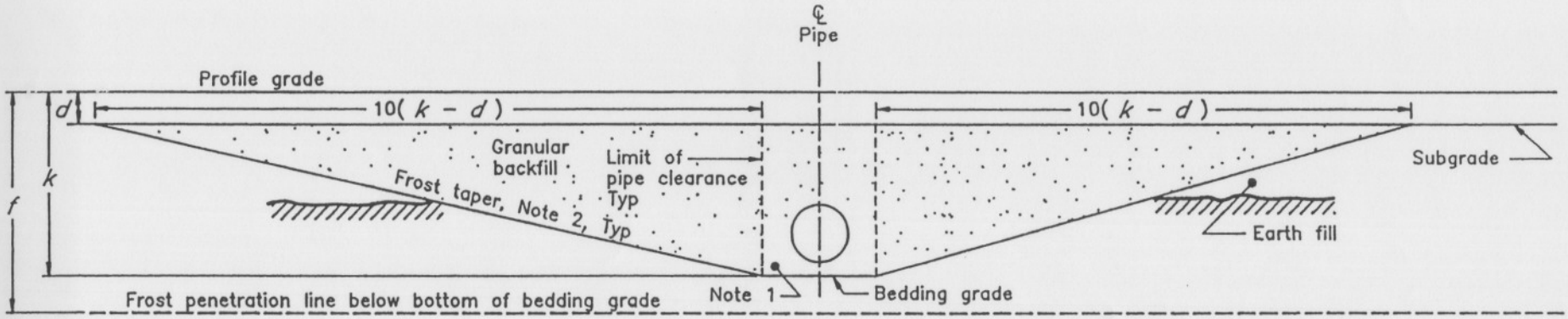
B This standard applies to rigid and non–rigid cast–in–place and precast concrete culverts.

C All dimensions are in millimetres unless otherwise shown.

LEGEND:

d = depth of roadbed granular
k = depth of frost treatment
f = depth of frost penetration

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 1999	Rev
BACKFILL AND COVER FOR CONCRETE CULVERTS		
	OPSD – 803.010	



FROST TREATMENT – RIGID AND FLEXIBLE PIPE

NOTES:

1 Pipe embedment according to:
   a) Flexible – OPSD–802.010, 802.014, 802.020 and 802.024;
   b) Rigid – OPSD–802.030 to 802.032, 802.034, 802.050 to 802.052 and 802.054.

2 Frost tapers start at bedding grade.

A Protection against heavy construction equipment according to OPSD–808.010.

B Frost tapers are not required in rock embankment.

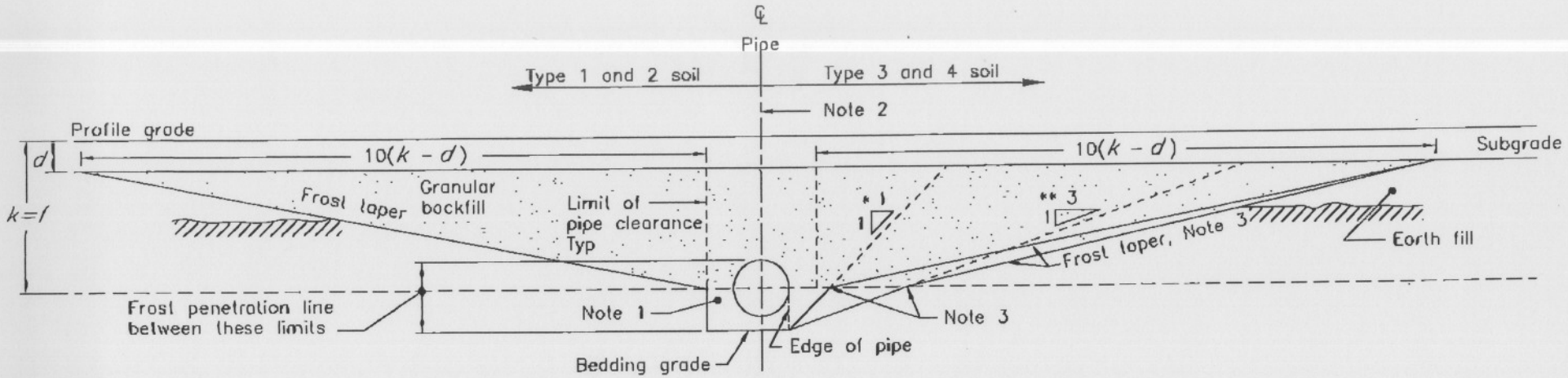
C Frost tapers not required when frost line is above the top of pipe.

D All dimensions are in millimetres or metres unless otherwise shown.

LEGEND:

d –depth of roadbed granular
k –depth of frost treatment
f –depth of frost penetration

ONTARIO PROVINCIAL STANDARD DRAWING	1996 09 15	Rev	
FROST TREATMENT – PIPE CULVERTS FROST PENETRATION LINE BELOW BEDDING GRADE	Date _____		
	OPSD – 803.030		



FROST TREATMENT – RIGID AND FLEXIBLE PIPE

NOTES:

1 Pipe embedment according to:
   a) Flexible – OPSD-802.010, 802.014, 802.020 and 802.024;
   b) Rigid – OPSD-802.030 to 802.032, 802.034, 802.050 to 802.052 and 802.054.

2 Condition of frost treatment symmetrical about centreline of pipe.

3 Frost tapers start at the intersection of the 1:1 or 3:1 slope and the frost penetration line.

A Protection against heavy construction equipment according to OPSD-808.010.

B Frost tapers are not required in rock embankment.

C Frost tapers not required when frost line is above the top of pipe.

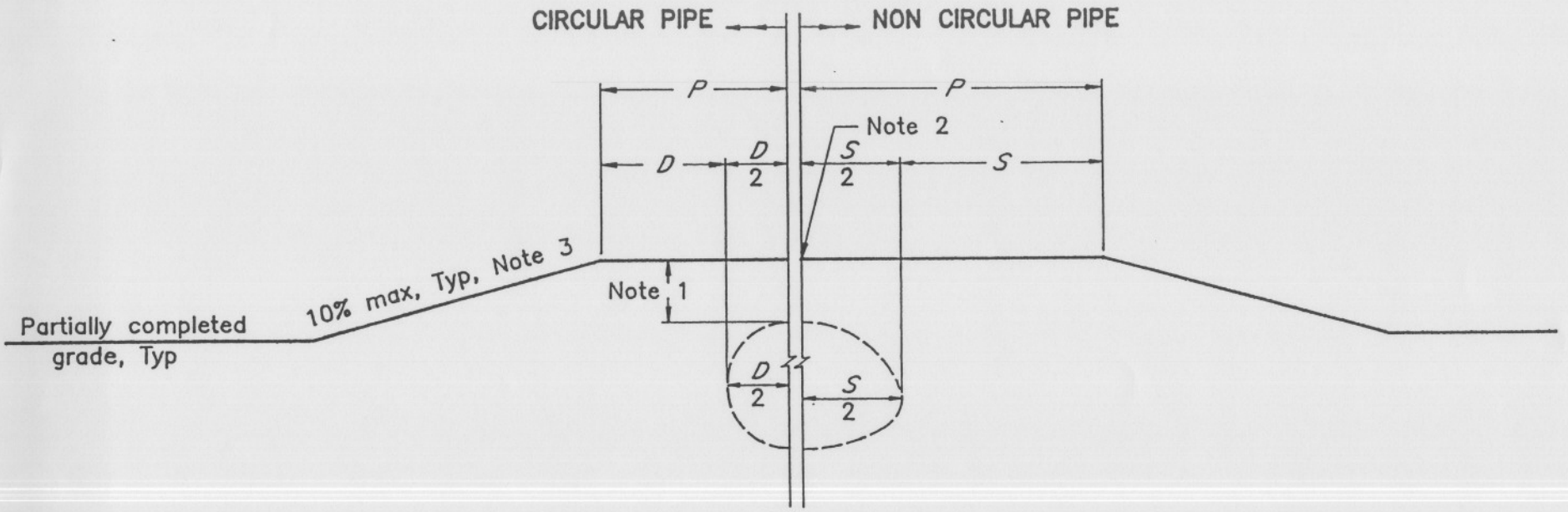
D Soil types as defined in the Health & Safety Act and Regulations for Construction Projects.

E All dimensions are in millimetres or metres unless otherwise shown.

LEGEND:

d – depth of roadbed granular
k – depth of frost treatment
f – depth of frost penetration
* – Type 3 soil
** – Type 4 soil

ONTARIO PROVINCIAL STANDARD DRAWING	1998 03 01	Rev	1
FROST TREATMENT – PIPE CULVERTS FROST PENETRATION LINE BETWEEN TOP OF PIPE AND BEDDING GRADE			
	OPSD – 803.031		



NOTES:

1 MINIMUM HEIGHT OF FILL FOR HEAVY EQUIPMENT CROSSING:

– For Flexible Pipe, the height of fill over top of pipe shall be 800mm or $\frac{D \text{ or } S}{4}$ plus 300mm whichever is greater.

– For Rigid Pipe, the height of fill over top of pipe shall be 1000mm min.

2 When protection is higher than subgrade, it is to be removed to subgrade level before placing granular base.

3 When protection is also used by public vehicular traffic, the maximum slope shall be 5%.

A This Standard to be used in conjunction with OPSD–802.010 to 802.014, 802.020 to 802.024, 802.030 to 802.034, 802.050 to 802.054, 803.030 and 803.031.

B All dimensions are in millimetres or metres unless otherwise shown.

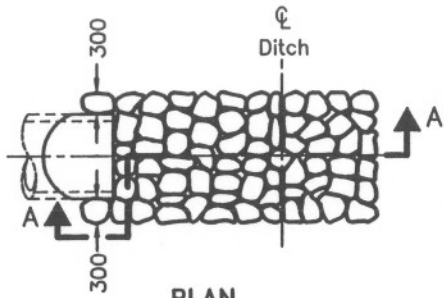
LEGEND:

P =1500mm, or 1.5D or 1.5S whichever is greater.

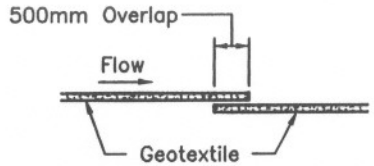
D =Inside diameter of circular pipe

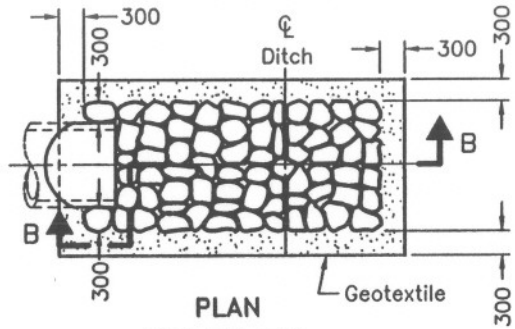
S =Span of non circular pipe.

ONTARIO PROVINCIAL STANDARD DRAWING	1996 09 15 Rev	
PIPE PROTECTION AGAINST HEAVY CONSTRUCTION EQUIPMENT	Date _____	OPSD – 808.010

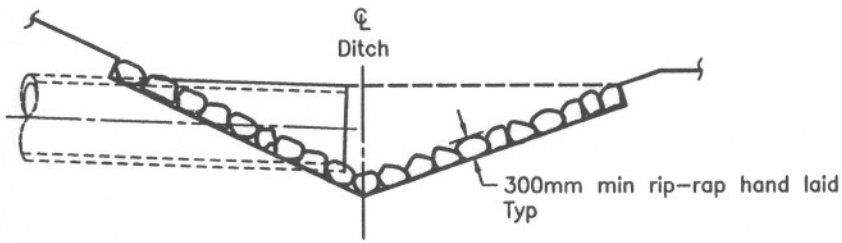


PLAN
CUT OR FILL

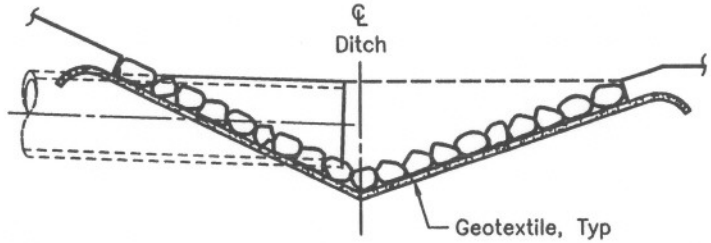




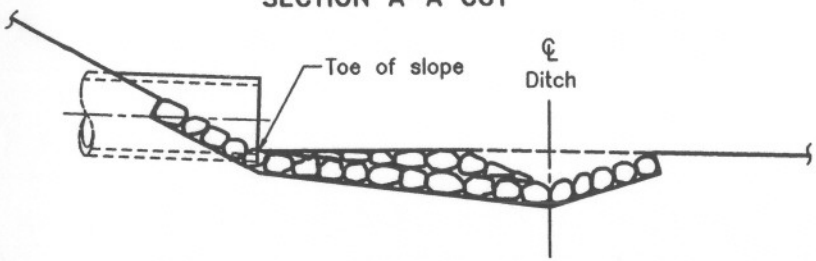
PLAN
CUT OR FILL



SECTION A–A CUT

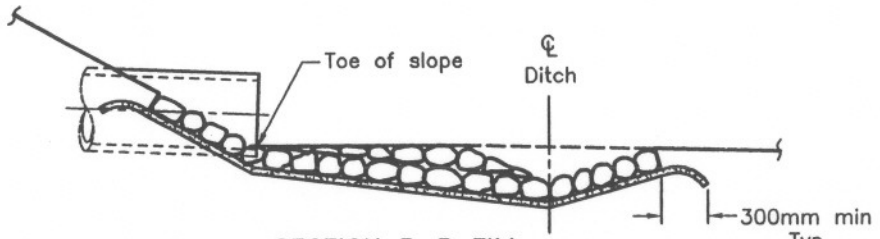


SECTION B–B CUT



SECTION A–A FILL

TYPE A – WITHOUT GEOTEXTILE



SECTION B–B FILL

TYPE B – WITH GEOTEXTILE

NOTES:

A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

RIP–RAP TREATMENT

FOR SEWER AND CULVERT OUTLETS

Nov 2001 | Rev 0

ONTARIO STANDARDS – MUNICIPAL – PROVINCIAL

OPSD – 810.010

APPENDIX F

Photographs

Photo 1
Highway 17 from intersection of Highway 17 & Lake Huron Dr., facing east.

Photo 2
Highway 17 from intersection of Highway 17 & Lake Huron Dr., facing west.

Photo 3
Proposed gabion basket retaining wall.
Location: West of Lake Huron Dr., facing northwest.

Photo 4
Proposed gabion basket retaining wall
Location: West of Lake Huron Dr., facing north.

Photo 5
Proposed gabion basket retaining wall
Location: West of Lake Huron Dr., facing east.

Photo 6
Proposed gabion basket retaining wall
Location: East of Lake Huron Dr., facing North.
Twin CSP culverts through Highway 17.
South end facing north.

Photo 7
Twin CSP culverts through Highway 17.
North end facing south.

Photo 8
Twin CSP culverts through Highway 17.
North end facing southeast.

Photo 9
Single & Twin CSP culverts through Lake Huron Dr. South
East end facing west

Photo 10
Single & Twin CSP culverts through Lake Huron Dr. South
East end facing northwest

Photo 11
Single & Twin CSP culverts through Lake Huron Dr. South
West end facing east

Photo 12
Single & Twin CSP culverts through Lake Huron Dr. South
West end facing east

Photo 13

Proposed location, for roadway protection, 1.0m North of centre line.