

G.I.-30 SEPT. 1976

REMARKS: _____

**Foundation Investigation & Design Report
Bridge Structure & Approaches
Trout Creek (Site 44-371S)
SOUTHBOUND LANES
Trout Creek By-Pass, King's Highway 11
District 54, Sudbury, Ontario
GWP No. 774-93-00**

Prepared For:

Marshall Macklin Monaghan
80 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N4

Trow Consulting Engineers Ltd.

Brampton, Calgary, Cambridge, Hamilton, Kingston, London, Markham, Montréal
North Bay, Iqaluit, Orillia, Ottawa, Sudbury, Thunder Bay, Winnipeg, Chicago, Tallahassee

807 Harold Crescent
Thunder Bay, Ontario, Canada
P7C 5H8

F98179-C/G
November 24, 1999

Telephone: (807) 623-9495
Facsimile: (807) 623-8070
e-mail: thunderbay@trow.com

Preface

Work Project GWP 774-93-00 is one of a series of projects for the four lane expansion of Highway 11. This project involves the four lane design of Highway 11, from 4.0 km south of Highway 522, northerly for 7.9 km. It will result in the construction of a by-pass of the existing Highway 11 to the west of the Town of Trout Creek.

This highway section is located in the Townships of Laurier and South Himsworth, within the geographic District of Parry Sound, as shown on the Key Plan, Figure A1 in Appendix A. The project requires geotechnical input for the following major components:

- New pavement design for the entire length of the four lane by-pass, including associated service roads.
- New structure, Trout Creek South Interchange (underpass), Site 44-372.
- New structure, Trout Creek Northbound Lanes, Site 44-371N.
- **New structure, Trout Creek Southbound Lanes, Site 44-371S.**
- New structure, Highway 522 (underpass), Site 44-370.
- New structure, Trout Creek North Interchange (underpass), Site 44-369.

This report deals with the new bridge structure for the **southbound lanes** at the proposed Trout Creek crossing, Site 44-371S, as well as the approach fills. Separate reports will be submitted for the additional components.

Part 1 of this report, Foundation Investigation, describes the geotechnical investigation methodology and the results derived, as pertaining to the design parameters required for the bridge foundations and related earthworks.

Part 2 of this report, Engineering Discussion and Recommendations, addresses the geotechnical engineering design considerations pertaining to the bridge foundations and the approaches.

Table of Contents

Preface	i
Table of Contents	ii
Part 1 Foundation Investigation	1
1.1 Introduction	1
1.2 Site Description and Geological Setting	1
1.3 Investigative Procedures	2
1.3.1 General	2
1.3.2 Field Investigation	2
1.3.3 Laboratory	4
1.4 Subsurface Conditions	4
1.4.1 Topsoil	5
1.4.2 Sand	5
1.4.3 Silty Sand	5
1.4.4 Silty Clay	5
1.4.5 Silty Sand and Gravel	7
1.4.6 Bedrock	7
1.5 Groundwater Conditions	9
Part 2 Engineering Discussion and Recommendations	10
2.1 Introduction	10
2.2 Foundations	11
2.2.1 Steel H-Piles (all locations)	11
2.2.2 Concrete Caissons (all locations)	14
2.2.3 Spread Footings	14
2.2.3.1 Spread Footings on Bedrock (WP1, WP2, WP3)	15
2.2.3.2 Spread Footings on Structural Fill (WP1 - South Abutment) ...	15
2.3 Backfill	17
2.4 Excavations and Dewatering	18
2.5 Bridge Approach Fills	19
2.5.1 Embankment Stability	20
2.5.1.1 South Approach Stability	20
2.5.1.2 North Approach Stability	21
2.5.2 Consolidation Settlement of Approach Embankments (North Approach)	
.....	21
2.5.2.1 Magnitudes of Consolidation Settlement	21
2.5.2.2 Time Rate of Consolidation Settlement	22
2.5.3 Secondary Compression of Clays	23
2.5.4 Rockfill and Rockfill Settlement	23
2.6 Instrumentation and Construction Monitoring	24
2.7 Closing Comments	24

Tables

Table 1-1.	Consolidation Parameters for Silty Clay	7
Table 1-2.	Bedrock and Refusal Depths and Elevations at Boreholes	8
Table 2-1.	H-Pile Design Pile Capacities (kN)	12
Table 2-2.	Pile Cap Insulation Dimensions	13
Table 2-3.	Concrete Caisson Design Capacities	14
Table 2-4.	ULS Reduction Factors for Inclined Loads on Spread Footings	15
Table 2-5.	Spread Footing ULS and SLS Bearing Resistance	16
Table 2-6.	Fill Types and Unfactored Geotechnical Properties	17
Table 2-7.	Geotechnical Parameters for Slope Stability Analyses	20
Table 2-8.	Estimated Embankment Consolidation Settlement - North Approach	22

Appendix A

Figure A1.	Key Plan
Figure A2a.	Borehole Location Plan and Profile - South
Figure A2b.	Borehole Location Plan and Profile - North
Figure A3.	Undrained Shear Strength, Atterberg Limits and Effective Stress Profiles
Figure A4.	Undrained Shear Strength - All Boreholes
Figure A5.	Estimated Consolidation Settlement - NORTH APPROACH

Appendix B

Borehole Logs and Rock Descriptions

Appendix C

Results of Laboratory Testing (grain size, Atterberg Limits, consolidation tests)

Appendix D

Stability Analysis Printouts

Rear Pockets

- Drawing No. 1. Bridge Site Plan & Profile
- Drawing No. 2. Bridge Site Plan & Sections

Part 1 Foundation Investigation

1.1 Introduction

This report presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the proposed bridge structure and approaches for the southbound lanes (SBL) at the Highway 11, Trout Creek crossing at Site 44-371S.

An original investigation was completed at this site in June and July of 1998 for an originally proposed 105 m long (\pm) three span structure. However, for technical reasons based on the results of the original investigation, as discussed more fully in Part 2 of this report, a longer (242 m), five span bridge was selected. Accordingly, a supplementary investigation was completed during September and November, 1998 which investigated the subsurface conditions at the revised pier and abutment locations of the new proposed five span structure, where conditions were not previously investigated as part of the original work.

This report contains the results of the supplementary investigation, plus the relevant results of the original investigation, compiled for the five span structure arrangement of the Highway 11, southbound lane crossing of Trout Creek. It is Trow's understanding that the 5 span structure will be located with the central span crossing Trout Creek. The structure will include an approximately 14 metre high south abutment, 22 metre high centre span, and 7 metre high north abutment. The span lengths will be approximately 40, 54, 54, 54, 40 metres in length, creating a bridge with a length of about 242 metres.

1.2 Site Description and Geological Setting

The site is located in Lot 30, Concession 2, Township of South Himsforth, District of Parry Sound, along the banks of Trout Creek, about 2 km west of the Town of Trout Creek, and 750 metres south of Highway 552, as shown on Figure A1, in Appendix A.

Generally, the terrain at the site is sloping towards the creek and is well drained. However several drainage gullies run parallel and perpendicular to the creek, with steep embankments on either side of the gullies, creating a highly variable terrain in the vicinity of the proposed structure. The relief

can vary at slopes steeper than 1H:1V within the site. There are mature trees with heavy underbrush across the site.

According to OGS Maps 2544 and 2556, as well as Ontario Geological Survey Map P.3160 (Quaternary Geology, South River Area), the site is located in what is known as the Central Gneiss Belt, with mainly felsic igneous rocks of the Mesoproterozoic Group.

The overburden soils have been mapped as glaciolacustrine deposits consisting of laminated, rhythmically bedded (also referred to as varved) to massive silts and clays. The southernmost portion of the site edges onto an area mapped as a bedrock drift complex with relatively thin, primarily cohesionless soil cover (till).

1.3 Investigative Procedures

1.3.1 General

Part 1 of this report describes the investigative procedures used for the geotechnical assessment of the southbound lanes crossing of Trout Creek, within the Trout Creek By-Pass, King's Highway 11. Properties of the overburden soils were obtained by *in situ* and laboratory testing and the procedures employed during the investigation are described below.

1.3.2 Field Investigation

The initial field investigation, or explorations, for the originally proposed three span arrangement was carried out between June 9 and July 2, 1998. Originally these explorations investigated only the pier and abutment locations, as well as the immediate approach embankments. With the discovery of clay at this site additional explorations were advanced, while initially on site, to outline the vertical and areal extent of the clay within the approach embankments. A further investigation of the north approach was completed September 23 and 24, 1998. The supplementary investigation of the revised, five span, arrangement occurred between November 10 and 24, 1998.

The locations of the boreholes, cones and probes, completed as part of these investigations are shown on Figures A2a and A2b, in Appendix A, as well as on Drawings, No. 1 and No. 2, located in the pockets at the end of this report. These locations, as well as the surface elevations, were established

from the terrain model for the project, and/or a survey crew from Marshall Macklin Monaghan, and are referenced to geodetic datum.

The investigation of the piers and abutments of the five span arrangement includes 12 boreholes (BH-1OF to BH-10OF, BH-4EF, BH-20EF), eight dynamic cone penetration tests (C-1EF, C-6EF, C-11OF to C-14OF, C-4EF, C-7EF), and nine auger probes (AP-1OF to AP-8OF, AP-1EF). All of these explorations were advanced to auger refusal or to refusal of the penetration cone ($N > 100$). Six of the boreholes were advanced into the bedrock to obtain core, as described below.

The investigation of the approaches included two additional boreholes (BH-17EP, BH-18EP) at the south approach and four additional boreholes (BH-20EP to BH-23EP) at the north approach. All of these boreholes were advanced to auger refusal, except for BH-23EP, which was terminated at a depth of about 14 m.

Other explorations completed in the vicinity of the SBL structure as part of the original three span investigation included nine boreholes, three dynamic cone penetration tests, and one auger probe, in addition to those explorations completed as part of the NBL investigations (see foundation report for the NBL structure).

The boreholes, cones and probes were advanced through the overburden soils using a Bombardier mounted CME-55 drill and a Dietric 50 drill, equipped with solid and hollow stem augers, and supplied by a soils drilling contractor, Master Soil Investigations Limited. At some of the borehole locations, a bulldozer was used to prepare the site for drill access.

Soil samples were obtained by using a 51 mm OD split-spoon sampler in conjunction with standard penetration tests at approximately 0.75 m and 1.5 m intervals. The standard penetration (N) values, together with the blows from the dynamic cone penetration tests, were recorded and used to provide an assessment of the compactness or consistency of the overburden soils. Sampling and testing procedures were in general accordance with ASTM D1586.

Several undisturbed, nominal 50 mm diameter, 'Shelby' tube samples were also obtained in the cohesive deposits. Field vane testing was completed in the boreholes and the auger probes throughout the cohesive soils to measure the *in situ* undrained shear strength of the cohesive soils. The field vane used had dimensions of 152 mm long by 70 mm diameter, not including the pointed 45° point. Torque measurement was by using two calibrated scales on a calibrated lever arm threaded to the drill rods. The testing was in general accordance with ASTM D2573.

The recovered soil samples were taken to Trow's Sudbury laboratories for additional examination, identification and laboratory testing.

At each bridge foundation element, conventional rock coring techniques were used to advance one of the explorations approximately 3 metres into the underlying bedrock. At Pier WP5, two boreholes were cored. A BQ size core barrel and casing was used and core samples of the bedrock were retrieved for rock quality determination and classification. The seven boreholes advanced into the underlying bedrock included BH-2OF, BH-3OF, BH-5OF, BH-7OF, BH-8OF, BH-4EF, and BH-9OF.

Details of the soil and bedrock conditions encountered in the boreholes are included on the logs in the attached Appendix B.

1.3.3 Laboratory

The laboratory testing program for selected soil samples consisted of the following:

- natural moisture content
- unit weight
- grain size distribution
- laboratory shear tests (lab vane, penetrometer)
- Atterberg limits
- 1-d consolidation test

The laboratory test results are summarized on the attached borehole logs in Appendix B and are also presented in Appendix C. Many of the results are also discussed in the following descriptive sections.

1.4 Subsurface Conditions

The borehole locations are shown on the site plans, Figures A2a and A2b in Appendix A, as well as on Drawings, No. 1 and No. 2. Centerline soil profiles are also shown on the Figures and Drawing No. 1 and the soil cross sections at the locations of the foundation elements are shown on Drawing No. 2.

The borehole, auger probe and dynamic cone penetration (CPT) logs are provided in Appendix B. In general, the following main soil layers were encountered, with increasing depth:

- topsoil
- sand
- silty sand
- silty clay
- silty sand and gravel
- bedrock

A summary of the soil strata encountered in the boreholes, and inferred from the probes and dynamic cone penetration tests, is presented below.

1.4.1 Topsoil

The majority of boreholes encountered a surficial layer of up to about 300 mm of topsoil. At some of the borehole locations, a bulldozer was used to prepare the site for drill access, thus the topsoil in these areas was removed in the process and the logs do not indicate the presence of topsoil.

1.4.2 Sand

A 300 mm to 600 mm thick layer of loose to compact, fine to medium grained brown sand was encountered beneath the topsoil at Boreholes, BH-9OF and BH-10OF, at the location of the north abutment, and was underlain by silty clay, as described below.

1.4.3 Silty Sand

Brown to grey, very loose to loose (N-values of 1 to 5) silty sand was encountered beneath the topsoil in Boreholes, BH-6OF and BH-7OF at the location of Pier WP4, adjacent to the north bank of Trout Creek. The soil contained organics such as roots and pieces of wood and may be a recent stream alluvium. At BH-6OF, the thickness was about 4 m and was underlain by the silty sand and gravel, described below. In BH-7OF, the silty sand was underlain by silt clay at a depth of about 2.3 m.

1.4.4 Silty Clay

Beneath the upper sand, topsoil, or silty sand, a stratum of silty clay was encountered as the principal soil in all boreholes at the locations of the foundation elements except at the south abutment (WP1),

BH-4OF at Pier WP2, and BH-6OF at Pier WP4. At the south abutment, the native soil consists of silty sand and gravel, described below. Silty sand and gravel was also encountered in BH-4OF (Pier WP2). In BH-6OF (Pier WP4), silty sand, as described above, was encountered.

The silty clay, where encountered, is relatively thin (1.5 m) in BH-3OF at the location of Pier WP2, and increases in thickness to between about 12 m to 14 m on the north side of Trout Creek, in the area of the north abutment and approach.

Generally, the silty clay is thinly laminated with silt (varved). The individual layers, or laminations, varied in thickness from a few millimetres to a few centimetres, but in general were less than about one centimetre. The proportions of clay to silt and clayey silt varied also, but in general the clay portion dominated.

The natural moisture content of the clay varies from about 20% to over 50% (depending on the silt content) and consistency. Atterberg limit determinations provided the following approximate ranges: Plastic Limit, 18 to 23; Liquid Limit, 28 to 50; Plasticity Index, 8 to 30. These data indicate that, in general, the clay can be described as a medium plasticity silty clay (CI). Locally, clayey silt soil (CL) was encountered. Typically, the silty clay is drier near the top and bottom, but there does not appear to be a depth relationship relative to the Atterberg Limits. The laboratory test data are shown on the borehole logs, on Figure A3 in Appendix A, and in Appendix C.

Standard penetration test (SPT) values ranging from about 1 to over 20 were obtained in the silty clay. The higher values were generally obtained within the upper metre, or so. *In situ* field vanes and laboratory shear vane testing, as well as the SPT values, indicate that the silty clay has a stiff to very stiff crust with undrained shear strengths exceeding 100 kPa. The silty clay consistency, however, reduces with depth to soft to firm to stiff, with undrained shear strengths of about 20 kPa to 70 kPa, at depths of about 3 m to 5 m. Sensitivity, the measure of peak shear strength to remoulded shear strength, ranged from about 2 to 16, with an average of about 7, indicating the clay is moderately sensitive. The undrained shear strength profile which includes shear strength data from all boreholes is shown on Figure A4. The strength profile shown on Figure A3 is based on the strength data from boreholes at the locations of the abutments and the design profile assumed is based on the actual vane test results and the SPT values.

Based on all the above, and with reference to Figure A3, it is evident that the clay is heavily overconsolidated in the upper 3 m to 4 m, becoming moderately to lightly overconsolidated with increasing depth. The preconsolidation pressure near the top of the stratum is estimated at about 400 kPa, on average. The overconsolidation ratio (OCR) is estimated as ranging from over 30 near

the top to about 3 at a depth of about 3 m. Thereafter with increasing depth, the OCR decreases gradually to about 1.6 at a depth of 14 m.

A one-dimensional consolidation test was performed on a sample of the silty clay extruded from a thin walled Shelby tube, obtained from BH-21EP. The results are presented graphically and numerically in Appendix C. The data are also summarized below in Table 1-1, along with the value ranges used in our subsequent analyses.

Table 1-1. Consolidation Parameters for Silty Clay		
	BH-21EP, 3 m	Values for Analyses
Compression ratio, $C_c' (= C_c/(1+e_0))$	0.08	0.08 - 0.20
Recompression ratio, $C_r' (= C_r/(1+e_0))$	0.006	0.008 - 0.02
Coefficient of consolidation (recompression), C_{vr}	40	25 - 60 (avg 40)
Coefficient of consolidation (virgin), C_v	7	5 - 12 (avg 8)
Coefficient of secondary compression, $C_{\alpha\epsilon}^*$	0.003 - 0.004	0.003 - 0.005
Notes: Coefficients of consolidation in units of $m^2/year$		
* $C_{\alpha\epsilon} = \Delta H/H_0$ (= secondary compression ratio, in some literature)		

1.4.5 Silty Sand and Gravel

A basal deposit of loose to dense, brown silty sand and gravel was encountered above the bedrock (or refusal) surface in almost all boreholes. Standard penetration indices (N-values) ranged from about 5 to over 100. Its thickness varied from less than about 0.5 m to over 3.5 m. Where bedrock is relatively shallow, such as at the south abutment, the sand and gravel was encountered as the uppermost soil overlying the bedrock.

1.4.6 Bedrock

The presence of bedrock was established by retrieving "BQ" size cores at each of the six foundation element locations, for depths of between about 3.1 m and 3.5 m. Detailed descriptions of the rock are presented in Table 1-1 in Appendix B, following the borehole logs. Generally, the bedrock can be described as a pink and light grey, biotite-hornblende gneiss. The rock is strong and unweathered for the most part.

Rock core recovery was 100% for all runs and the Rock Quality Designation (RQD) values for individual core runs ranged from about 35% to 96%. The average RQD for the rock core recovered was about 80%, based on the 23 core runs. In accordance with the MTO classification system, the rock quality can be described as poor to excellent, with an average of fair. It is noted that the RQD values are likely conservative; it is expected that higher values would be obtained using NQ core.

Table 1-2, below, lists the bedrock depths and elevations as well as those of refusal, at the locations of each of the six foundation elements. It can be seen that the bedrock and refusal depths and elevations are quite variable, even within short distances at the individual element locations. Refusal (to augering or dynamic cone penetration testing (CPT)) is inferred to be due to probable bedrock, but it is noted that refusal may be due to cobbles, boulders, or very dense soil. The bedrock depths and elevations have been positively established only at the locations where the bedrock has been cored.

Table 1-2. Bedrock and Refusal Depths and Elevations at Boreholes					
Location	Borehole	Orig. Gr. Elev. (m)	Bedrock or Refusal Elev (m)	Overburden Thickness (m)	Comment RQD (by run)
WP1 South Abutment	BH-1OF	310.76	307.56	3.20	auger refusal
	BH-2OF	311.74	308.62	3.12	B/R cored 80%, 80%, 90%
	AP-1OF	312.05	309.15	2.90	auger refusal
	AP-2OF	312.05	310.17	1.68	auger refusal
	AP-3OF	311.24	308.56	2.68	auger refusal
	AP-4OF	311.83	309.09	2.74	auger refusal
WP2 Pier	BH-3OF	305.90	302.55	3.35	B/R cored 75%, 97%
	BH-4OF	306.84	303.94	2.90	auger refusal
	AP-5OF	306.65	302.54	4.11	auger refusal
	AP-6OF	307.39	304.71	2.68	auger refusal
	AP-7OF	306.10	302.38	3.72	auger refusal
	AP-8OF	305.77	302.72	3.05	auger refusal
WP3 Pier	BH-5OF	303.79	298.52	5.27	B/R cored 35%, 50%, 60%
	AP&C-1EF	301.02	295.84	5.18	auger/cone refusal
	C-6EF	300.50	295.90	4.60	CPT refusal

Table 1-2. Bedrock and Refusal Depths and Elevations at Boreholes					
Location	Borehole	Orig. Gr. Elev. (m)	Bedrock or Refusal Elev (m)	Overburden Thickness (m)	Comment RQD (by run)
WP4 Pier	BH-6OF	299.89	293.95	5.94	auger refusal
	BH-7OF	300.22	293.90	6.32	B/R cored 70%, 92%
	C-11OF	300.01	293.33	6.68	CPT refusal
	C-12OF	300.16	293.94	6.22	CPT refusal
	C-13OF	300.57	293.96	6.61	CPT refusal
	C-14OF	300.12	294.06	6.06	CPT refusal
WP5 Pier	BH-8OF	303.23	294.94	8.29	B/R cored 65%, 78%
	BH-4EF	305.36	295.45	9.91	B/R cored 80%, 90%
	BH-20EF	303.20	293.90	9.30	auger refusal
	C-7EF	303.70	294.51	9.19	CPT refusal
WP6 North Abutment	BH-9OF	312.07	297.65	14.42	B/R cored 82%, 93%
	BH-10OF	311.62	297.96	13.66	auger refusal

1.5 Groundwater Conditions

Information regarding the groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling and by tactile examination of the recovered samples. The measured or inferred groundwater levels are shown on the borehole logs and the stratigraphic sections. In general, the groundwater table at the times of the field work was between about 1 m and 4 m in depth. It appears to follow the topography and this suggests that local subsurface drainage would be towards Trout Creek.

Part 2 Engineering Discussion and Recommendations

2.1 Introduction

The following subsection addresses the geotechnical design considerations pertaining to the proposed five span bridge for the Southbound Lanes crossing of Trout Creek, as well as the approaches.

An original investigation was completed at this site in June and July of 1998 for an originally proposed 105 m long (\pm) three span structure and revealed significant clay deposits on either side of Trout Creek which caused concern for the stability of the approach embankments, which were about 20 m high. Various design alternatives were considered including removal of the clay to the underlying bedrock, extensive berming of the embankments, the use of lightweight fill within the embankments, retaining walls, and a lengthening of the structure to limit the impact of the clay deposits. A subsequent cost benefit analysis of the design alternatives proposed by Trow, performed by Marshall Macklin Monaghan, indicated the preferred alternative was to lengthen the structure.

It was considered that the lengthened structure would effectively span the clay deposit, so that the approach embankments could either be located on a thinner or absent clay layer, or alternatively the lengthened structure would extend to the point where the height of the approach embankments could be reduced, and thus reduce or eliminate the complications encountered by placing high approach embankments on thick clay deposits.

Upon MTO acceptance of the lengthened structure alternative, a supplementary investigation was completed during September and November, 1998 as described in Part 1 of this report. The supplementary investigation examined the soil conditions at the revised pier and abutment locations of the new proposed five span structure, where conditions were not previously investigated as part of the original work.

The five span bridge is proposed to carry southbound Highway 11 traffic over Trout Creek and its valley. It is Trow's understanding that the bridge will be located with the central span crossing Trout Creek. The structure will include an approximately 14 metre high south abutment, 22 metre high centre span, and 7 metre high north abutment. The span lengths will be approximately 40, 54, 54, 40 metres in length, creating a bridge with a length of about 242 metres.

It is understood that the project is scheduled for completion within a two year time frame. Accordingly, some of the discussions and design recommendations presented herein are based on this time frame.

2.2 Foundations

In general, because of the presence of loose to compact sand and silt and relatively weak and compressible clay at the locations of the foundation elements, it is not considered feasible to support the proposed bridge foundations on spread footings constructed on the native mineral soils. For all foundation elements, driven steel H-piles are considered to be the preferred alternative. Alternate types of foundations may, however, be considered for the support of the bridge piers and abutments. The alternate types that are considered applicable to the site and proposed layout include large diameter reinforced concrete caissons and spread footings on rock or structural fill. Not all of these foundation types are applicable to all six foundation elements.

The following sections present the foundation design recommendations for the six foundation elements of the proposed bridge.

2.2.1 Steel H-Piles (all locations)

All abutments and piers are recommended to be supported on steel H-piles driven to the bedrock surface, using the ULS capacities for HP310x110 and HP310x132 sections, as given in Table 2-1, below.

Current design practice requires that consideration be given to downdrag loads that may be generated as a result of soil consolidation due to fills, groundwater table fluctuations and the soil stresses induced by pile installation. We consider that, even after primary consolidation of the clay soils due to the fill placement is complete, the potential exists for downdrag loads due to events such as significant groundwater lowering and the long term process of secondary compression. At this site, secondary compression is the likely mechanism. Secondary compression of the clay foundation soils is discussed further in a subsequent section of this report. Accordingly, we have considered the effects of downdrag loads on the pile capacities given in the following sections, where applicable.

Table 2-1. H-Pile Design Pile Capacities (kN)						
	HP 310x110			HP 310x132		
Factored Structural Capacity (OHBDC)	3285			3890		
Factored Axial Resistance (MTO*)	2000			2300 (est)		
Pile Location ----->	South Abutment W1	Piers W2, W3, W4, W5	North Abutment W6	South Abutment W1	Piers W2, W3, W4, W5	North Abutment W6
Factored Downdrag Load	-	-	1200	-	-	1500
Factored Axial Capacity at ULS**	2000	2000	2000	2300	2300	2300
Notes: MTO* = Structural Office Policy Memo 98-01, April 15, 1998 ** Factored axial capacity at ULS is the lesser of , a) factored structural capacity minus factored drag load, or b) factored axial resistance. SLS capacity not applicable to piles driven to bedrock						

The axial capacity at SLS is not applicable to steel piles driven to bedrock because very high loads, in excess of the ULS capacity, are required to produce unacceptable deformations. The pile structural capacity will govern.

The capacities given are axial capacities, for both vertical and inclined piles. No reduction is required for inclined piles. Notwithstanding the above, the horizontal and vertical loads acting on all piles must be resolved axially, such that the vector sum of these loads does not exceed the ULS capacity provided above.

For design purposes, the modulus of horizontal subgrade reaction for steel H-piles can be taken as 8,000 kN/m³ for the cohesive soils (silty clays) and 40,000 kN/m³ for the cohesionless soils. It is expected, however, that inclined piles will be required to accommodate the lateral loads. These can be designed using the same axial capacities given in Table 2-1.

A minimum soil embedment depth of 3 m below the pile cap is recommended. Pile caps should be provided with at least 2 m of soil cover for frost protection. Local grade raises may be required in order to provide this cover.

If the underside of the pile caps cannot be provided with a minimum of 2 m earth cover, insulation will be required. Insulation should consist of rigid board extruded polystyrene, meeting CAN/CGSB-51.20-M87 (Type 4), such as DOW SM™. The insulation is recommended to be placed

beneath the pile caps, prior to placement of concrete. Since the insulation will not carry any significant loads, high strength/low compressibility insulation (such as *DOW HI40™*, etc.) is not required. Products other than those made by *DOW CORNING* may be used, provided they meet the above noted specification.

The insulation thickness and lateral extension beyond the edges of the pile caps will depend on the depth of placement (i.e., underside of pile cap), in accordance with Table 2-2, below. A minimum soil cover of 300 mm is recommended over the top of the insulation.

Table 2-2. Pile Cap Insulation Dimensions		
Depth (mm)	Thickness (mm)	Lateral Extension (mm)
500	90	1500
1000	50	1000
1500	25	500

As discussed in following subsections of this report, substantial settlements of the north approach fill will occur as will some associated lateral strains. Accordingly, piles should not be installed until after the majority of the fill settlement has occurred, based on monitoring during construction. This is particularly important for inclined piles, that would be subjected to bending stresses.

All piles should be driven to bedrock. Pile tip elevations can be estimated from Table 1-2 which provides the bedrock or refusal elevations encountered at the boreholes drilled at the various foundation elements. The boreholes indicate that the bedrock elevations are quite erratic and the potential for irregular steeply sloping bedrock at the foundation locations is considered to be high at most locations. As such, problems may arise during pile seating. At some locations, the piles may have a tendency to skip over the bedrock surface resulting in alignment problems and deeper penetration. In the event that this problem occurs, somewhat longer piles may be required and, in some cases, piles may have to be added or replaced.

To minimize seating difficulties, rock injector points should be used to facilitate proper seating. All piles must be fitted with reinforcing plates welded to the flanges as per OPSD 3301 to minimize pile damage. It is recommended that, during pile driving and upon initial contact with the bedrock, the

pile driving energy should be reduced and subsequently increased incrementally until the piles have been sufficiently seated.

2.2.2 Concrete Caissons (all locations)

As an alternative foundation system, concrete caissons installed on or into the bedrock can be considered for all locations. However, they will likely only be practical for the foundations at the south abutment (WP1) and Piers WP2 and WP3, where the bedrock surface is generally within about 1.7 m to 5.3 m below original grade. The load capacity will be derived by end bearing, in accordance with the values given in Table 2-3. As for steel H-piles, the effects of downdrag loads must be considered.

Table 2-3. Concrete Caisson Design Capacities	
Factored Downdrag Load (north abutment only)*	3800 kN per m of pile diameter
Factored Bearing Resistance at ULS	8000 kPa
Notes: SLS resistance not applicable to caissons on bedrock * Factored Downdrag Load to be applied to the factored dead loads	

In order to provide an adequate socket, the caisson should be installed at least one pile diameter into the bedrock, or be heavily dowelled. While these units can provide high capacities, because of the irregular and potentially steeply sloping bedrock surface expected at this site, caisson installation may prove difficult, thus expensive. This is complicated by the fact that in most cases the bedrock is overlain by silty sand and gravel that may create dewatering and stability problems during work at the base of the caissons.

2.2.3 Spread Footings

Spread footings for the south abutment and Piers, WP2 and WP3, can be considered for design and construction on bedrock or on structural fill, as described in the following sections. We do not consider spread footings to be feasible alternatives for the remaining foundation elements, either because of a great depth of excavation or low SLS bearing resistance for footings near the ground surface.

2.2.3.1 Spread Footings on Bedrock (WP1, WP2, WP3)

An alternate foundation for the south abutment (WP1) and Piers WP2 and WP3 is a spread footing constructed on the bedrock. The elevations of footings can be estimated from Table 1-2. This alternative is not considered practical for the other locations because of the excavation depths exceeding 6 m. The factored bearing resistance at ULS for footings on unweathered bedrock is **8,000 kPa**. The bearing resistance at SLS does not apply because of the much higher pressures required to produce unacceptable deformations.

In order to evaluate the sliding resistance of spread footings on bedrock, the unfactored coefficients of friction for mass concrete on clean bedrock can be taken as 0.7. If the factored resistance against sliding failure is inadequate based on friction only, steel dowels will be required for footings on bedrock.

The ULS capacity of spread footings must be reduced for the effects of inclined loads. The reduction factors given in Table 2-4, below, can be used for footings on bedrock. Interpolation is possible. These factors must be applied to the ULS bearing resistance given previously.

Table 2-4. ULS Reduction Factors for Inclined Loads on Spread Footings	
Ratio of Horizontal to Vertical Load	Footings on Rock
0.1	0.86
0.2	0.76
0.3	0.66
0.4	0.58
The ULS reduction factors for inclined loads have been taken from Figure 6-8.4.2 of the OHBDC	

2.2.3.2 Spread Footings on Structural Fill (WP1 - South Abutment)

Spread footings can be designed for construction on structural fill at the south abutment. Structural fill should be constructed after removal of the overburden soils, where shallow, or it can be placed on the stripped native soils, as described below. For spread footing support, it is recommended that the structural fill consist of OPSS Granular A, placed in small lifts and adequately compacted (100%

standard Proctor). Alternatively, a relatively fine well graded rockfill, with a maximum size of 300 mm can be used. This finer graded rockfill should be placed in lifts limited to about 500 mm and adequately compacted with heavy vibratory rollers (minimum 6 passes, 10 tonnes).

At the south abutment, a spread footing abutment foundation, if considered, should be designed for construction in the approach fill, with a depth of about 2 m below the slope face. This would place the base of the footing at a distance of about 7 m to 8 m above original ground, at an elevation of about 318 m.

If the native granular soils are left in place, the structural fill supporting the foundation should have a thickness at least equal to the width of the footing. In addition, the structural fill should be constructed to occupy a zone, down and out from the footing edges at a slope of no steeper than 1H:2V, in order to accommodate the footing stresses.

The ULS resistance values given in Table 2-5, below, can be used for design. For 25 mm immediate settlement, the SLS resistance is greater than at ULS. Accordingly, the ULS resistance governs the design. Consolidation settlement is not considered an issue at this location since cohesive soils were not encountered in the investigation.

Table 2-5. Spread Footing ULS and SLS Bearing Resistance	
Factored Bearing Resistance at ULS on Unweathered Bedrock ¹	8000 kPa
Factored Bearing Resistance at ULS on Structural Fill ²	1000 kPa
Bearing Resistance at SLS - Initial Elastic Settlement - Structural fill ³	> 1000 kPa
Notes: 1. SLS resistance not applicable to footings on bedrock 2. Thickness of structural fill greater than footing width 3. Structural fill placed on native granular soils after removal of organics/topsoil, and bottom of footing about 7 m to 8 m above original ground (approx el. 318 m).	

For the determination of the sliding resistance of spread footings, the unfactored coefficient of friction for mass concrete on granular structural fill can be taken as 0.6. If the factored resistance against sliding failure is inadequate based on friction only, a soil key can be considered for footings on structural fill, making use of the passive soil resistance. Passive earth pressure coefficients are provided in Section 2.3.

The ULS resistance of spread footings must be reduced for the effects of inclined loads. For footings on granular structural fill, Figure 6-8.4.2 of the OHBDC may be used for the applicable footing depth to effective width ratio. These factors must be applied to the ULS resistance given previously in Table 2-5.

2.3 Backfill

Backfill for abutments or retaining walls should consist of free draining granular materials such as Granular A, Granular B, or rock fill. Computation of earth pressures shall be in accordance with Section 6.7.4 of the Ontario Highway Bridge Design Code. Unfactored properties for backfill materials are provided in the following Table 2-6.

Table 2-6. Fill Types and Unfactored Geotechnical Properties					
Material	Friction Angle, ϕ'	γ (kN/m³)	K_A	K_P	K_0
Granular A	35 degrees	22	0.27	3.7	0.43
Granular B	30 degrees	21	0.33	3	0.5
Rock Fill	42 degrees	20	0.2	5	0.33
Note: Values given for K_A and K_P are for horizontal backfill, and will vary for other configurations. K_A is the earth pressure coefficient corresponding to the active state. K_P is the earth pressure coefficient corresponding to the passive state. K_0 is the earth pressure coefficient at rest.					

The mobilization of full active or passive resistance requires a measurable and perhaps significant wall movement or rotation, in general accordance with that indicated in Figure C6-7.1 of the OHBDC. Therefore, unless the structural element can tolerate these deflections, the at rest earth pressure should be used in design. Alternatively, partially mobilized active and passive earth pressure coefficients may be used, in accordance with the deflections given in the Figure.

The effects of compaction surcharge should be taken into account in the calculation of active and at rest earth pressures. In accordance with Section 6-7.4.3 of the OHBDC, the lateral pressure due to compaction should be taken as at least 16 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

16 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.

If rock fill is used as backfill behind abutments, the particle size should be limited to no greater than 300 mm and the backfill must be placed carefully in a manner that does not cause damage to the abutments or other structural components of the bridge.

Weep holes should be provided in the abutments and a filter wrapped, 150 mm diameter perforated PVC drainage pipe should be installed behind the abutments, at or slightly above the base.

2.4 Excavations and Dewatering

All work associated with design and construction relative to excavations shall be in accordance with Part III of Ont. Reg. 213/91 of the Occupational Health and Safety Act. Where the width of the base of the excavation is less than twice its depth, conformance with this regulation is required.

The existing organic zone (topsoil) with a depth ranging to about 300 mm will have to be removed from beneath the approach fill footprints. For pile caps at the pier locations, excavations of at least 2 m depth will likely be required, in order to provide the recommended frost cover. Since the ground surface is uneven at the pier locations, deeper excavations will be required to place the pile cap at a common elevation, unless the finished site grades are raised with fill or the caps are provided with insulation. Based on the borehole information, excavations would generally proceed through the loose to compact upper sand and into the stiff to firm silty clay at most locations.

At the locations of Piers WP2, WP3 and WP5, excavations should be relatively straight forward, since they will likely terminate above the prevailing groundwater level. The upper sand and silty clay is considered a Type 3 soil and excavations should be cut back to at least 1H:1V. If minor groundwater seepage occurs and loosens/softens the soil, flatter slopes will be required. Dewatering of the excavations should be possible by pumping from sumps within the excavations.

At the location of Pier WP4, on the north side of Trout Creek, the excavation will likely be carried out entirely within the loose to compact silty sand and would terminate close to or below the prevailing water level of Trout Creek. These soils would then be classified as Type 4 soils and excavations should be sloped back at 3H:1V. Pumping from sumps within the excavation should

suffice here as well, in order to maintain a safe and workable area, although more aggressive effort will likely be required. In order to stabilize the base of the excavation if it becomes loosened due to groundwater infiltration, a 300 mm layer of crushed clear stone may be required to improve working conditions.

If the native soils are to be removed and replaced with structural fill at the south abutment, or to place foundations on the bedrock at Piers WP2 and WP3, excavations of between about 1.7 m and 5.3 m will be required, based on the results of the investigation. The soils to be excavated will consist of sand, and silty sand and gravel, as well as silty clay in some locations. The water table would be encountered well above the 5.3 m depth. Accordingly, excavations in this area should be sloped back at 3H:1V, or flatter. Aggressive pumping from sumps will likely be required. Alternatively, sheeted and braced excavations could be considered, but this may prove problematic because of the variable bedrock surface.

Excavations carried out within granular structural fill in the approaches can likely be completed using a 1H:1V cut since it will be above the water table.

It is recommended that a non-standard special provision (NSSP) for dewatering be provided in the contract documents.

2.5 Bridge Approach Fills

The construction of the bridge approaches will require embankment fills of up to about 14 m height at the south abutment and about 6 m height at the north abutment. The soils at the south abutment are predominantly granular, with a maximum thickness of about 3.5 m, based on the results of the investigation. At the north abutment, the principal soils consist of stiff to firm silty clay, to depths of up to about 14 m. The two principal design and construction considerations are embankment stability and consolidation settlement. These two issues are discussed in the following sections.

In all of the following discussions, it is assumed that all organic material (topsoil) is removed from beneath the embankments and the embankments are constructed on the native mineral soils. Fill heights should be measured from the top of the native mineral soil.

2.5.1 Embankment Stability

Highway embankments can be constructed using structural fill of various acceptable soil materials. Typically, however, in this part of the province they are constructed using rockfill as the principal component. A typical MTO section will consist of a minimum (steepest) slope of 1.25H to 1V to a maximum height of 6 m. For embankment sections greater than 6 m height, a 2 m wide horizontal bench is required before the next 6 m, 1.25H to 1V lift is constructed. A 14 m crest width has also been assumed, based on the drawings provided.

Slope stability analyses have been performed using SLOPE/W (ver. 3.x), based on Bishop's Method, using total stress parameters, for the cohesive soils. This analysis would apply to rapid construction (short term stability) and factors of safety can be expected to increase with time. The undrained shear strength profile shown on Figure A3 was used to provide the shear strength parameters for the silty clay soils. Table 2-7, below, lists the parameters used.

Table 2-7. Geotechnical Parameters for Slope Stability Analyses			
	γ_{total} (kN/m ³)	c_u (kPa)	ϕ'
Rockfill	20	0	42°
Sand	20	0	32°
Silty clay	19.5	variable (see Fig. A3)	0
Sand and Gravel	21.5	0	35°
Notes: Embankment crest width 14 m.			

Appendix D contains many of the SLOPE/W graphical printouts, for the various analyses performed and discussed below.

2.5.1.1 South Approach Stability

The south approach embankment will rest on essentially cohesionless soils. The results of the analyses performed on the embankment cross-sections, for an approach height of 14 m above original ground, indicates that the factor of safety against a foundation failure is about 1.7. Accordingly, the section as proposed is acceptable.

2.5.1.2 North Approach Stability

The north approach will rest on essentially cohesive soils. The results of the total stress analyses performed on the embankment cross-sections, for heights of 5 m to 8 m, resulted in safety factors ranging from about 2.9 to 2.0, which are considered more than adequate.

An analysis was also performed on the longitudinal design section (front slope) as shown on Figure A2b and Drawing No. 2. The calculated factor of safety for this slope is 1.40, which is considered adequate.

2.5.2 Consolidation Settlement of Approach Embankments (North Approach)

Long term consolidation settlement will result only at the north approach since cohesive soils are present as the principal foundation soils. The soils at the south approach are primarily cohesionless and consolidation settlement will not occur. Accordingly, the following discussion will apply only to the north approach.

2.5.2.1 Magnitudes of Consolidation Settlement

For the north approach embankment, consolidation settlement calculations have been performed using the effective stress profiles shown on Figure A3 and compression ratios ($C_c' = C_c / [1 + e_0]$) ranging from 0.08 to 0.20. The values used were established from the consolidation test data, previous experience at the north and south interchanges of this project, as well as from geotechnical literature. Recompression indices ($C_r' = C_r / [1 + e_0]$) ranging from about 0.008 to 0.02 were used. The stress increases in the foundation soils due to the embankment loadings have been calculated based on the Boussinesq elastic solutions. Recompression and virgin consolidation has been calculated based on the assumed existing overburden pressure and preconsolidation stress profiles shown on Figure A3.

The results of the calculations for embankment centerline and crest settlement using rockfill to construct the embankments are provided in Table 2-8, below and are shown graphically in the top panel of Figure A5. The thickness of the compressible silty clay soil ranges up to about 14 m. Because of the unevenness of the original ground surface at the approaches, the height of fill may vary slightly. Accordingly, the analyses have been performed taking this into account by using a varying fill height.

Table 2-8. Estimated Embankment Consolidation Settlement - North Approach

Embankment Ht	Centerline Settlement (mm)	Crest Settlement (mm)
5 m	35	30
6 m	40	35
7 m	70	45
8 m	115	75

Notes: Embankment crest width 14 m. Values rounded to nearest 5 mm

The loadings imposed by the fill will approach and may exceed the indicated preconsolidation pressure, such that the silty clay soils will be normally consolidated following the consolidation process due to the fill. Examination of the top panel of Figure A5 indicates that the settlement is expected to increase significantly as the embankment height exceeds about 6 m, where the settlement curve steepens. This will result in greater settlements due to any future additional loadings, such as grade changes, for example. Accordingly, it may be prudent to overbuild the embankment by 1 or 2 m, allow consolidation to take place and subsequently remove the excess fill height (*i.e.* preloading). The preload should be left in place for about a year, unless monitoring indicates that it can be removed sooner. This will result in a slight overconsolidation of the foundation silty clay soils.

If consideration is to be given to the use of light weight fill, for preliminary design purposes, the total consolidation settlements can be reduced **approximately** by proportion of rockfill replaced by lightweight polystyrene (eg. 30% replacement of fill height with polystyrene will result in about 70% of the indicated settlement).

2.5.2.2 Time Rate of Consolidation Settlement

The time rate of consolidation settlement has been calculated for the various cases of embankment height for vertical drainage only. It is also assumed for the purposes of calculation, all embankments are constructed to full height in about a one month construction period. Coefficients of consolidation (virgin), C_v , of 8 m²/year, and (recompression), C_{vr} , of 40 m²/year, have been used in the analyses, based on the results of the consolidation tests and the geotechnical literature.

The bottom panel of Figure A5 shows the calculated consolidation rate for the various fill heights at the north approach. Primary consolidation should be complete anywhere between about 18 months to over 24 months, depending on the fill height.

2.5.3 Secondary Compression of Clays

Calculations have been performed to estimate the magnitudes of secondary compression of the foundation clays, following the completion of primary consolidation. For purposes of analysis and discussion, the primary consolidation is assumed to be essentially complete within one to two years from the start of construction of the embankments. The calculations are based on use of a coefficient of secondary compression, $C_{\alpha c}$, of 0.004, based on the results of the consolidation tests, previous experience, and the geotechnical literature.

The calculations indicate that the secondary settlement may be about 30 mm to 50 mm in the first 10 years.

2.5.4 Rockfill and Rockfill Settlement

Rockfill used in the embankments and approaches should consist of hard, durable, angular quarried rock. Rockfill should be tested for acid drainage potential and checked against the appropriate regulatory requirements for acceptability.

For the bridge abutments that are to be supported by driven steel H-piles, as discussed in a previous section, these will have to be installed after all the embankment fill has been placed. The driving of steel piles through rockfill will be difficult, if not impossible, unless care is taken to ensure that the rockfill meets a tight size range, generally smaller than 75 mm. For the majority of the embankments and approach fills, however, larger rockfill can be used.

The use of large rockfill, loosely placed or end dumped and compacted by conventional construction traffic only may result in long term settlements of up to about 2% of the fill height. Accordingly, a 10 m high rockfill may settle up to 200 mm following completion of construction. This is primarily due to the rockfill "adjusting" under highway service conditions.

In order to minimize the long term settlements associated with the rockfill itself, consideration can be given to specifying the use of a finer graded rockfill, with a maximum size of 400 mm. This finer graded rockfill should be placed in lifts limited to about 800 mm and compacted with heavy vibratory rollers. While the production of the finer graded rockfill and its placement, as described

above, carries with it a cost premium, the long term performance of the finished highway pavement will be improved.

It is recommended that an NSSP for rockfill material and placement requirements be included in the contract documents.

2.6 Instrumentation and Construction Monitoring

Construction of embankments should be monitored during construction using a properly designed and effective system of instrumentation, consisting primarily of settlement points. Lateral slope movements should also be monitored both during and following construction of the embankments. This will provide indications of the rate of settlement, such that construction timing of the foundations can be modified, if required.

2.7 Closing Comments

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for the use of Marshall Macklin Monaghan and its design team for the design of the bridge foundations and approach fills for the southbound lanes, five span bridge to be constructed over Trout Creek, as part of the Highway 11 Trout Creek By-Pass Project. We request that we be retained to review the design and our recommendations as the design proceeds, to ensure that the final design is in general agreement with our recommendations and that our recommendations have been interpreted as intended.

A subsurface investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to allow reassessment of our recommendations. It may then be necessary to carry out additional field work and analyses.

Contractors bidding on or undertaking the works should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as the their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions at the site of the proposed southbound lanes bridge over Trout Creek. The conclusions presented in this report reflect

site conditions existing at the time of the investigation. It is noted that the soil boundaries indicated on the logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

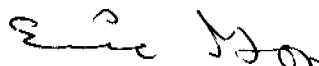
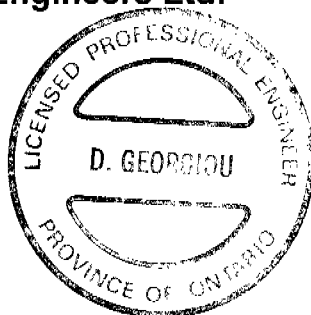
This report has been prepared by Mr. D.N. Georgiou, P.Eng. and was reviewed by Messrs. S.E. Gonsalves, P.Eng., and E. Gonneau, P.Eng. The field investigation was performed by Messrs. I. Dumpis, C.E.T., R. Moore, C.E.T., and S. McAuliffe, and was supervised by Mr. E.A. Gonneau, P.Eng.

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

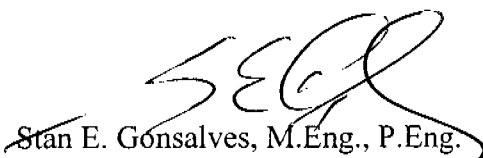
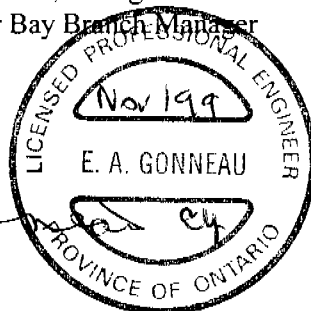
All the foregoing and attachments respectfully submitted,
Trow Consulting Engineers Ltd.



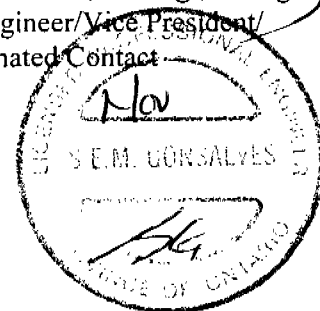
Demetri N. Georgiou, M.A.Sc., P.Eng.
Principal Engineer/Thunder Bay Branch Manager



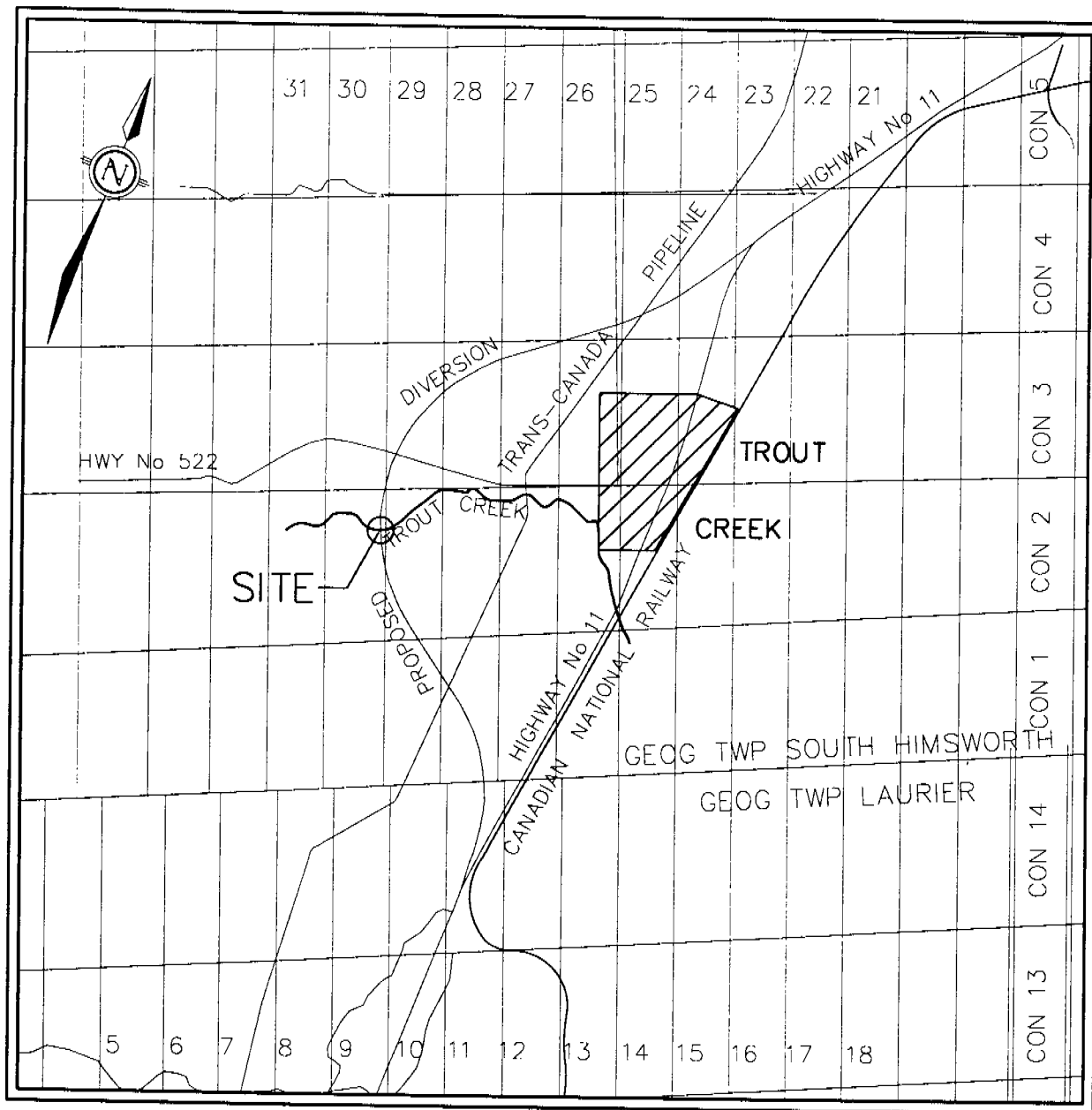
Eric A. Gonneau, P.Eng.
Project Manager



Stan E. Gonsalves, M.Eng., P.Eng.
Principal Engineer/Vice President/
MTO Designated Contact



A



500 0 500 1000
IN METRES



Trow

Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

FIGURE
A1

KEY PLAN

Trout Creek By Pass
Trout Creek Bridge-Southbound Lanes

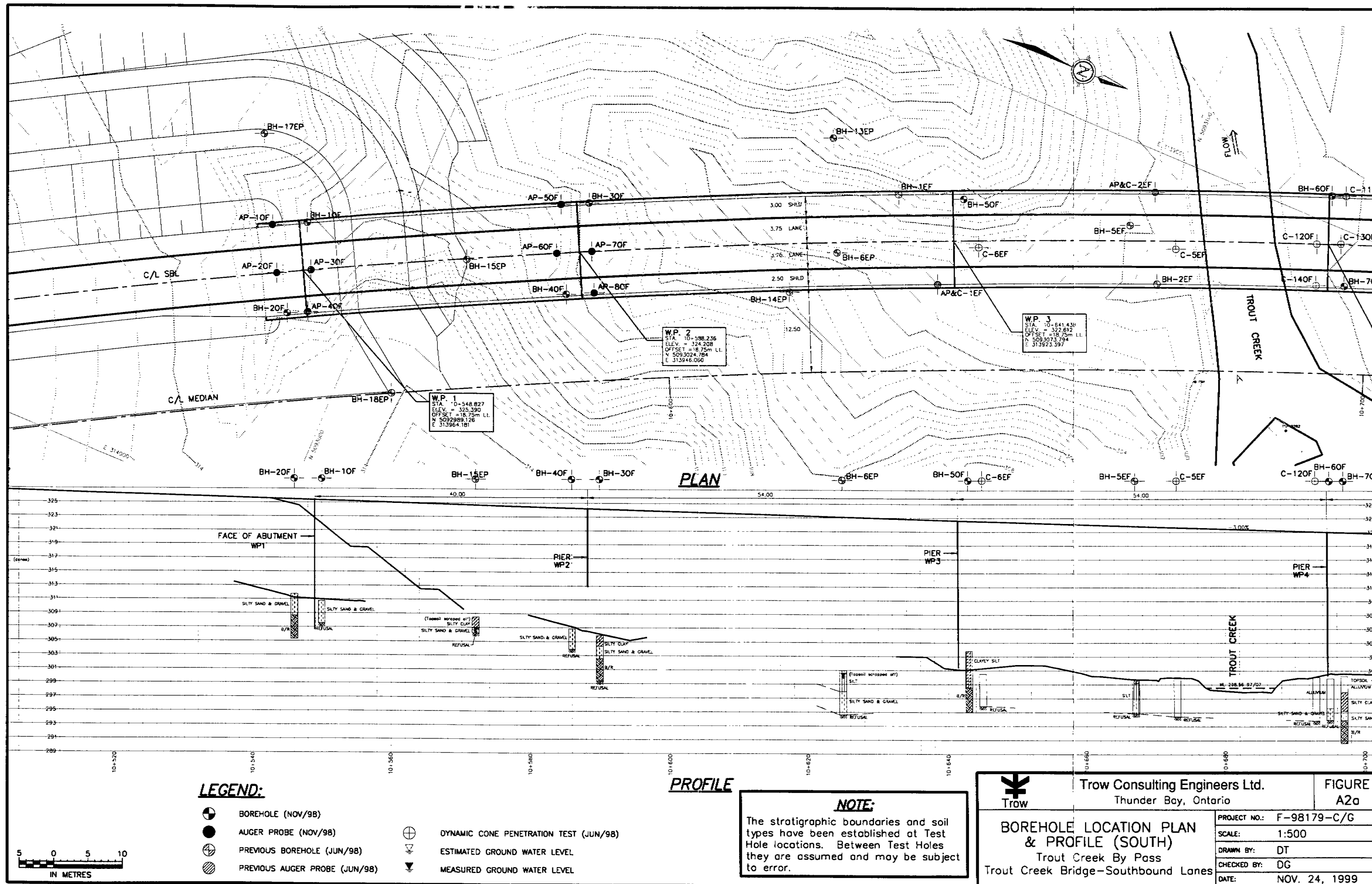
PROJECT NO.: F-98179-C/G

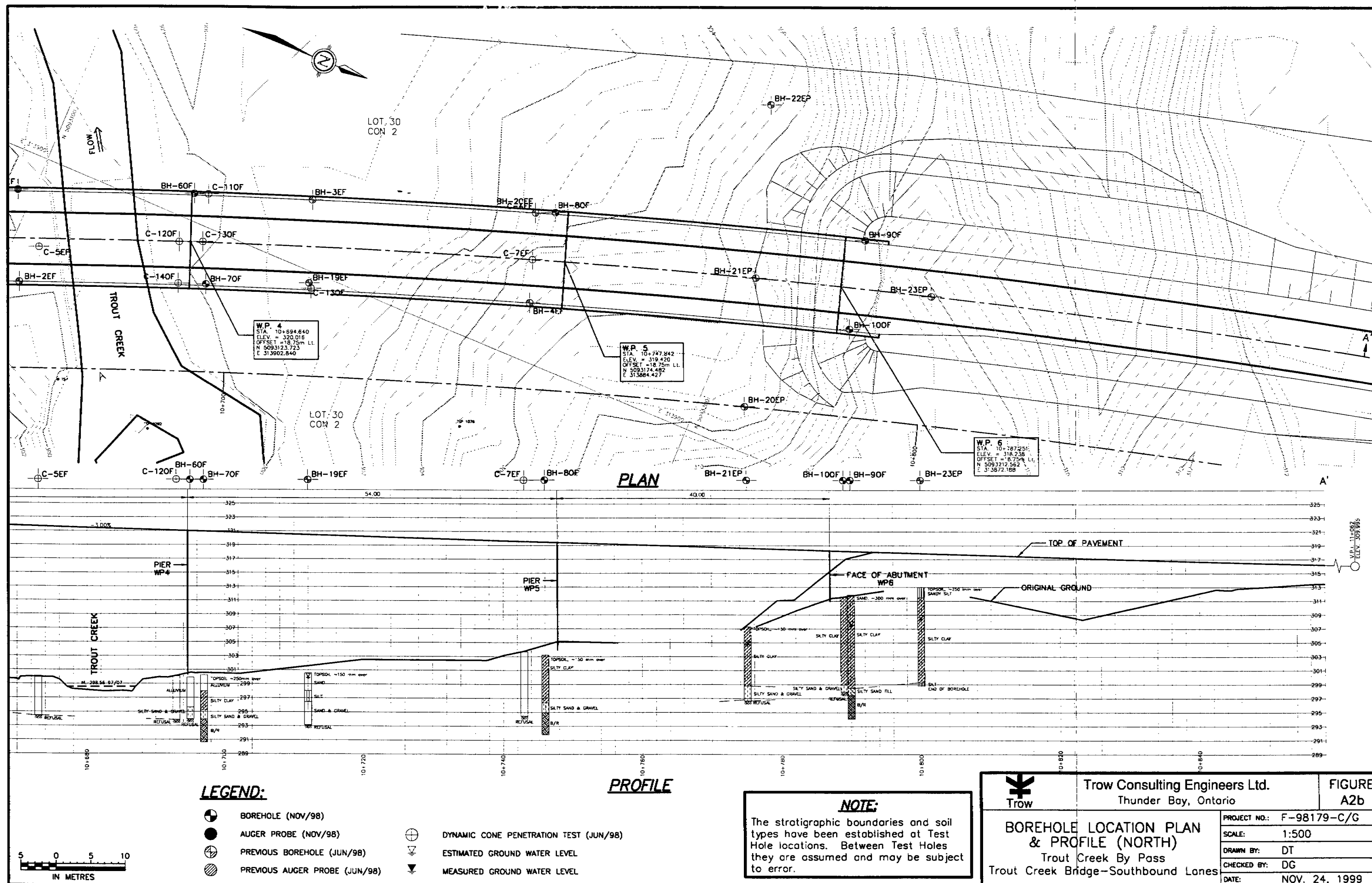
SCALE: 1:50000

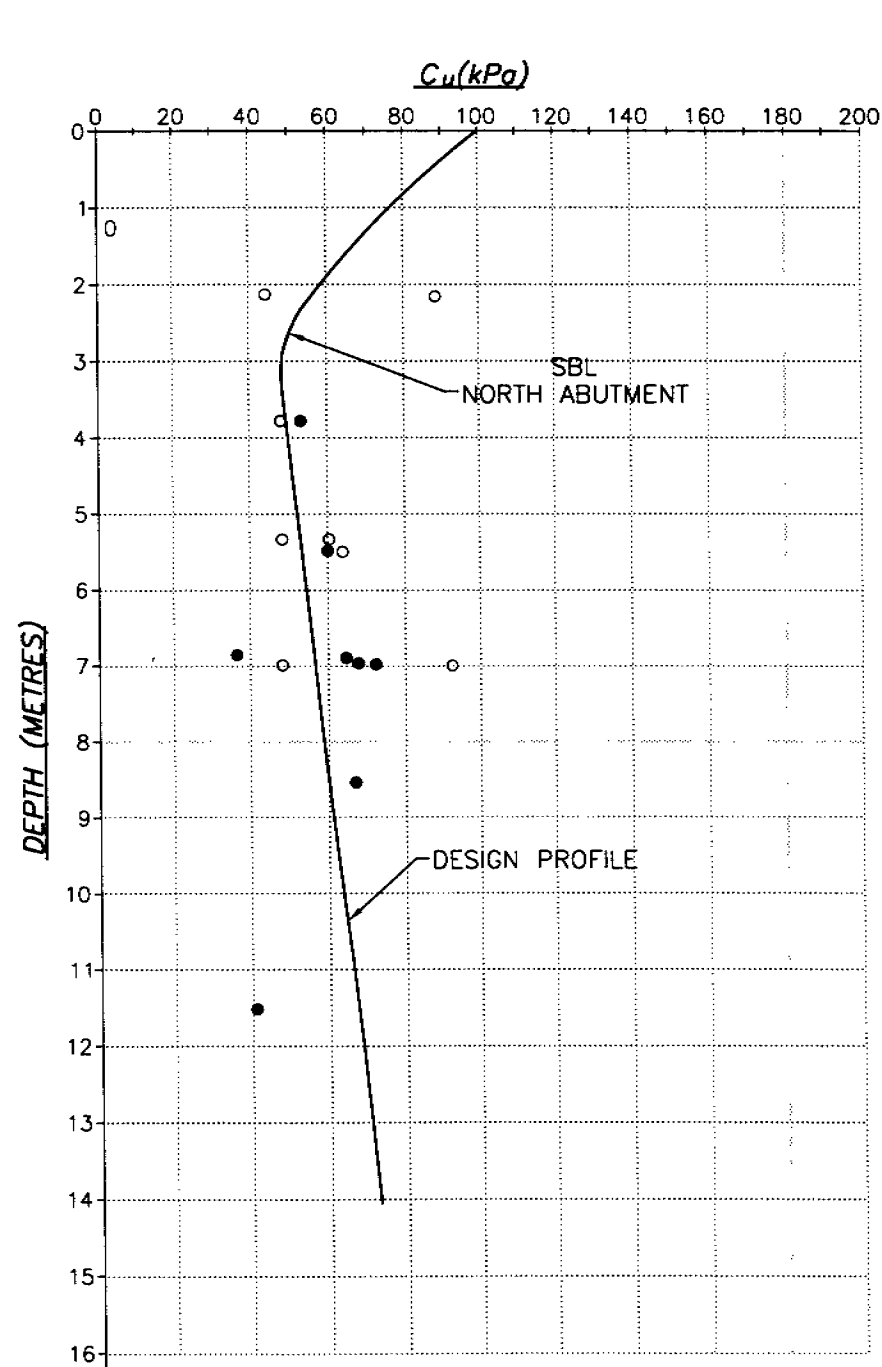
DRAWN BY: DT

CHECKED BY: DG

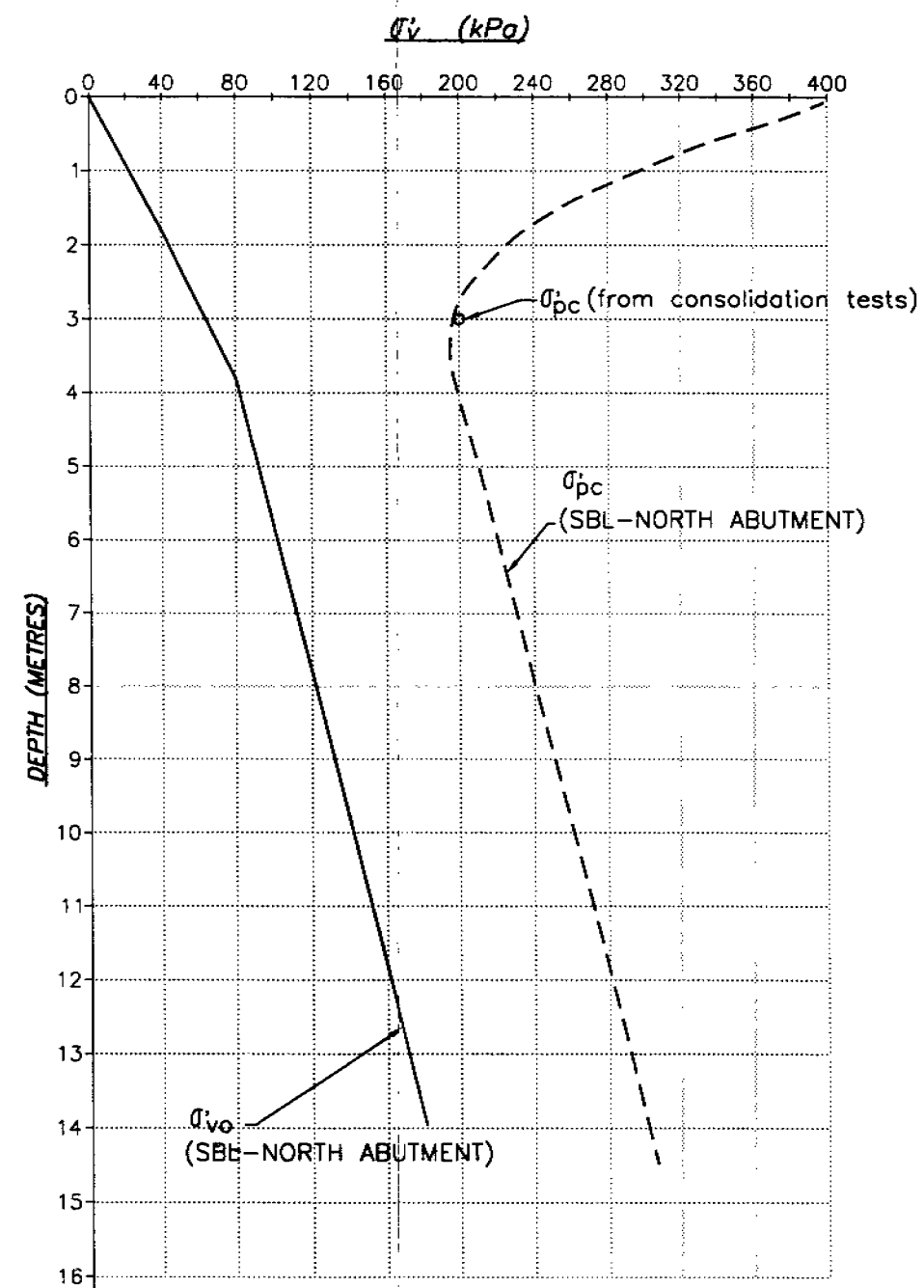
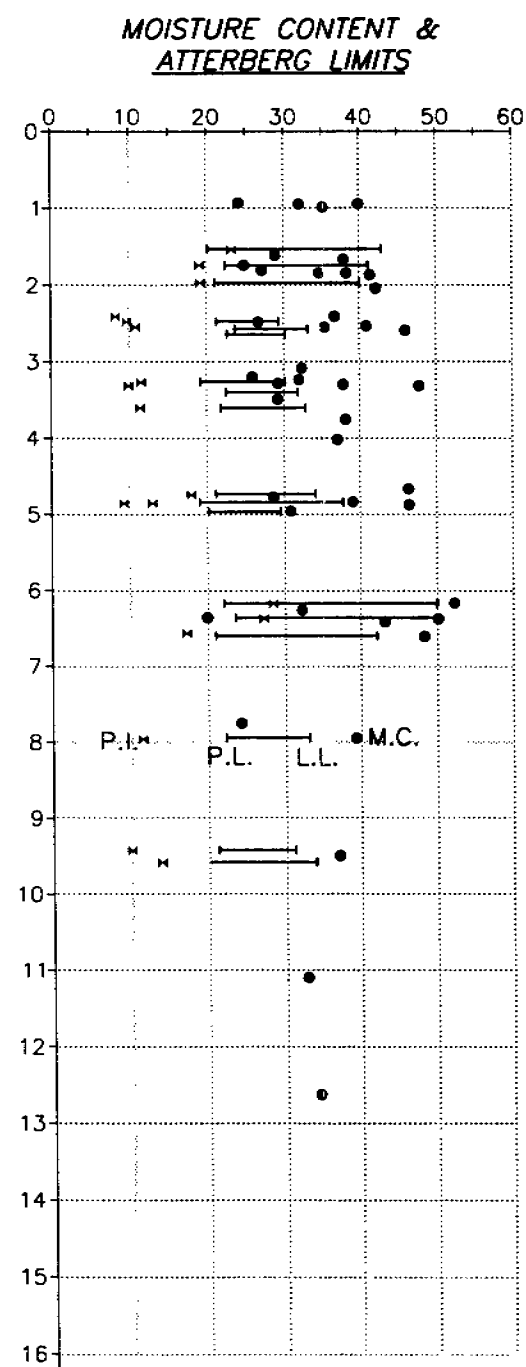
DATE: MARCH 12, 1999







● NBL - NORTH ABUTMENT
○ SBL - NORTH ABUTMENT

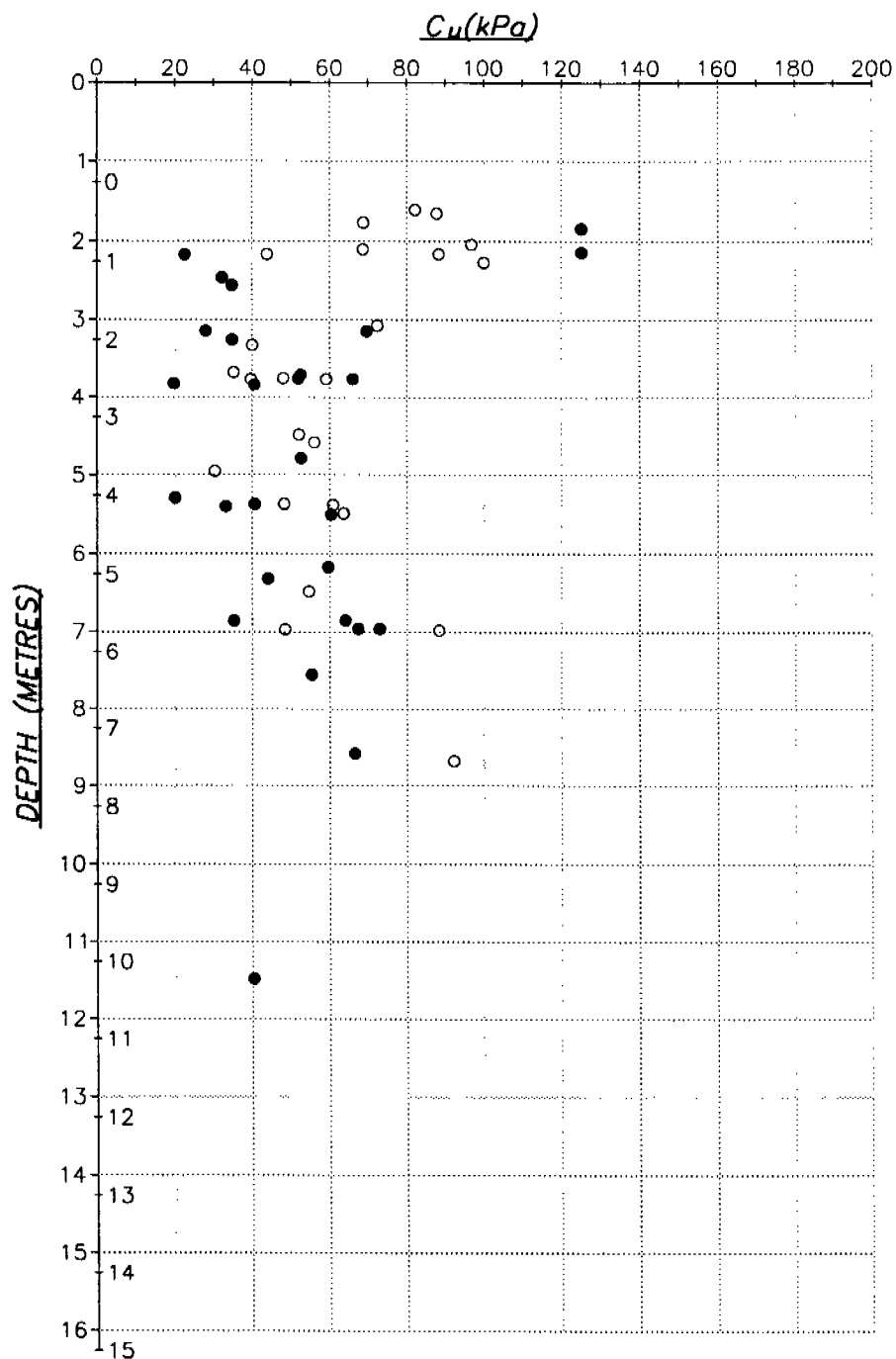


Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

FIGURE
A3

UNDRAINED SHEAR STRENGTH,
ATTERBERG LIMITS &
EFFECTIVE STRESS PROFILES
Trout Creek By Pass
Trout Creek Bridge-Southbound Lanes

PROJECT NO.:	F-98179-C/G
SCALE:	AS SHOWN
DRAWN BY:	DT
CHECKED BY:	DG
DATE:	MARCH 12, 1999



LEGEND:

- SHEAR STRENGTHS (NBL)
- SHEAR STRENGTHS (SBL)



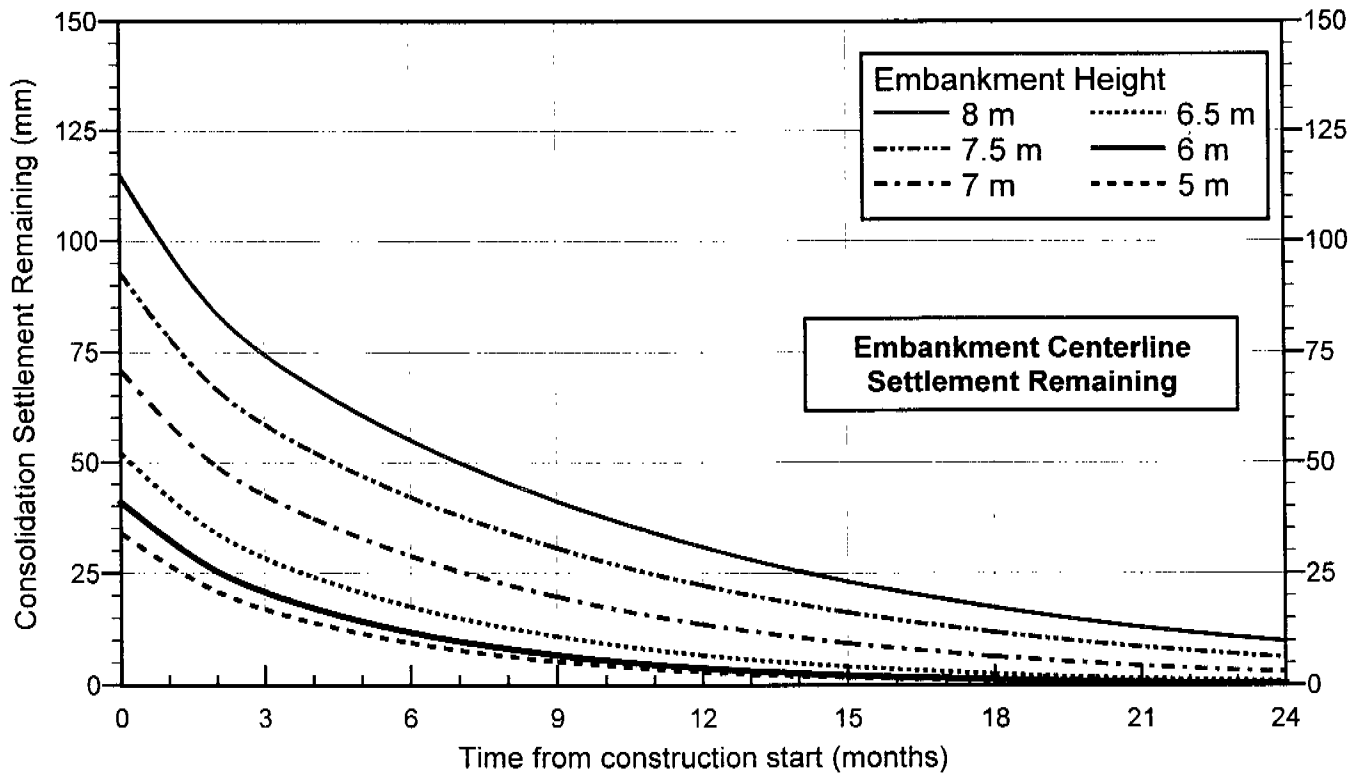
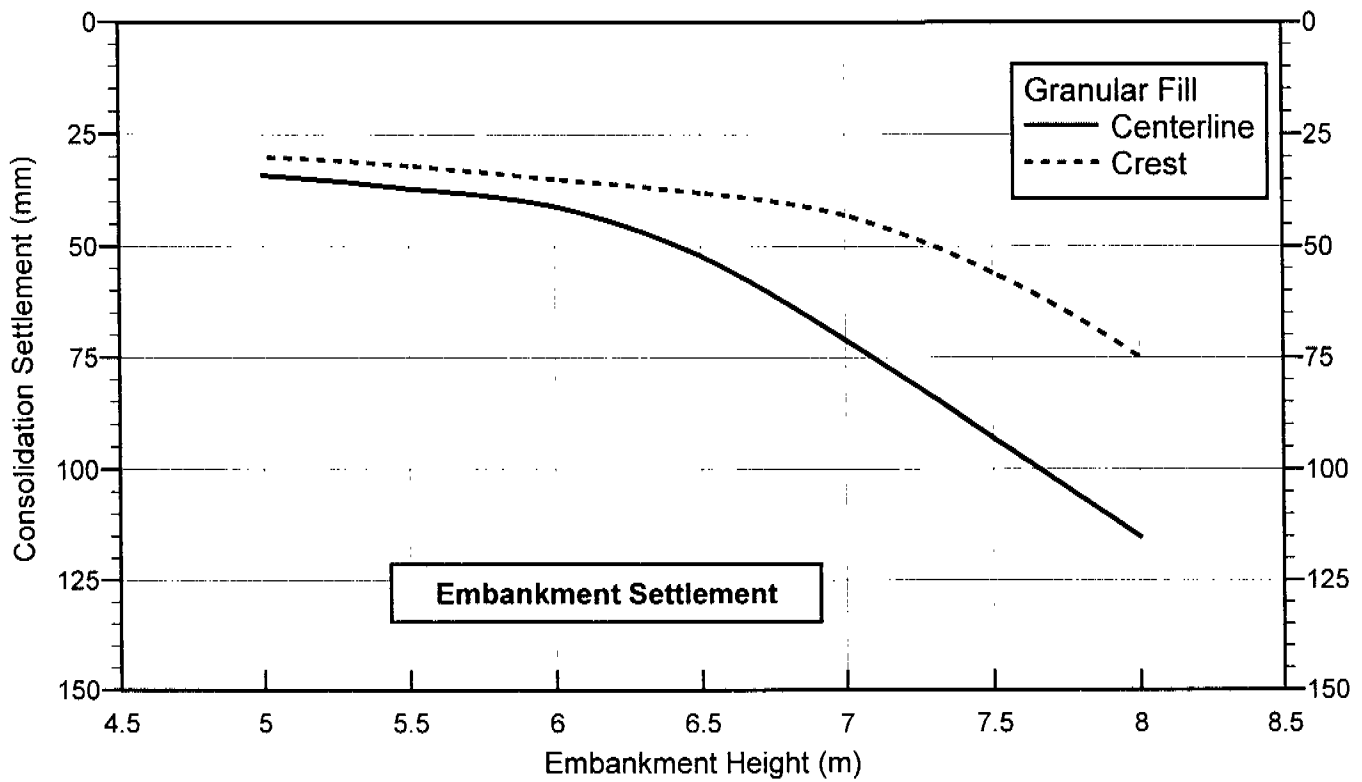
Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

**FIGURE
A4**

**UNDRAINED SHEAR STRENGTH
ALL BOREHOLES**

Trout Creek By Pass
Trout Creek Bridge—Southbound Lanes

PROJECT NO.:	F-98179-C/G
SCALE:	AS SHOWN
DRAWN BY:	DT
CHECKED BY:	DG
DATE:	MARCH 12, 1999



Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

**Estimated Consolidation Settlement
NORTH APPROACH**

F98179-C/G

Marshall Macklin Monaghan

Trout Creek Bridge - SOUTHBOUND LANES

Mar 3/99

Figure A5

B

RECORD OF BOREHOLE BH-10F 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station +10+550, offset 7 m left of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 12, 1998

CHECKED BY E.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/0.3m					
310.76	GROUND SURFACE											
0.00	SILTY SAND & GRAVEL, some cobbles, brown, wet. (compact)		1	SS	6							
			2	SS	24							
			3	SS	21							
307.56	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER		4	SS	bu							
3.20	Notes: 1) This borehole forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 092 986.9 N, 313 957.4 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Water level was at ~2.6 m & hole was open to ~2.8 m depth on completion. 5) This area was levelled with a bulldozer prior to advancing borehole.											



RECORD OF BOREHOLE BH-20F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+546, offset 6 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / B.Q. core COMPILED BY M.D.
 DATUM Geodetic DATE November 13, 1998 CHECKED BY E.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa		WATER CONTENT (%)			
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	wp	wl		
311.74	GROUND SURFACE												
0.00	SILTY SAND & GRAVEL, some cobbles, brown, wet, till-like structure below ~1.5 m depth. (compact to dense)		1	SS	22								
			2	SS	50								
			3	WS									
308.62			4	SS	60								
3.12	BIOTITE HORNBLENDE GNEISS		5	BQ									Rec. 100%R.Q.D. 90%
			6	BQ									Rec. 100%R.Q.D. 80%
			7	BQ									Rec. 100%R.Q.D. 80%
305.28	END OF BOREHOLE												
6.46	Notes: 1) This borehole forms part of the Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 092 989.4 N, 313 970.8 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Water level was at ~1.1 m & hole was open to ~2.2 m depth on completion. 5) This area was levelled with a bulldozer prior to advancing borehole. 6) Drill encountered auger refusal on a probable boulder at ~1.6 m depth. Drill moved ~0.5 m from BH-20F and advanced borehole to completion.												



RECORD OF BOREHOLE BH-30F 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station +10+590, offset ~7 m left of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / B.Q. core

COMPILED BY M.D.

DATUM Geodetic

DATE November 12, 1998

CHECKED BY E.G.

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	NUMBER	TYPE		20	40	60	80	wp	w	wl	WATER CONTENT (%)		
305.90	GROUND SURFACE														
0.00	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff to firm)		1	SS	13										3% 30% 67%
304.38	SILTY SAND & GRAVEL, some cobbles, till-like below ~3 m depth, brown, wet. (compact then dense below ~3 m depth)		2	SS	26										
1.52			3	SS	10										
			4	SS	27										
302.55	BIOTITE HORNBLende GNEISS		5	BQ											Rec. 100%R.Q.D. 75%
3.35			6	BQ											Rec. 100%R.Q.D. 97%
299.35	END OF BOREHOLE														
6.55	Notes: 1) This borehole forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 023.3 N, 313 939.0 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Water level was at ~2.0 m & hole was open to ~2.7 m depth on completion. 5) This area was levelled with a bulldozer prior to advancing borehole.														



RECORD OF BOREHOLE BH-40F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+586, offset ~6 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 12, 1998 CHECKED BY E.G.

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80				wp ——— w ——— wl					
								SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)					
							● UNCONFINED QUICK TRIAXIAL ● FIELD VANE 										



RECORD OF BOREHOLE BH-50F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 110 643, offset 16 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / B.Q. core COMPILED BY M.D.
 DATUM Geodetic DATE November 11, 1998 CHECKED BY E.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (meters)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80					
303.79 0.00	GROUND SURFACE														
	CLAYEY SILT, with SILT bands, brown to grey, wet. (loose)		1	SS	8										0% 0% 100%
			2	SS	6										
			3	SS	6										
			4	SS	7										
			5	SS	7										0% 0% 100%
298.52 5.27	BIOTITE HORNBLENDE GNEISS		6	BQ											Rec. 100% R.Q.D. 60%
			7	BQ											Rec. 100% R.Q.D. 50%
295.01 8.78	END OF BOREHOLE		8	BQ											Rec. 100% R.Q.D. 35%
Notes: 1) This borehole forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 072.8 N, 313 917.3 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Water level was at 1.2 m & hole was open to 4.6 m depth on completion.															



RECORD OF BOREHOLE BH-60F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+695, offset 77 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 18, 1998 CHECKED BY E.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (m, ft)	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 TO 300 mm			SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)				
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	wp	w	wl				
299.89	GROUND SURFACE															
0.00	TOPSOIL - 300 mm over ALLUVIUM, SILTY SAND, brown to grey, some organics, wood chunks. (loose)		1	SS	0											
			2	SS	2											
			3	SS	2											
			4	SS	5											
295.62																
4.27	SILTY SAND & GRAVEL, some cobbles, grey. (compact)		5	SS	9											
293.95																
5.94	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER															
Notes: 1) This borehole forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 121.5 N, 313 896.2 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Water level was at ~0.6 m & hole was open to ~0.7 m depth on completion.																



RECORD OF BOREHOLE BH-70F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+697, offset ~6 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / BQ core COMPILED BY M.D.
 DATUM Geodetic DATE November 18, 1998 CHECKED BY E.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80					
300.22	GROUND SURFACE														
0.00	TOPSOIL, ~250 mm over ALLUVIUM, SILTY SAND, brown to grey, some organics, wood chunks. (very loose to loose)		1	SS	4										
			2	SS	1										
297.92			3	SS	4										
2.30	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		4	SS	6										
			5	SS	4										
295.22			6	SS	60										
5.00	SILTY SAND & GRAVEL, brown to grey, wet. (compact)		7	BQ											
293.90			8	BQ											
6.32	BIOTITE HORNBLENDE GNEISS														
290.62															
9.60	END OF BOREHOLE														
Notes: 1) This borehole forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 128.1 N, 313 907.6 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Water level was at ~0.5 m & hole was open to ~0.6 m depth on completion.															



RECORD OF BOREHOLE BH-80F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+746, offset ~7 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / BQ core COMPILED BY M.D.
 DATUM Geodetic DATE November 19, 1998 CHECKED BY E.G.

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				WATER CONTENT (%)				
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	wp	w	wl				
						20	40	60	80	10	20	30	40	kN/m ³	GR SA (SI & CL)	
303.23	GROUND SURFACE															
0.00	TOPSOIL, ~150 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	8											
			2	SS	4											
			3	SS	3											
			4	SS	5											
			5	SS	6											
			6	SS	6											
296.37	SILTY SAND & GRAVEL, some cobbles. (loose to compact)		7	SS	8											
6.86																
294.94	BIOTITE HORNBLENDE GNEISS		8	BQ												
8.29			9	BQ												
291.80	END OF BOREHOLE															
11.43	Notes: 1) This borehole forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 170.4 N, 313 878.4 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan from their terrain model. 4) Water level was at ~3.2 m & hole was open to ~4.2 m depth on completion. 5) This area was levelled with a bulldozer prior to advancing borehole.															



RECORD OF BOREHOLE BH-90F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+790, offset 7 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / BQ core COMPILED BY M.D.
 DATUM Geodetic DATE November 23, 1998 CHECKED BY E.G.

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80				wp w wl				
								SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL FIELD VANE LAB SHEAR 20 40 60 80				WATER CONTENT (%) 10 20 30 40				
312.07	GROUND SURFACE															
0.00	SAND, brown, fine, ~300 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff becoming firm)		1	SS	25											
			2	SS	19											
			3	SS	9											
			4	SS	6											
			5	SS	2											
			6	SS	3											
			7	SS	6											
			8	SS	7											
			9	SS	11											
			10	SS	8											
298.66			11	SS	7											
13.41	SILTY SAND & GRAVEL, some cobbles, grey, till-like structure, wet. (compact)		12	BQ												
297.65	BIOTITE HORNBLENDE GNEISS		13	BQ												
14.42	Notes: 1) This borehole forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 213.2 N, 313 864.7 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan from their terrain model.		14	BQ												
294.27	END OF BOREHOLE															
17.80	Notes: (cont'd) 4) Borehole caved wet at ~11.1 m depth on completion. 5) This area was levelled with a bulldozer prior to advancing borehole.															



RECORD OF BOREHOLE BH-100F 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station +10+789, offset 7.6 m right of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 23, 1998

CHECKED BY E.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80					
311.62	GROUND SURFACE														
0.00	SAND, fine, brown, ~600 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff becoming firm)		1	SS	7										
			2	SS	13										0% 0% 100%
			3	SS	11										
			4	SS	6										
			5	SS	2										
			6	SS	2										0% 0% 100%
			7	SS	4										
			8	SS	6										
			9	SS	8										
			10	SS	8										
298.97	SILTY SAND & GRAVEL, grey, till-like structure, wet. (compact)														
12.65															
297.96	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
13.66	Notes: 1) This borehole forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 216.0 N, 313 855.4 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan from their terrain model. 4) Borehole caved wet at ~11.7 m depth on completion. 5) This area was levelled with a bulldozer prior to advancing borehole.														



RECORD OF BOREHOLE BH-1EF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station ~10+634, offset ~7 m left of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 10, 1998

CHECKED BY I.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION						
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60			80	wp	w	wl		
							SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL FIELD VANE LAB SHEAR		WATER CONTENT (%)									
303.95	GROUND SURFACE						20	40	60	80	10	20	30	40	GR	SA	(SI & CL)	
0.00	(Topsoil scraped off) SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff becoming firm)		1	SS	10		303											
			2	SS	8		302			S=9								
			3	SS	4		301									0%	0%	100%
			4	SS	7		300			S=7	X							
			5	SS	5		299			S=5	X							
			6	SS	7		298											
			7	SS	40		297			S=10								
296.13																		
7.82	BIOTITE HORNBLende GNEISS, good to excellent rock quality, slightly weathered to unweathered.		8	BQ														
			9	BQ														
293.13																		
10.82	END OF BOREHOLE																	
<p>Notes:</p> <p>1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation.</p> <p>2) Borehole located at U.T.M. coordinates 5 093 064.0 N, 313 920.0 E.</p> <p>3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew.</p> <p>4) Water level was at ~1.5 m depth on completion.</p>																		



RECORD OF BOREHOLE BH-2EF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station +10+670, offset +6 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 10, 1998 CHECKED BY I.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m					wp ——— w ——— wl				
												WATER CONTENT (%)				
							SHEAR STRENGTH: Cu, KPa									
							UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR									
							20 40 60 80				10 20 30 40					
299.90	GROUND SURFACE															
0.00	(Topsoil scraped off) SAND, with gravel inclusions & pieces of wood, grey/brown, wet. (very loose)		1	SS	3											
298.40	ALLUVIUM															
1.50	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		2	SS	5				S = 12							
			3	SS	3			X								
			4	SS	3			X								
294.72			5	SS	9				S = 5							
5.18	BIOTITE HORNBLENDE GNEISS, good rock quality, unweathered.		6	BQ												
			7	BQ												
291.58	END OF BOREHOLE															
8.32	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 102.8 N, 313 917.6 N. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Water level was at ~1.4 m & hole was open to ~1.6 m depth on completion.															



RECORD OF BOREHOLE BH-3EF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+712, offset ~7 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 25, 1998 CHECKED BY I.G.

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	20 40 60 80				wp — w — wl				
								SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)				
							UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR							kN/m ³ GR SA (SI & CL)		
300.36	GROUND SURFACE															
0.00	TOPSOIL, ~200 mm over SAND, some gravel sizes & root inclusions, traces of clay & silt, brown, wet. (compact)		1	SS	14										0% 66% 34%	
298.36			2	SS	18											
2.00	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		3	SS	5											
			4	SS	6											
295.36			5	SS	8										0% 16% 84%	
5.00	SAND & GRAVEL, some cobbles, brown, wet. (loose then dense at base)		6	SS	5										14% 69% 17%	
			7	SS	35											
292.23																
8.13	BIOTITE HORNBLENDE GNEISS, excellent rock quality, unweathered.		8	BQ											Rec. 100% RQD 95%	
			9	BQ											Rec. 100% RQD 95%	
289.29	END OF BOREHOLE															
11.07	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 137.8 N, 313 890.0 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Drill met auger refusal at ~5.5 m depth. Drill moved ~0.6 m south of BH-3EF & carried out borehole to completion. 5) Water level was at ~0.9 m & hole was open to ~6.4 m depth on completion.															



RECORD OF BOREHOLE BH-4EF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station ~10+743, offset ~6 m right of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 30, 1998

CHECKED BY I.G.

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	20	40	60	80			wp	w
305.36 0.00	GROUND SURFACE (Topsoil scraped off) CLAYEY SILT , some layering, brown to grey, moist. (loose)		1	SS	7										
			2	SS	5										
			3	SS	4										
			4	SS	7										
301.36 4.00	SILT , occasional thin clay seams, grey, wet. (loose)		5	SS	7										
			6	SS	7										
298.36 7.00	SAND & GRAVEL , some cobbles & possible boulders, grey, wet. (compact)		7	SS	9										
			8	SS	12										
295.45 9.91	BIOTITE HORNBLLENDE GNEISS , fair to excellent rock quality, slightly weathered to unweathered.		9	BQ											
			10	BQ											
292.38 12.98	END OF BOREHOLE														
Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 171.8 N, 313 891.7 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at ~8.1 m depth on completion.															



RECORD OF BOREHOLE BH-5EF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+667, offset 2 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 11, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	WATER CONTENT (%) w	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60						
299.76 0.00	GROUND SURFACE															
	TOPSOIL, 150 mm over SILT, some sand, grey, traces of clay, wet below 800 mm depth. (loose)		1	SS	3											
			2	SS	5											
			3	SS	5											
			4	SS	5											
294.88 4.88	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER		5	SS	40											
	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 096.9 N, 313 911.4 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Water level was at 3.8 m & hole was open to 4.3 m depth on completion.															



RECORD OF BOREHOLE BH-6EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+625, offset 2 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 15, 1998 CHECKED BY I.G.

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	20	40	60						80	20	40
300.97	GROUND SURFACE																	
0.00	(Topsoil scraped off) SILT, occasional thin clay seams, grey, wet. (very loose to loose)		1	SS	2													
			2	SS	8													
			3	SS	9													
297.97																		
3.00	SILTY SAND & GRAVEL, some cobble sizes, brown, wet. (dense to very dense)		4	SS	36													
			5	SS	105													
294.63			6	SS	60													
6.34	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																	
	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 053.4 N, 313 932.0 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Water level was at 0.9 m & hole was open to 2.4 m depth on completion.																	



RECORD OF BOREHOLE BH-12EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+499, on centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 18, 1998 CHECKED BY I.G.

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			20 40 60 80				wp — w — wl					
								SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)					
316.75	GROUND SURFACE																
0.00	TOPSOIL, ~150 mm over																
316.08	SAND & GRAVEL																
	(dense)																
0.67	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																
Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 032 944.9 N, 313 988.7 E 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole was dry & open to full depth on completion. 5) Drill made 4 other attempts to drill adjacent BH-12EF & met auger refusals from ~0.4 m to ~0.7 m depths.																	



RECORD OF BOREHOLE BH-13EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+625, offset 15 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 19, 1998 CHECKED BY I.G.

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION			
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80	wp			w	wl	
GROUND SURFACE							SHEAR STRENGTH: Cu, KPa		WATER CONTENT (%)							
307.33						UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	10			20	30	40	GR	SA	(SI & CL)
0.00	(Topsoil scraped off) SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	4											
			2	SS	5			S=7								
			3	SS	6											
			4	SS	6											
			5	TW												
			6	SS	7											
300.33																
7.00	SILT, traces of fine sand, some gravel sizes at base, wet. (compact)		7	SS	9			S=4								
299.25																
8.08	SAND & GRAVEL (dense)															
298.34																
8.99	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER															
<p>Notes:</p> <p>1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation.</p> <p>2) Borehole located at U.T.M. coordinates 5 093 052.4 N, 313 916.5 E.</p> <p>3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew.</p> <p>4) Borehole caved dry at ~4.8 m depth on completion.</p>																



RECORD OF BOREHOLE BH-14EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+618, offset ~7 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 19, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				WATER CONTENT (%)				UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT					
303.60	GROUND SURFACE															
0.00	(Topsoil scraped off) SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	4											
			2	SS	5											
301.10	SILTY SAND & GRAVEL, some cobbles, grey, wet. (compact)		3	SS	20											
2.50			4	SS	24											
300.75																
3.35	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 055.0 N, 313 939.5 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved dry at ~2.7 m depth on completion.															



RECORD OF BOREHOLE BH-15EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+572, on centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 19, 1998 CHECKED BY I.G.

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	20	40	60	80	wp			w
309.49	GROUND SURFACE														
0.00	(Topsoil scraped off) SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	8										
307.69	SILTY SAND & GRAVEL (compact to dense)		2	SS	26										
1.80															
307.23															
2.26	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 010.0 N, 313 953.4 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved dry at ~2.2 m depth on completion.															



RECORD OF BOREHOLE BH-17EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+545, offset 20 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 19, 1998 CHECKED BY I.G.

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				WATER CONTENT (%)				
						UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR			wp	w	wl				
						20 40 60 80	20 40 60 80			10 20 30 40						
313.84	GROUND SURFACE															
0.00	TOPSOIL, 180 mm over CLAYEY SILT, bands of SILT, brown to grey, wet silt seams below 2.0 m depth. (firm to stiff)		1	SS	6											
			2	SS	6											
309.34	SILTY SAND & GRAVEL, cobbles. (dense)		3	SS	37										20% 61% 19%	
308.51	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER															
5.33	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 092 976.3 N, 313 948.3 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at 3.8 m depth on completion.															



RECORD OF BOREHOLE BH-18EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station +560, on centreline of Median ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 19, 1998 CHECKED BY I.G.

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			20 40 60 80		20 40 60 80		wp — w — wl		WATER CONTENT (%)		10 20 30 40				kN/m³	GR SA (SI & CL)
								SHEAR STRENGTH: Cu, KPa		UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR											
313.75	GROUND SURFACE																				
0.00	TOPSOIL, ~125 mm over CLAYEY SILT, seams of SILT, brown to grey, wet below ~2.0 m depth. (stiff)																				
			1	SS	6																
			2	SS	4																
	Cobbles at base.																				
309.48	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																				
4.27	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 007.8 N, 313 975.6 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved dry at ~3.3 m depth on completion.																				



RECORD OF BOREHOLE BH-19EF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+712, offset 5 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80				wp ——— w ——— wl					
								SHEAR STRENGTH: Cu, KPa UNCONFINED FIELD VANE QUICK TRIAXIAL LAB SHEAR 20 40 60 80				WATER CONTENT (%) 10 20 30 40					
300.52	GROUND SURFACE																
0.00	TOPSOIL, ~150 mm over SAND, trace of silt, brown, wet below ~600 mm depth. (compact)																
298.02			1	SS	11												
2.50	SILT, some thin clay seams, grey, wet. (loose)		2	SS	9												
296.42																	
4.10	SAND & GRAVEL, some cobbles & possible boulders. (compact to dense)		3	SS	29												
			4	SS	31												
293.17																	
7.35	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 141.9 N, 313 901.3 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Water level was at ~2.0 m & hole was open to ~2.1 m depth on completion.																



RECORD OF BOREHOLE BH-20EF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station ~10 + 742, offset ~7 m left of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 26, 1998

CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80		wp — w — wl			
								SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL FIELD VANE LAB SHEAR		WATER CONTENT (%) 10 20 30 40			
303.20	GROUND SURFACE												
0.00	TOPSOIL, ~150 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	9								
			2	SS	8								
			3	SS	6								
			4	SS	5								
			5	TW									
			6	SS	5								
296.70			7	SS	5								
6.50	SAND & GRAVEL, some cobbles & possible boulders, grey, wet. (loose)		8	SS	7								
293.90													
9.30	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER												
<div>Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 166.6 N, 313 879.7 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Water level was at ~4.9 m & hole was open to ~5.94 m depth on completion.</div>													



RECORD OF BOREHOLE BH-21EP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+775, on centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 1, 1998

CHECKED BY I.G.

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	20 40 60 80	20 40 60 80	wp	w			wl
307.28 0.00	GROUND SURFACE													
	TOPSOIL, ~150 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	3									
			2	SS	5									
			3	AS										
			4	TW										
			5	SS	5									
			6	SS	5									
			7	SS	10									
298.78 8.50	SILTY SAND & GRAVEL, grey, wet. (compact)		8	SS	17									
296.67 10.61	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER													
<p>Notes:</p> <p>1) This borehole forms part of Trout Creek Bridge Southbound Lane Approach Foundation Investigation.</p> <p>2) Borehole located at U.T.M. coordinates 5 093 200.7 N, 313 875.9 E.</p> <p>3) Borehole elevation obtained from Marshall Macklin Monaghan survey crew.</p> <p>4) Borehole caved wet at ~8.8 m depth on completion.</p>														



RECORD OF BOREHOLE BH-22EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+775, offset 25 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE July 1, 1998 CHECKED BY I.G.

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	NUMBER	TYPE		20	40	60	80	wp	w	wl	WATER CONTENT (%)		
305.85	GROUND SURFACE														
0.00	TOPSOIL, ~150 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	7										
			2	SS	5										
			3	SS	3										
			4	SS	3										
			5	TW											
299.85	SILTY SAND & GRAVEL, till-like structure, some cobbles, grey, wet. (compact to dense)		6	SS	28										
6.00			7	SS	15										
297.65	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
8.20	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 193.2 N, 313 852.0 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at ~5.3 m depth on completion.														



RECORD OF BOREHOLE BH-23EP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+800, on centreline of Southbound Lane ORIGINATED BY S.M.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE October 24, 1998 CHECKED BY E.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				CONE PENETRATION TEST			UNIT WEIGHT KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60	80	wp	w		
313.04	GROUND SURFACE														
0.00	TOPSOIL, ~250 mm over SANDY SILT, brown, moist. (compact)														
311.54	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff becoming firm)		1	SS	18										
1.50			2	SS	9										
			3	SS	2										
			4	TW											
			5	SS	3										
			6	SS	9										
			7	SS	9										
			8	SS	12										
299.32	SILT, with SAND seams, grey brown, moist. (compact)		9	SS	16										
13.72	END OF BOREHOLE														
298.87															
14.17															

0% 0% 100%

0% 0% 100%

Notes:
 1) This borehole forms part of Trout Creek Bridge Southbound Lane Approach Foundation Investigation.
 2) Borehole located at U.T.M. coordinates 5 093 225.0 N, 313 868.5 E.
 3) Borehole elevation obtained from Dearden and Stanton Ltd., O.L.S.
 4) Borehole caved wet at ~10.3 m depth on completion.



RECORD OF BOREHOLE BH-24EP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station +10+875, on centreline of Southbound Lane

ORIGINATED BY S.M.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE October 24, 1998

CHECKED BY E.G.

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	20	40	60						80	Wp
313.54	GROUND SURFACE																
0.00	TOPSOIL, 250 mm over SILTY SAND, brown, moist. (compact)		1	SS	14										1%	95%	4%
311.10	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		2	SS	5												
2.44			3	SS	2										0%	0%	100%
			4	SS	1												
			5	TW											0%	0%	100%
			6	SS	6												
			7	SS	10												
301.35	SILT, trace of SAND, grey brown, moist. (compact)		8	SS	15												
12.19	END OF BOREHOLE																
300.89																	
12.65																	
	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 298.6 N, 313 849.3 E. 3) Borehole elevation obtained from Dearden and Stanton Ltd., O.L.S. terrain model. 4) Borehole caved wet at ~10.3 m depth on completion.																



RECORD OF BOREHOLE AP-10F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+545, offset 7 m left of centreline of Southbound Lane ORIGINATED BY J.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 12, 1998 CHECKED BY E.G.

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	20	40	60	80	wp	w	wl			10	20
312.05 0.00	GROUND SURFACE																	
	Probable SAND, GRAVEL & COBBLES																	
309.15 2.90	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This auger probe forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Auger probe located at U.T.M. coordinates 5 092 982.4 N, 313 959.8 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.																	



RECORD OF BOREHOLE AP-20F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+545, on centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 12, 1998 CHECKED BY E.G.

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	20	40	60	80	wp			w
312.05 0.00	GROUND SURFACE														
	Probable SAND, GRAVEL & COBBLES														
310.37 1.68	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
	Notes: 1) This auger probe forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Auger probe located at U.T.M. coordinates 5 092 985.7 N, 313 966.0 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.														



RECORD OF BOREHOLE AP-30F 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+550, on centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Standard augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 12, 1998

CHECKED BY E.G.

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	20	40	60	80	wp	w		
311.24 0.00	GROUND SURFACE														
	Probable SAND, GRAVEL & COBBLES														
308.56 2.68	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
	Notes: 1) This auger probe forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 092 990.1 N, 313 963.7 E. 3) Borehole elevation obtained from Dearden and Stanton Ltd., O.L.S. terrain model.														



RECORD OF BOREHOLE AP-40F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+549, offset 6 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 12, 1998 CHECKED BY E.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80	wp	w	wl		
311.83 0.00	GROUND SURFACE			BLOWS/0.3m											GR SA (SI & CL)
310.00 1.83	Probable SANDY GRAVEL					311									
309.09 2.74	Probable SAND, GRAVEL & COBBLES					310									
	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
	Notes: 1) This auger probe forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Auger probe located at U.T.M. coordinates 5 092 992.1 N, 313 969.4 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.														



RECORD OF BOREHOLE AP-50F 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10 + 586, offset 7 m left of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Standard augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 12, 1998

CHECKED BY E.G.

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	20	40	60	80	20	40	60	80	wp	w	wl	10	20	30	40	kN/m ³	GR	SA	(SI & CL)		
306.65 0.00	GROUND SURFACE																											
305.13 1.52	Probable SILTY SAND & GRAVEL																											
302.54 4.11	Probable SAND, GRAVEL & COBBLES																											
	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																											
	Notes: 1) This auger probe forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Auger probe located at U.T.M. coordinates 5 093 019.6 N, 313 940.8 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.																											



RECORD OF BOREHOLE AP-60F 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10 + 585, on centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Standard augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 12, 1998

CHECKED BY E.G.

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			20 40 60 80				wp ——— w ——— wl						
								SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)						
						● UNCONFINED QUICK TRIAXIAL	■ FIELD VANE	× LAB SHEAR					10 20 30 40				KN/m³	GR SA (SI & CL)
307.39 0.00	GROUND SURFACE																	
	Probable SILTY SAND & GRAVEL						307											
							306											
305.56 1.83	----- Probable SAND, GRAVEL & COBBLES	---					305											
304.71 2.68	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																	
	Notes: 1) This auger probe forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 021.8 N, 313 947.5 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model.																	



RECORD OF BOREHOLE AP-70F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+590, on centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 12, 1998 CHECKED BY E.G.

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	20	40	60	80	wp			w
306.10 0.00	GROUND SURFACE														
	Probable SILTY CLAY														
303.66 2.44	Probable SAND, GRAVEL & COBBLES														
302.38 3.72	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This auger probe forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Auger probe located at U.T.M. coordinates 5 093 026.4 N, 313 945.3 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.														



RECORD OF BOREHOLE AP-80F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10 - 590, offset 16 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 12, 1998 CHECKED BY E.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (meters)	SPT TEST (N-Value)				CONE PENETRATION TEST				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA	NUMBER			TYPE	BLOWS/0.3m	20	40	60	80	20	40					
305.77 0.00	GROUND SURFACE																	
305.16 0.61	Probable SILT																	
	Probable SAND, GRAVEL & COBBLES																	
302.72 3.09	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																	
<p>Notes:</p> <p>1) This auger probe forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation.</p> <p>2) Auger probe located at U.T.M. coordinates 5 093 029.0 N, 313 950.7 E.</p> <p>3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.</p>																		



RECORD OF BOREHOLE AP&C-1EF₁ OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+639, offset 6 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone / Standard auger COMPILED BY M.D.
 DATUM Geodetic DATE June 10, 1998 CHECKED BY I.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	WATER CONTENT (%)	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER							
301.02 0.00	GROUND SURFACE (Topsoil scraped off)									
	Probable SILTY CLAY									
295.84 5.18	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER									
	Notes: 1) This cone test forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Auger probe & cone test located at U.T.M. coordinates 5 093 073.9 N, 313 929.9 E. 3) Probe elevation obtained by Marshall Macklin Monaghan survey crew.									



RECORD OF BOREHOLE AP&C-2EF¹ OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+670, offset 7 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone / Standard auger COMPILED BY M.D.
 DATUM Geodetic DATE June 10, 1998 CHECKED BY I.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/0.3m	CONE PENETRATION TEST				w _p — w — w _l		WATER CONTENT (%)			
						SHEAR STRENGTH: Cu, KPa											
						UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR											
						20	40	60	80			10	20	30	40		
299.84 0.00	GROUND SURFACE (Topsoil scraped off)																
	Assumed SILTY CLAY																
294.87 4.97	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This cone test forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Auger probe located at U.T.M. coordinates 5 093 097.8 N, 313 905.6 E. 3) Probe elevation obtained by Marshall Macklin Monaghan survey crew.																



RECORD OF BOREHOLE C-110F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+697, offset 7 m left of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 25, 1998 CHECKED BY E.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (Metric)	SPT TEST (N-Value)		CONE PENETRATION TEST		PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLLOT	NUMBER	TYPE			BLOWS/30 cm	20	40	60	80	wp	w	wl	10	20	30	40	kN/m ³		
300.01 0.00	GROUND SURFACE Dynamic cone test only.																				
293.33 6.68	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This cone test forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 123.4 N, 313 895.4 E. 3) Cone elevation obtained from Marshall Macklin Monaghan terrain model.																				



RECORD OF BOREHOLE C-120F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+693, offset on centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 25, 1998 CHECKED BY E.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				PLASTIC LIMIT			NATURAL MOISTURE CONTENT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA	NUMBER			TYPE	BLOWS/0.3m	CONE PENETRATION TEST				wp	w	wl	WATER CONTENT (%)		
300.16 0.00	GROUND SURFACE Dynamic cone test only.																
293.94 6.22	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This cone test forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 122.2 N, 313 903.4 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model.																



RECORD OF BOREHOLE C-130F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10 697, on centreline of Southbound Lane
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone / CME-55
 DATUM Geodetic DATE November 25, 1998
 ORIGINATED BY I.D.
 COMPILED BY M.D.
 CHECKED BY E.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (meters)	SPT TEST (N-Value)		PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/0.3m	CONE PENETRATION TEST	UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	wp	w	wl	WATER CONTENT (%)	GR	SA		
300.57 0.00	GROUND SURFACE Dynamic cone test only.						20 40 60 80						10 20 30 40					
293.96 6.61	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This cone test forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 126.0 3) Cone elevation obtained from Marshall Macklin Monaghan terrain model.																	



RECORD OF BOREHOLE C-140F 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+693, offset 6 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 25, 1998 CHECKED BY E.G.

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	20	40	60	80	wp	w			wl	20	40	60	80	10	20	30	40	kN/m ³
300.12 0.00	GROUND SURFACE Dynamic cone test only.																								
294.06 6.06	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This cone test forms part of the Trout Creek Bridge, Southbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 124.3 N, 313 909.2 E. 3) Cone elevation obtained from Marshall Macklin Monaghan terrain model.																								



RECORD OF BOREHOLE C-3EF

1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+712, offset 6 m right of centreline of Southbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone / COMPILED BY M.D.
 DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

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	NUMBER	TYPE			BLOWS/0.3m	20	40	60	80	wp	w		
300.59	GROUND SURFACE														
0.00	Dynamic cone penetration test only.														
293.40	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
7.19	Notes: 1) This cone test forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 142.3 N, 313 902.2 E. 3) Cone elevation obtained by Marshall Macklin Monaghan survey crew.														



RECORD OF BOREHOLE C-4EF

1 OF 1

METRIC

W.P. 774-93-00
 DIST 54 HWY 11
 DATUM Geodetic

LOCATION Station 10+744, offset 7 m left of centreline of Southbound Lane
 BOREHOLE TYPE Dynamic cone /
 DATE June 26, 1998

ORIGINATED BY I.D.
 COMPILED BY M.D.
 CHECKED BY I.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			CONES/0.3m	CONE PENETRATION TEST								
303.19	GROUND SURFACE						SPT TEST (N-Value) CONE PENETRATION TEST 20 40 60 80 SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR 20 40 60 80				wp	w	wl	WATER CONTENT (%)	10 20 30 40	GR SA (SI & CL)
0.00	Dynamic cone penetration test only.					303										
						302										
						301										
						300										
						299										
						298										
						297										
						296										
						295										
294.00	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER					294										
9.19	Notes: 1) This cone test forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 168.5 N, 313 879.1 E. 3) Cone elevation obtained by Marshall Macklin Monaghan survey crew. 5093170.0N 313885.9E															



1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station ~10+673, offset ~1 m right of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11BOREHOLE TYPE Dynamic cone /

COMPILED BY M.D.

DATUM Geodetic

DATE June 10, 1998

CHECKED BY I.G.

[illegible]

RECORD OF BOREHOLE C-6EF

1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station +10+645, offset 1 m right of centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic cone /

COMPILED BY M.D.

DATUM Geodetic

DATE June 10, 1998

CHECKED BY I.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/0.3m					
300.50	GROUND SURFACE											
0.00	Dynamic cone penetration test only.											
295.90	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER											
4.60	Notes: 1) This cone test forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 077.5 N, 313 922.9 E. 3) Cone elevation obtained by Marshall Macklin Monaghan survey crew.											



RECORD OF BOREHOLE C-7EF

1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station ~10+743, on centreline of Southbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic cone /

COMPILED BY M.D.

DATUM Geodetic

DATE June 26, 1998

CHECKED BY I.G.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	WATER CONTENT (%)	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)		
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60							80	20
303.70	GROUND SURFACE																	
0.00	Dynamic cone penetration test only.																	
294.51	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON PROBABLE BEDROCK OR POSSIBLE BOULDER																	
9.19	Notes: 1) This cone test forms part of Trout Creek Bridge Southbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 170.0 N, 313 885.9 E. 3) Cone elevation obtained from Marshall Macklin Monaghan terrain model.																	



SO7524G/O/F

TABLE 1
ROCK CORE DESCRIPTION

BH#	Core Recovery				Core Description	
	RC #	Depth (m)	% CR*	% RQD**	Depth (m)	Description
SOUND BOUND LANE						
2-OF	1	3.14 to 4.66	100	78	3.14 to 6.46	Biotite Hornblende Gneiss - light grey to pink, medium to coarse grained, unweathered with sulfide inclusions, very close spacing of fractures dipping 45° to 90° from vertical, planar to slightly undulated, rough
	2	4.66 to 6.46	100	88		
3-OF	1	3.35 to 4.81	100	69	3.35 to 6.55	Biotite Hornblende Gneiss - light grey, medium to coarse grained, unweathered with sulfide inclusions, moderately spaced fractures and joints dipping 45° to 90° from vertical, rough and slightly undulating
	2	4.81 to 6.55	100	97		
5-OF	1	5.27 to 6.67	100	90	5.27 to 8.78	Biotite Hornblende Gneiss , light grey to pink, medium to coarse grained, slightly weathered, very close spacing of cemented fissures, joints and fissures dipping 0° to 90° from vertical, smooth and slightly undulating
	2	6.67 to 8.78	100	90		

SO7524G/O/F

TABLE 1
ROCK CORE DESCRIPTION

BH#	Core Recovery				Core Description	
	RC #	Depth (m)	% CR*	% RQD**	Depth (m)	Description
7-OF	1	6.37 to 7.90	100	71	6.37 to 9.60	Biotite Hornblende Gneiss (Garnetiferous) , light grey to grey pink, medium to coarse grained, unweathered, moderate spacing of fractures dipping 90° from vertical, slightly undulated, rough
	2	7.90 to 9.60	100	86		
8-OF	1	8.29 to 9.84	100	95	8.29 to 11.43	Biotite Hornblende Gneiss (Garnetiferous) , light grey to grey-pink, medium to coarse grained, unweathered, moderate spacing of joints and fissures, some sulfide inclusions, close spacing of fractures dipping 45° to 90° from vertical, planar and smooth
	2	9.84 to 11.43	100	77		
9-OF	1	14.42 to 15.95	100	81	14.42 to 17.74	Biotite Hornblende Gneiss (Garnetiferous) , light grey to pink, unweathered, very close spacing of cemented fractures, inclusions of sulfides, fractures dipping 0° to 90° from vertical, rough and undulating
	2	15.95 to 17.74	100	100		

*CR = Core Recovery

**RQD = Rock Quality Designation

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT

SAND

GRAVEL

FINE

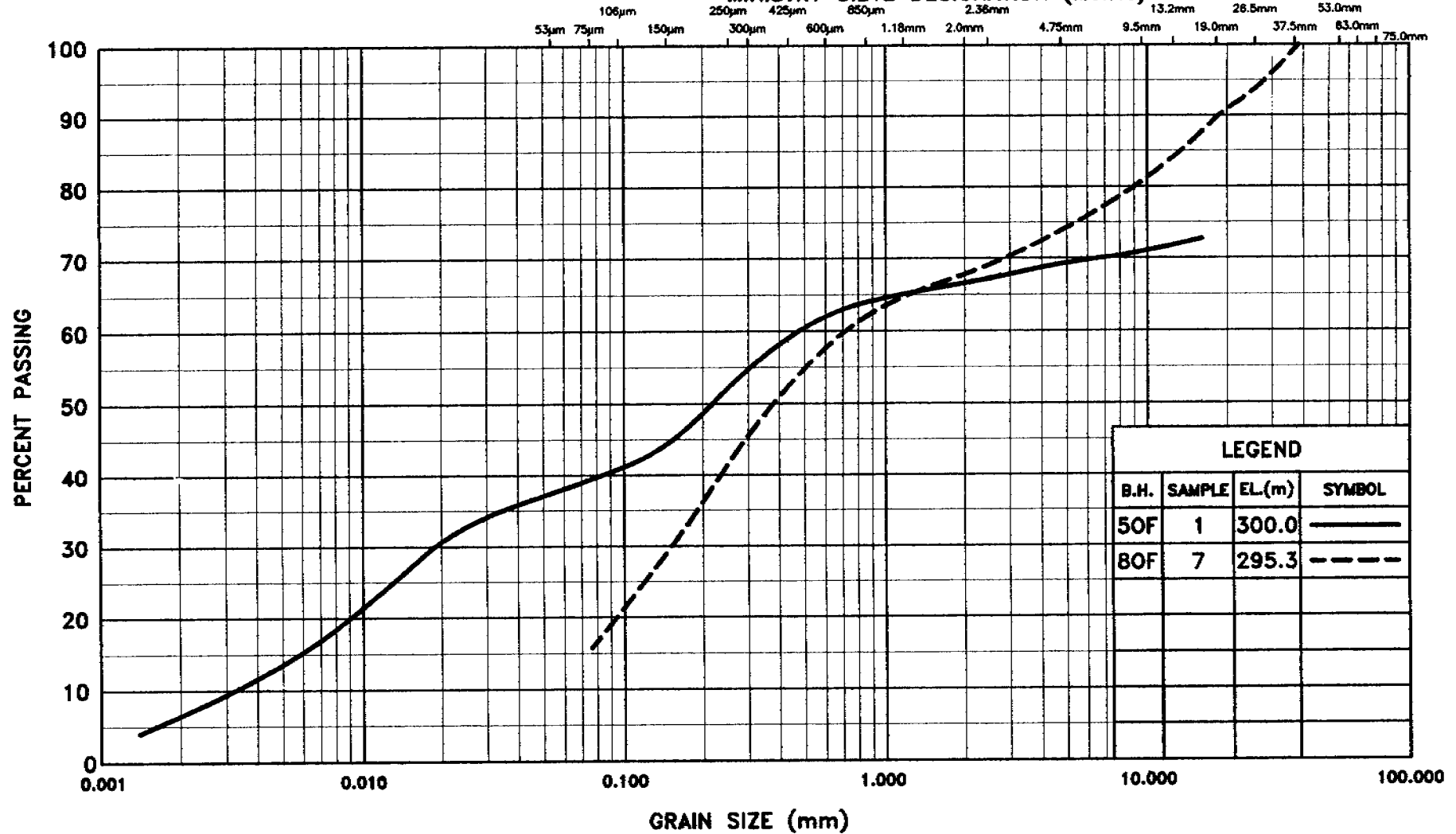
MEDIUM

COARSE

FINE

COARSE

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

B.H.	SAMPLE	EL.(m)	SYMBOL
50F	1	300.0	————
80F	7	295.3	-----

Ministry of
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

SAND & GRAVEL

FIGURE C-1

W.P. 774-93-00

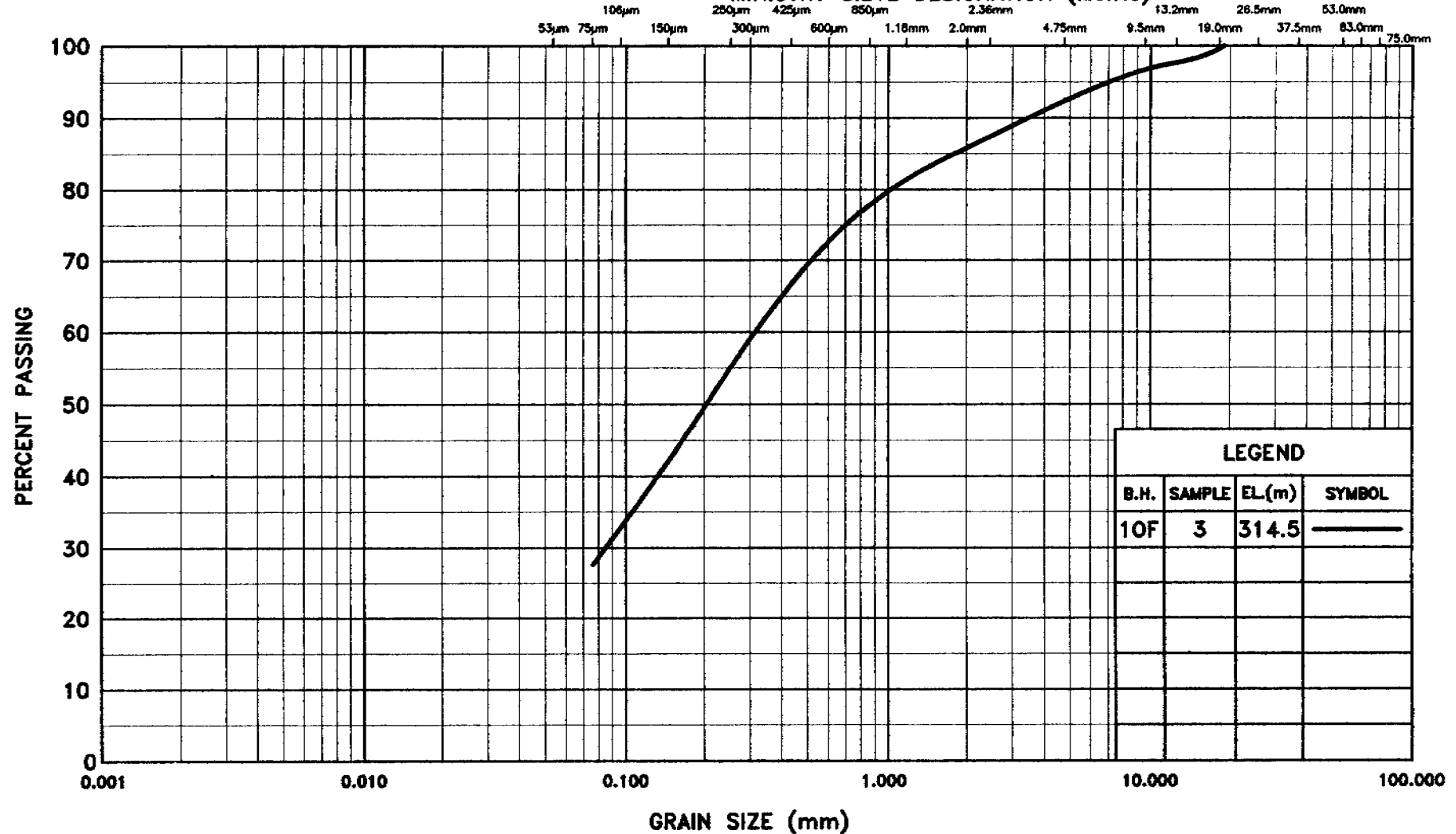


PROJ. No. S07524GO

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

SAND

FIGURE C-2

W.P. 774-93-00

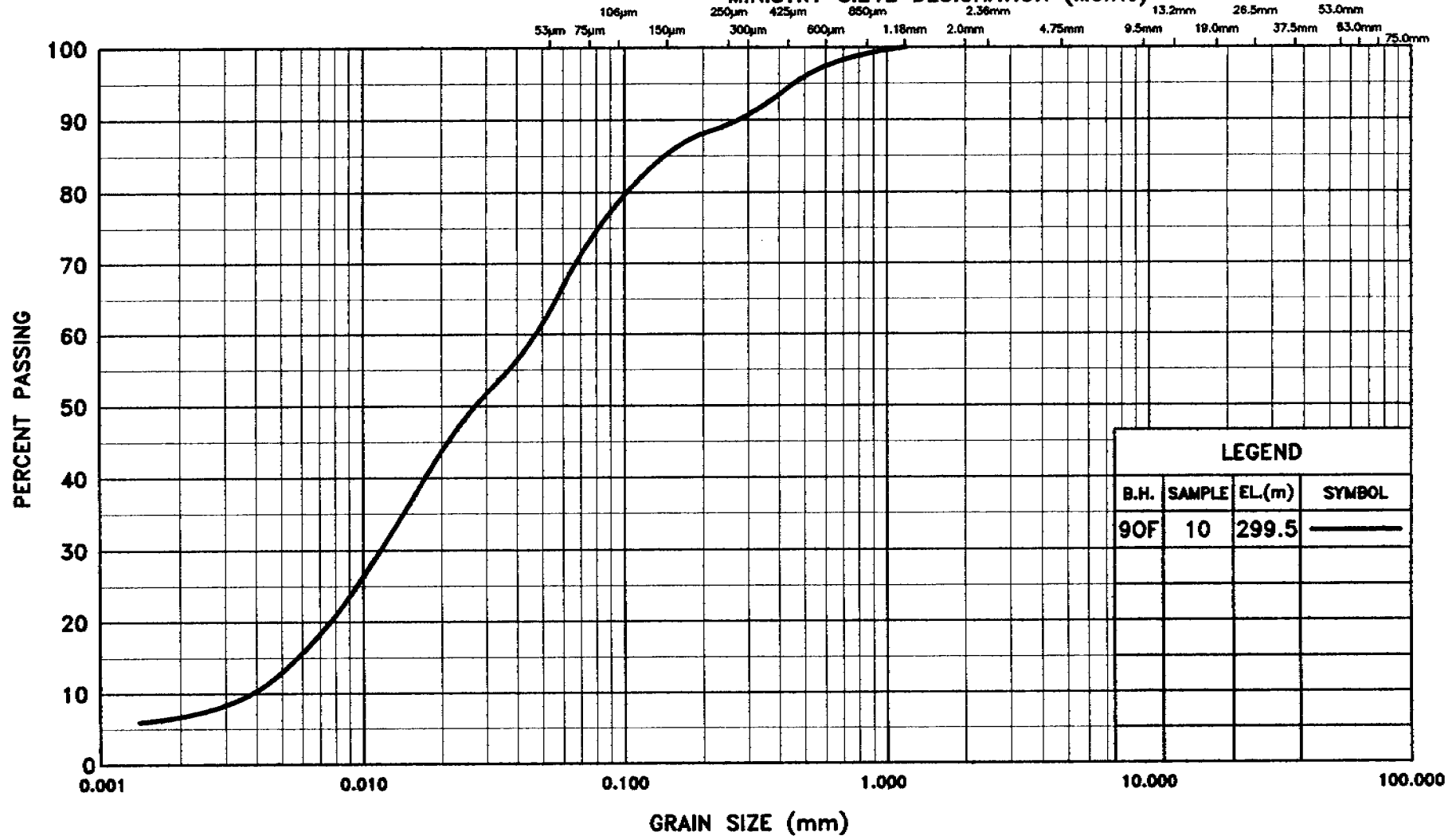


PROJ. No. S07524GO

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

SANDY SILT

FIGURE C-3

W.P. 774-93-00

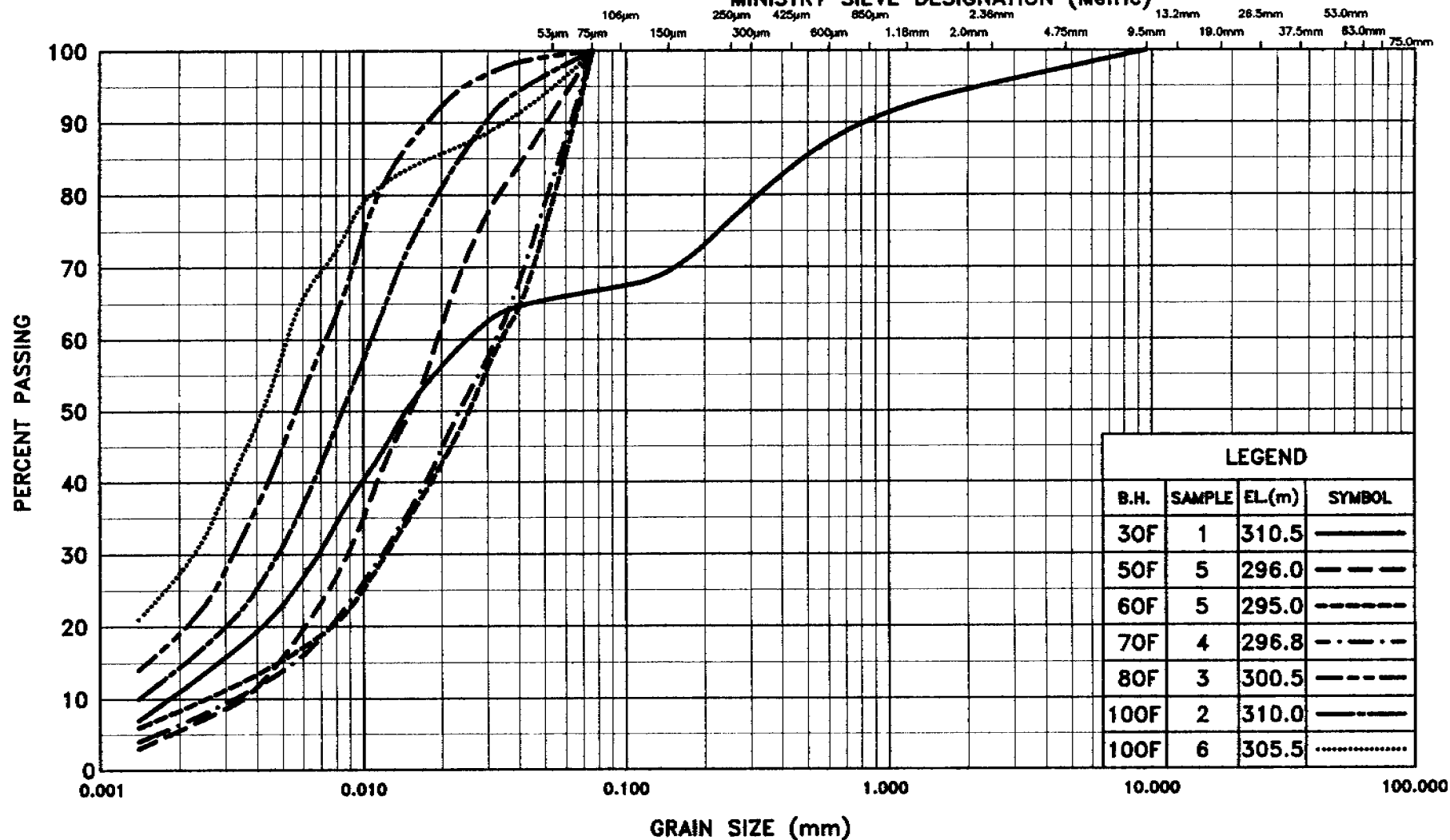


PROJ. No. S07524G0

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

SILTY CLAY

FIGURE C-4

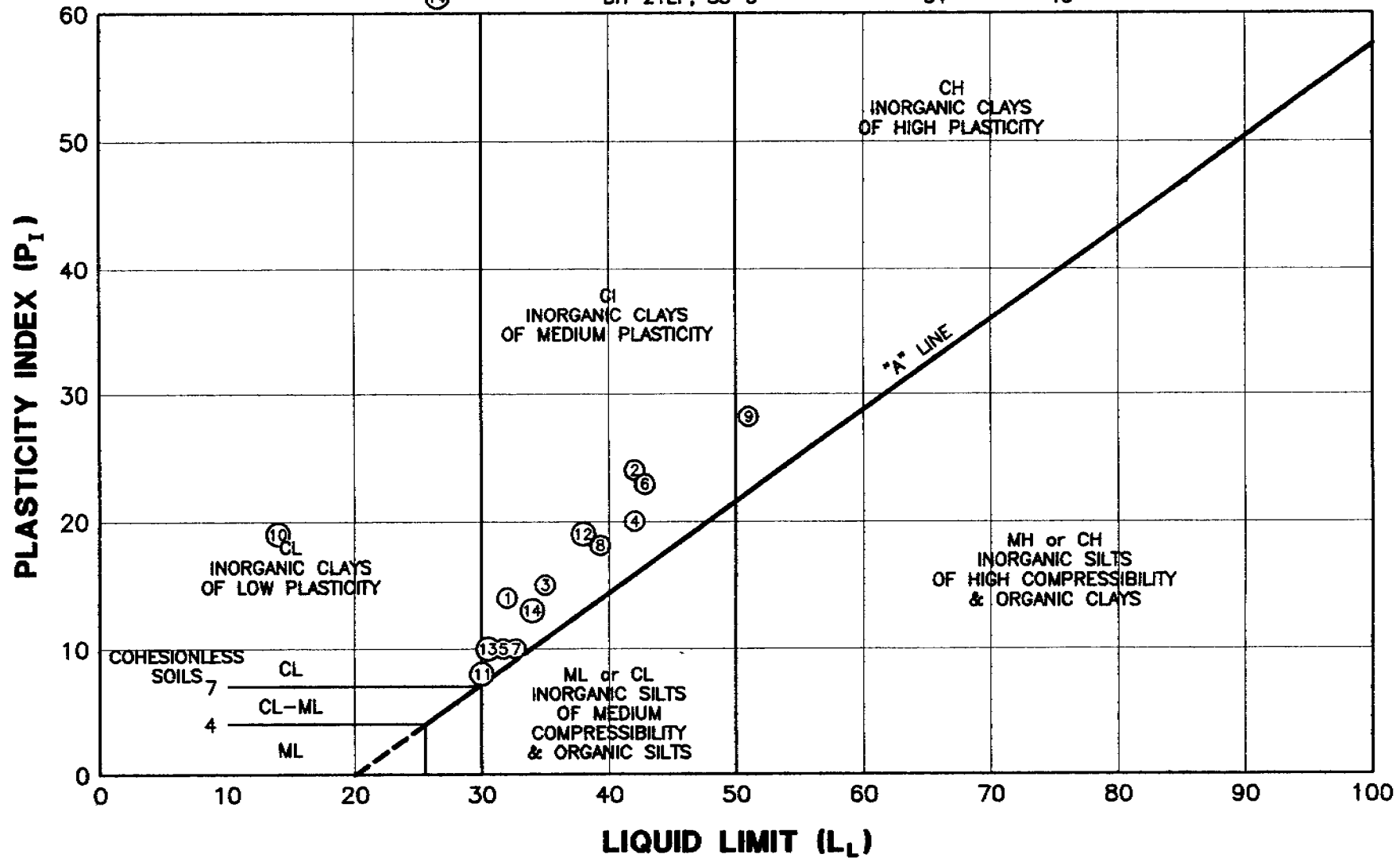
W.P. 774-93-00



PROJ. No. S07524G0

ATTERBERG LIMITS - PLASTICITY CHART

SYMBOL	DESCRIPTION	LL	PI
①	BH-1EF, SS-5	32	14
②	BH-4EF, SS-2	42	24
③	BH-4EF, SS-4	35	15
④	BH-13EP, SS-2	42	20
⑤	BH-17EP, SS-2	32	10
⑥	BH-21EP, SS-2	43	23
⑦	BH-21EP, TW-4	33	10
⑧	BH-80F, SS-3	39	18
⑨	BH-100F, SS-6	51	28
⑩	BH-90F, SS-2	41	19
⑪	BH-100F, SS-3	30	8
⑫	BH-100F, SS-5	38	19
⑬	BH-100F, SS-8	31	10
⑭	BH-21EP, SS-5	34	13

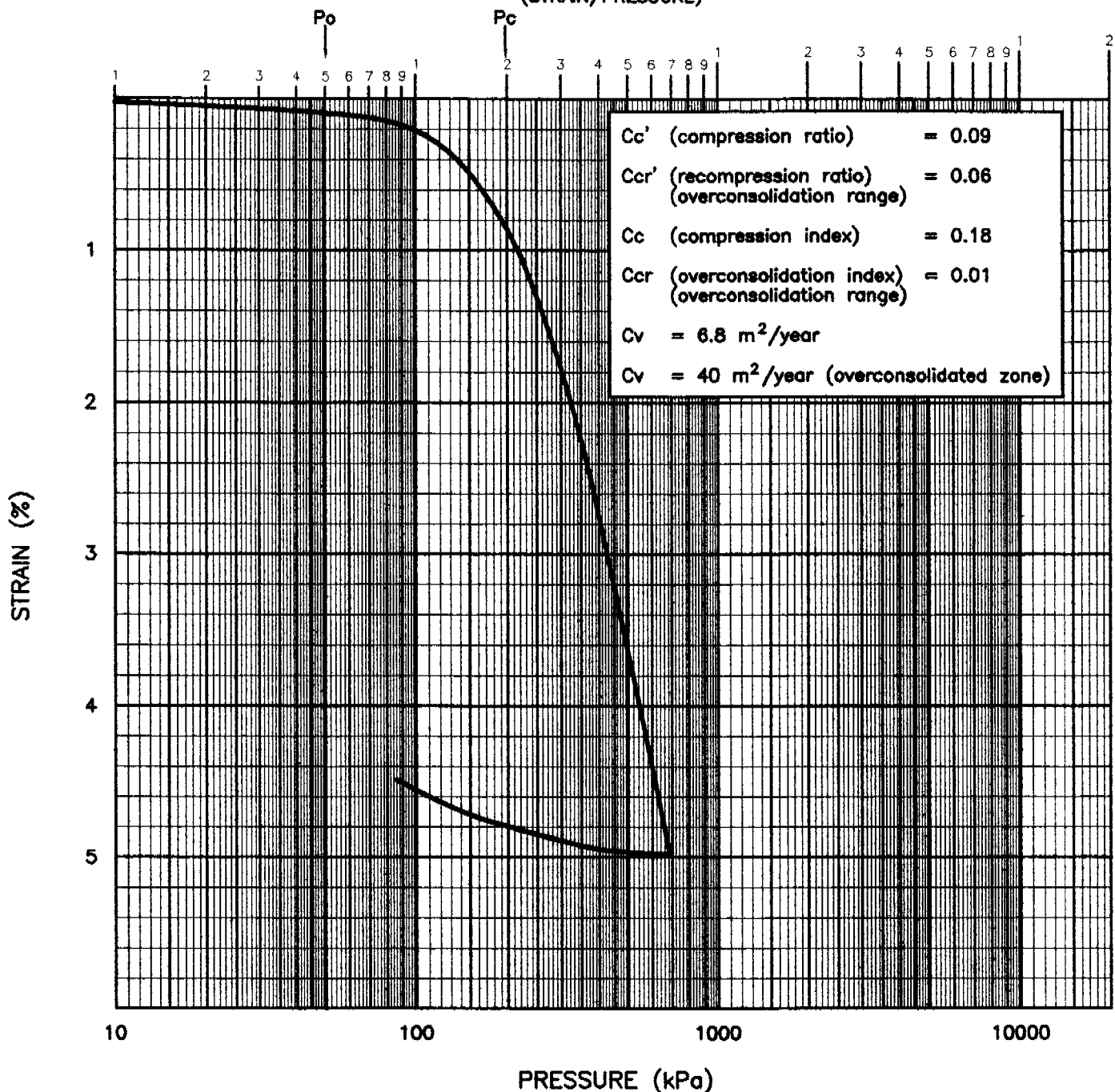


S07524G0

FIG. No. C-5

TROW

CONSOLIDATION TEST RESULTS (STRAIN/PRESSURE)

BOREHOLE No. 21EPDEPTH 3 mMOISTURE CONTENT 30.3 %LIQUID LIMIT 32 %PLASTIC LIMIT 22 % e_o 1.02UNIT WEIGHT 18.6 kN/m³

SAMPLE DESCRIPTION

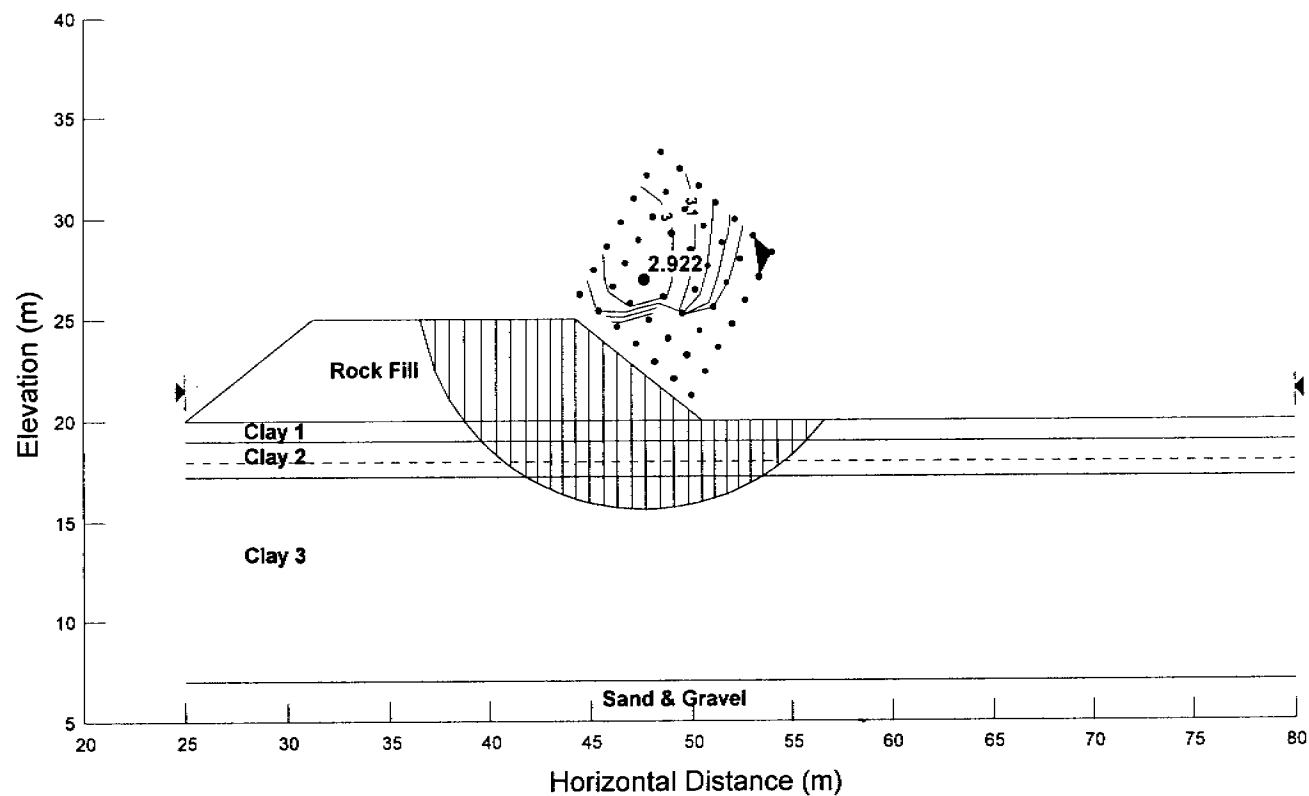
SILTY CLAY with firm to stiff, grey SILT layers

$$M_v = \frac{\Delta \text{ strain}}{\Delta \text{ pressure}} = 0.032 \text{ MPa}^{-1}$$

(COEFFICIENT OF VOLUME COMPRESSIBILITY)

D

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-C/G)
 North Abutment - Southbound Lanes
 5 metre embankment height, 1.25:1 side slopes
 N_S5H.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

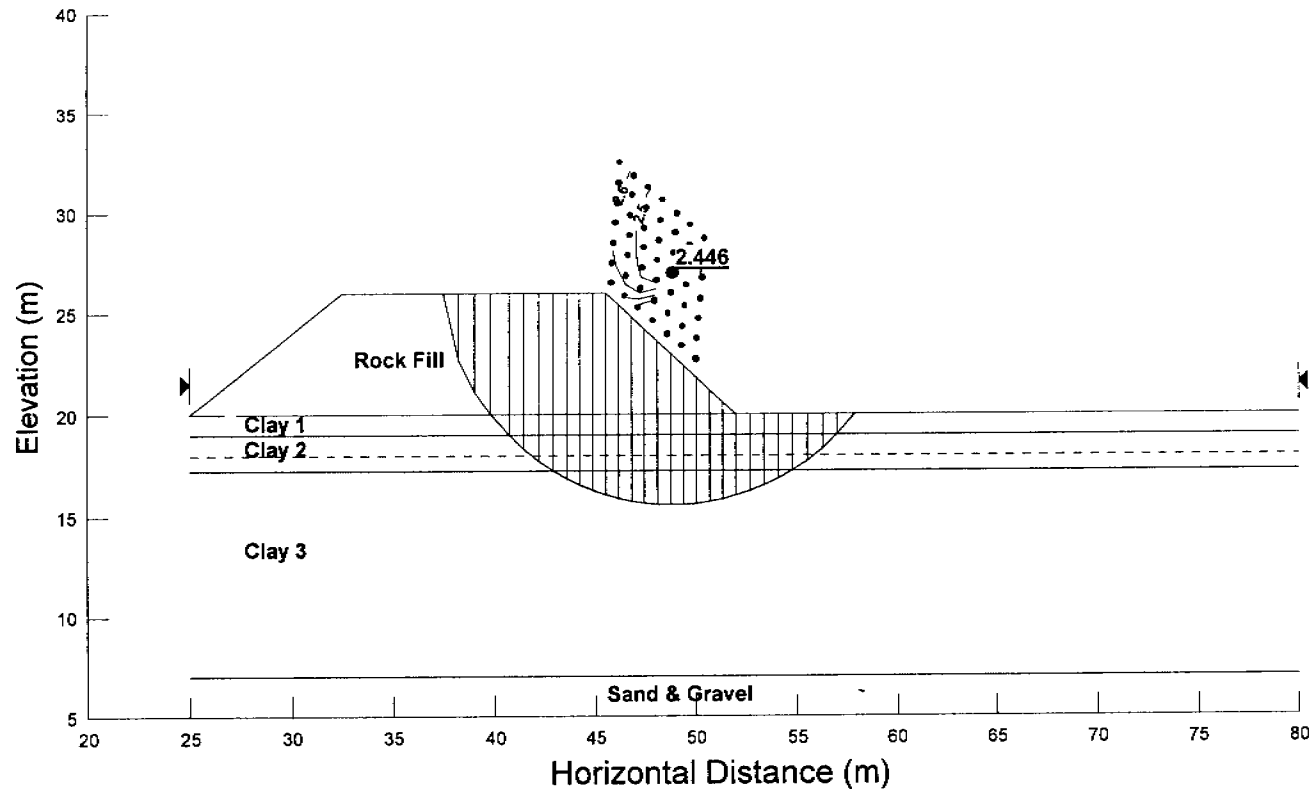
Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 100
 Rate of Increase -30
 Cv - Minimum 70
 Ch/Cv Ratio 1

Clay 2
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 70
 Rate of Increase -28.57
 Cv - Minimum 50
 Ch/Cv Ratio 1

Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 50
 Rate of Increase 1.95
 Cv - Maximum 70
 Ch/Cv Ratio 1

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-C/G)
 North Abutment - Southbound Lanes
 6 metre embankment height, 1.25:1 side slopes
 N_S6H.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 100
 Rate of Increase -30
 Cv - Minimum 70
 Ch/Cv Ratio 1

Clay 2
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 70
 Rate of Increase -28.57
 Cv - Minimum 50
 Ch/Cv Ratio 1

Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 50
 Rate of Increase 1.95
 Cv - Maximum 70
 Ch/Cv Ratio 1

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-C/G)
 North Abutment - Southbound Lanes
 7 metre embankment height, 1.25:1 side slopes
 4 metre high, 2 metre wide bench
 N_S7H.SLP

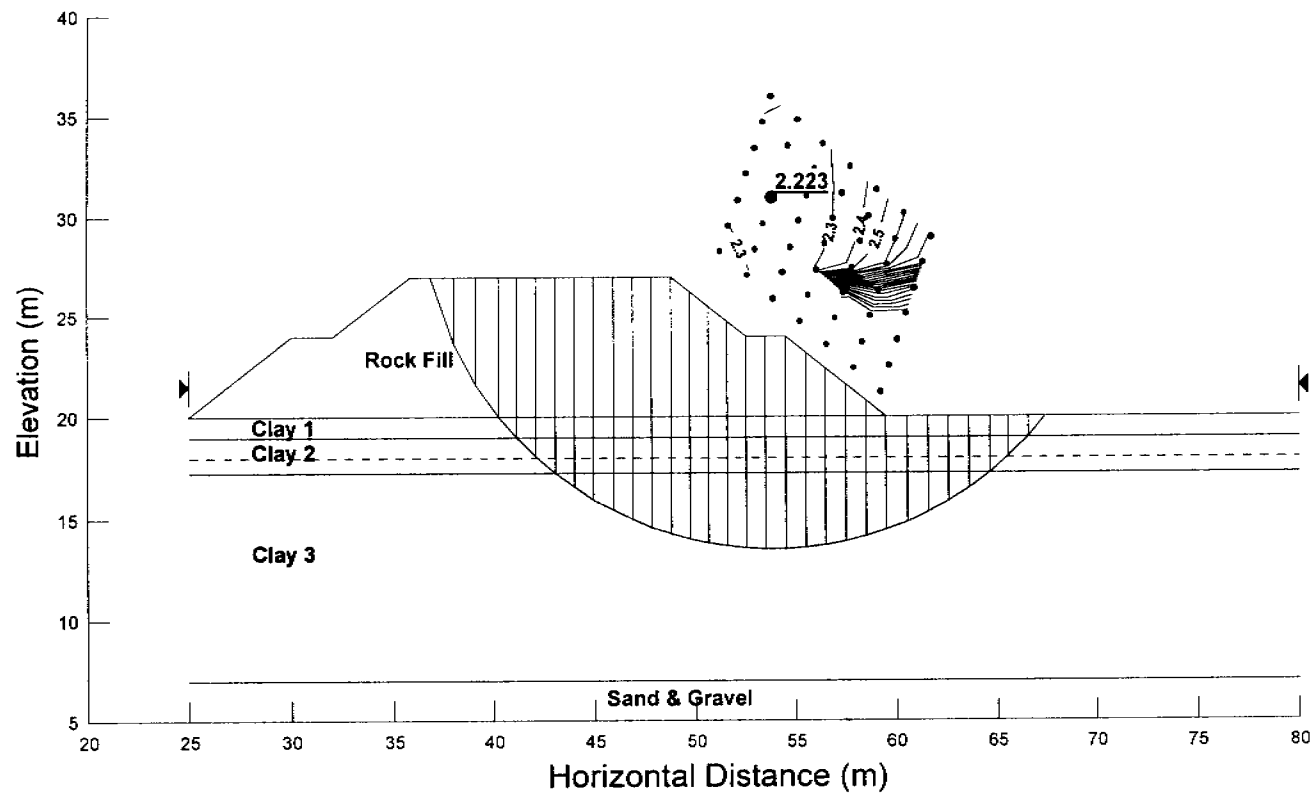
Rock Fill
 Soil Model Mohr-Coulom
 Unit Weight 20
 Cohesion 0
 Phi 42

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 100
 Rate of Increase -30
 Cv - Minimum 70
 Ch/Cv Ratio 1

Clay 2
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 70
 Rate of Increase -28.57
 Cv - Minimum 50
 Ch/Cv Ratio 1

Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 50
 Rate of Increase 1.95
 Cv - Maximum 70
 Ch/Cv Ratio 1

Sand & Gravel
 Soil Model Mohr-Coulom
 Unit Weight 20
 Cohesion 0
 Phi 39



Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-C/G)
 North Abutment - Southbound Lanes
 8 metre embankment height, 1.25:1 side slopes
 5 metre high, 2 metre wide bench
 N_S8H.SLP

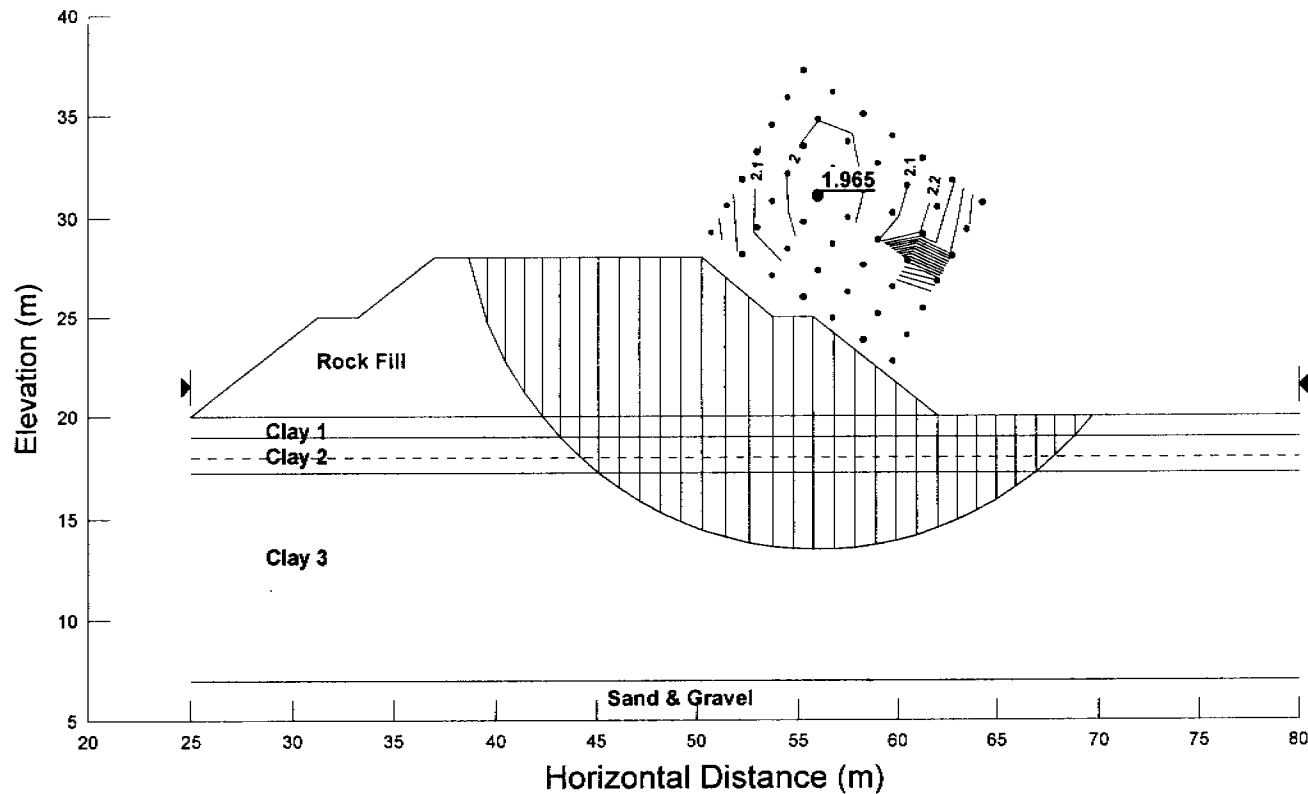
Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 100
 Rate of Increase -30
 Cv - Minimum 70
 Ch/Cv Ratio 1

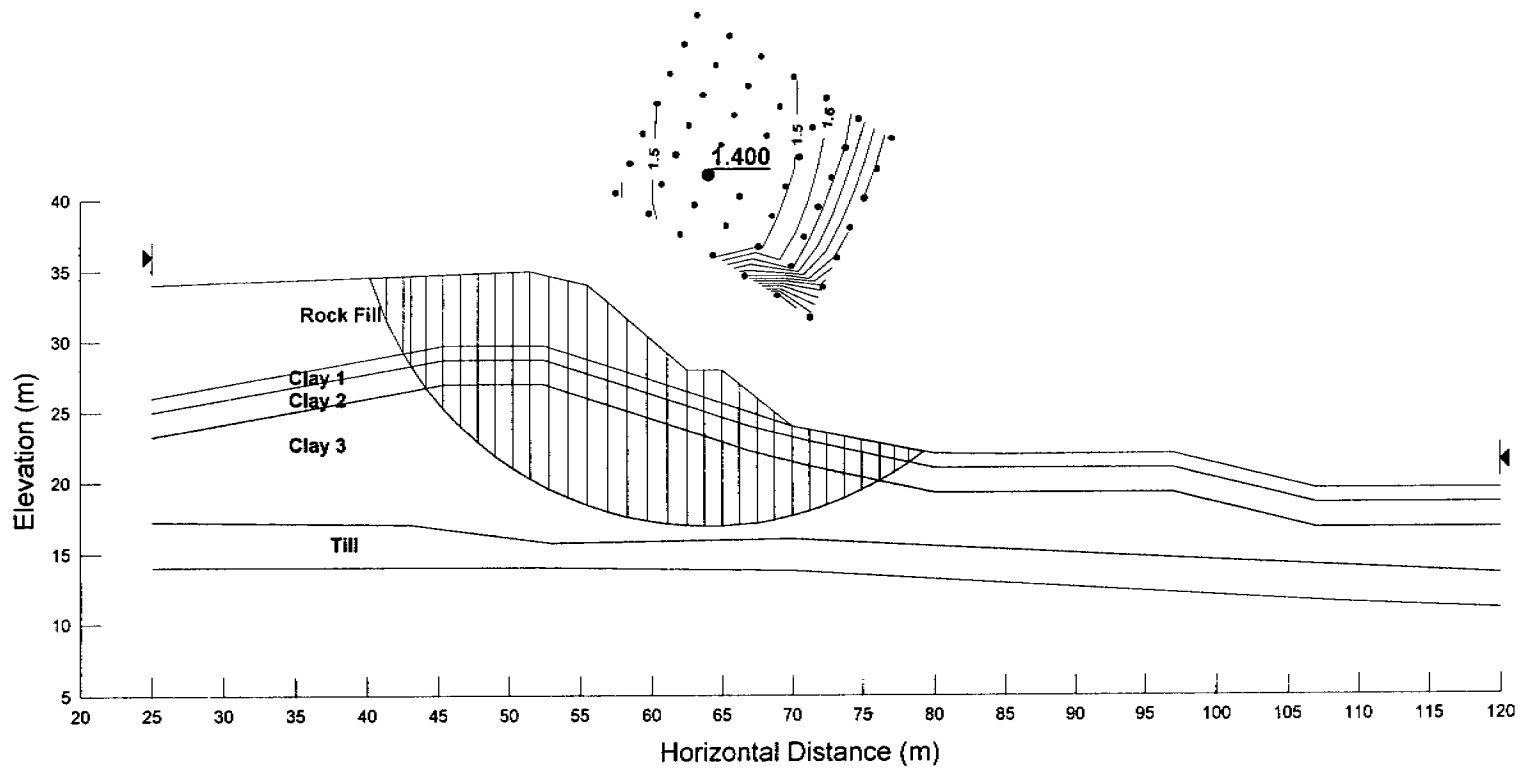
Clay 2
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 70
 Rate of Increase -28.57
 Cv - Minimum 50
 Ch/Cv Ratio 1

Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 50
 Rate of Increase 1.95
 Cv - Maximum 70
 Ch/Cv Ratio 1

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39



Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Southbound Lane, North Abutment
 With Extended Berm
 SBL_NALV.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 100
 Rate of Increase -30
 Cv - Minimum 70
 Ch/Cv Ratio 1

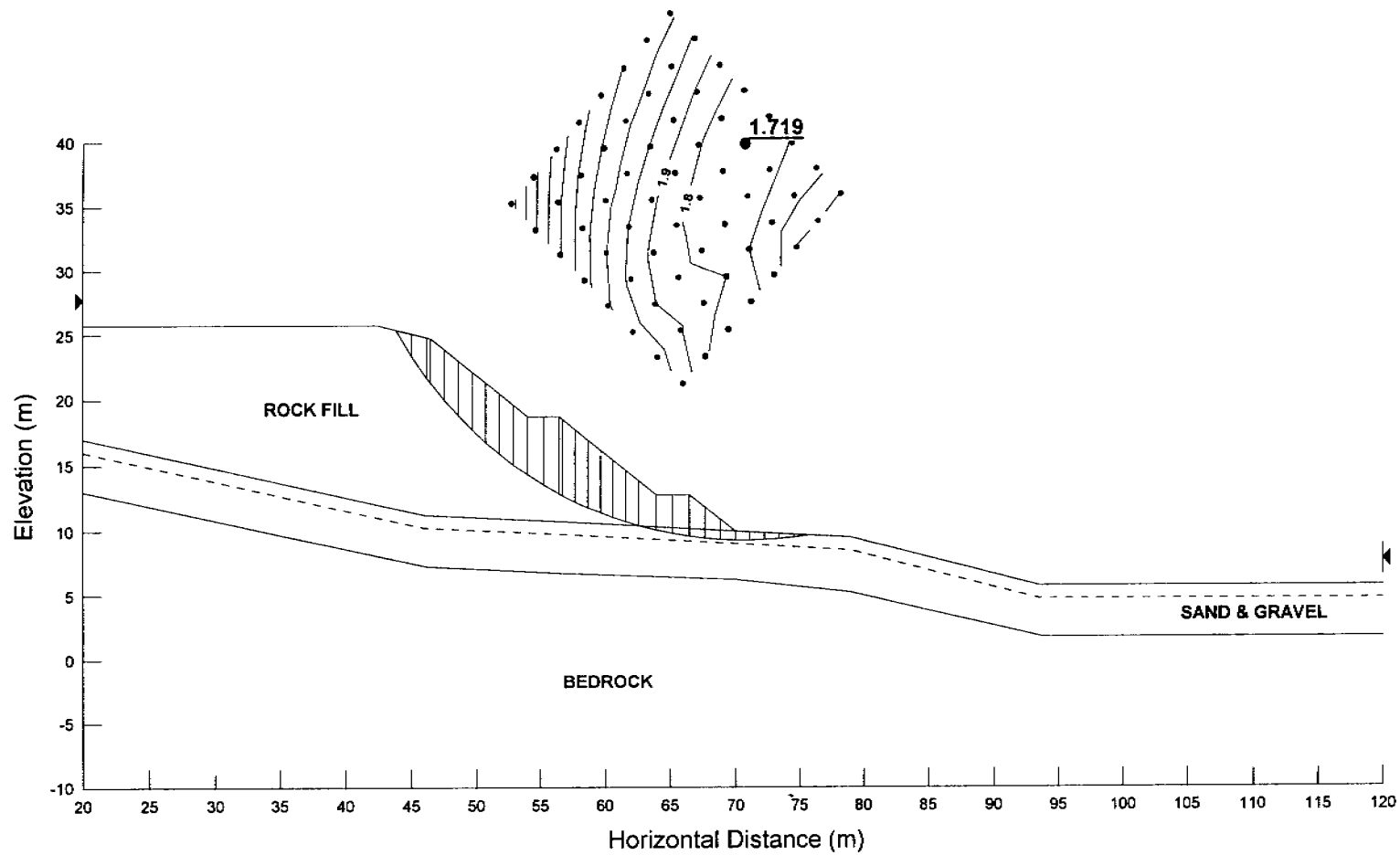
Clay 2
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 70
 Rate of Increase -28.57
 Cv - Minimum 50
 Ch/Cv Ratio 1

Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 50
 Rate of Increase 1.95
 Cv - Maximum 70
 Ch/Cv Ratio 1

Till
 Soil Model Mohr-Coulomb
 Unit Weight 21.5
 Cohesion 0
 Phi 35
 Unsaturated Phi B 0

Bedrock
 Soil Model Bedrock
 Unit Weight -1
 Piezometric Line # 0
 Pore-Air Pressure 0

Slope Stability - Total Stress Analysis
Trout Creek - Highway 11 (F-98179-C/G)
Southbound Lane, South Abutment
With Extended Berm
SBL_SA.SLP



Rock Fill
Soil Model Mohr-Coulomb
Unit Weight 20
Cohesion 0
Phi 42

Sand and Gravel
Soil Model Mohr-Coulomb
Unit Weight 21
Cohesion 0
Phi 35

Bedrock
Soil Model Bedrock

OVERSIZE DRAWING

**Foundation Investigation & Design Report
Bridge Structure & Approaches
Trout Creek (Site 44-371N)
NORTHBOUND LANES
Trout Creek By-Pass, King's Highway 11
District 54, Sudbury, Ontario
GWP No. 774-93-00**

Prepared For:

Marshall Macklin Monaghan
80 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N4

Trow Consulting Engineers Ltd.

Brampton, Calgary, Cambridge, Hamilton, Kingston, London, Markham, Montréal
North Bay, Iqaluit, Orillia, Ottawa, Sudbury, Thunder Bay, Winnipeg, Chicago, Tallahassee

807 Harold Crescent
Thunder Bay, Ontario, Canada
P7C 5H8

Telephone: (807) 623-9495
Facsimile: (807) 623-8070
e-mail: thunderbay@trow.com

F98179-B/G
November 24, 1999

Preface

Work Project GWP 774-93-00 is one of a series of projects for the four lane expansion of Highway 11. This project involves the four lane design of Highway 11, from 4.0 km south of Highway 522, northerly for 7.9 km. It will result in the construction of a by-pass of the existing Highway 11 to the west of the Town of Trout Creek.

This highway section is located in the Townships of Laurier and South Himsworth, within the geographic District of Parry Sound, as shown on the Key Plan, Figure A1 in Appendix A. The project requires geotechnical input for the following major components:

- New pavement design for the entire length of the four lane by-pass, including associated service roads.
- New structure, Trout Creek South Interchange (underpass), Site 44-372.
- **New structure, Trout Creek Northbound Lanes, Site 44-371N.**
- New structure, Trout Creek Southbound Lanes, Site 44-371N.
- New structure, Highway 522 (underpass), Site 44-370.
- New structure, Trout Creek North Interchange (underpass), Site 44-369.

This report deals with the new bridge structure for the **northbound lanes** at the proposed Trout Creek crossing, Site 44-371N, as well as the approach fills. Separate reports will be submitted for the additional components.

Part 1 of this report, Foundation Investigation, describes the geotechnical investigation methodology and the results derived, as pertaining to the design parameters required for the bridge foundations and related earthworks.

Part 2 of this report, Engineering Discussion and Recommendations, addresses the geotechnical engineering design considerations pertaining to the bridge foundations and the approaches.

Table of Contents

Preface	i
Table of Contents	ii
Part 1 Foundation Investigation	1
1.1 Introduction	1
1.2 Site Description and Geological Setting	1
1.3 Investigative Procedures	2
1.3.1 General	2
1.3.2 Field Investigation	2
1.3.3 Laboratory	4
1.4 Subsurface Conditions	4
1.4.1 Topsoil	5
1.4.2 Sand	5
1.4.3 Silty Sand	5
1.4.4 Silty Clay	5
1.4.5 Silty Sand and Gravel	7
1.4.6 Bedrock	7
1.5 Groundwater Conditions	9
Part 2 Engineering Discussion and Recommendations	10
2.1 Introduction	10
2.2 Foundations	11
2.2.1 Steel H-Piles (all locations)	11
2.2.2 Concrete Caissons (WP1 - South Abutment)	14
2.2.3 Spread Footings (WP1 - South Abutment)	14
2.2.3.1 Spread Footing on Bedrock	15
2.2.3.2 Spread Footing on Structural Fill	15
2.3 Backfill	18
2.4 Excavations and Dewatering	19
2.5 Bridge Approach Fills	20
2.5.1 Embankment Stability	20
2.5.1.1 South Approach Stability	21
2.5.1.2 North Approach Stability	22
2.5.2 Consolidation Settlement of Embankments	23
2.5.2.1 Magnitudes of Consolidation Settlement	23
2.5.2.2 Time Rate of Consolidation Settlement	25
2.5.3 Secondary Compression of Clays	25
2.5.5 Rockfill and Rockfill Settlement	26
2.6 Instrumentation and Construction Monitoring	27
2.7 Closing Comments	27

Tables

Table 1-1.	Consolidation Parameters for Silty Clay	7
Table 1-2.	Bedrock and Refusal Depths and Elevations at Boreholes	8
Table 2-1.	H-Pile Design Pile Capacities (kN)	12
Table 2-2.	Pile Cap Insulation Dimensions	13
Table 2-3.	Concrete Caisson Design Capacities	14
Table 2-4.	ULS Reduction Factors for Inclined Loads on Spread Footings	15
Table 2-5.	Spread Footing ULS and SLS Bearing Resistance	16
Table 2-6.	Fill Types and Unfactored Geotechnical Properties	18
Table 2-7.	Geotechnical Parameters for Slope Stability Analyses	21
Table 2-8.	Safety Factors for Total Stress Stability Analyses - South Approach	22
Table 2-9.	Estimated Embankment Consolidation Settlement	23
Table 2-10.	Estimated Embankment Consolidation Settlement	24

Appendix A

Figure A1.	Key Plan
Figure A2a.	Borehole Location Plan and Profile - South
Figure A2b.	Borehole Location Plan and Profile - North
Figure A3.	Undrained Shear Strength, Atterberg Limits and Effective Stress Profiles
Figure A4.	Undrained Shear Strength - All Boreholes
Figure A5.	Footing SLS Bearing Resistance - Granular Fill on Native Soil - SOUTH APPROACH
Figure A6.	Estimated Consolidation Settlement - SOUTH APPROACH
Figure A7.	Estimated Consolidation Settlement - NORTH APPROACH

Appendix B

Borehole Logs and Rock Descriptions

Appendix C

Results of Laboratory Testing (grain size, Atterberg Limits, consolidation tests)

Appendix D

Stability Analysis Printouts

Rear Pockets

Drawing No. 1. Bridge Site Plan & Profile
Drawing No. 2. Bridge Site Plan & Sections

Part 1 Foundation Investigation

1.1 Introduction

This report presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the proposed bridge structure and approaches for the northbound lanes (NBL) at the Highway 1, Trout Creek crossing at Site 44-371N.

An original investigation was completed at this site in June and July of 1998 for an originally proposed 105 m long (\pm) three span structure. However, for technical reasons based on the results of the original investigation, as discussed more fully in Part 2 of this report, a longer (242 m), five span bridge was selected. Accordingly, a supplementary investigation was completed during September and November, 1998 which investigated the subsurface conditions at the revised pier and abutment locations of the new proposed five span structure, where conditions were not previously investigated as part of the original work.

This report contains the results of the supplementary investigation, plus the relevant results of the original investigation, compiled for the five span structure arrangement of the Highway 11, northbound lane crossing of Trout Creek. It is Trow's understanding that the 5 span structure will be located with the central span crossing Trout Creek. The structure will include an approximately 11 metre high south abutment, 22 metre high centre span, and 5 metre high north abutment. The span lengths will be approximately 40, 54, 54, 54, 40 metres in length, creating a bridge with a length of about 242 metres.

1.2 Site Description and Geological Setting

The site is located in Lot 30, Concession 2, Township of South Himsforth, District of Parry Sound, along the banks of Trout Creek, about 2 km west of the Town of Trout Creek, and 750 metres south of Highway 552, as shown on Figure A1, in Appendix A.

Generally, the terrain at the site is sloping towards the creek and is well drained. However several drainage gullies run parallel and perpendicular to the creek, with steep embankments on either side of the gullies, creating a highly variable terrain in the vicinity of the proposed structure. The relief

can vary at slopes steeper than 1H:1V within the site. There are mature trees with heavy underbrush across the site.

According to OGS Maps 2544 and 2556, as well as Ontario Geological Survey Map P.3160 (Quaternary Geology, South River Area), the site is located in what is known as the Central Gneiss Belt, with mainly felsic igneous rocks of the Mesoproterozoic Group.

The overburden soils have been mapped as glaciolacustrine deposits consisting of laminated, rhythmically bedded (also referred to as varved) to massive silts and clays. The southernmost portion of the site edges onto an area mapped as a bedrock drift complex with relatively thin, primarily cohesionless soil cover (till).

1.3 Investigative Procedures

1.3.1 General

Part 1 of this report describes the investigative procedures used for the geotechnical assessment of the northbound lanes crossing of Trout Creek, within the Trout Creek By-Pass, King's Highway 11. Properties of the overburden soils were obtained by *in situ* and laboratory testing and the procedures employed during the investigation are described below.

1.3.2 Field Investigation

The initial field investigation, or explorations, for the originally proposed three span arrangement was carried out between June 9 and July 2, 1998. Originally these explorations investigated only the pier and abutment locations, as well as the immediate approach embankments. With the discovery of clay at this site additional explorations were advanced, while on site, to outline the vertical and areal extent of the clay within the approach embankments. A further investigation of the north approach was completed September 23 and 24, 1998. The supplementary investigation of the revised, five span, arrangement occurred between November 10 and 24, 1998. The locations of the boreholes, cones and probes, completed as part of these investigations are shown on Figures A2a and A2b, in Appendix A, as well as on Drawings, No. 1 and No. 2, located in the pockets at the end of this report. These locations, as well as the surface elevations, were established from the terrain model for the project, and/or a survey crew from Marshall Macklin Monaghan, and are referenced to geodetic datum.

The investigation of the piers and abutments of the five span arrangement includes 13 boreholes (BH-1NF to BH-10NF, inclusive, BH-8DP, BH-3DF, BH-18DF), two dynamic cone penetration tests (C-3DF, C-5DF), and four auger probes (AP-1NF to AP-4NF inclusive). All of these explorations were advanced to auger refusal or to refusal of the penetration cone ($N > 100$). Six of the boreholes were advanced into the bedrock to obtain core, as described below.

The investigation of the approaches included six additional boreholes (BH-23DP, BH-24DP, BH-10DP, BH-11DP, BH-12DP, BH-18EP). Boreholes BH-23DP and BH-24DP were advanced within the northern approach and were advanced to beneath the upper silt and clay layer. Boreholes BH-10DP, BH-11DP, BH-12DP and BH-18EP were advanced within the southern approach, until auger refusal.

Other explorations completed in the vicinity of the NBL structure, as part of the original three span investigation, or as part of the subsequent investigation to determine the horizontal extent of the clay layer included 16 boreholes (BH-1DF, BH-2DF, BH-4DF, BH-6DP, BH-7DP, BH-9DP, BH-11 EP, BH-13DP, BH-14DP, BH-15DP, BH-16DP, BH-17DP, BH-19DF, BH-20 DP, BH-21DP, BH-22DP), five dynamic cone penetration tests (C-1DF, C-2DF, C-4DF, C-5DF, C-6DF) and two auger probes (AP-1DF, AP-2DF), plus those explorations completed as part of the SBL investigations (see foundation report for the SBL structure).

The boreholes, cones and probes were advanced through the overburden soils using a Bombardier mounted CME-55 drill and a Dietric 50 drill, equipped with solid and hollow stem augers, and supplied by a soils drilling contractor, Master Soil Investigations Limited. At some of the borehole locations, a bulldozer was used to prepare the site for drill access.

Soil samples were obtained by using a 51 mm OD split-spoon sampler in conjunction with standard penetration tests at approximately 0.75 m and 1.5 m intervals. The standard penetration (N) values, together with the blows from the dynamic cone penetration tests, were recorded and used to provide an assessment of the compactness or consistency of the overburden soils. Sampling and testing procedures were in general accordance with ASTM D1586.

Several undisturbed, nominal 50 mm diameter, 'Shelby' tube samples were also obtained in the cohesive deposits. Field vane testing was completed in the boreholes and the auger probes throughout the cohesive soils to measure the *in situ* undrained shear strength of the cohesive soils. The field vane used had dimensions of 152 mm long by 70 mm diameter, not including the pointed 45° point. Torque measurement was by using two calibrated scales on a calibrated lever arm threaded to the drill rods. The testing was in general accordance with ASTM D2573.

At each bridge foundation element, conventional rock coring techniques were used to advance one of the explorations approximately 3 metres into the underlying bedrock. A BQ size core barrel and casing was used and core samples of the bedrock were retrieved for rock quality determination and classification. These six explorations advanced into the underlying bedrock included BH-2NF, BH-3NF, BH-5NF, BH3-DF, BH-7NF and BH-10NF.

Details of the soil and bedrock conditions encountered in the boreholes are included on the logs in the attached Appendix B.

1.3.3 Laboratory

The laboratory testing program for selected soil samples consisted of the following:

- natural moisture content
- unit weight
- grain size distribution
- laboratory shear tests (lab vane, penetrometer)
- Atterberg limits
- 1-d consolidation test

The laboratory test results are summarized on the attached borehole logs in Appendix B and are also presented in Appendix C. Many of the results are also discussed in the following descriptive sections.

1.4 Subsurface Conditions

The borehole locations are shown on the site plans, Figures A2a and A2b in Appendix A, as well as on Drawings, No. 1 and No. 2. Centerline soil profiles are also shown on the Figures and Drawing No. 1 and the soil cross sections at the locations of the foundation elements are shown on Drawing No. 2.

The borehole, auger probe and dynamic cone penetration (CPT) logs are provided in Appendix B. In general, the following main soil layers were encountered, with increasing depth:

- topsoil
- sand
- silty sand
- silty clay

- silty sand and gravel
- bedrock

A summary of the soil strata encountered in the boreholes, and inferred from the probes and dynamic cone penetration tests, is presented below.

1.4.1 Topsoil

The majority of boreholes encountered a surficial layer of approximately 150 mm to 200 mm of topsoil. At some of the borehole locations, a bulldozer was used to prepare the site for drill access, thus the topsoil in these areas was removed in the process and the logs do not indicate the presence of topsoil.

1.4.2 Sand

A layer of loose to compact (N-values from 5 to 25), fine to medium grained brown sand was encountered beneath the topsoil at many of the boreholes advanced at the foundation elements. The thickness ranged from less than 200 mm to over 2 m, and was usually underlain by silty clay, as described below. For the boreholes drilled at the foundation elements, the sand was not encountered in Boreholes, BH-5NF, BH-6NF, BH-8NF, BH-3DF, BH-18DF, BH-5DF, BH-10DF or BH-23DF.

1.4.3 Silty Sand

Brown to grey, very loose to compact silty sand with local gravel was encountered beneath the topsoil in Boreholes, BH-3DF and BH-18DF at the location of Pier WP4, adjacent to the north bank of Trout Creek. The standard penetration indices ranged from about 1 to 17. The soil contained organics such as roots and pieces of wood and may be a recent stream alluvium. This soil was underlain by silty sand and gravel at a depth of about 4 m.

1.4.4 Silty Clay

Beneath the upper sand or topsoil, a stratum of silty clay was encountered as the principal soil in all boreholes at the locations of the foundation elements except BH-2NF (WP1 - south abutment) and BH-3DF and BH-18DF (WP4 - pier). In BH-2NF, silty sand and gravel, as described in the next section was encountered. In BH-3DF and BH-18DF, silty sand, as described in the previous section was encountered.

The silty clay is relatively thin (3 m to 4 m) at the location of the south abutment and increases in thickness to between about 12 m to 14 m on the north side of Trout Creek, in the areas of Pier WP5 and the north abutment and approach. Generally, the silty clay is thinly laminated with silt (varved). The individual layers, or laminations, varied in thickness from a few millimetres to a few centimetres, but in general were less than about one centimetre. The proportions of clay to silt and clayey silt varied also, but in general the clay portion dominated.

The natural moisture content of the clay varies from about 20% to over 50% (depending on the silt content) and consistency. Atterberg limit determinations provided the following approximate ranges: Plastic Limit, 18 to 23; Liquid Limit, 28 to 50; Plasticity Index, 8 to 30. These data indicate that, in general, the clay can be described as a low plasticity silty clay (CL) to medium plasticity silty clay (CI). Typically, the silty clay is drier near the top and bottom, but there does not appear to be a depth relationship relative to the Atterberg Limits. The laboratory test data are shown on the borehole logs, on Figure A3 in Appendix A, and in Appendix C.

Standard penetration test (SPT) values ranging from about 1 to over 20 were obtained in the silty clay. The higher values were generally obtained within the upper metre, or so. *In situ* field vanes and laboratory shear vane testing, as well as the SPT values, indicate that the silty clay has a stiff to very stiff crust with undrained shear strengths exceeding 100 kPa. The silty clay consistency, however, reduces with depth to soft to firm to stiff, with undrained shear strengths of about 20 kPa to 70 kPa, at depths of about 3 m to 5 m. Sensitivity, the measure of peak shear strength to remoulded shear strength, ranged from about 2 to 16, with an average of about 7, indicating the clay is moderately sensitive. The undrained shear strength profile which includes shear strength data from all boreholes is shown on Figure A4. The strength profile shown on Figure A3 is based on the strength data from boreholes at the locations of the abutments and the design profile assumed is based on the actual vane test results and the SPT values.

Based on all the above, and with reference to Figure A3, it is evident that the clay is heavily overconsolidated in the upper 3 m to 4 m, becoming moderately to lightly overconsolidated with increasing depth. The preconsolidation pressure near the top of the stratum is estimated at about 400 kPa, on average. The overconsolidation ratio (OCR) is estimated as ranging from over 30 near the top to about 3 at a depth of about 3 m. Thereafter with increasing depth, the OCR decreases gradually to about 1.6 at a depth of 14 m.

A one-dimensional consolidation test was performed on a sample of the silty clay extruded from a thin walled Shelby tube, obtained from BH-21EP. The results are presented graphically and numerically

in Appendix C. The data are also summarized below in Table 1-1, along with the value ranges used in our subsequent analyses.

Table 1-1. Consolidation Parameters for Silty Clay		
	BH-21EP, 3 m	Values for Analyses
Compression ratio, $C_c' (= C_c/(1+e_0))$	0.08	0.08 - 0.20
Recompression ratio, $C_r' (= C_r/(1+e_0))$	0.006	0.008 - 0.02
Coefficient of consolidation (recompression), C_{vr}	40	25 - 60 (avg 40)
Coefficient of consolidation (virgin), C_v	7	5 - 12 (avg 8)
Coefficient of secondary compression, $C_{\alpha\epsilon}^*$	0.003 - 0.004	0.003 - 0.005
Notes: Coefficients of consolidation in units of $m^2/year$ * $C_{\alpha\epsilon} = \Delta H/H_0$ (= secondary compression ratio, in some literature)		

1.4.5 Silty Sand and Gravel

A basal deposit of loose to dense, brown silty sand and gravel was encountered above the bedrock (or refusal) surface in most of the boreholes. Standard penetration indices (N-values) ranged from about 6 to 58. Its thickness varied from less than about 0.5 m to over 4 m.

1.4.6 Bedrock

The presence of bedrock was established by retrieving "BQ" size cores in one sampled borehole at each of the six foundation element locations, for depths of between about 3.1 m and 3.4 m. Detailed descriptions of the rock are presented in Table 1-1 in Appendix B, following the borehole logs. Generally, the bedrock can be described as a pink and light grey, biotite-hornblende gneiss. The rock is strong and unweathered for the most part.

Rock core recovery was 100% for all runs and the Rock Quality Designation (RQD) values for individual core runs ranged from about 10% to 96%. The average RQD for the rock core recovered was about 70%, based on the 20 core runs. In accordance with the MTO classification system, the rock quality can be described as very poor to excellent, with an average of fair. It is noted that the RQD values are likely conservative; it is expected that higher values would be obtained using NQ core.



Table 1-2, below, lists the bedrock depths and elevations as well as those of refusal, at the locations of each of the six foundation elements. It can be seen that the bedrock and refusal depths and elevations are quite variable, even within short distances at the individual element locations. Refusal (to augering or dynamic cone penetration testing (CPT)) is inferred to be due to probable bedrock, but it is noted that refusal may be due to cobbles, boulders, or very dense soil. The bedrock depths and elevations have been positively established only at the locations where the bedrock has been cored.

Table 1-2. Bedrock and Refusal Depths and Elevations at Boreholes					
Location	Borehole	Orig. Gr. Elev. (m)	Bedrock or Refusal Elev (m)	Overburden Thickness (m)	Comment RQD (by run)
WP1 South Abutment	BH-1NF	313.8	307.46	6.34	auger refusal
	BH-2NF	314.3	310.43	3.87	B/R cored 87%, 96%
	AP-1NF	313.82	308.58	5.24	auger refusal
	AP-2NF	313.91	309.76	4.15	auger refusal
	AP-3NF	313.9	309.72	4.18	auger refusal
	AP-4NF	314.21	310.6	3.61	auger refusal
WP2 Pier	BH-3NF	312.54	302.42	10.12	B/R cored 78%, 90%
	BH-4NF	313.51	304.52	8.99	auger refusal
	BH-8DP	313.26	303.51	9.75	auger refusal
WP3 Pier	BH-5NF	307.04	300.12	6.92	B/R cored 10%, 20%, 75%
	BH-6NF	304.88	296.04	8.84	auger refusal
	C-5DF	305.9	299.42	6.48	CPT refusal
WP4 Pier	BH-3DF	301.11	294.34	6.77	B/R cored 98%, 100%
	BH-18DF	300.76	295.09	5.67	auger refusal
	C-3DF	300.64	294.95	5.69	CPT refusal

Table 1-2. Bedrock and Refusal Depths and Elevations at Boreholes					
Location	Borehole	Orig. Gr. Elev. (m)	Bedrock or Refusal Elev (m)	Overburden Thickness (m)	Comment RQD (by run)
WP5 Pier	BH-7NF	310.51	299.14	11.37	B/R cored 65%, 65%, 78%
	BH-8NF	312.21	298.4	13.81	auger refusal
WP6 North Abutment	BH-9NF	312.8	298.11	14.69	auger refusal
	BH-10NF	312.93	298.18	14.75	B/R cored 82%, 93%

1.5 Groundwater Conditions

Information regarding the groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling and by tactile examination of the recovered samples. The measured or inferred groundwater levels are shown on the borehole logs and the stratigraphic sections. In general, the groundwater table at the times of the field work was between about 1 m and 4 m in depth. It appears to follow the topography and this suggests that local subsurface drainage would be towards Trout Creek.

Part 2 Engineering Discussion and Recommendations

2.1 Introduction

The following subsection addresses the geotechnical design considerations pertaining to the proposed five span bridge for the Northbound Lanes crossing of Trout Creek, as well as the approaches.

An original investigation was completed at this site in June and July of 1998 for an originally proposed 105 m long (\pm) three span structure and revealed significant clay deposits on either side of Trout Creek which caused concern for the stability of the approach embankments, which were about 20 m high. Various design alternatives were considered including removal of the clay to the underlying bedrock, extensive berming of the embankments, the use of lightweight fill within the embankments, retaining walls, and a lengthening of the structure to limit the impact of the clay deposits. A subsequent cost benefit analysis of the design alternatives proposed by Trow, performed by Marshall Macklin Monaghan, indicated the preferred alternative was to lengthen the structure.

It was considered that the lengthened structure would effectively span the clay deposit, so that the approach embankments could either be located on a thinner or absent clay layer, or alternatively the lengthened structure would extend to the point where the height of the approach embankments could be reduced, and thus reduce or eliminate the complications encountered by placing high approach embankments on thick clay deposits.

Upon MTO acceptance of the lengthened structure alternative, a supplementary investigation was completed during September and November, 1998 as described in Part 1 of this report. The supplementary investigation examined the soil conditions at the revised pier and abutment locations of the new proposed five span structure, where conditions were not previously investigated as part of the original work.

The five span bridge is proposed to carry northbound Highway 11 traffic over Trout Creek and its valley. It is Trow's understanding that the bridge will be located with the central span crossing Trout Creek. The structure will include an approximately 11 metre high south abutment, 22 metre high centre span, and 5 metre high north abutment. The span lengths will be approximately 40, 54, 54, 54, 40 metres in length, creating a bridge with a length of about 242 metres.

It is understood that the project is scheduled for completion within a two year time frame. Accordingly, some of the discussions and design recommendations presented herein are based on this time frame.

2.2 Foundations

In general, because of the presence of loose to compact sand and silt and relatively weak and compressible clay at the locations of the foundation elements, it is not considered feasible to support the proposed bridge foundations on spread footings constructed on the native mineral soils. For all foundation elements, driven steel H-piles are considered to be the preferred alternative. Alternate types of foundations may, however, be considered for the support of the bridge piers and abutments. The alternate types that are considered applicable to the site and proposed layout include large diameter reinforced concrete caissons and spread footings on rock or structural fill. Not all of these foundation types are applicable to all six foundation elements.

The following sections present the foundation design recommendations for the six foundation elements of the proposed bridge.

2.2.1 Steel H-Piles (all locations)

All abutments and piers are recommended to be supported on steel H-piles driven to the bedrock surface, using the ULS capacities for HP310x110 and HP310x132 sections, as given in Table 2-1, below.

Current design practice requires that consideration be given to downdrag loads that may be generated as a result of soil consolidation due to fills, groundwater table fluctuations and the soil stresses induced by pile installation. We consider that, even after primary consolidation of the clay soils due to the fill placement is complete, the potential exists for downdrag loads due to events such as significant groundwater lowering and the long term process of secondary compression. At this site, secondary compression is the likely mechanism. Secondary compression of the clay foundation soils is discussed further in a subsequent section of this report. Accordingly, we have considered the effects of downdrag loads on the pile capacities given in the following sections, where applicable.

Table 2-1. H-Pile Design Pile Capacities (kN)						
	HP 310x110			HP 310x132		
Factored Structural Capacity (OHBDC)	3285			3890		
Factored Axial Resistance (MTO*)	2000			2300 (est)		
Pile Location ----->	South Abutment W1	Piers W2, W3, W4, W5	North Abutment W6	South Abutment W1	Piers W2, W3, W4, W5	North Abutment W6
Factored Downdrag Load	1000	-	1000	1150	-	1150
Factored Axial Capacity at ULS**	2000	2000	2000	2300	2300	2300
Notes: MTO* = Structural Office Policy Memo 98-01, April 15, 1998 ** Factored axial capacity at ULS is the lesser of: (a) factored structural capacity minus factored downdrag load, and (b) factored axial resistance SLS capacity not applicable to piles driven to bedrock						

The axial capacity at SLS is not applicable to steel piles driven to bedrock because very high loads, in excess of the ULS capacity, are required to produce unacceptable deformations. The pile structural capacity will govern.

The capacities given are axial capacities, for both vertical and inclined piles. No reduction is required for inclined piles. Notwithstanding the above, the horizontal and vertical loads acting on all piles must be resolved axially, such that the vector sum of these loads does not exceed the ULS capacity provided above.

For design purposes, the modulus of horizontal subgrade reaction for steel H-piles can be taken as 8,000 kN/m³ for the cohesive soils (silty clays) and 40,000 kN/m³ for the cohesionless soils. It is expected, however, that inclined piles will be required to accommodate the lateral loads. These can be designed using the same axial capacities given in Table 2-1.

A minimum soil embedment depth of 3 m below the pile cap is recommended. Pile caps should be provided with at least 2 m of soil cover for frost protection. Local grade raises may be required in order to provide this cover.

If the underside of the pile caps cannot be provided with a minimum of 2 m earth cover, insulation will be required. Insulation should consist of rigid board extruded polystyrene, meeting

CAN/CGSB-51.20-M87 (Type 4), such as *DOW SM™*. The insulation is recommended to be placed beneath the pile caps, prior to placement of concrete. Since the insulation will not carry any significant loads, high strength/low compressibility insulation (such as *DOW HI40™*, etc.) is not required. Products other than those made by *DOW CORNING* may be used, provided they meet the above noted specification.

The insulation thickness and lateral extension beyond the edges of the pile caps will depend on the depth of placement (i.e., underside of pile cap), in accordance with Table 2-2, below. A minimum soil cover of 300 mm is recommended over the top of the insulation.

Table 2-2. Pile Cap Insulation Dimensions		
Depth (mm)	Thickness (mm)	Lateral Extension (mm)
500	90	1500
1000	50	1000
1500	25	500

As discussed in following subsections of this report, substantial settlements of the approach fills will occur as will some associated lateral strains. Accordingly, piles should not be installed until after the majority of the fill settlement has occurred, based on monitoring during construction. This is particularly important for inclined piles, that would be subjected to bending stresses.

All piles should be driven to bedrock. Pile tip elevations can be estimated from Table 1-2 which provides the bedrock or refusal elevations encountered at the boreholes drilled at the various foundation elements. The boreholes indicate that the bedrock elevations are quite erratic and the potential for irregular steeply sloping bedrock at the foundation locations is considered to be high at most locations. As such, problems may arise during pile seating. At some locations, the piles may have a tendency to skip over the bedrock surface resulting in alignment problems and deeper penetration. In the event that this problem occurs, somewhat longer piles may be required and, in some cases, piles may have to be added or replaced.

To minimize seating difficulties, rock injector points should be used to facilitate proper seating. All piles must be fitted with reinforcing plates welded to the flanges as per OPSD 3301 to minimize pile damage. It is recommended that, during pile driving and upon initial contact with the bedrock, the

pile driving energy should be reduced and subsequently increased incrementally until the piles have been sufficiently seated.

2.2.2 Concrete Caissons (WP1 - South Abutment)

As an alternative foundation system, concrete caissons installed on or into the bedrock can be considered for all locations. However, they will likely only be practical for the foundation at the south abutment (WP1), where the bedrock surface is generally within about 3.5 m to 6.5 m below original grade. The load capacity will be derived by end bearing, in accordance with the values given in Table 2-3. As for steel H-piles, the effects of downdrag loads must be considered.

Table 2-3. Concrete Caisson Design Capacities	
Factored Downdrag Load (WP1 abutment)*	2800 kN/m pile diameter
Factored Axial Capacity at ULS	8000 kPa
Notes: SLS capacity not applicable to caissons on bedrock * Factored Downdrag Load to be applied to the factored dead loads	

In order to provide an adequate socket, the caisson should be installed at least one pile diameter into the bedrock, or be heavily dowelled. While these units can provide high capacities, because of the irregular and potentially steeply sloping bedrock surface expected at this site, caisson installation may prove difficult, thus expensive. This is complicated by the fact that in most cases the bedrock is overlain by silty sand and gravel that may create dewatering and stability problems during work at the base of the caissons.

2.2.3 Spread Footings (WP1 - South Abutment)

An alternate foundation for the south abutment is a conventional abutment on a spread footing. This alternative is not considered practical for the other locations because of the low capacities that will result from SLS considerations when constructed on soil or the need to excavate greater than 6 m for construction on bedrock. At the south abutment, a spread footing abutment can be constructed either on the bedrock or on structural fill placed over the bedrock or over the native soil.

2.2.3.1 Spread Footing on Bedrock

The elevations of a footing on bedrock can be estimated from Table 1-2. The factored bearing resistance at ULS for footings on unweathered bedrock is **8,000 kPa**. The bearing resistance at SLS does not apply because of the much higher pressures required to produce unacceptable deformations.

In order to evaluate the sliding resistance of spread footings on bedrock, the unfactored coefficients of friction for mass concrete on clean bedrock can be taken as 0.7. If the factored resistance against sliding failure is inadequate based on friction only, steel dowels will be required for footings on bedrock.

The ULS capacity of spread footings must be reduced for the effects of inclined loads. The reduction factors given in Table 2-4, below, can be used for footings on bedrock. Interpolation is possible. These factors must be applied to the ULS bearing resistance given previously.

Table 2-4. ULS Reduction Factors for Inclined Loads on Spread Footings	
Ratio of Horizontal to Vertical Load	Footings on Rock
0.1	0.86
0.2	0.76
0.3	0.66
0.4	0.58
The ULS reduction factors for inclined loads have been taken from Figure 6-8.4.2 of the OHBDC	

2.2.3.2 Spread Footing on Structural Fill

Spread footings can be designed for construction on structural fill. Structural fill can be constructed after removal of the overburden soils, where shallow, or it can consist of the granular (or rockfill) approach fill placed on the stripped native soils. For the abutment support, it is recommended that

the structural fill consist of OPSS Granular A, placed in small lifts and adequately compacted (100% standard Proctor). Alternatively, a relatively fine well graded rockfill, with a maximum size of 300 mm can be used. This finer graded rockfill should be placed in lifts limited to about 500 mm and adequately compacted with heavy vibratory rollers (minimum 6 passes, 10 tonnes).

At the south abutment, a spread footing abutment foundation, if considered, should be designed for construction in the approach fill, with a depth of about 2 m below the slope face (to provide adequate frost cover). This would place the base of the footing at a distance of about 6 m above original ground, at an elevation of about 320 m.

If the native soils are left in place, the structural fill supporting the foundation should have a thickness at least equal to the width of the footing. In addition, the structural fill should be constructed to occupy a zone, down and out from the footing edges at a slope of no steeper than 1H:2V, in order to accommodate the footing stresses.

For a foundation constructed on structural fill, as discussed above, the ULS bearing resistance given in Table 2-5, below, can be used.

Table 2-5. Spread Footing ULS and SLS Bearing Resistance	
Factored Bearing Resistance at ULS on Unweathered Bedrock ¹	8000 kPa
Factored Bearing Resistance at ULS on Structural Fill ²	1000 kPa
Bearing Resistance at SLS - for 25 mm settlement - Fill on native soil ³	See Figure A5
Bearing Resistance at SLS - for 25 mm settlement - Fill on bedrock ⁴	> 1000 kPa
Notes: 1. SLS resistance not applicable to footings on bedrock 2. Thickness of fill greater than footing width. 3. 25 mm settlement is combined immediate granular settlement and primary consolidation settlement of clay soil. Structural fill placed on native soils after removal of organics/topsoil, and bottom of footing about 6 m above original ground. 4. Structural fill placed on bedrock after removal of all native soil, and bottom of footing about 6 m above original ground.	

The bearing resistance at SLS, however, will depend on whether the fill is placed on the bedrock after the removal of the native soil, or if it is placed over the native soil after stripping. If the native soil

is removed and replaced with granular structural fill, the SLS bearing resistance for 25 mm immediate elastic settlement is greater than at ULS. Accordingly, the ULS resistance governs the design.

If the native soil is left in place, the resulting settlements will be due to a combination immediate elastic settlement of the fill as well as consolidation settlement of the underlying cohesive soil. Figure A5 shows the footing bearing resistance at SLS for various footing sizes, based on 25 mm combined settlement.

Because of the consolidation settlement that will occur due to the loading by the embankment itself, footing construction should be delayed until the majority of settlement is complete, as discussed in a subsequent section of this report.

It is important to note that the stratigraphic cross section at the south abutment (WP1) shows silty clay as not having been encountered in BH-2NF or AP-4NF (the east end of the abutment). Accordingly, differential consolidation settlement of a large spread footing constructed over this zone will likely result in rotation or tilting. The magnitudes will likely be in the same order as the total deflections on which the SLS bearing resistance curves shown on Figure A5 are based.

Secondary compression of the silty clay soils will also occur, primarily due to the embankment fill loading, as discussed later in Section 2.5.4. Up to about 20 mm of associated settlement may occur within 10 years following construction, and this magnitude may be differential as discussed in the previous paragraph. Additional minor related settlements will occur beyond the 10 year period.

For the determination of the sliding resistance of spread footings, the unfactored coefficient of friction for mass concrete on granular structural fill can be taken as 0.6. If the factored resistance against sliding failure is inadequate based on friction only, a soil key can be considered for footings on structural fill, making use of the passive soil resistance. Passive earth pressure coefficients are provided in Section 2.3.

The ULS resistance of spread footings must be reduced for the effects of inclined loads. For footings on granular structural fill, Figure 6-8.4.2 of the OHBDC may be used for the applicable footing depth to effective width ratio. These factors must be applied to the ULS resistance given previously in Table 2-5.

2.3 Backfill

Backfill for abutments or retaining walls should consist of free draining granular materials such as Granular A, Granular B, or rock fill. Computation of earth pressures shall be in accordance with Section 6.7.4 of the Ontario Highway Bridge Design Code. Unfactored properties for backfill materials are provided in the following Table 2-6.

Table 2-6. Fill Types and Unfactored Geotechnical Properties					
Material	Friction Angle, ϕ'	γ (kN/m³)	K_A	K_P	K_0
Granular A	35 degrees	22	0.27	3.7	0.43
Granular B	30 degrees	21	0.33	3	0.5
Rock Fill	42 degrees	20	0.2	5	0.33
Note: Values given for K_A and K_P are for horizontal backfill, and will vary for other configurations. K_A is the earth pressure coefficient corresponding to the active state. K_P is the earth pressure coefficient corresponding to the passive state. K_0 is the earth pressure coefficient at rest.					

The mobilization of full active or passive resistance requires a measurable and perhaps significant wall movement or rotation, in general accordance with that indicated in Figure C6-7.1 of the OHBDC. Therefore, unless the structural element can tolerate these deflections, the at rest earth pressure should be used in design. Alternatively, partially mobilized active and passive earth pressure coefficients may be used, in accordance with the deflections given in the Figure.

The effects of compaction surcharge should be taken into account in the calculation of active and at rest earth pressures. In accordance with Section 6-7.4.3 of the OHBDC, the lateral pressure due to compaction should be taken as at least 16 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 16 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.

If rock fill is used as backfill behind abutments, the particle size should be limited to no greater than 300 mm and the backfill must be placed carefully in a manner that does not cause damage to the abutments or other structural components of the bridge.

Weep holes should be provided in the abutments and a filter wrapped, 150 mm diameter perforated PVC drainage pipe should be installed behind the abutments, at or slightly above the base.

2.4 Excavations and Dewatering

All work associated with design and construction relative to excavations shall be in accordance with Part III of Ont. Reg. 213/91 of the Occupational Health and Safety Act. Where the width of the base of the excavation is less than twice its depth, conformance with this regulation is required.

The existing organic zone (topsoil) with a depth ranging to about 200 mm will have to be removed from beneath the approach fill footprints. For pile caps at the pier locations, excavations of at least 2 m depth will likely be required, in order to provide the recommended frost cover. Since the ground surface is uneven at the pier locations, deeper excavations will be required to place the pile cap at a common elevation, unless the finished site grades are raised with fill or the caps are provided with insulation. Based on the borehole information, excavations would generally proceed through the loose to compact upper sand and into the stiff to firm silty clay at most locations.

At the locations of Piers WP2, WP3 and WP5, excavations should be relatively straight forward, since they will likely terminate above the prevailing groundwater level. The upper sand and silty clay is considered a Type 3 soil and excavations should be cut back to at least 1H:1V. If minor groundwater seepage occurs and loosens/softens the soil, flatter slopes will be required. Dewatering of the excavations should be possible by pumping from sumps within the excavations.

At the location of Pier WP4, on the north side of Trout Creek, the excavation will likely be carried out entirely within the loose to compact silty sand and would terminate close to or below the prevailing water level of Trout Creek. These soils would then be classified as Type 4 soils and excavations should be sloped back at 3H:1V. Pumping from sumps within the excavation should suffice here as well, in order to maintain a safe and workable area, although more aggressive effort will likely be required. In order to stabilize the base of the excavation if it becomes loosened due to groundwater infiltration, a 300 mm layer of crushed clear stone may be required to improve working conditions.

If the native soils are to be removed and replaced with structural fill at the south abutment, or to place foundations on the bedrock, excavations as deep as about 6.5 m will be required, based on the results of the investigation. The soils to be excavated will consist of sand, silty clay and silty sand and gravel. The water table would be encountered well above the 6.5 m depth. Accordingly, excavations in this area should be sloped back at 3H:1V, or flatter. Aggressive pumping from sumps will be required. Alternatively, sheeted and braced excavations could be considered, but this may prove problematic because of the variable bedrock surface.

Excavations carried out within granular structural fill in the approaches can likely be completed using a 1H:1V cut since it will be above the water table.

It is recommended that a non-standard special provision (NSSP) for dewatering be provided in the contract documents.

2.5 Bridge Approach Fills

The construction of the bridge approaches will require embankment fills of up to about 11 m height at the south abutment and about 5 m height at the north abutment over areas with varying thicknesses of predominantly firm, compressible silty clay soils. This creates two principal design and construction considerations: embankment stability and consolidation settlement. These two issues are discussed in the following sections.

In all of the following discussions, it is assumed that all organic material (topsoil) is removed from beneath the embankments and the embankments are constructed on the native mineral soils. Fill heights should be measured from the top of the native mineral soil.

2.5.1 Embankment Stability

Highway embankments can be constructed using structural fill of various acceptable soil materials. Typically, however, in this part of the province they are constructed using rockfill as the principal component. A typical MTO section will consist of a minimum (steepest) slope of 1.25H to 1V to a maximum height of 6 m. For embankment sections greater than 6 m height, a 2 m wide horizontal bench is required before the next 6 m, 1.25H to 1V lift is constructed. A 14 m crest width has also been assumed, based on the drawings provided.

Slope stability analyses have been performed using SLOPE/W (ver. 3.x), based on Bishop's Method using total stress parameters. This analysis would apply to rapid construction (short term stability) and factors of safety can be expected to increase with time. The undrained shear strength profile shown on Figure A3 was used to provide the shear strength parameters for the clay soils. Table 2-7, below, lists the parameters used.

Table 2-7. Geotechnical Parameters for Slope Stability Analyses			
	γ_{total} (kN/m ³)	c_u (kPa)	ϕ'
Rockfill	20	0	42°
Sand	20	0	32°
Silty clay	19.5	variable (see Fig. A3)	0
Sand and Gravel	21.5	0	35°
Notes: Embankment crest width 14 m.			

Many of the SLOPE/W graphical printouts, for the various analyses performed and discussed below, are included in Appendix D.

2.5.1.1 South Approach Stability

The results of the total stress analyses performed on the embankment cross-sections, for heights of 10 m to 13 m, are shown in Table 2-8, below. The short term factors of safety for the embankments assessed are marginally below the recommended value of 1.3. It is our opinion, however, that the factors of safety are likely greater than calculated, since some excess pore water pressure dissipation will occur during the assumed one month construction period. At this location, the silty clay layer is relatively thin (3 m to 4 m) and the results of the consolidation analyses, discussed later in Section 2.5.5.2, support this.

Notwithstanding, we have performed calculations for embankments with benches wider than the standard 2 m width at 6 m height. These required widths to provide a calculated factor of safety of at least 1.3 are shown in Table 2-8, also. Accordingly, it is considered prudent to provide the indicated berm widths to provide a calculated factor of safety of 1.3.

Since the recommended short term factors of safety are considered adequate, with only minor modifications to the geometry, effective stress analyses are not required and have not been performed.

Table 2-8. Safety Factors for Total Stress Stability Analyses - South Approach

Embankment Height	Factor of Safety*	Bench Width**
10 m	1.28	+ 0.5 m (2.5 m)
11 m	1.23	+ 2 m (4 m)
12 m	1.18	+ 3 m (5 m)
13 m	1.21	+ 4 m (6 m)

Notes: * Factor of safety for embankment with standard 2 m wide bench at 6 m height
** Bench width required to provide safety factor >1.3. First number is width to add to standard 2 m wide lower bench.

An analysis was also performed on the longitudinal design section (front slope) as shown on Figure A2b and Drawing No. 2. The calculated factor of safety for this slope is 1.58, which is considered adequate.

2.5.1.2 North Approach Stability

The results of the total stress analyses performed on the embankment cross-sections, for heights of 4 m to 7 m, resulted in safety factors ranging from about 3.6 to 2.2, which are considered more than adequate.

An analysis was also performed on the longitudinal design section (front slope) as shown on Figure A2b and Drawing No. 2. The calculated factor of safety for this slope is 3.0, which is also considered adequate.

2.5.2 Consolidation Settlement of Embankments

2.5.2.1 Magnitudes of Consolidation Settlement

Consolidation settlement calculations have been performed using the effective stress profiles shown on Figure A3 and compression ratios ($C_c' = C_c / [1 + e_0]$) ranging from 0.08 to 0.20. The values used were established from the consolidation test data, previous experience at the north and south interchanges of this project, as well as from geotechnical literature. Recompression indices ($C_r' = C_r / [1 + e_0]$) ranging from about 0.008 to 0.02 were used. The stress increases in the foundation soils due to the embankment loadings have been calculated based on the Boussinesq elastic solutions. Recompression and virgin consolidation has been calculated based on the assumed existing overburden pressure and preconsolidation stress profiles shown on Figure A3.

South Approach

The results of the calculations for embankment centerline and crest settlement using rockfill to construct the embankments are provided in Table 2-9, below and are shown graphically on Figure A6. The thickness of the compressible silty clay soil ranges up to about 4 m. Because of the unevenness of the original ground surface at the approaches, the height of fill may vary slightly. Accordingly, the analyses have been performed taking this into account by using a varying fill height.

Table 2-9. Estimated Embankment Consolidation Settlement - South Approach		
Embankment Ht	Centerline Settlement (mm)	Crest Settlement (mm)
10 m	170	155
11 m	185	175
12 m	200	190
13 m	215	205
Notes: Embankment crest width 16 m, average side slopes = 1.4H:1V Values rounded to nearest 5 mm		

In addition, the loadings imposed by the fill will exceed the indicated preconsolidation pressure, such that the silty clay soils will be normally consolidated following the consolidation process. This will

result in greater settlements due to future additional loadings, such as footings as discussed in a previous section, or due to grade changes, for example. For these reasons, it may be prudent to overbuild the embankment by 1 or 2 m, allow consolidation to take place and subsequently remove the excess fill height (*i.e.* preloading). This will result in a slight overconsolidation of the foundation silty clay soils.

It is noted that, the compressible silty clay was not encountered everywhere beneath the embankment, as was discussed in Section 2.2.3 of this report. Accordingly, there may be greater differential settlement between crest and centerline, as well as along the length of the approach. The differential settlement may approach the total settlements indicated in the Table above.

Notwithstanding the potential for relatively large differential settlement, the time to facilitate this settlement should be relatively rapid (within about nine months), as discussed in Section 2.5.2.2, below. Therefore, minor regrading prior to providing the final granulars and pavement should be possible within the two year construction period that has been inferred.

North Approach

The results of the calculations for embankment centerline and crest settlement using rockfill to construct the embankments are provided in Table 2-10, below and are shown graphically in the top panel of Figure A7. The thickness of the compressible silty clay soil ranges up to about 12 m. Because of the unevenness of the original ground surface at the approaches, the height of fill may vary slightly. Accordingly, the analyses have been performed taking this into account by using a varying fill height.

Table 2-10. Estimated Embankment Consolidation Settlement - North Approach		
Embankment Ht	Centerline Settlement (mm)	Crest Settlement (mm)
4 m	30	25
5 m	35	30
6 m	40	35
7 m	70	45
Notes: Embankment crest width 16 m, average side slopes = 1.4H:1V Values rounded to nearest 5 mm		

The loadings imposed by the fill will approach, and may exceed, the indicated preconsolidation pressure, such that the silty clay soils will be normally consolidated following the consolidation process due to the fill. Examination of the top panel of Figure A7 indicates that the settlement is expected to increase significantly as the embankment height approaches 6 m, where the settlement curve steepens. This is due to the preconsolidation pressure of the foundation soil being exceeded.

This will result in greater settlements due to any future additional loadings, such as grade changes, for example. Accordingly, it may be prudent to overbuild the embankment by 1 or 2 m, allow consolidation to take place and subsequently remove the excess fill height (*i.e.* preloading). The preload should be left in place for about a year, unless monitoring indicates that it can be removed sooner. This will result in a slight overconsolidation of the foundation silty clay soils.

If consideration is to be given to the use of light weight fill, for preliminary design purposes, the total consolidation settlements can be reduced **approximately** by proportion of rockfill replaced by lightweight polystyrene (eg. 30% replacement of fill height with polystyrene will result in about 70% of the indicated settlement).

2.5.2.2 Time Rate of Consolidation Settlement

The time rate of consolidation settlement has been calculated for the various cases of embankment height for vertical drainage only. It is also assumed for the purposes of calculation, all embankments are constructed to full height in about a one month construction period. Coefficients of consolidation (virgin), C_v , of 8 m²/year, and (recompression), C_{vr} , of 40 m²/year, have been used in the analyses, based on the results of the consolidation tests and the geotechnical literature.

The bottom panels of Figures A6 and A7 show the calculated consolidation rate for the various fill heights at the south and north approaches, respectively.

At the south approach, virtually all of the primary consolidation settlement should be complete within about 9 months. At the north approach, because of the thicker silty clay deposit, the time rate of consolidation will be slower, and should be complete anywhere between about 15 months to over 24 months, depending on the fill height.

2.5.3 Secondary Compression of Clays

Calculations have been performed to estimate the magnitudes of secondary compression of the foundation clays, following the completion of primary consolidation. For purposes of analysis and

discussion, the primary consolidation is assumed to be essentially complete within one to two years from the start of construction of the embankments. The calculations are based on use of a coefficient of secondary compression, C_{α} , of 0.004, based on the results of the consolidation tests, previous experience, and the geotechnical literature.

At the south approach, calculations indicate that 15 mm to 20 mm may occur in the first 10 years, while at the north approach, the secondary settlement may be about 30 mm to 50 mm in the first 10 years.

2.5.5 Rockfill and Rockfill Settlement

Rockfill used in the embankments and approaches should consist of hard, durable, angular quarried rock. Rockfill should be tested for acid drainage potential and checked against the appropriate regulatory requirements for acceptability.

For the bridge abutments that are to be supported by driven steel H-piles, as discussed in a previous section, these will have to be installed after all the embankment fill has been placed. The driving of steel piles through rockfill will be difficult, if not impossible, unless care is taken to ensure that the rockfill meets a tight size range, generally smaller than 75 mm. For the majority of the embankments and approach fills, however, larger rockfill can be used.

The use of large rockfill, loosely placed or end dumped and compacted by conventional construction traffic only may result in long term settlements of up to about 2% of the fill height. Accordingly, a 10 m high rockfill may settle up to 200 mm following completion of construction. This is primarily due to the rockfill "adjusting" under highway service conditions.

In order to minimize the long term settlements associated with the rockfill itself, consideration can be given to specifying the use of a finer graded rockfill, with a maximum size of 400 mm. This finer graded rockfill should be placed in lifts limited to about 800 mm and compacted with heavy vibratory rollers. While the production of the finer graded rockfill and its placement, as described above, carries with it a cost premium, the long term performance of the finished highway pavement will be improved.

It is recommended that an NSSP for rockfill material and placement requirements be included in the contract documents.

2.6 Instrumentation and Construction Monitoring

Construction of embankments should be monitored during construction using a properly designed and effective system of instrumentation, consisting primarily of settlement points. Lateral slope movements should also be monitored both during and following construction of the embankments. This will provide indications of the rate of settlement, such that construction timing of the foundations can be modified, if required.

2.7 Closing Comments

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for the use of Marshall Macklin Monaghan and its design team for the design of the bridge foundations and approach fills for the northbound lanes, five span bridge to be constructed over Trout Creek, as part of the Highway 11 Trout Creek By-Pass Project. We request that we be retained to review the design and our recommendations as the design proceeds, to ensure that the final design is in general agreement with our recommendations and that our recommendations have been interpreted as intended.

A subsurface investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to allow reassessment of our recommendations. It may then be necessary to carry out additional field work and analyses.

Contractors bidding on or undertaking the works should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions at the site of the proposed northbound lanes bridge over Trout Creek. The conclusions presented in this report reflect site conditions existing at the time of the investigation. It is noted that the soil boundaries indicated on the logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

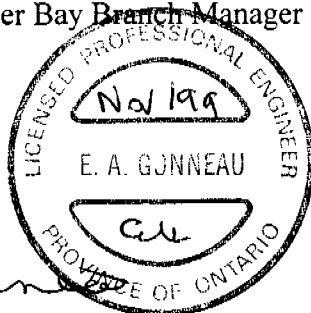

This report has been prepared by Mr. D.N. Georgiou, P.Eng. and was reviewed by Messrs. S.E. Gonsalves, P.Eng., and E. Gonneau, P.Eng. The field investigation was performed by Messrs. I. Dumpis, C.E.T., R. Moore, C.E.T., and S. McAuliffe, and was supervised by Mr. E.A. Gonneau, P.Eng.

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

All the foregoing and attachments respectfully submitted,
Trow Consulting Engineers Ltd.



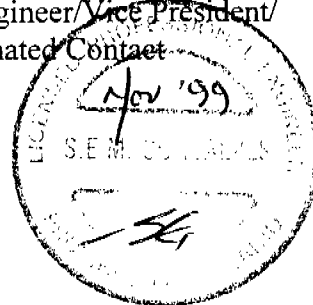

Demetri N. Georgiou, M.A.Sc., P.Eng.
Principal Engineer/Thunder Bay Branch Manager

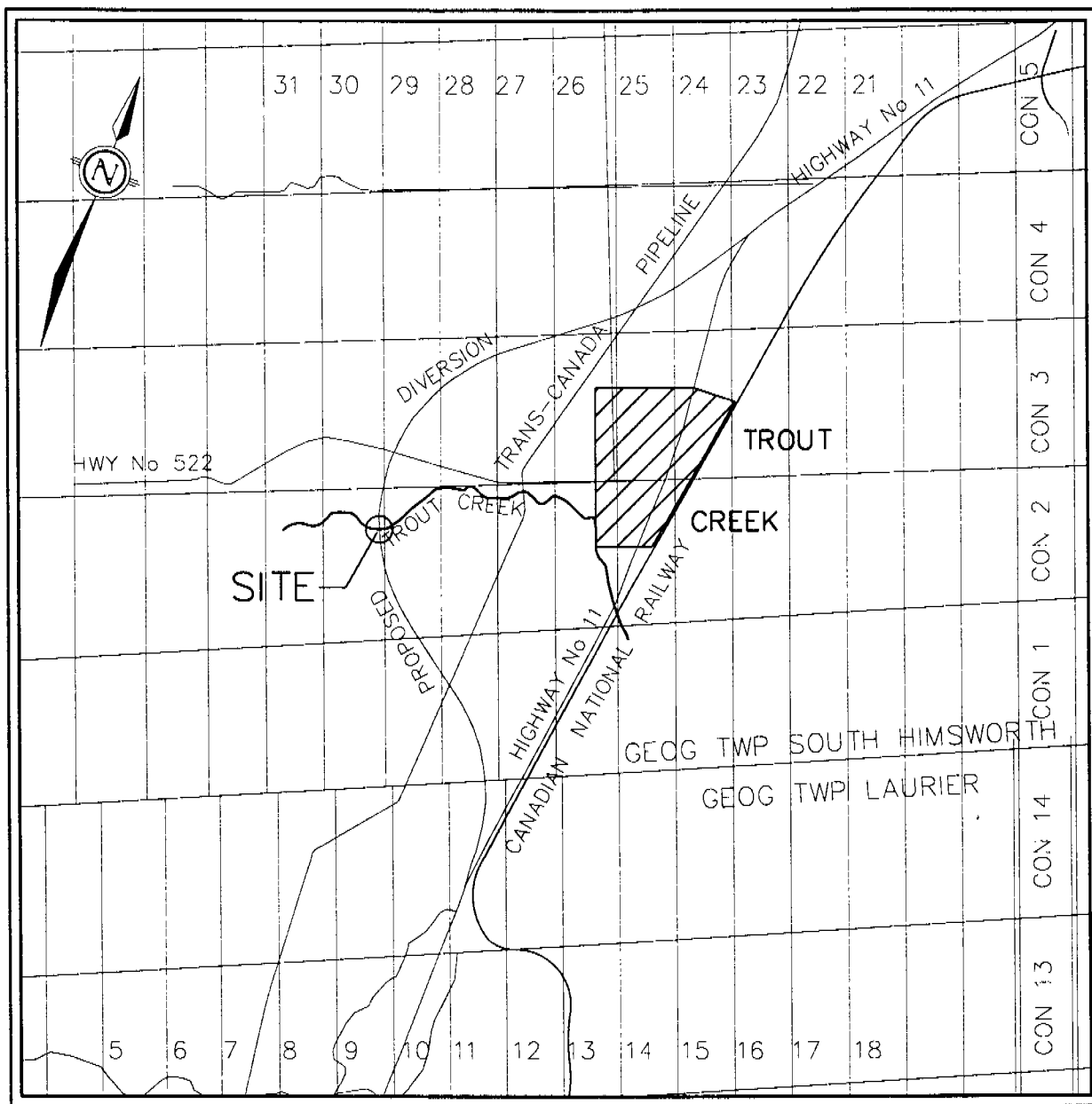
Eric A. Gonneau, P.Eng.
Project Manager



S.E. Gonsalves, M.Eng., P.Eng.
Principal Engineer/Vice President/
MTO Designated Contact



A



500 0 500 1000
IN METRES



Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

FIGURE
A1

KEY PLAN

Trout Creek By Pass
Trout Creek Bridge—Northbound Lanes

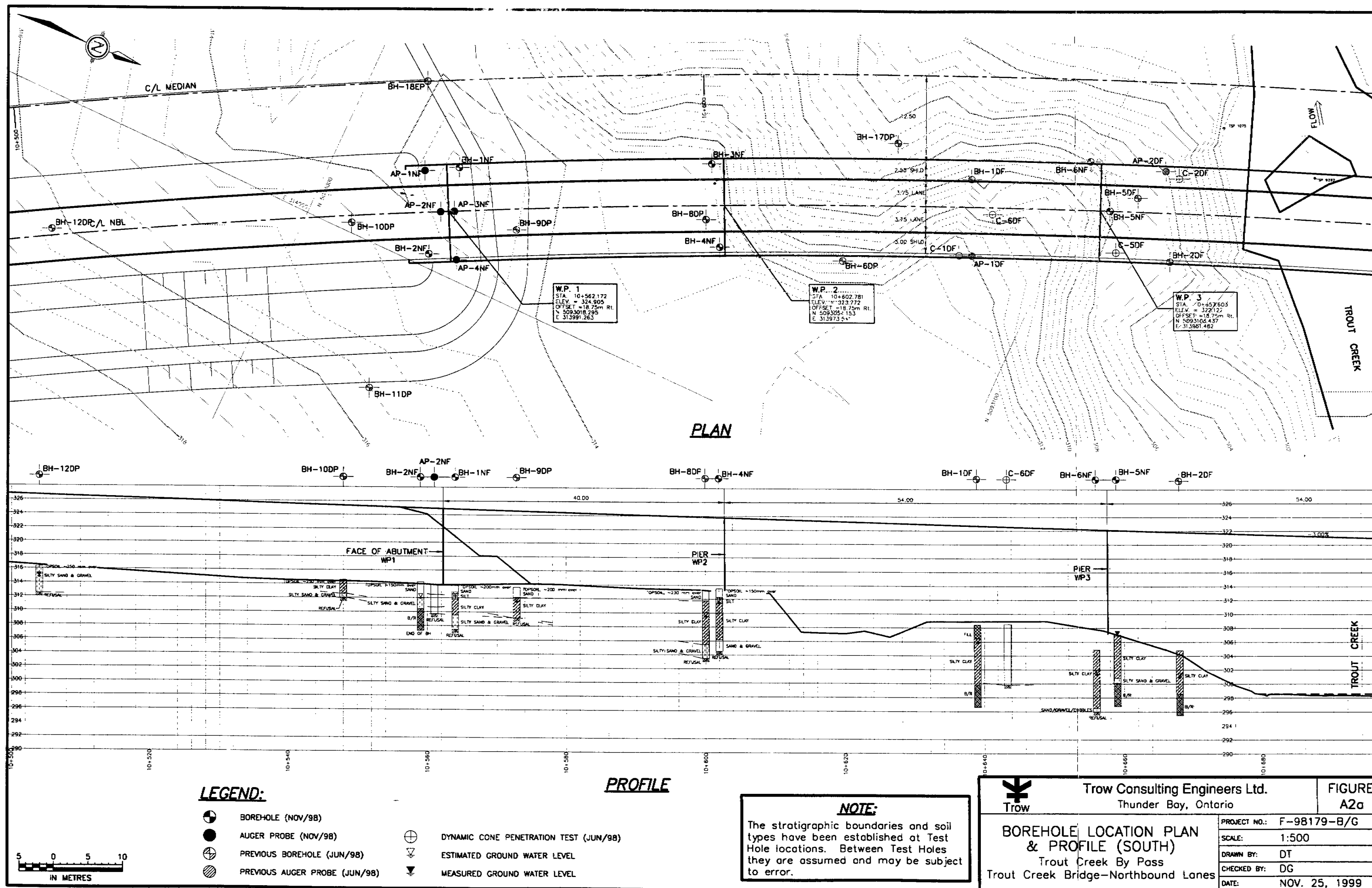
PROJECT NO.: F-98179-B/G

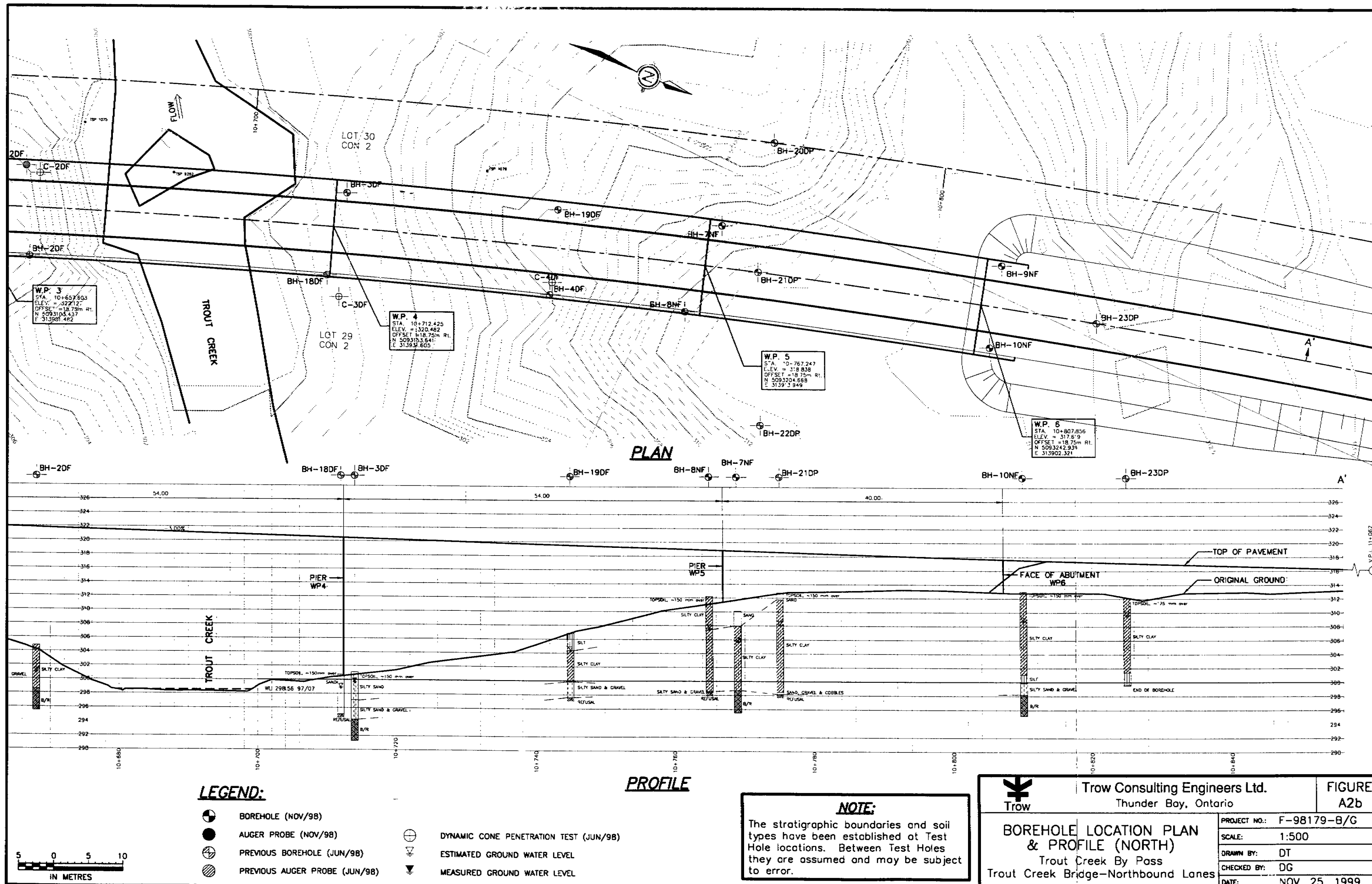
SCALE: 1:50000

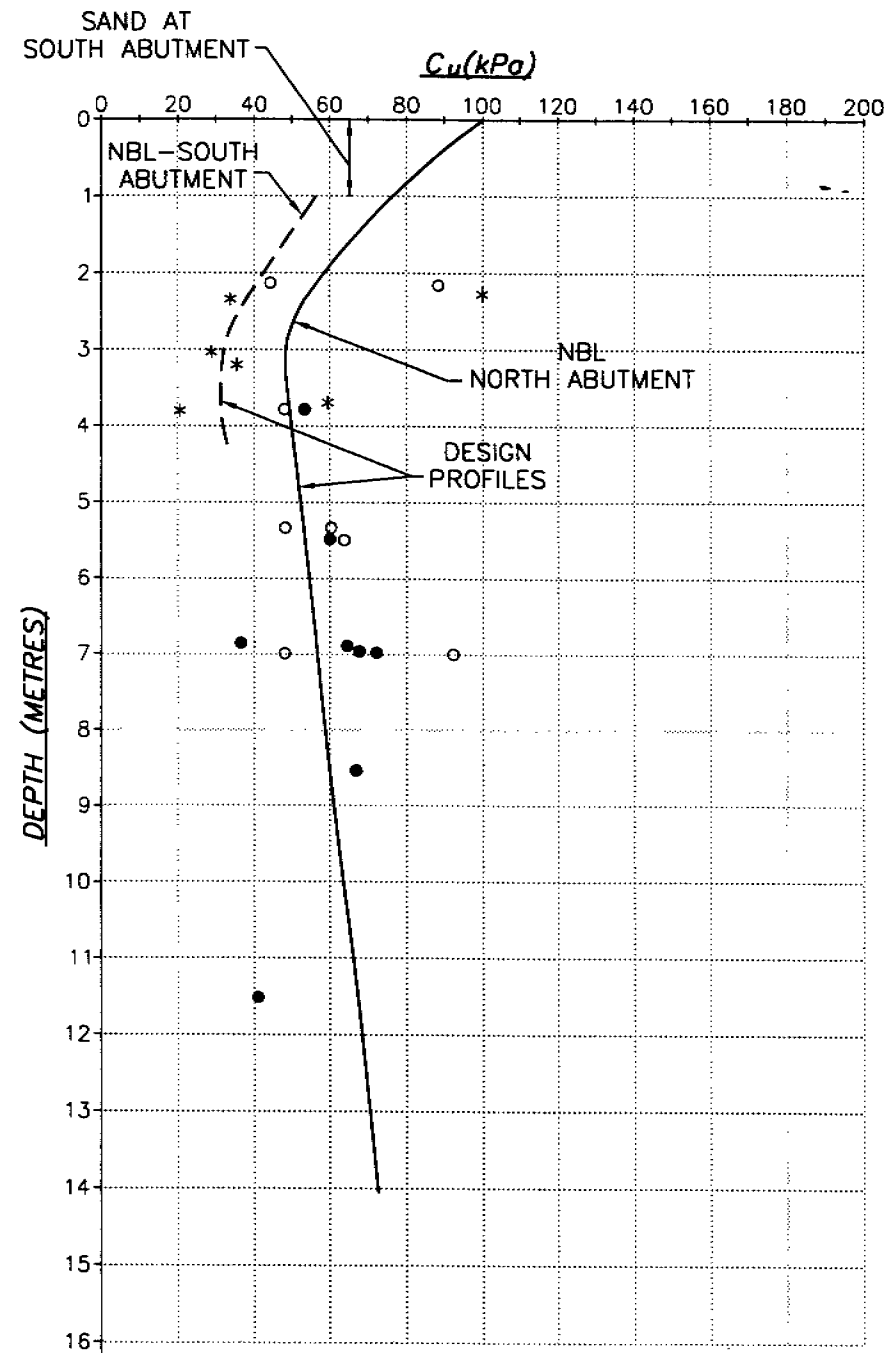
DRAWN BY: DT

CHECKED BY: DG

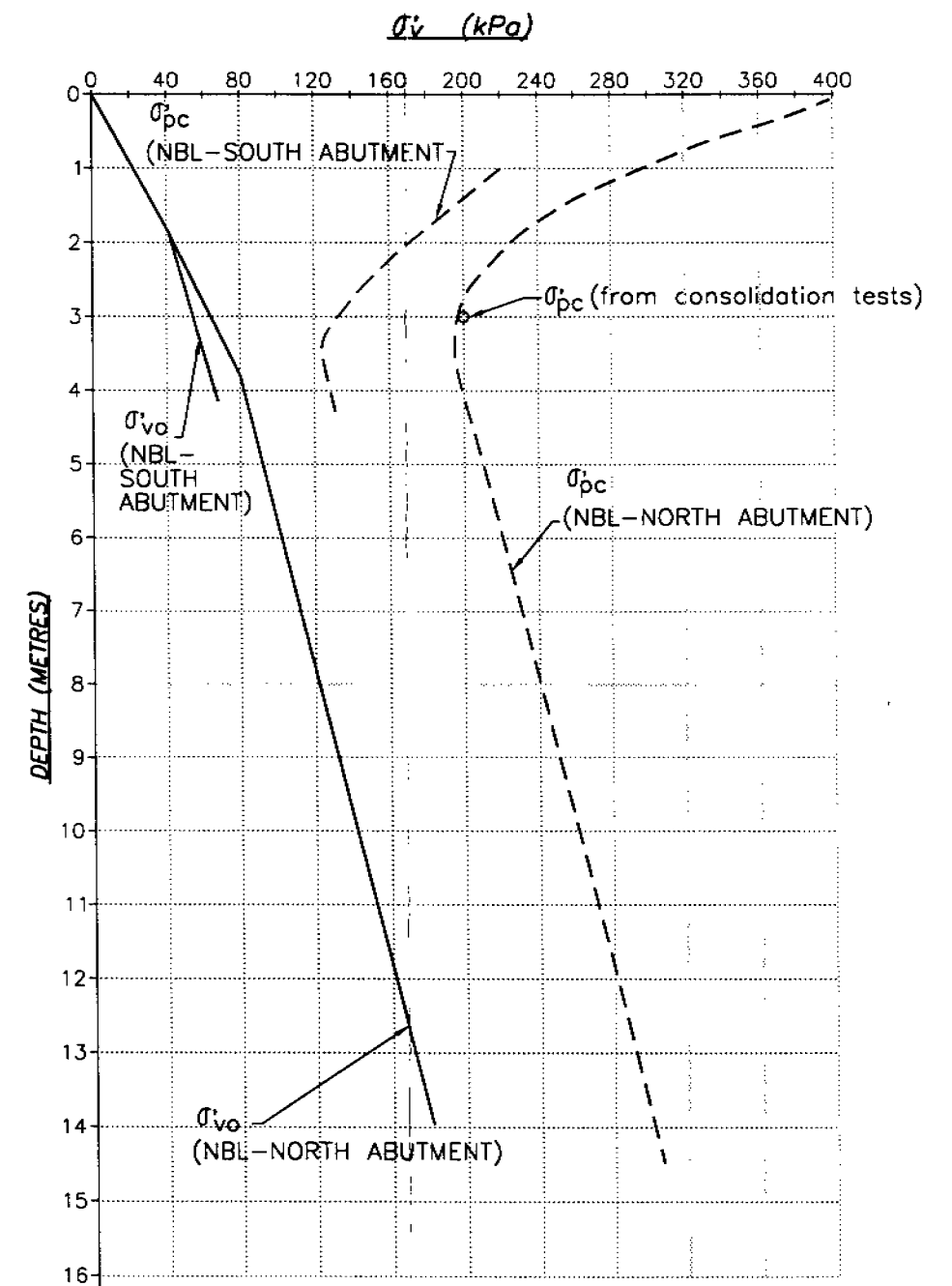
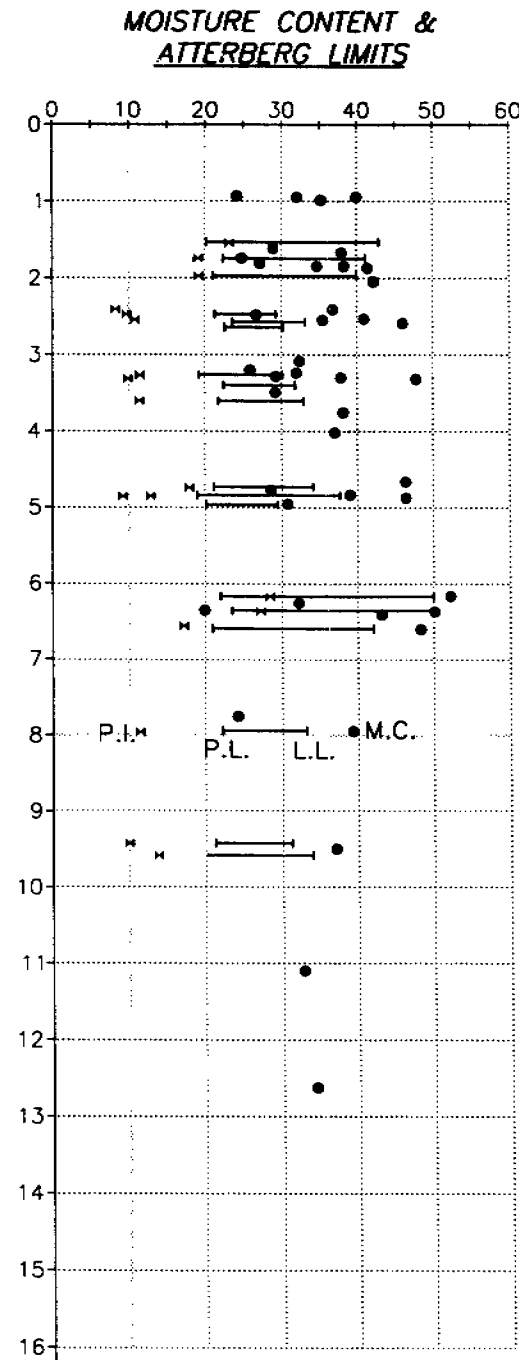
DATE: MARCH 12, 1999







*NBL - SOUTH ABUTMENT
 •NBL - NORTH ABUTMENT
 ○SBL - NORTH ABUTMENT

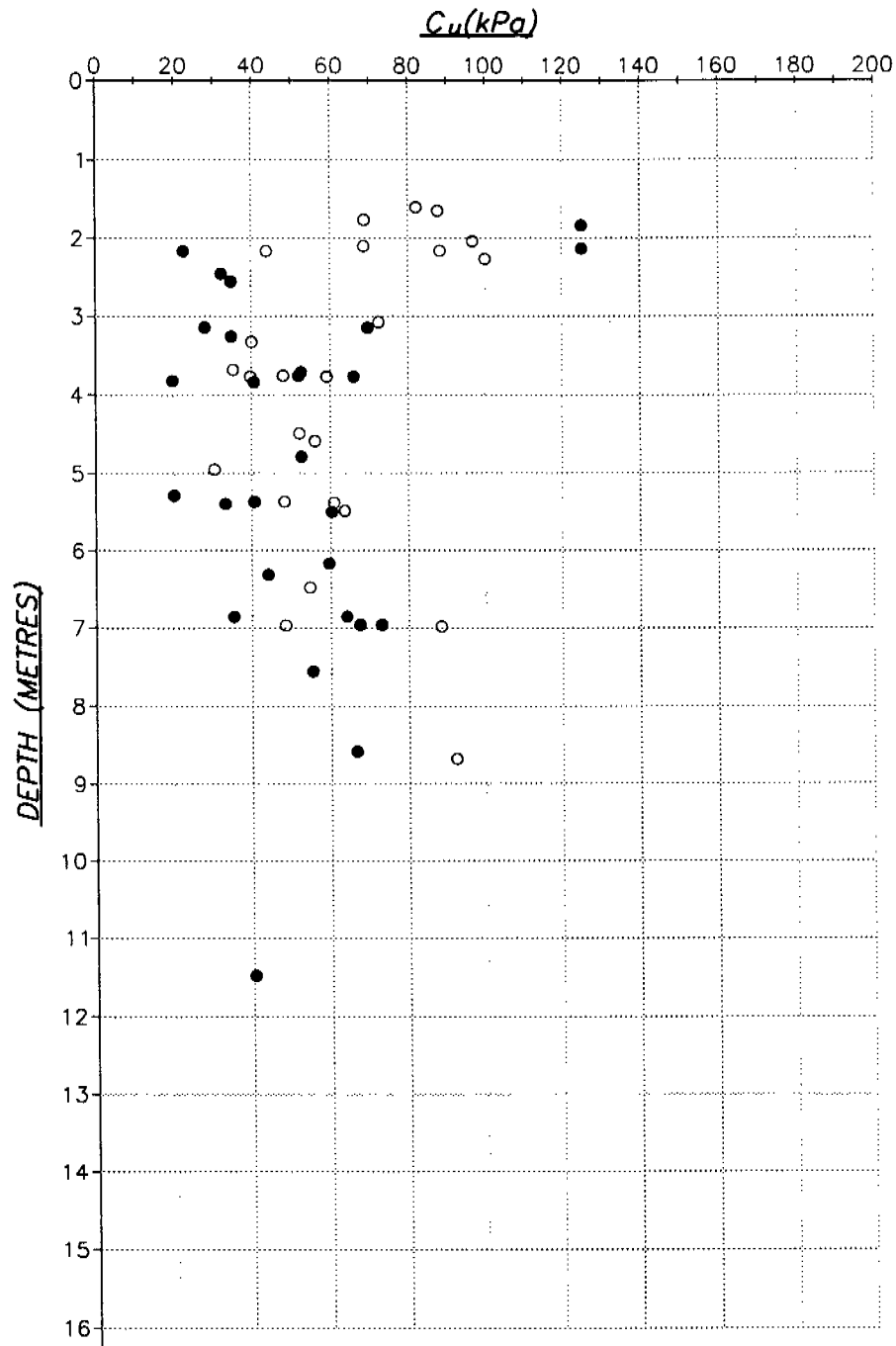


Trow Consulting Engineers Ltd.
 Thunder Bay, Ontario

FIGURE
 A3

UNDRAINED SHEAR STRENGTH,
 ATTERBERG LIMITS &
 EFFECTIVE STRESS PROFILES
 Trout Creek By Pass
 Trout Creek Bridge-Northbound Lanes

PROJECT NO.: F-98179-B/G
 SCALE: AS SHOWN
 DRAWN BY: DT
 CHECKED BY: DG
 DATE: MARCH 12, 1999



LEGEND:

- SHEAR STRENGTHS (NBL)
- SHEAR STRENGTHS (SBL)



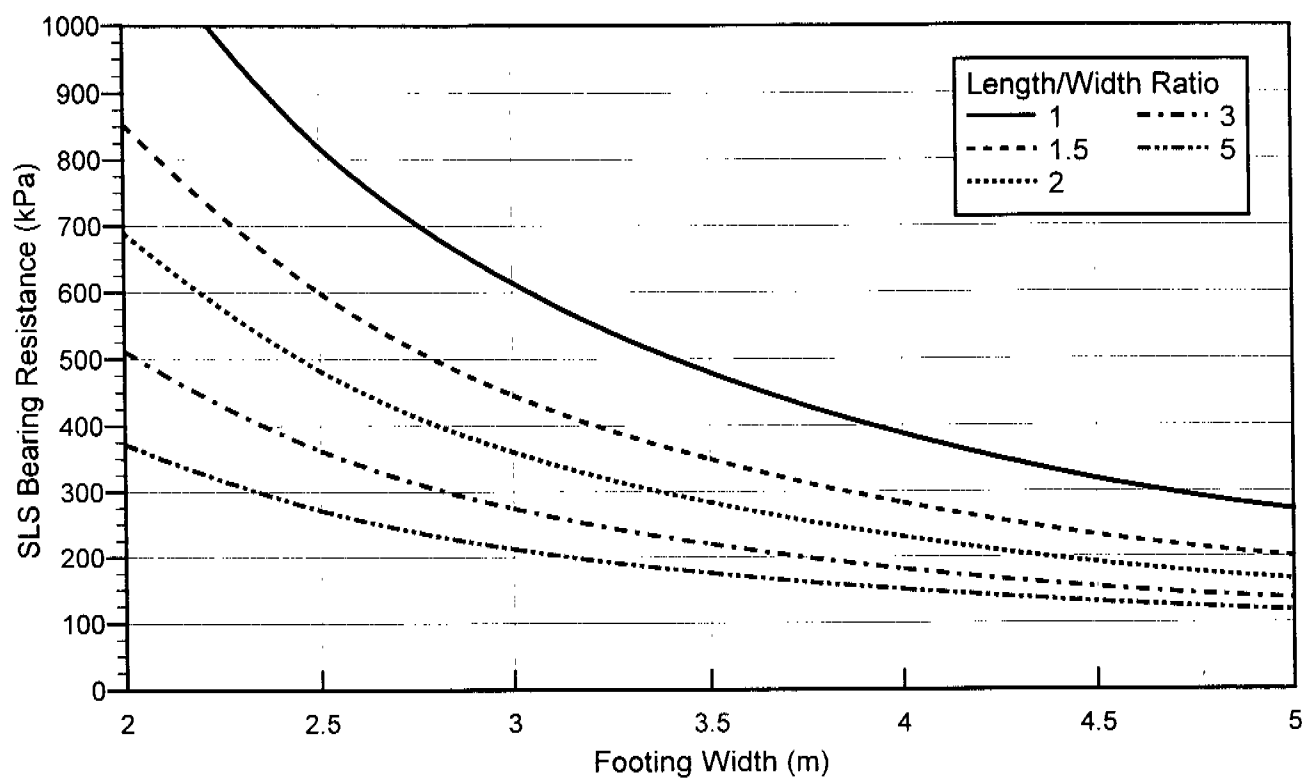
Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

FIGURE
A4

UNDRAINED SHEAR STRENGTH
ALL BOREHOLES

Trout Creek By Pass
Trout Creek Bridge-Northbound Lanes

PROJECT NO.:	F-98179-B/G
SCALE:	AS SHOWN
DRAWN BY:	DT
CHECKED BY:	DG
DATE:	MARCH 12, 1999



**Combined Immediate and
Consolidation Settlement = 25 mm
Bottom of footing at 6 m above O/G**



Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

Footing SLS Bearing Resistance
Granular Fill on Native Soil - SOUTH APPROACH

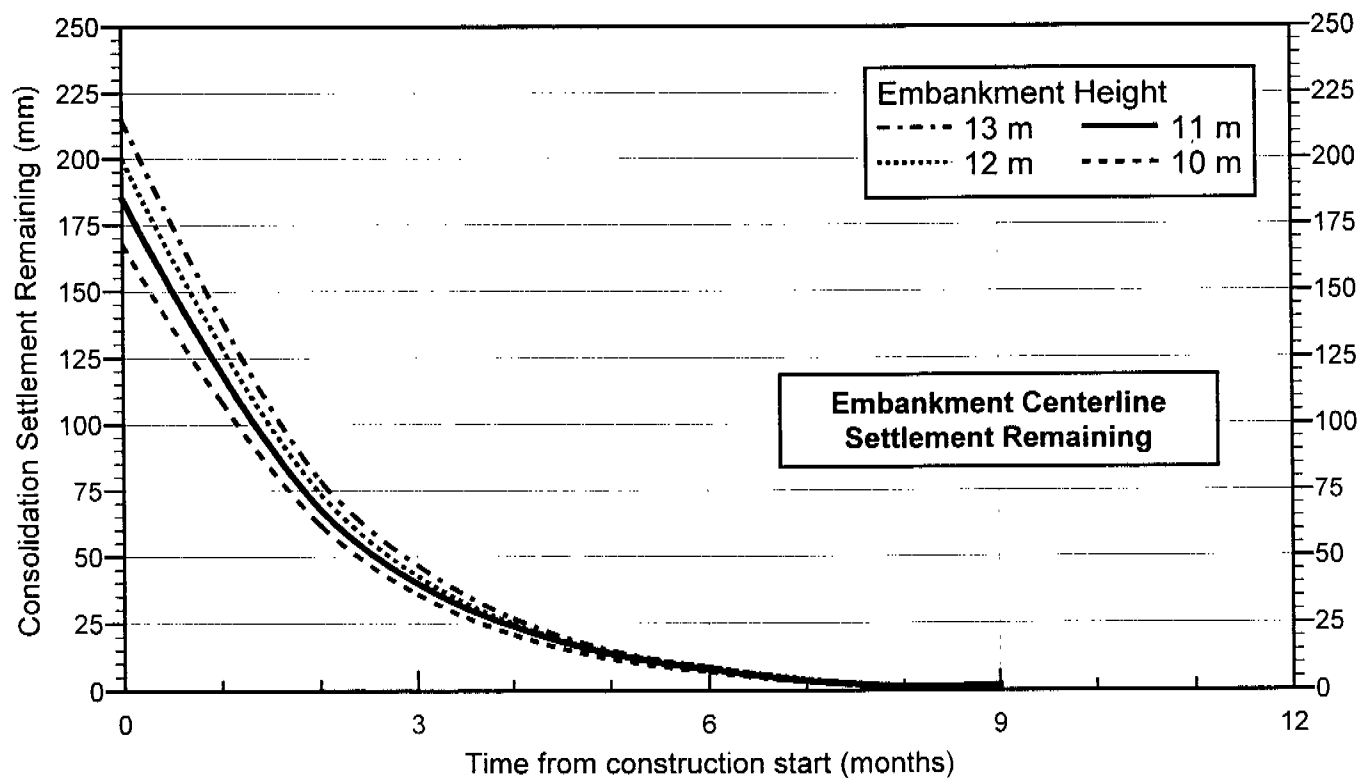
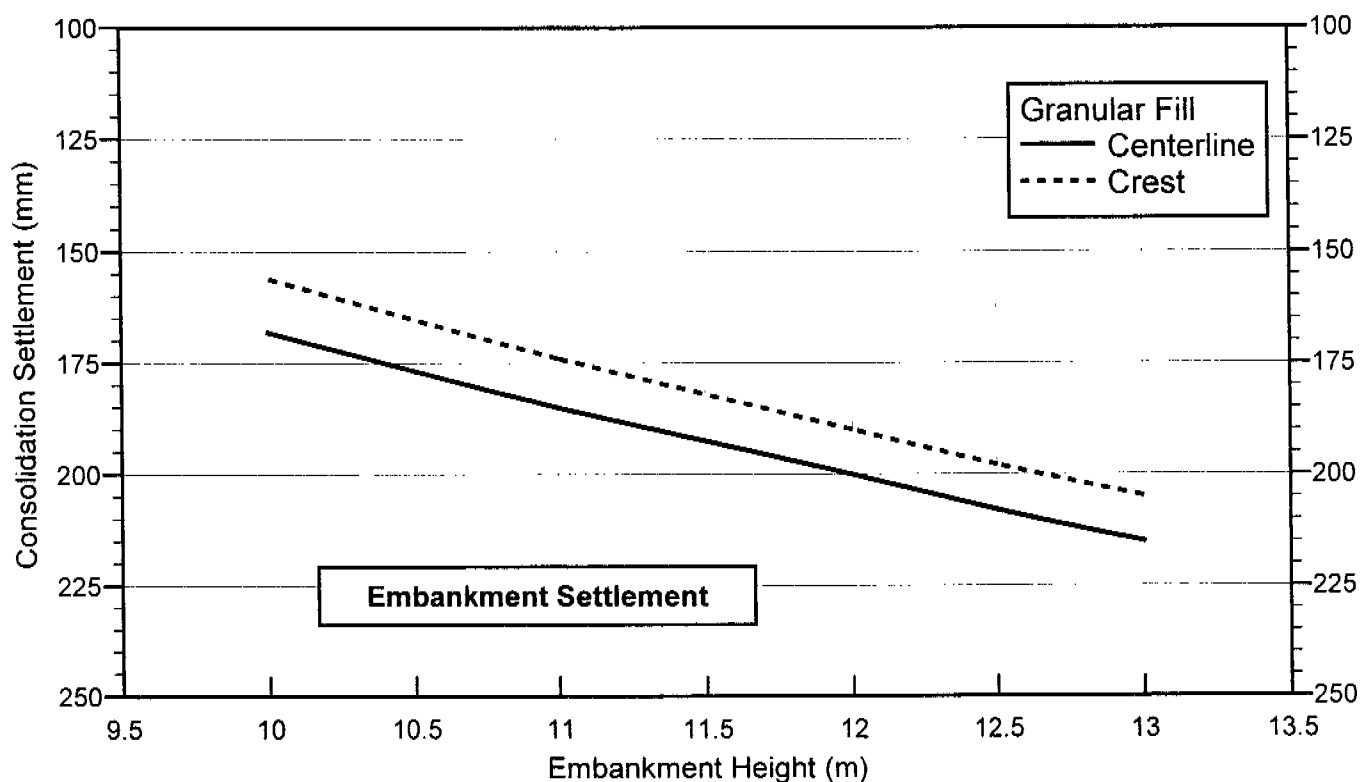
F98179-B/G

Nov 23/99

Marshall Macklin Monaghan

Trout Creek Bridge - NORTHBOUND LANES

Figure A5



Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

Estimated Consolidation Settlement
SOUTH APPROACH

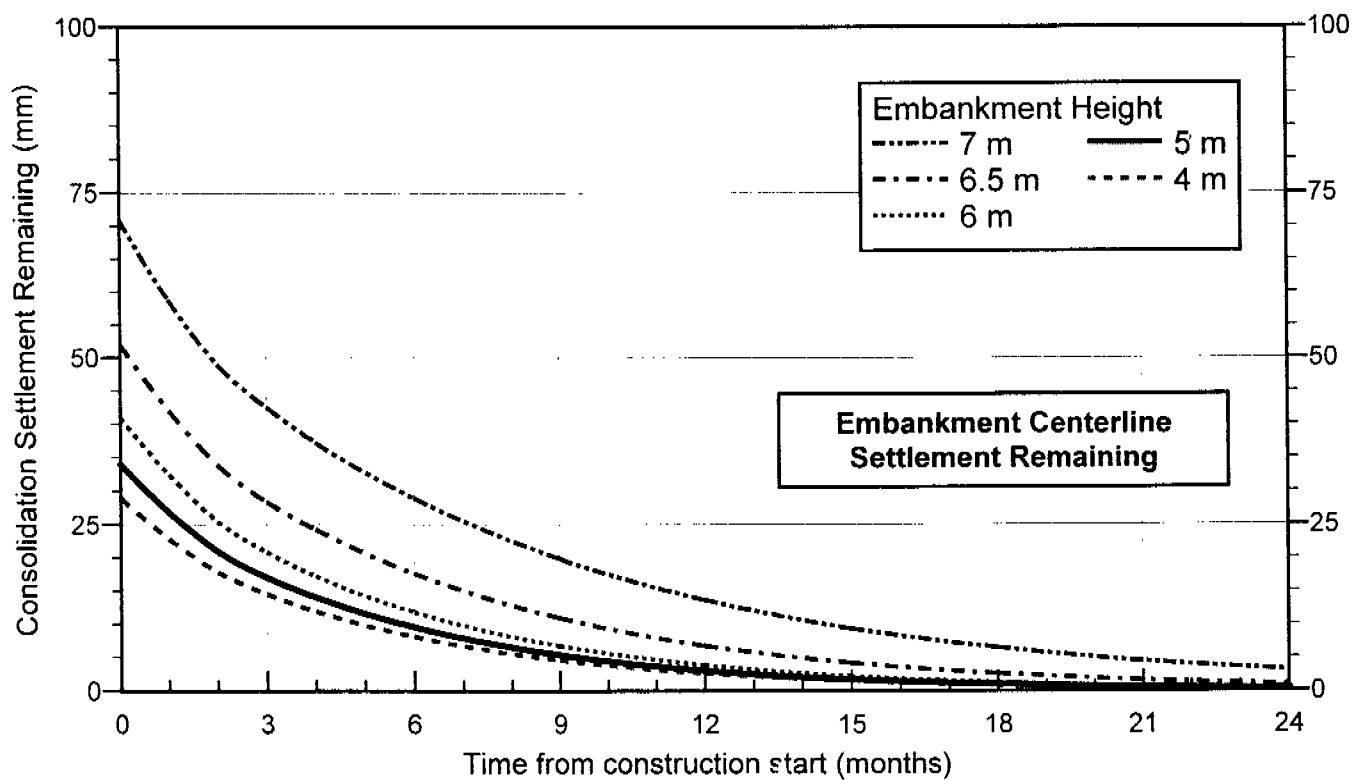
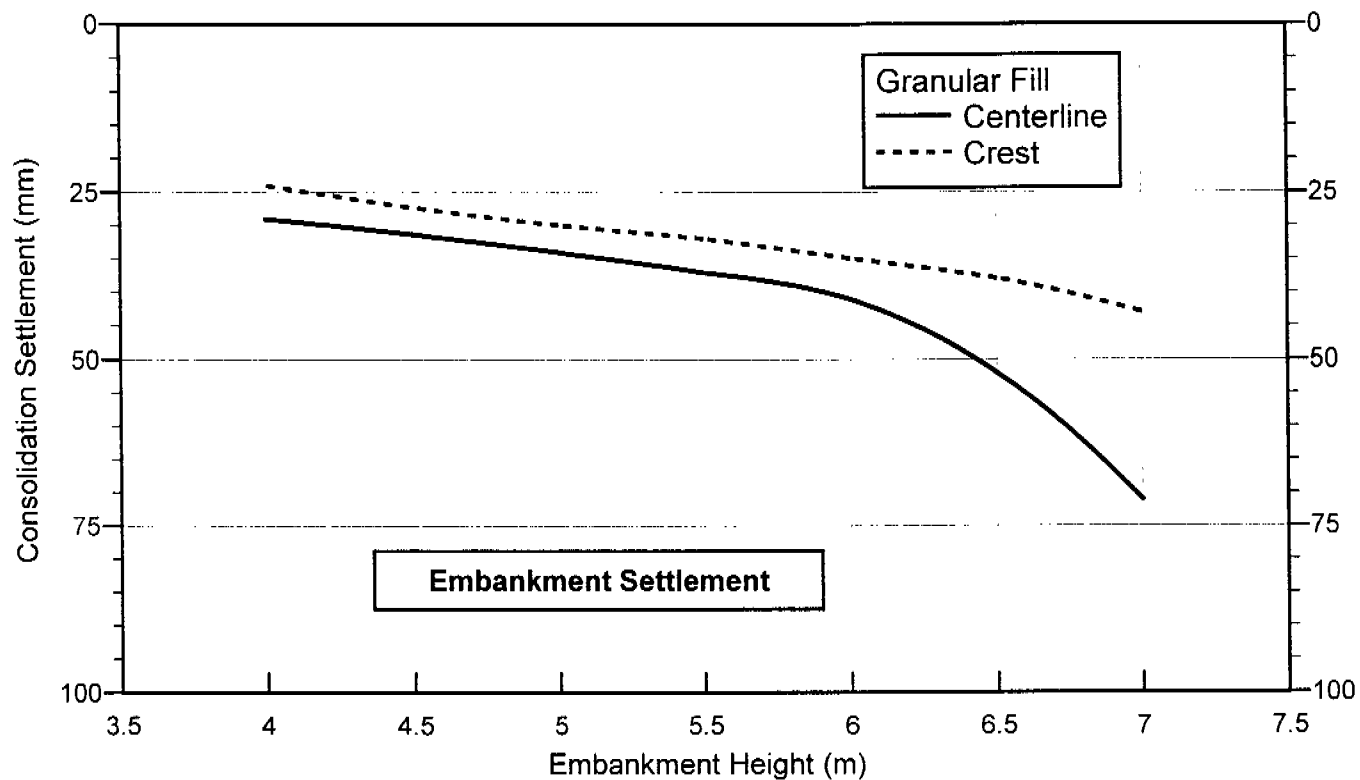
F98179-B/G

Marshall Macklin Monaghan

Trout Creek Bridge - NORTHBOUND LANES

Mar 3/99

Figure A6



Trow Consulting Engineers Ltd.
Thunder Bay, Ontario

**Estimated Consolidation Settlement
NORTH APPROACH**

F98179-B/G

Mar 3/99

Marshall Macklin Monaghan

Trout Creek Bridge - NORTHBOUND LANES

Figure A7

B

RECORD OF BOREHOLE BH-1NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+564, offset 6 m left of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 17, 1998 CHECKED BY E.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa		WATER CONTENT (%)			
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	wp	wl		
313.80	GROUND SURFACE												
0.00	TOPSOIL, ~150 mm over SAND, fine to medium, some SILT, brown. (loose)		1	SS	9								
312.60			2	SS	8								
1.20	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff becoming firm)		3	SS	2								
			4	SS	2								
309.53													
4.27	SILTY SAND & GRAVEL, till like structure, some cobbles, grey, wet. (dense)		5	SS	27								0% 0% 100%
307.46			6	SS	60								20% 65% 15%
6.34	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 017.2 N, 313 985.1 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model.												



RECORD OF BOREHOLE BH-2NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+559, offset 6 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / B.Q. core COMPILED BY M.D.
 DATUM Geodetic DATE November 17, 1998 CHECKED BY E.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80				wp — w — wl					
								SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)					
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR								
314.30	GROUND SURFACE					≡	314									0% 97% 3%	
0.00	TOPSOIL, 150 mm over SAND, fine to medium, trace of SILT, brown, occasional organics. (compact)		1	SS	25		313										
			2	SS	15		312										
311.95			3	SS	17		311										
2.35	SILTY SAND & GRAVEL, till-like structure, some cobbles, grey, wet. (compact)		4	SS	11		310										
							309										
310.43							308										
3.87	BIOTITE HORNBLende GNEISS		5	BQ												Rec. 100% RQD 87%	
			6	BQ												Rec. 100% RQD 96%	
307.29																	
7.01	END OF BOREHOLE																
Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 092 981.7 N, 313 998.0 E. 3) Borehole elevation obtained Marshall Macklin Monaghan terrain model. 4) Water level was ~2.3 & hole was open to ~2.4 m depth on completion.																	



RECORD OF BOREHOLE BH-3NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+601, offset 6 m left of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / B.Q. core COMPILED BY M.D.
 DATUM Geodetic DATE November 16, 1998 CHECKED BY E.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80					
312.54	GROUND SURFACE														
0.00	SAND, fine to medium, occasional organics, brown, dry.														
311.94	CLAYEY SILT, with bands of SILT, brown to grey, wet seams below 2.5 m depth. (compact to loose)		1	SS	14										
0.60			2	SS	12										
			3	SS	4										
309.49	SILTY CLAY, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff becoming firm)		4	SS	3										
3.05			5	SS	2										
			6	SS	3										
304.62	SAND & GRAVEL, till-like structure, some cobbles, trace of SILT, grey, wet. (dense)		7	SS	18										
7.92			8	SS	30										
302.42	BIOTITE HORNBLENDE GNEISS		9	BQ											
10.12			10	BQ											
299.25	END OF BOREHOLE														
13.29	Notes: 1) This borehole forms part of the Trout Creek Bridge, Northbound Lane, Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 050.0 N, 313 968.9 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Borehole caved dry at 8.4 m depth on completion. 5) Area levelled with a bulldozer prior to advancing borehole. 6) This borehole is located at the top edge of a steep slope (dropping of northward).														



RECORD OF BOREHOLE BH-4NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+602, offset ~6 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 16, 1998 CHECKED BY E.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20 40 60 80		wp — w — wl			
							SHEAR STRENGTH: Cu, KPa		WATER CONTENT (%)			
							UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	10 20 30 40			
313.51	GROUND SURFACE											GR SA (SI & CL)
0.00	TOPSOIL, ~150 mm over SAND, fine to medium, occasional organics, brown, dry. (compact)		1	SS	11							
312.29 1.22	SILTY CLAY, grey, moist to wet, thinly laminated with bands of SILT, low to medium plasticity. (stiff becoming firm)		2	SS	11							
			3	SS	3							0% 0% 100%
			4	SS	2							
			5	SS	1							0% 0% 100%
			6	SS	3							
306.19 7.32	SAND & GRAVEL, till-like structure, some cobbles, trace of silt, grey, moist. (dense)		7	SS	38							
304.52 8.99	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER											
<p>Notes:</p> <p>1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation.</p> <p>2) Borehole located at U.T.M. coordinates 5 093 056.0 N, 313 979.3 E.</p> <p>3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew.</p> <p>4) Borehole caved wet at ~7.8 m depth on completion.</p> <p>5) This borehole was located at the top edge of a cliff (dropping off northward).</p>												



RECORD OF BOREHOLE BH-5NF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+659, on centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 10, 1998

CHECKED BY E.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)				
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	wp	w	wl				
307.04	GROUND SURFACE															
0.00	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	5											
			2	SS	3											
			3	SS	2											
			4	SS	4											
			5	SS	6											
301.81	SILTY SAND & GRAVEL, brown, wet. (compact)		6	SS	20											
5.23																
300.12	BIOTITE HORNBLENDE GNEISS,		7	BQ												
6.92			8	BQ												
			9	BQ												
296.77	END OF BOREHOLE															
10.27	Notes: 1) This borehole forms part of the Trout Creek Bridge, Northbound Lane, Foundation Investigation. 2) Borehole located at U.T.M. coordinates 7 093 104.7 N, 313 950.9 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Water level was at surface & hole was open to 5.7 m depth on completion. 5) This area was levelled with a bulldozer prior to advancing borehole. 6) This borehole is located at the top edge of a cliff (dropping off northward).															



RECORD OF BOREHOLE BH-6NF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+656, offset 7 m left of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 13, 1998

CHECKED BY E.G.

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	NUMBER	TYPE		20	40	60	80	wp	w	wl	WATER CONTENT (%)		
304.88	GROUND SURFACE														
0.00	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	4										
			2	SS	5										
			3	SS	6										
			4	SS	8										
			5	SS	6										
			6	SS	3										
			7	SS	7										
296.50	SAND, GRAVEL & COBBLES														
8.38															
296.04	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
8.84															
	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 099.2 N, 313 945.6 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at 7.2 m depth on completion. 5) This area was levelled with a bulldozer prior to advancing borehole. 6) This borehole is located at the top edge of a cliff (dropping off northward).														



RECORD OF BOREHOLE BH-8NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station +10+765, offset 7 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 20, 1998 CHECKED BY E.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80	wp	w	wp	w	wp	w		
312.21	GROUND SURFACE																	
0.00	TOPSOIL, ~150 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff to firm)		1	SS	22													
			2	SS	26													
			3	SS	15													
			4	SS	10													
			5	SS	5													
			6	SS	3													
			7	SS	3													
			8	SS	6													
			9	SS	7													
			10	SS	11													
298.51			11	SS	60													
19.79																		
298.40																		
13.81																		
	SILTY SAND & GRAVEL, till-like structure, possible cobbles, wet. (dense)																	
	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																	
	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 204.7 N, 313 921.3 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at ~11.6 m depth on completion.																	



RECORD OF BOREHOLE BH-9NF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+810, offset 16 m left of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 24, 1998

CHECKED BY E.G.

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)			
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80						wp — w — wl		
								SHEAR STRENGTH: Cu, KPa ● UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR						WATER CONTENT (%) 10 20 30 40		
312.80	GROUND SURFACE															
0.00	TOPSOIL, ~150 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff to firm)		1	SS	15											
			2	SS	15								0% 0% 100%			
			3	SS	8											
			4	SS	6											
			5	SS	1											
			6	SS	2								0% 2% 98%			
			7	SS	3											
			8	SS	6											
			9	SS	6											
301.37			10	SS	8											
11.43	SILT, occasional thin CLAY seams, grey, wet. (loose)															
299.39			11	SS	13											
13.41	SILTY SAND & GRAVEL, till-like structure, grey, wet. (compact to dense)															
298.11																
14.69	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER															
Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 243.3 N, 313 896.0 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Borehole caved wet at ~12.7 m depth on completion.																



RECORD OF BOREHOLE BH-10NF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+810, offset 6 m right of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE November 24, 1998

CHECKED BY E.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION		
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20	40	60	80	wp	w			wl	
								SHEAR STRENGTH: Cu, KPa									WATER CONTENT (%)
						● UNCONFINED QUICK TRIAXIAL	■ FIELD VANE LAB SHEAR										
						20	40	60	80	10 20 30 40				GR SA (SI & CL)			
312.93	GROUND SURFACE																
0.00	TOPSOIL, ~150 mm over SAND, fine, ~150 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff to firm)		1	SS	17												
			2	SS	12												
			3	SS	9												
			4	SS	4												
			5	TW													
			6	SS	2												
			7	TW													
			8	SS	8												
			9	SS	12												
301.04			10	SS	21												
11.89	SILT, with occasional thin CLAY seams, grey, wet. (loose)																
299.82																	
13.11	SILTY SAND & GRAVEL, till-like structure, grey, moist. (compact to dense)		11	SS	6												
298.18																	
14.75	BIOTITE HORNBLENDE GNEISS		12	BQ													
	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 246.6 N, 313 907.5 E.		13	BQ													
295.13																	
17.80	END OF BOREHOLE Notes: (cont'd) 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Borehole caved wet at ~11.4 m depth on completion.																



RECORD OF BOREHOLE BH-2DF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+668, offset ~7 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 11, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)		
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80						20	40
304.80	GROUND SURFACE																
0.00	SILTY CLAY , grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	7												
			2	SS	8												
			3	SS	5												
			4	SS	3												
			5	SS	4												
298.55			6	SS	8												
6.25	BIOTITE HORNBLENDE GNEISS , good to excellent rock quality, unweathered.		7	BQ													
			8	BQ													
295.50																	
9.30	END OF BOREHOLE																
Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 115.5 N, 313 954.0 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at ~6.0 m depth on completion.																	



RECORD OF BOREHOLE BH-3DF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+714, offset 5 m left of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / Dynamic cone COMPILED BY M.D.
 DATUM Geodetic DATE June 26, 1998 CHECKED BY I.G.

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		20	40	60	80	wp	w	wl	WATER CONTENT (%)		
301.11	GROUND SURFACE														
0.00	TOPSOIL, 150 mm over SILTY SAND, some wood inclusions, brown to grey, wet below 1.5 m depth, CREEK ALLUVIUM. (loose to very loose)		1	SS	7										
			2	SS	9										
			3	SS	3										
			4	SS	0										
297.11															
4.00	SILTY SAND & GRAVEL, till-like structure, occasional cobbles, grey, wet. (dense)		5	SS	40										
			6	SS	10										
294.34															
6.77	BIOTITE HORNBLende GNEISS, excellent rock quality, unweathered.		7	BQ											
			8	BQ											
291.27															
9.84	END OF BOREHOLE														
Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 153.4 N, 313 926.4 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan survey crew. 4) Water level was at 1.4 m & hole was open to 3.9 m depth on completion.															



RECORD OF BOREHOLE BH-4DF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station +10+745, offset 7 m right of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / Dynamic cone

COMPILED BY M.D.

DATUM Geodetic

DATE June 29, 1998

CHECKED BY I.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80			wp	w	wl																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
SHEAR STRENGTH: Cu, KPa													WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							



RECORD OF BOREHOLE BH-5DF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+663, offset 2 m left of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 11, 1998 CHECKED BY I.G.

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			20	40	60	80					
304.31 0.00	GROUND SURFACE														
	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	5										
			2	SS	6										
			3	SS	5										
			4	SS	6										
			5	SS	7										
298.27 6.04	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER														
	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 107.6 N, 313 947.6 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole was dry & open to full depth on completion.														



RECORD OF BOREHOLE BH-6DP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+620, offset 7.8 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 16, 1998 CHECKED BY I.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER TYPE			20	40	60	80	wp	wl	wp	wl	wp	wl		
313.74 0.00	GROUND SURFACE																
311.74 2.00	TOPSOIL, ~200 mm over SAND, fine to medium, some silt, brown, moist. (loose to very loose)		1 SS 3														
			2 SS 9														0% 97% 3%
	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff becoming firm)		3 SS 5														
			4 SS 4														
			5 SS 3														
			6 TW													18.30	
			7 SS 6														
305.24 8.50	SILTY SAND & GRAVEL, till-like structure, some cobbles, grey, wet. (compact)		8 SS 24														25% 57% 18%
303.99 9.75	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER																
Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 072.8 N, 313 973.6 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Borehole caved wet at ~9.3 m depth on completion.																	



RECORD OF BOREHOLE BH-8DP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+600, offset ~2 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 16, 1998 CHECKED BY I.G.

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION			
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20	40	60	80	wp			w	wl	WATER CONTENT (%)
313.26	GROUND SURFACE																
0.00	TOPSOIL, ~230 mm over SAND, fine to medium, some silt, brown. (compact)		1	SS	6												
311.76	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff to firm)		2	SS	7												
1.50			3	SS	3												
			4	SS	4												
			5	TW													
			6	SS	5												
305.46	SILTY SAND & GRAVEL, till-like structure, some cobbles, grey, wet. (very dense)		7	SS	52												
7.80			8	SS	58												
303.51	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER																
9.75	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 052.5 N, 313 976.5 e. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at ~8.9 m depth on completion.																



RECORD OF BOREHOLE BH-9DP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+572, offset ~3 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 16, 1998 CHECKED BY I.G.

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	20	40					
313.59 0.00	GROUND SURFACE													
	TOPSOIL, ~200 mm over SAND, fine to medium, some silt, brown. (compact)		1	SS	16									
312.09 1.50	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		2	SS	10									
			3	SS	1									
			4	TW										
309.63 3.96	SAND, GRAVEL & COBBLES													
309.17 4.42	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER													
<p>Notes:</p> <p>1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation.</p> <p>2) Borehole located at U.T.M. coordinates 5 093 028.3, 313 989.5 E.</p> <p>3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew.</p> <p>4) Water level was at ~4.1 m & hole was open to ~4.2 m depth on completion.</p>														



RECORD OF BOREHOLE BH-10DP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station +10+548, offset +1 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 17, 1998 CHECKED BY I.G.

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		20	40	60	80	wp	w	wl	WATER CONTENT (%)		
314.56	GROUND SURFACE														
0.00	TOPSOIL, ~230 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff to firm)		1	SS	17										
312.56			2	SS	21										
2.00	SILTY SAND & GRAVEL, some cobbles. (compact to dense)		3	SS	33										
311.97															
2.59	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 006.4 N, 313 998.6 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole was dry & open to depth on completion. 5) Drill moved ~2.0 m south of BH-10DF & met auger refusal at 2.6 m depth.														



RECORD OF BOREHOLE BH-12DP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+504, offset ~1 m left of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 17, 1998 CHECKED BY I.G.

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		20	40	60	80	wp	w	wl		
316.32	GROUND SURFACE													
0.00	TOPSOIL, ~250 mm over SILTY SAND & GRAVEL, till-like structure, some cobbles, brown to grey, wet below ~1.2 m depth. (compact to dense)		1	SS	12									
			2	SS	35									29% 53% 18%
			3	SS	25									
			4	SS	21									
312.45	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER													
3.87	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 092 967.5 N, 314 017.8 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Water level was at ~1.5 m & hole was open to ~3.7 m depth on completion. 5) Drill moved ~2.0 m north of BH-12DF & met auger refusal at ~3.8 m depth.													



RECORD OF BOREHOLE BH-17DP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station ~10+628, offset ~9 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 19, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80		wp — w — wl				WATER CONTENT (%) 10 20 30 40
								SHEAR STRENGTH: Cu, KPa ● UNCONFINED QUICK TRIAXIAL × FIELD VANE LAB SHEAR						
304.11	GROUND SURFACE													
0.00	TOPSOIL, ~150 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm to soft)		1	SS	4		304							
			2	SS	2		303	⊗				○		
							302	⊗	S = 2			○		
			3	SS	4		301	⊗				○		
301.11							300							
3.00	SILTY SAND & GRAVEL, till-like structure, grey, some cobbles. (compact to dense)		4	SS	50		301	⊗			○			
							300							
			5	SS	28		299	⊗			○			
298.93	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER						299							
5.18	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 07.0 N, 313 954.9 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at ~2.6 m depth on completion.													



RECORD OF BOREHOLE BH-18DF 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+712, offset 7 m right of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 26, 1998

CHECKED BY I.G.

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	NUMBER			TYPE	BLOWS/0.3m	UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR			wp
300.76	GROUND SURFACE											
0.00	TOPSOIL - 150 mm over SAND, traces of organics & roots, brown to grey, wet below 2.0 m depth. (loose)		1	SS	17							
			2	SS	5							
			3	SS	6							
			4	SS	10							
			5	AS								
295.09	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											
5.67	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 155.7 N, 313 938.3 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Water level was at 2.1 m & hole was open to 2.4 m depth on completion. 5) Dynamic cone penetration test driven at station 10+712, offset 6 m right of centreline as referenced to the Northbound Lane.											



METRIC

W.P. 774-93-00

LOCATION Station ~10+745, offset ~5 m left of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE June 30, 1998

CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)		CONE PENETRATION TEST		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa		WATER CONTENT (%)		wp	w	wl			
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	10	20				30		
306.87	GROUND SURFACE																
0.00	SILT, grey, moist, local sand layers. (loose)		1	SS	13												
304.37																	
2.50	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm to soft)		2	SS	6												
			3	SS	3												
			4	TW													
299.87																	
7.00	SILTY SAND & GRAVEL, till-like structure, grey, wet. (compact)		5	SS	13												
			6	SS	10												
297.63																	
9.24	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER																
Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 182.2 N, 313 916.1 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved wet at 7.2 m depth on completion.																	



RECORD OF BOREHOLE BH-21DP 1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+775, on centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Hollow stem augers / CME-55

COMPILED BY M.D.

DATUM Geodetic

DATE July 2, 1998

CHECKED BY I.G.

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION		
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20 40 60 80					SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL X FIELD VANE LAB SHEAR	WATER CONTENT (%) 10 20 30 40
							20 40 60 80						
312.76	GROUND SURFACE												
0.00	TOPSOIL, ~150 mm over SAND, medium, brown, moist. (loose)												
311.76	SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (stiff to firm)		1	SS	8								
1.00			2	SS	5								
			3	SS	13								
			4	SS	9								
			5	SS	5								
			6	SS	1								
			7	TW									
			8	SS	7								
			9	SS	7								
			10	SS	10								
			11	SS	12								
298.46	SAND, GRAVEL & COBBLES												
14.30													
298.19	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER												
14.57													
	Notes: 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 211.9 N, 313 911.6 E. 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model. 4) Borehole caved dry at ~11.4 m depth on completion.												

Notes:
 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation.
 2) Borehole located at U.T.M. coordinates 5 093 211.9 N, 313 911.6 E.
 3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model.
 4) Borehole caved dry at 11.4 m depth on completion.



RECORD OF BOREHOLE BH-23DP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+825, on centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Hollow stem augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE September 23, 1998 CHECKED BY E.G.

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			20 40 60 80				wp — w — wl					
								SHEAR STRENGTH: Cu, KPa UNCONFINED QUICK TRIAXIAL FIELD VANE LAB SHEAR 20 40 60 80				WATER CONTENT (%) 10 20 30 40					
312.14	GROUND SURFACE																
0.00	TOPSOIL, ~175 mm over SILTY CLAY, grey, moist to wet, thinly laminated with SILT, low to medium plasticity. (firm)		1	SS	11												
			2	SS	7											0% 0% 100%	
			3	SS	6												
			4	SS	4												
			5	TW											19.50		
			6	SS	4											0% 0% 100%	
			7	SS	8												
			8	SS	7												
301.39 10.75	SILT, grey, wet. (loose to compact)		9	SS	11												
299.64 12.50	SAND, brown. (dense)		10	SS	16												
299.49 12.65	END OF BOREHOLE																
<p>Notes:</p> <p>1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation.</p> <p>2) Borehole located at U.T.M. coordinates 5 093 259.2 N, 313 897.8 E.</p> <p>3) Borehole elevation obtained from Dearden and Stanton Ltd., O.L.S. terrain model.</p> <p>4) Borehole caved wet at ~5.8 m depth on completion.</p>																	

Notes:
 1) This borehole forms part of the Trout Creek Bridge Northbound Lane Approach Foundation Investigation.
 2) Borehole located at U.T.M. coordinates 5 093 259.2 N, 313 897.8 E.
 3) Borehole elevation obtained from Dearden and Stanton Ltd., O.L.S. terrain model.
 4) Borehole caved wet at ~5.8 m depth on completion.



RECORD OF BOREHOLE BH-18EP 1 OF 1

METRIC

W.P. 774-93-00	LOCATION Station +10+560, on centreline of Median	ORIGINATED BY I.D.
DIST 54 HWY 11	BOREHOLE TYPE Hollow stem augers / CME-55	COMPILED BY M.D.
DATUM Geodetic	DATE June 19, 1998	CHECKED BY I.G.

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	UNCONFINED QUICK TRIAXIAL						
313.75	GROUND SURFACE													
0.00	TOPSOIL, ~125 mm over CLAYEY SILT, seams of SILT, brown to grey, wet below ~2.0 m depth. (stiff)		1	SS	6									
			2	SS	4									
	Cobbles at base.													
309.48	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER													
4.27	Notes: 1) This borehole forms part of Trout Creek Bridge Southbound Lane Approach Foundation Investigation. 2) Borehole located at U.T.M. coordinates 5 093 007.8 N, 313 975.6 E. 3) Borehole elevation obtained by Marshall Macklin Monaghan survey crew. 4) Borehole caved dry at ~3.3 m depth on completion.													



RECORD OF BOREHOLE AP-1NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+559, offset 6 m left of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 17, 1998 CHECKED BY E.G.

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	20	40	60	80	wp	w	wl	WATER CONTENT (%)		
313.82 0.00	GROUND SURFACE														
312.60 1.22	Probable SAND														
310.47 3.35	Probable SILT and SILTY CLAY														
308.58 5.24	Probable SAND, GRAVEL & COBBLES TILL														
307.34 7.90	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER														
Notes: 1) This auger probe forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Probe located at U.T.M. coordinates 5 093 012.8 N, 313 987.4 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.															



RECORD OF BOREHOLE AP-2NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+561, on centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 17, 1998 CHECKED BY E.G.

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	20	40	60	80	20	40	60					
313.91 0.00	GROUND SURFACE																		
312.54 1.37	Probable SAND					313													
310.71 3.20	Probable SILT and SILTY CLAY					312													
309.76 4.15	Probable SAND, GRAVEL & COBBLE TILL					311													
	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER.					310													
<p>Notes:</p> <p>1) This auger probe forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation.</p> <p>2) Borehole located at U.T.M. coordinates 5 093 017.3 N, 313 991.8 E.</p> <p>3) Borehole elevation obtained from Marshall Macklin Monaghan terrain model.</p>																			



RECORD OF BOREHOLE AP-3NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+563, on centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 17, 1998 CHECKED BY E.G.

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 kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)	
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20 40 60 80				wp — w — wl					
								SHEAR STRENGTH: Cu, KPa		FIELD VANE LAB SHEAR		WATER CONTENT (%)					
						UNCONFINED QUICK TRIAXIAL											
313.90 0.00	GROUND SURFACE																
312.53 1.37	Probable SAND																
310.85 3.05	Probable SILT and SILTY CLAY																
309.72 4.18	Probable SAND, GRAVEL & COBBLES																
	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER.																
	Notes: 1) This auger probe forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Probe located at U.T.M. coordinates 5 093 019.0 N, 313 990.9 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.																



RECORD OF BOREHOLE AP-4NF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+563, offset 7 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE November 17, 1998 CHECKED BY E.G.

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	20 40 60 80				wp — w — wl								
						SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)								
314.21	GROUND SURFACE																	
0.00	TOPSOIL, ~150 mm over																	
	Probable SAND																	
312.99 1.22	-----																	
	Probable SILT and SILTY CLAY																	
311.47 2.74	-----																	
	Probable SAND, GRAVEL & COBBLES																	
310.60 3.61	END OF PROBE DUE TO REFUSAL TO AUGER ON PROBABLE BEDROCK OR POSSIBLE BOULDER.																	
	Notes: 1) This auger probe forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Probe located at U.T.M. coordinates 5 093 022.2 N, 313 997.1 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.																	



RECORD OF BOREHOLE AP-1DF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station +10+639, offset +7 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 19, 1998 CHECKED BY I.G.

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/30.3m	20	40	60	80	wp	w			wl	10	20
311.05 0.00	GROUND SURFACE																	
	Probable SILTY CLAY																	
299.62 11.43	END OF AUGER PROBE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER																	
	Notes: 1) This auger probe forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Auger probe located at U.T.M. coordinates 5 093 089.4 N, 313 965.1 E. 3) Probe elevation obtained from Marshall Macklin Monaghan terrain model.																	



RECORD OF BOREHOLE AP-2DF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station +667, offset 6 m left of centreline of Northbound Lane ORIGINATED BY J.D.
 DIST 54 HWY 11 BOREHOLE TYPE Standard augers / CME-55 COMPILED BY M.D.
 DATUM Geodetic DATE June 19, 1998 CHECKED BY J.G.

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 PLLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60	80	20	40	60	80	wp	w	wl	10	20	30	40			kN/m ³
303.83 0.00	GROUND SURFACE																								
	Probable SILTY CLAY																								
297.86 5.97	END OF AUGER PROBE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER																								
	Notes: 1) This auger probe forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Auger probe located at U.T.M coordinates 5 093 109.7N, 313 942.4 E. 3) Probe elevation obtained by Marshall Macklin Monaghan survey crew.																								



1 OF 1

ORIGINATED BY I.D.

LOCATION Station ~10+637, offset ~7 m right of centreline of Northbound Lane

BOREHOLE TYPE Dynamic cone /

COMPILED BY M.D.

DATE June 9, 1998

— CHECKED BY I.G.

[illegible]

RECORD OF BOREHOLE C-2DF

1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+669, offset 5 m left of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic cone /

COMPILED BY M.D.

DATUM Geodetic

DATE June 9, 1998

CHECKED BY I.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	BLOWS/30.3m	CONE PENETRATION TEST				wp	w	wl	WATER CONTENT (%)					
						20	40	60	80				10	20	30	40				
303.77	GROUND SURFACE																			
0.00	Dynamic cone penetration test only.																			
299.20	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON BEDROCK OR BOULDER																			
4.57	Notes: 1) This cone test forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 111.9 N, 313 924.5 E. 3) Cone elevation obtained by Marshall Macklin Monaghan survey crew.																			



RECORD OF BOREHOLE C-3DF

1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station ~10+714, offset ~10 m right of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic cone /

COMPILED BY M.D.

DATUM Geodetic

DATE June 26, 1998

CHECKED BY I.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)			
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	20	40	60						80	20	40
300.64	GROUND SURFACE																	
0.00	Dynamic cone penetration test only.																	
294.95	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON BEDROCK OR BOULDER																	
5.69	Notes: 1) This cone test forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 158.6 N, 313 940.4 E. 3) Cone elevation obtained by Marshall Macklin Monaghan survey crew.																	



RECORD OF BOREHOLE C-4DF

1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+745, offset 5 m left of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic cone /

COMPILED BY M.D.

DATUM Geodetic

DATE June 30, 1998

CHECKED BY I.G.

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	UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	wp	w	wl	wp	w	wl	wp	w	wl		
306.87	GROUND SURFACE																			
0.00	Dynamic cone penetration test only.																			
297.60	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON BEDROCK OR BOULDER																			
9.27	Notes: 1) This cone test forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 185.5 N, 313 925.6 E. 3) Cone elevation obtained by Marshall Macklin Monaghan survey crew.																			



RECORD OF BOREHOLE C-5DF

1 OF 1

METRIC

W.P. 774-93-00

LOCATION Station 10+660, offset 6 m right of centreline of Northbound Lane

ORIGINATED BY I.D.

DIST 54 HWY 11

BOREHOLE TYPE Dynamic cone /

COMPILED BY M.D.

DATUM Geodetic

DATE June 9, 1998

CHECKED BY J.G.

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value)				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER			TYPE	CONE PENETRATION TEST							
						SHEAR STRENGTH: Cu, KPa				WATER CONTENT (%)				
						UNCONFINED	QUICK TRIAXIAL	FIELD VANE	LAB SHEAR	wp	w	wl	kN/m ³	GR SA (SI & CL)
						20	40	60	80	10	20	30	40	
305.90	GROUND SURFACE													
0.00	Dynamic cone penetration test only.													
299.42	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON BEDROCK OR BOULDER													
6.48	Notes: 1) This cone test forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 107.9 N, 313 956.1 E. 3) Cone elevation obtained by Marshall Macklin Monaghan survey crew.													



RECORD OF BOREHOLE C-6DF

1 OF 1

METRIC

W.P. 774-93-00 LOCATION Station 10+642, offset 1 m right of centreline of Northbound Lane ORIGINATED BY I.D.
 DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone / COMPILED BY M.D.
 DATUM Geodetic DATE June 9, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) CONE PENETRATION TEST				PLASTIC LIMIT wp	NATURAL MOISTURE CONTENT w	LIQUID LIMIT wl	UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (S) & CL		
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			BLOWS/0.3m	SHEAR STRENGTH: Cu, KPa								WATER CONTENT (%)	
								UNCONFINED QUICK TRIAXIAL	FIELD VANE LAB SHEAR	20							40
308.50	GROUND SURFACE																
0.00	Dynamic cone penetration test only.																
299.81	END OF CONE TEST DUE TO 'BOUNCING' REFUSAL ON BEDROCK OR BOULDER																
8.69	Notes: 1) This cone test forms part of the Trout Creek Bridge Northbound Lane Foundation Investigation. 2) Cone test located at U.T.M. coordinates 5 093 089.7 N, 313 958.4 E. 3) Cone elevation obtained by Marshall Macklin Monaghan survey crew.																



SO7524G/N/P

TABLE 1
ROCK CORE DESCRIPTION

BH#	Core Recovery				Core Description	
	RC #	Depth (m)	% CR*	% RQD**	Depth (m)	Description
SOUTH ABUTMENT - NORTH BOUND LANE						
2-NF	1	3.87 to 4.68	100	80	3.87 to 7.01	Biotite Hornblende Gneiss (Garnetiferous) , light grey to grey pink, medium to coarse grained, unweathered sulfate inclusions in joints, moderately close spacing of fractures dipping 45° to 90° from vertical, planar to smooth
	2	4.68 to 7.01	100	85		
3-NF	1	10.12 to 11.60	100	75	10.12 to 13.29	Biotite Hornblende Gneiss , grey to grey pink, medium to coarse grained, unweathered with sulfide inclusions, moderately spaced fractures and joints dipping 45° to 90° from vertical, planar and rough
	2	11.60 to 13.29	100	93		
5-NF	1	6.92 to 8.33	100	53	6.92 to 10.27	Biotite Hornblende Gneiss (Garnetiferous) , grey pink to pinkish red, medium to coarse grained, weathered, fractures very closely spaced, dipping 0° to 90° from vertical, planar, smooth to slightly undulated
	2	8.45 to 10.27	100	81.4		

SO7524G/N/F

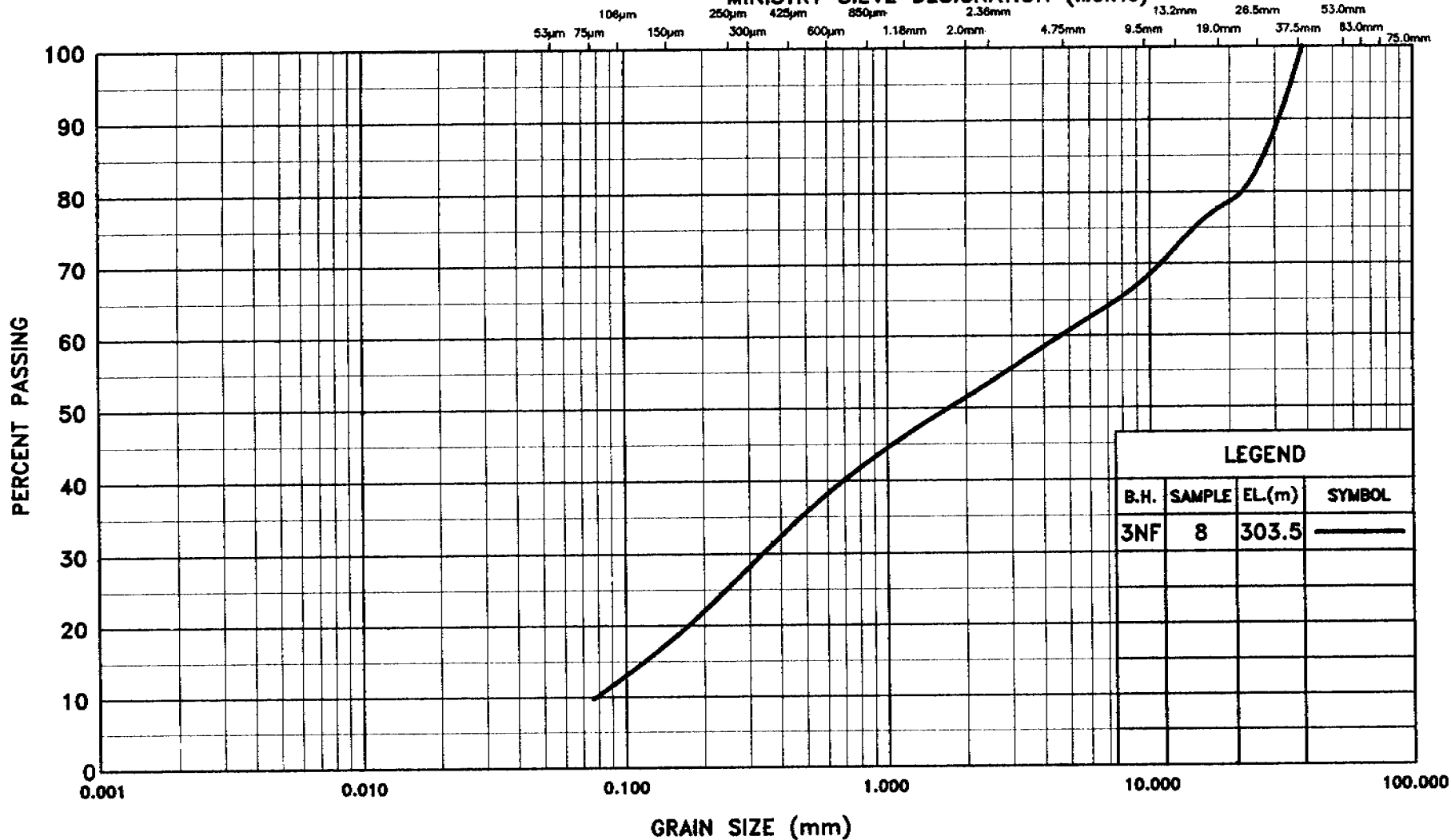
TABLE 1
ROCK CORE DESCRIPTION

BH#	Core Recovery				Core Description	
	RC #	Depth (m)	% CR*	% RQD**	Depth (m)	Description
7-NF	1	11.37 to 12.86	100	67	11.37 to 14.57	Biotite Hornblende Gneiss , light grey to grey-pink, medium to coarse grained, unweathered with sulfide inclusions, moderately spaced fractures and joints dipping 45° to 90° from vertical, rough and slightly undulating
	2	12.86 to 14.57	100	63		
10-NF	1	14.76 to 16.29	100	90	14.76 to 17.80	Biotite Hornblende Gneiss (Garnetiferous) , light grey to grey-pink, unweathered, some sulfide inclusions, moderately close spacing of fractures and joints dipping from 40° to 90° from vertical, planar and smooth
	2	16.29 to 17.80	100	100		
<div>*CR = Core Recovery</div> <div>**RQD = Rock Quality Designation</div>						

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation

METRIC

GRAIN SIZE DISTRIBUTION

BH-3NF, SS-8 SAND & GRAVEL

FIGURE C-1

W.P. 774-93-00

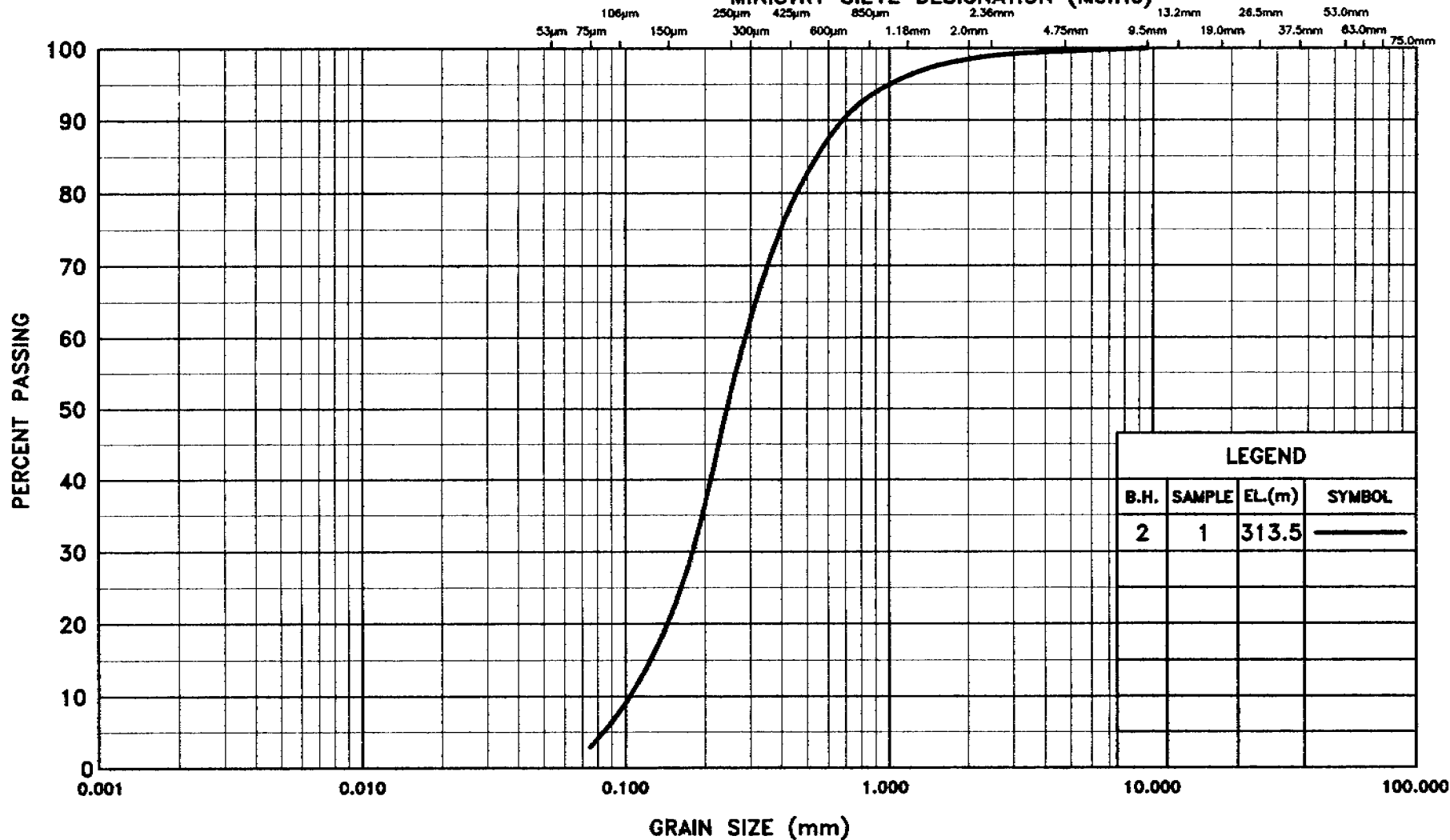


PROJ. No. S07524GN

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation

METRIC

BH-2NF, SS-1

GRAIN SIZE DISTRIBUTION

SAND

FIGURE C-2

W.P. 774-93-00



PROJ. No. S07524GN

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT

SAND

GRAVEL

FINE

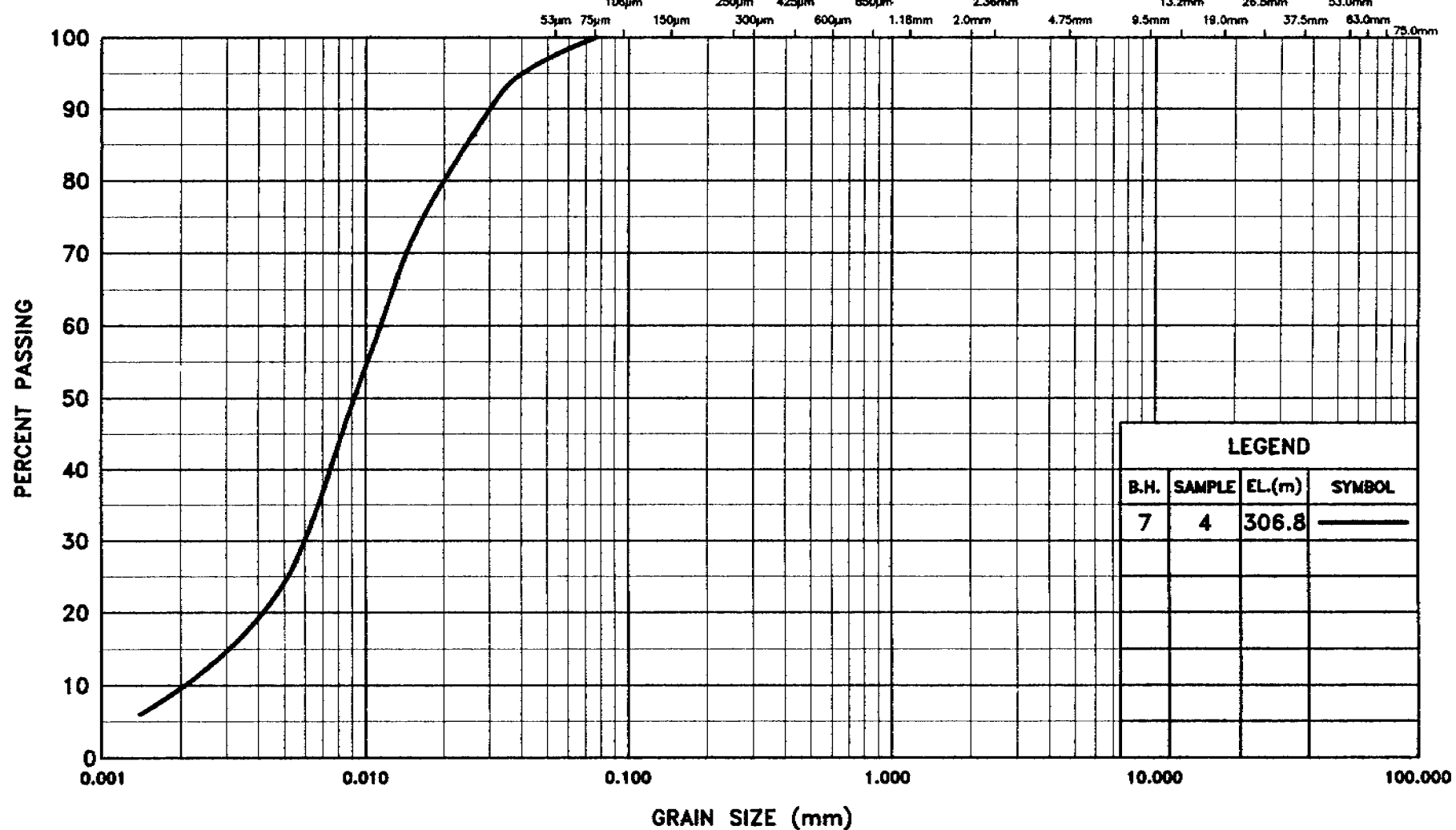
MEDIUM

COARSE

FINE

COARSE

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

B.H.	SAMPLE	EL.(m)	SYMBOL
7	4	306.8	—

Ministry of
Transportation

METRIC

GRAIN SIZE DISTRIBUTION

BH-7NF, SS-4 SILT

FIGURE C-3

W.P. 774-93-00



PROJ. No. S07524GN

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT

SAND

GRAVEL

FINE

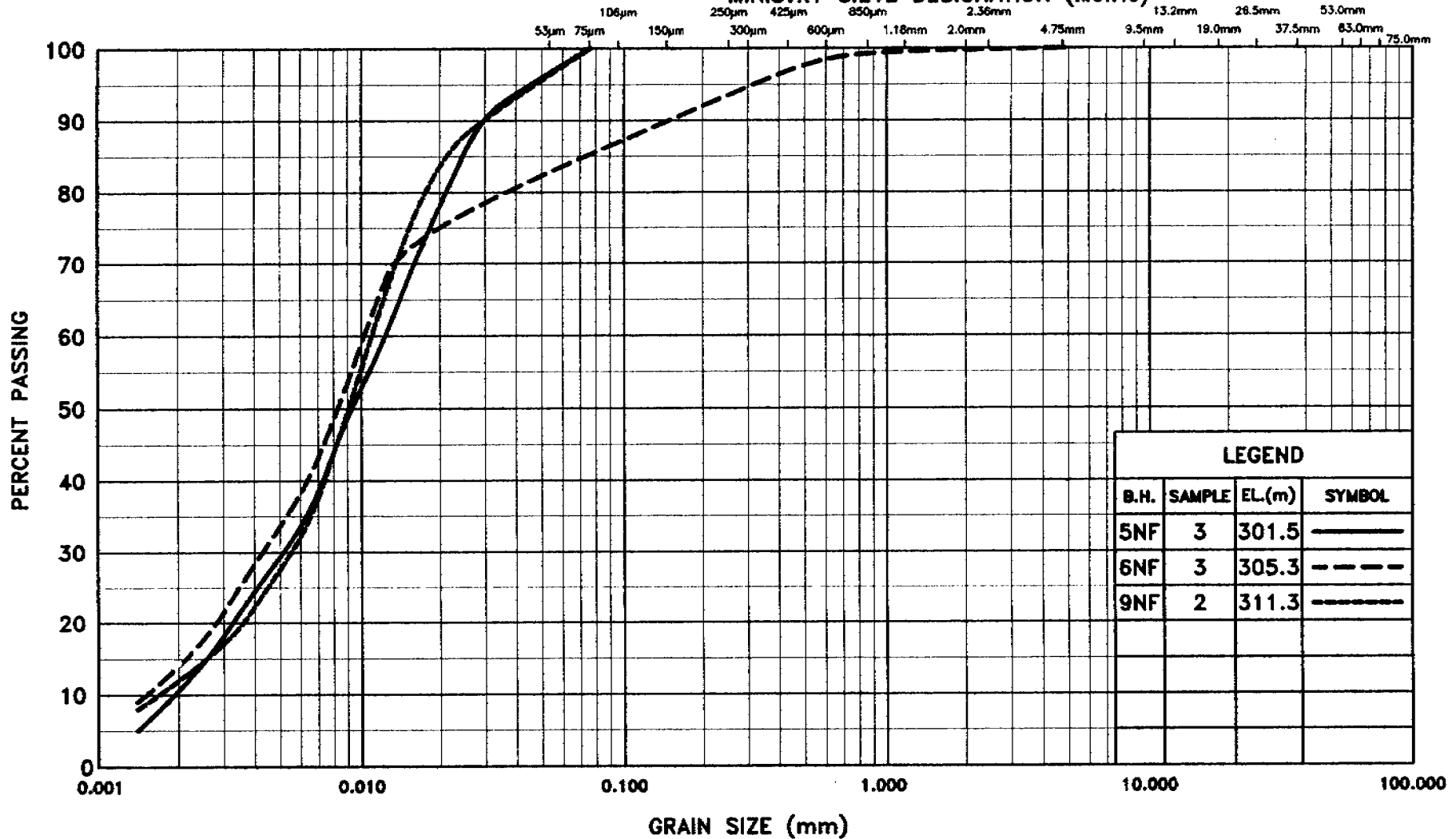
MEDIUM

COARSE

FINE

COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

CLAYEY SILT

FIGURE C-4

W.P. 774-93-00



PROJ. No. S07524GN

UNIFIED SOIL CLASSIFICATION

CLAY AND SILT

SAND

GRAVEL

FINE

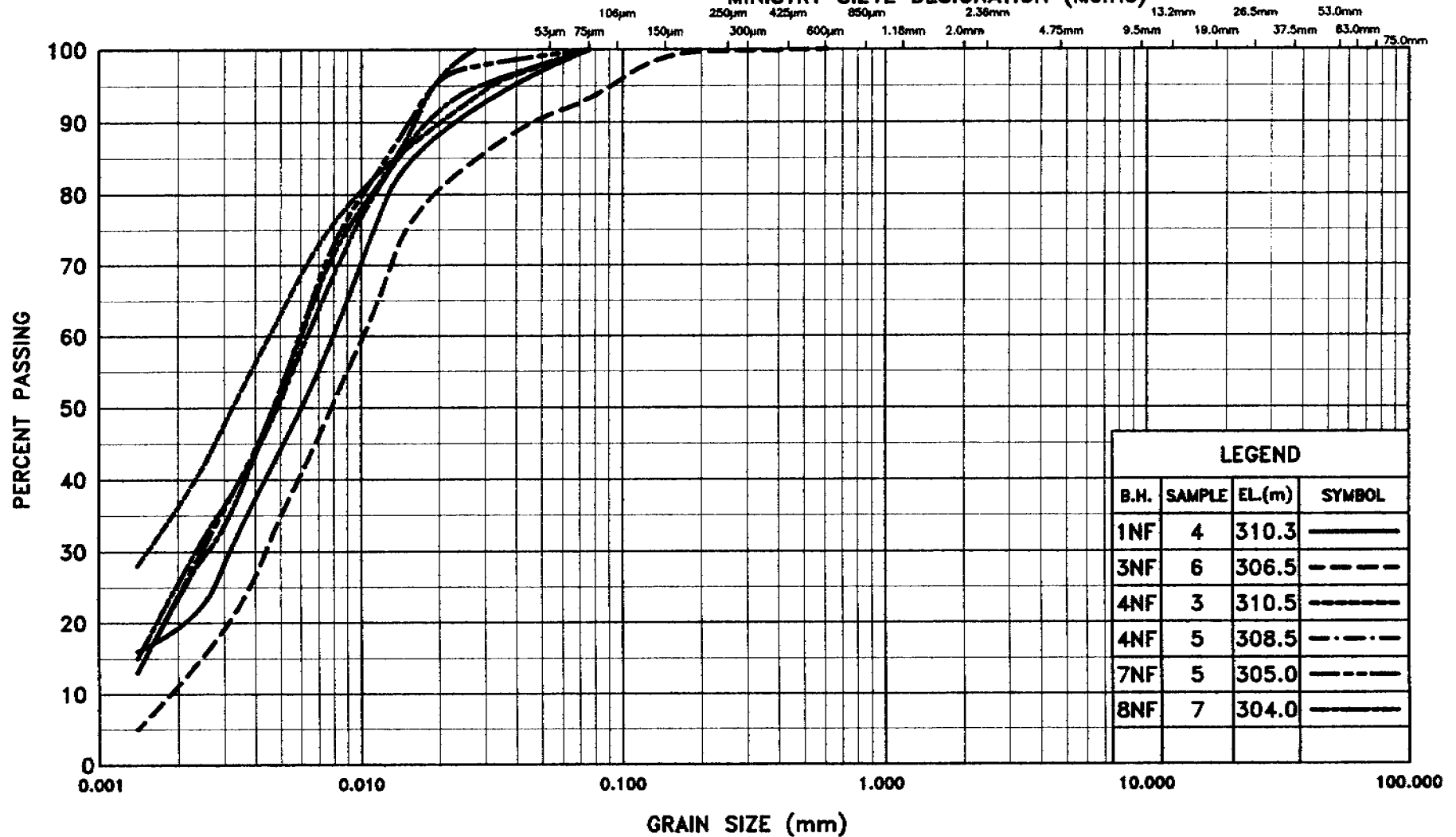
MEDIUM

COARSE

FINE

COARSE

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation

METRIC

ALL SAMPLES

GRAIN SIZE DISTRIBUTION

SILTY CLAY

FIGURE C-5

W.P. 774-93-00



PROJ. No. S07524GN

ATTERBERG LIMITS - PLASTICITY CHART

SYMBOL

DESCRIPTION

LL

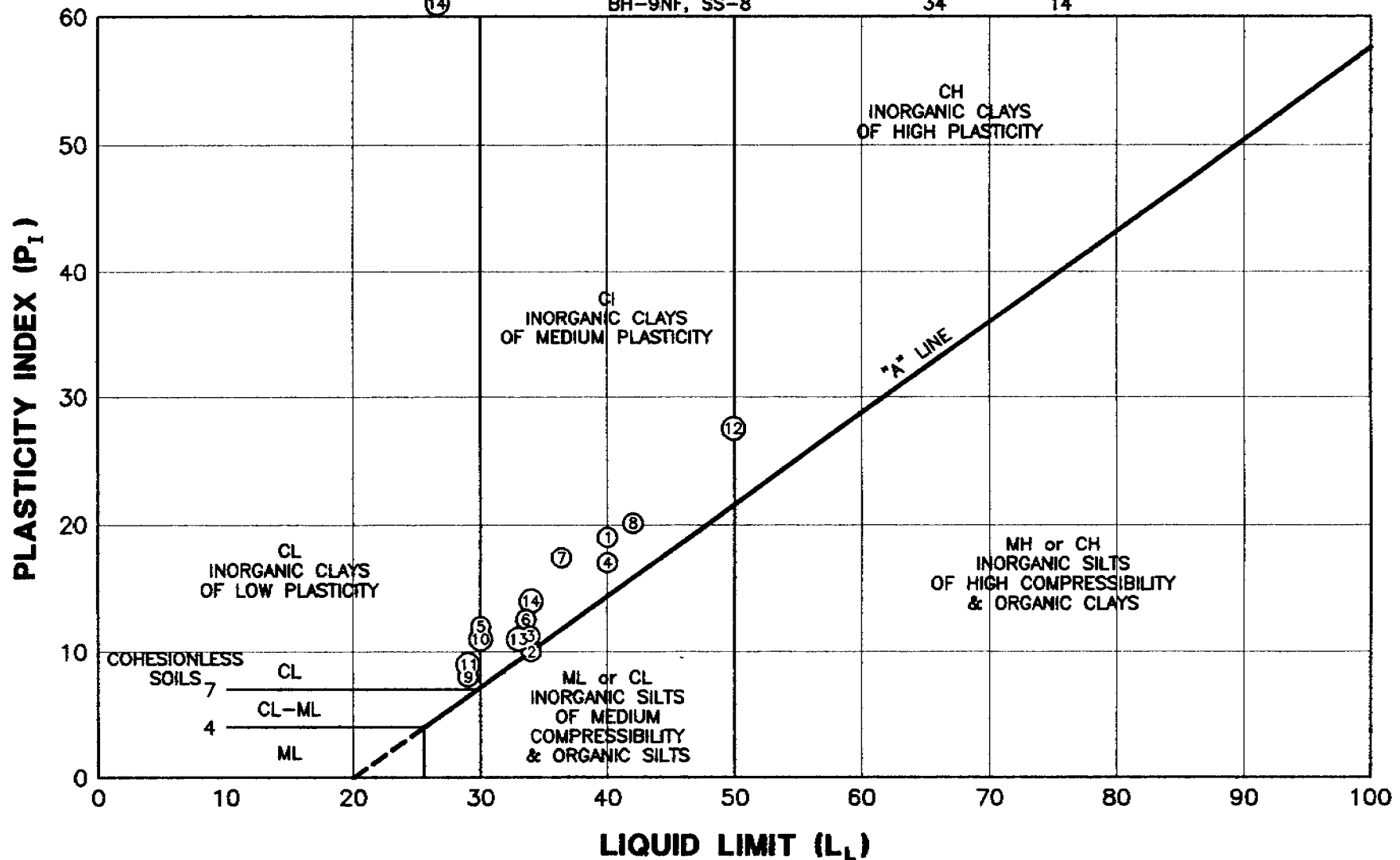
PI

①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
⑭

BH-1NF, SS-2
BH-1NF, SS-3
BH-1NF, SS-4
BH-3NF, SS-3
BH-5NF, SS-3
BH-6NF, SS-5
BH-7NF, SS-5
BH-8NF, SS-7
BH-9NF, SS-3
BH-9NF, SS-4
BH-9NF, SS-6
BH-9NF, SS-6
BH-9NF, SS-7
BH-9NF, SS-8

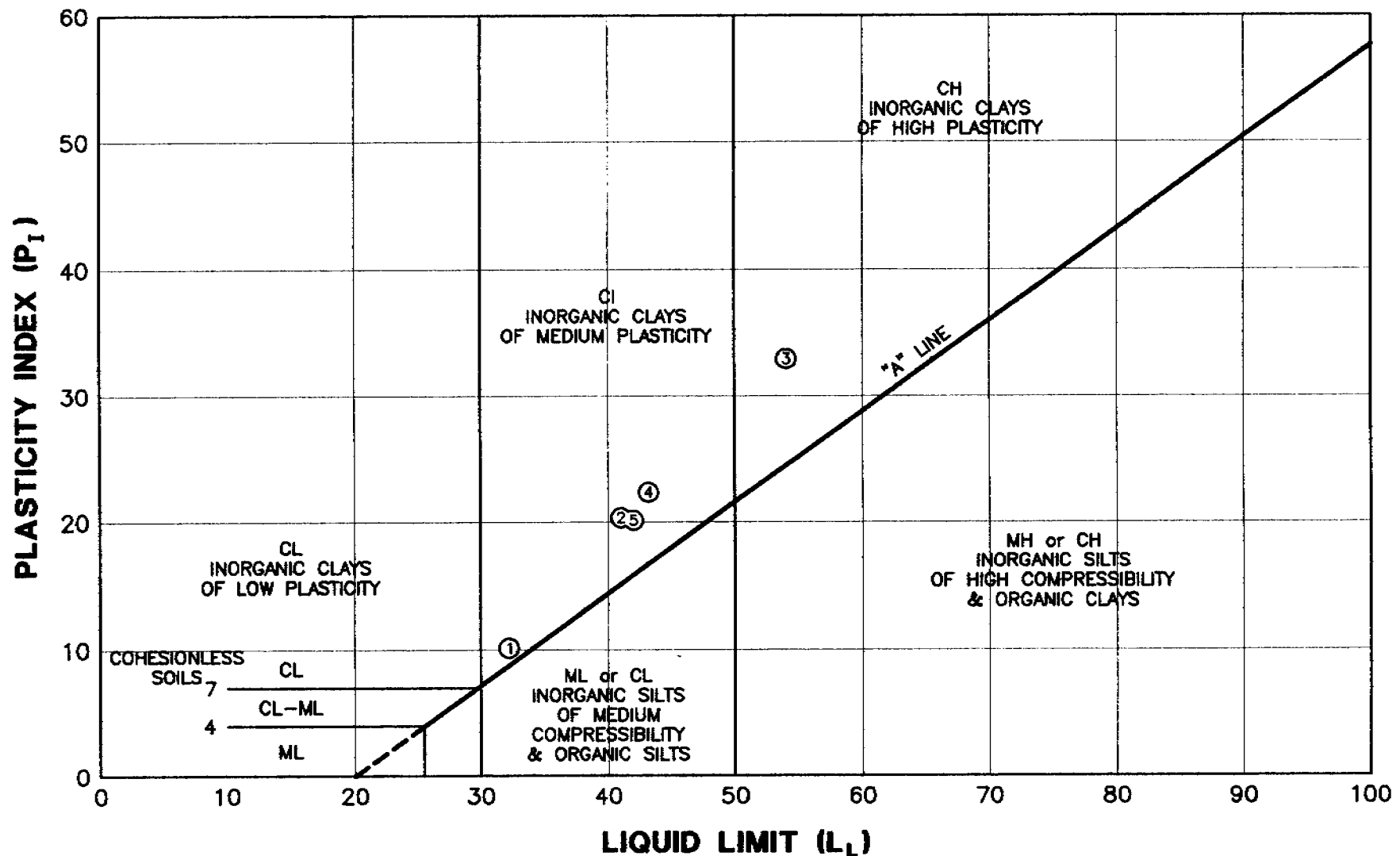
40
34
34
40
30
34
36
42
29
30
29
50
33
34

19
10
11
17
12
12
17
20
8
11
9
28
11
14



ATTERBERG LIMITS - PLASTICITY CHART

SYMBOL	DESCRIPTION	LL	PI
①	BH-1DF, SS-3	32	10
②	BH-21DP, SS-6	41	21
③	BH-4DF, SS-2	54	33
④	BH-6DP, SS-5	43	22
⑤	BH-8NF, SS-8	42	20



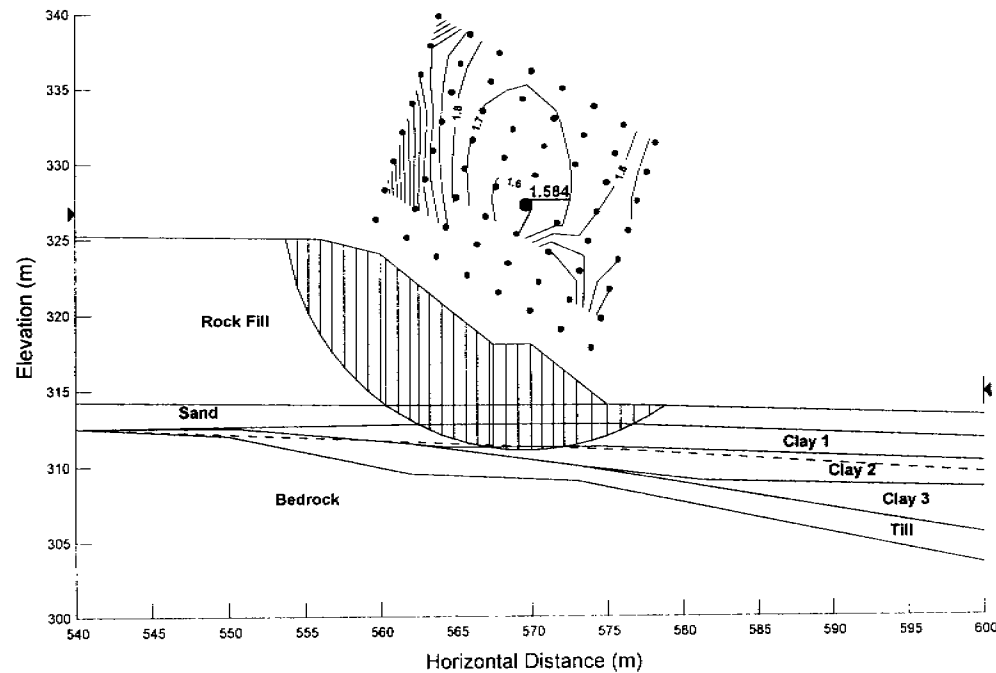
S07524GN

FIG. No. C-8



D

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 NBL_SALU.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Undrained (Phi=0)
 Unit Weight 19
 Cohesion 35

Soil 5
 Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 35
 Rate of Increase 2.86
 Cv - Maximum 70
 Ch/Cv Ratio 1

Till
 Soil Model Mohr-Coulomb
 Unit Weight 21.5
 Cohesion 0
 Phi 35

Bedrock
 Soil Model Bedrock

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 North Abutment
 4 metre embankment height, 1.25:1 side slopes
 NS_N4H.SLP

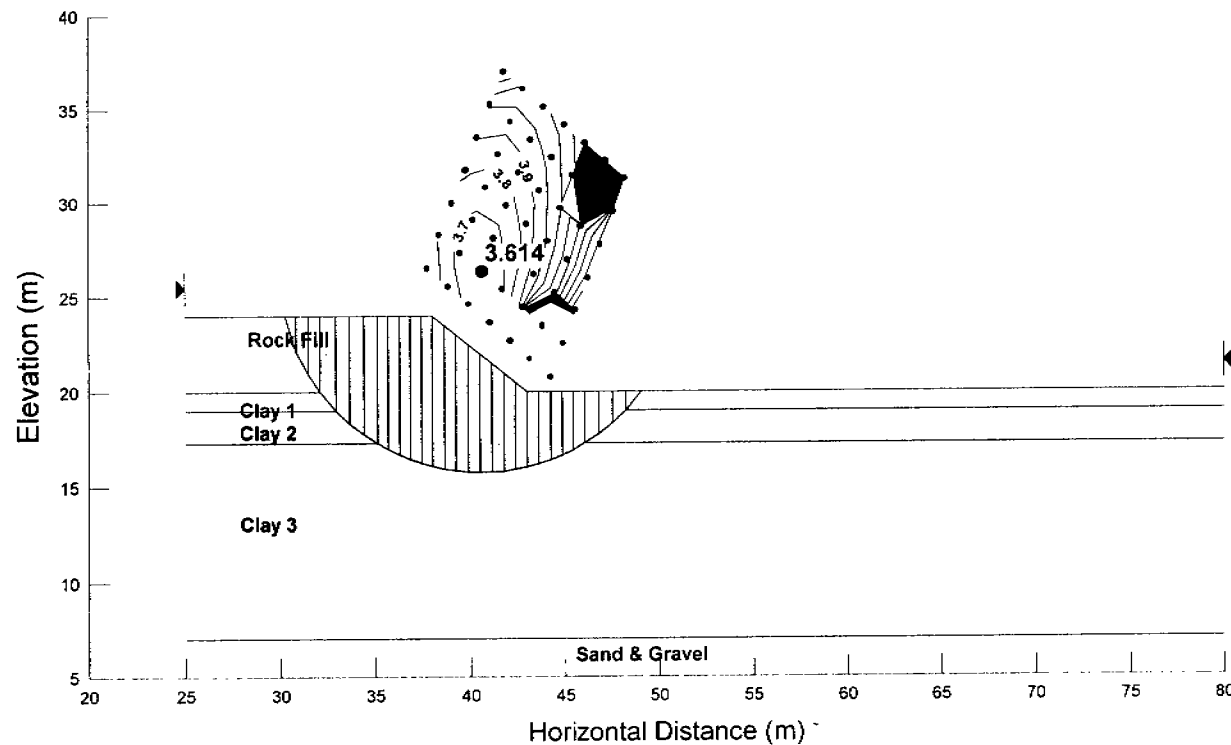
Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 100
 Rate of Increase -30
 Cv - Minimum 70
 Ch/Cv Ratio 1

Clay 2
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 70
 Rate of Increase -28.57
 Cv - Minimum 50
 Ch/Cv Ratio 1

Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 50
 Rate of Increase 1.95
 Cv - Maximum 70
 Ch/Cv Ratio 1

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39



Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 North Abutment
 5 metre embankment height, 1.25:1 side slopes
 NS_N5H.SLP

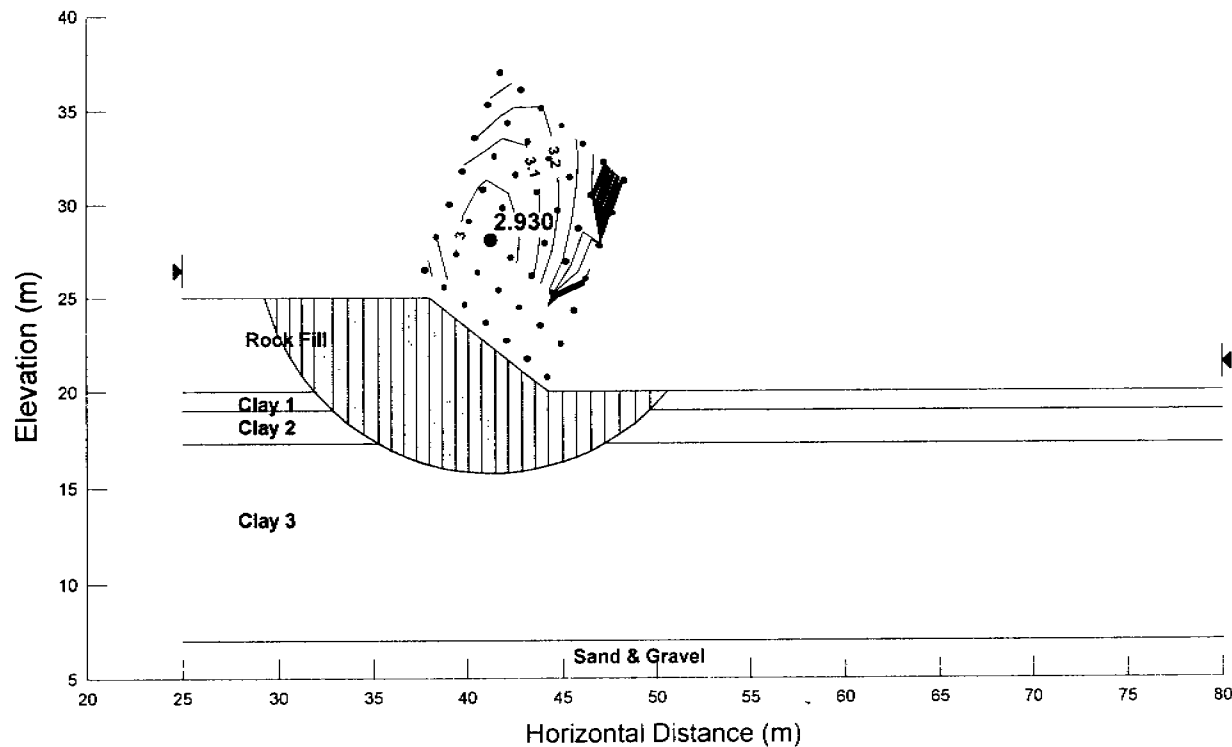
Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 100
 Rate of Increase -30
 Cv - Minimum 70
 Ch/Cv Ratio 1

Clay 2
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 70
 Rate of Increase -28.57
 Cv - Minimum 50
 Ch/Cv Ratio 1

Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 50
 Rate of Increase 1.95
 Cv - Maximum 70
 Ch/Cv Ratio 1

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39



Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 North Abutment
 6 metre embankment height, 1.25:1 side slopes
 NS_N6H.SLP

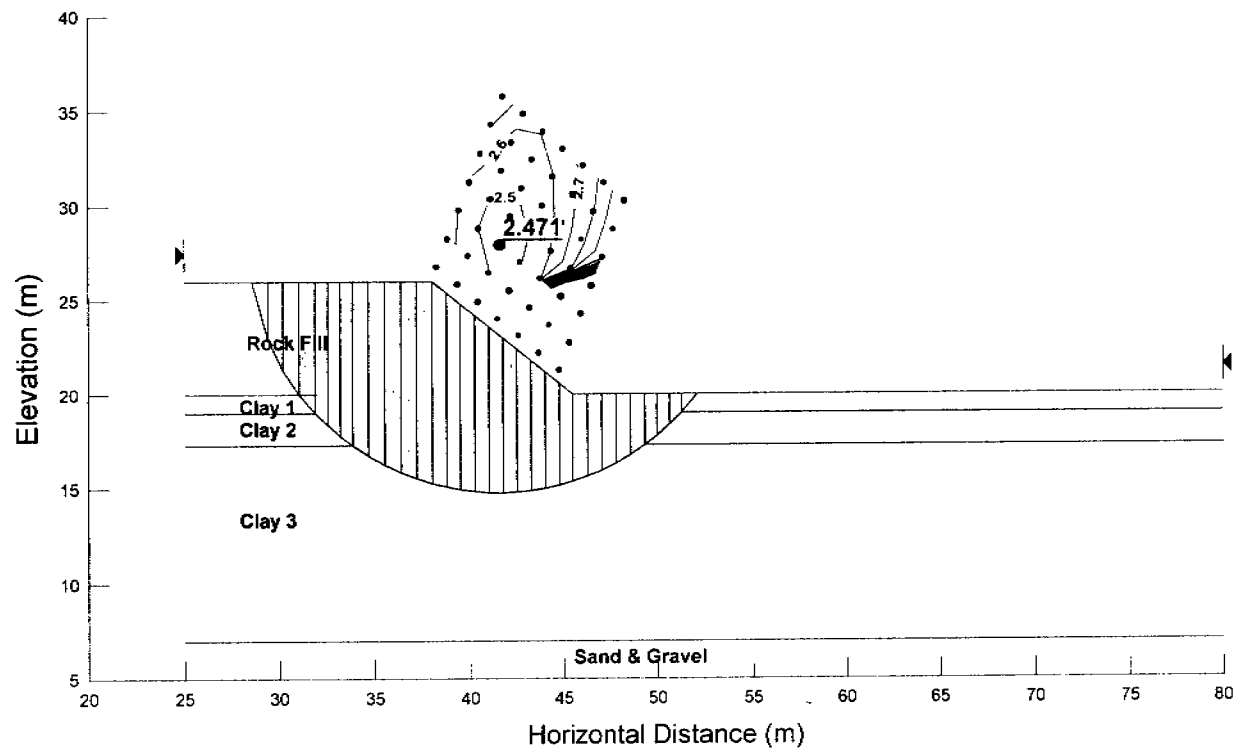
Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 100
 Rate of Increase -30
 Cv - Minimum 70
 Ch/Cv Ratio 1

Clay 2
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 70
 Rate of Increase -28.57
 Cv - Minimum 50
 Ch/Cv Ratio 1

Clay 3
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 50
 Rate of Increase 1.95
 Cv - Maximum 70
 Ch/Cv Ratio 1

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39



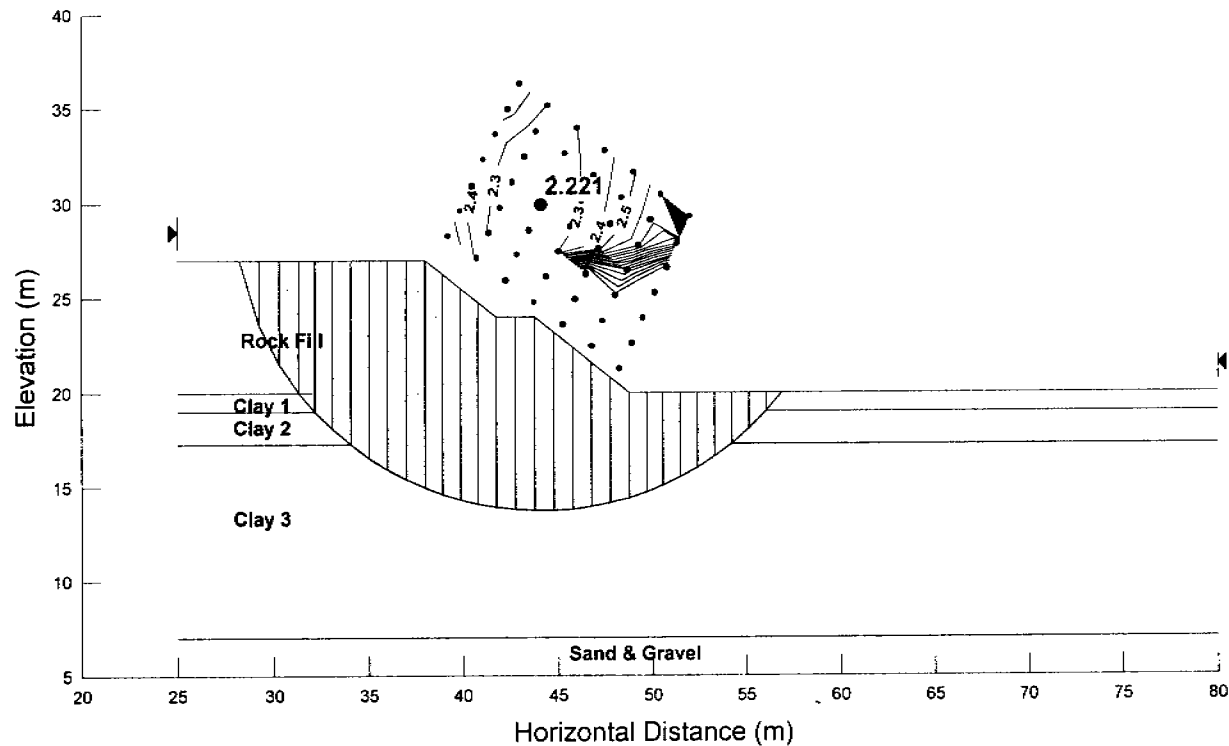
Rock Fill
Soil Model Mohr-Coulomb
Unit Weight 20
Cohesion 0
Phi 42

Clay 1
Soil Model $S=f(\text{depth})$
Unit Weight 19
 C_v 100
Rate of Increase -30
 C_v - Minimum 70
 C_h/C_v Ratio 1

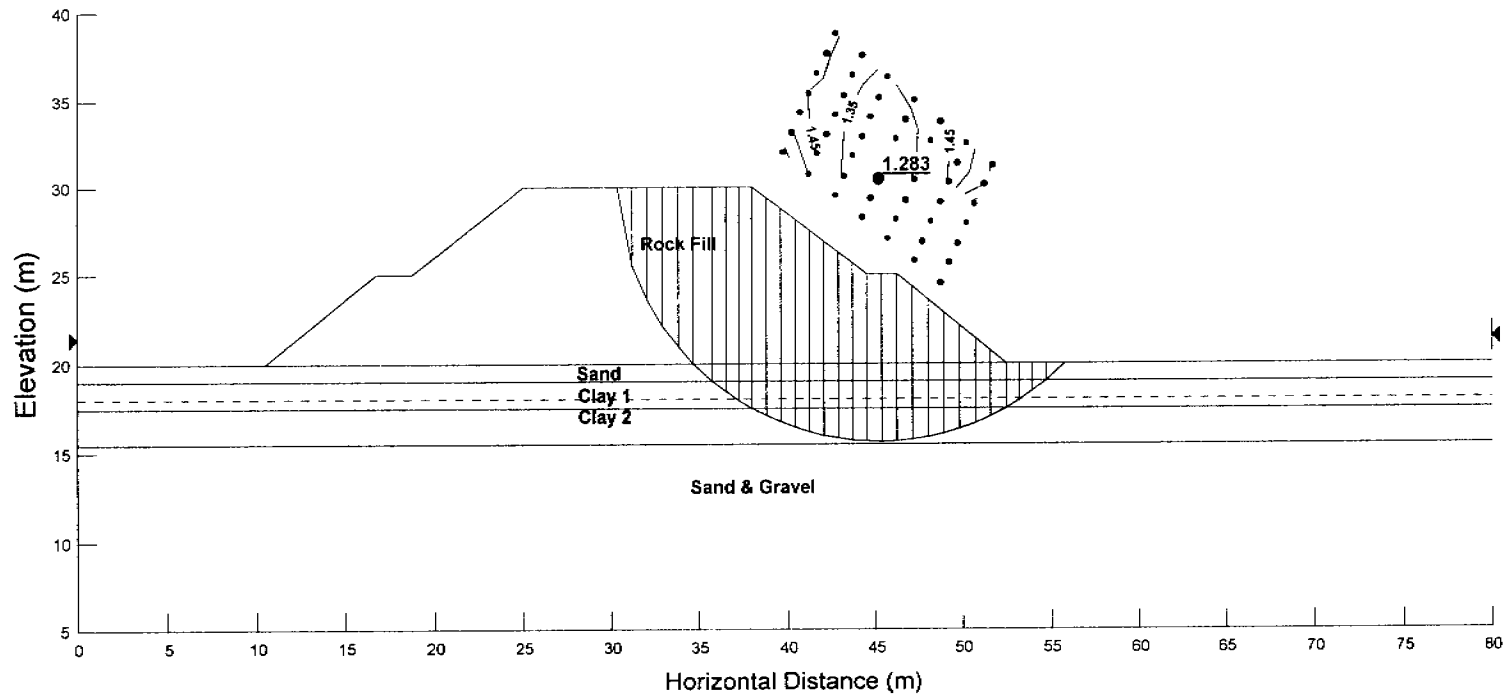
Clay 2
Soil Model $S=f(\text{depth})$
Unit Weight 19
 C_v 70
Rate of Increase -28.57
 C_v - Minimum 50
Ch/ C_v Ratio 1

Clay 3
Soil Model $S=f(\text{depth})$
Unit Weight 19
 C_v 50
Rate of Increase 1.95
 C_v - Maximum 70
 C_h/C_v Ratio 1

Sand & Gravel
Soil Model Mohr-Coulomb
Unit Weight 20
Cohesion 0
Phi 39



Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 10 metre embankment height, 1.25:1 side slopes
 5 metre high, 2 metre long bench
 N_S10H.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

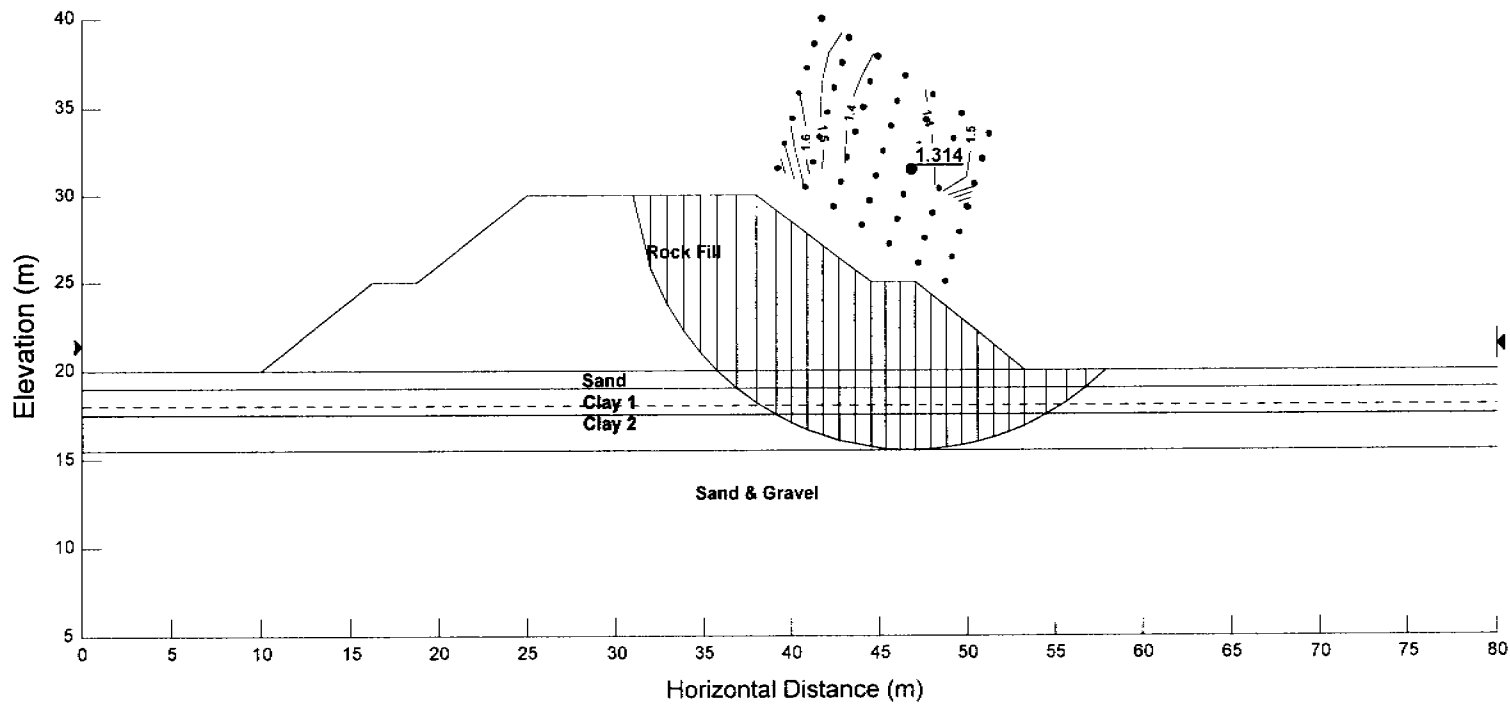
Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Mohr-Coulomb
 Unit Weight 19
 Cohesion 35
 Phi 0

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 10 metre embankment height, 1.25:1 side slopes
 5 metre high, 2.5 metre long bench
 N_S10H1.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

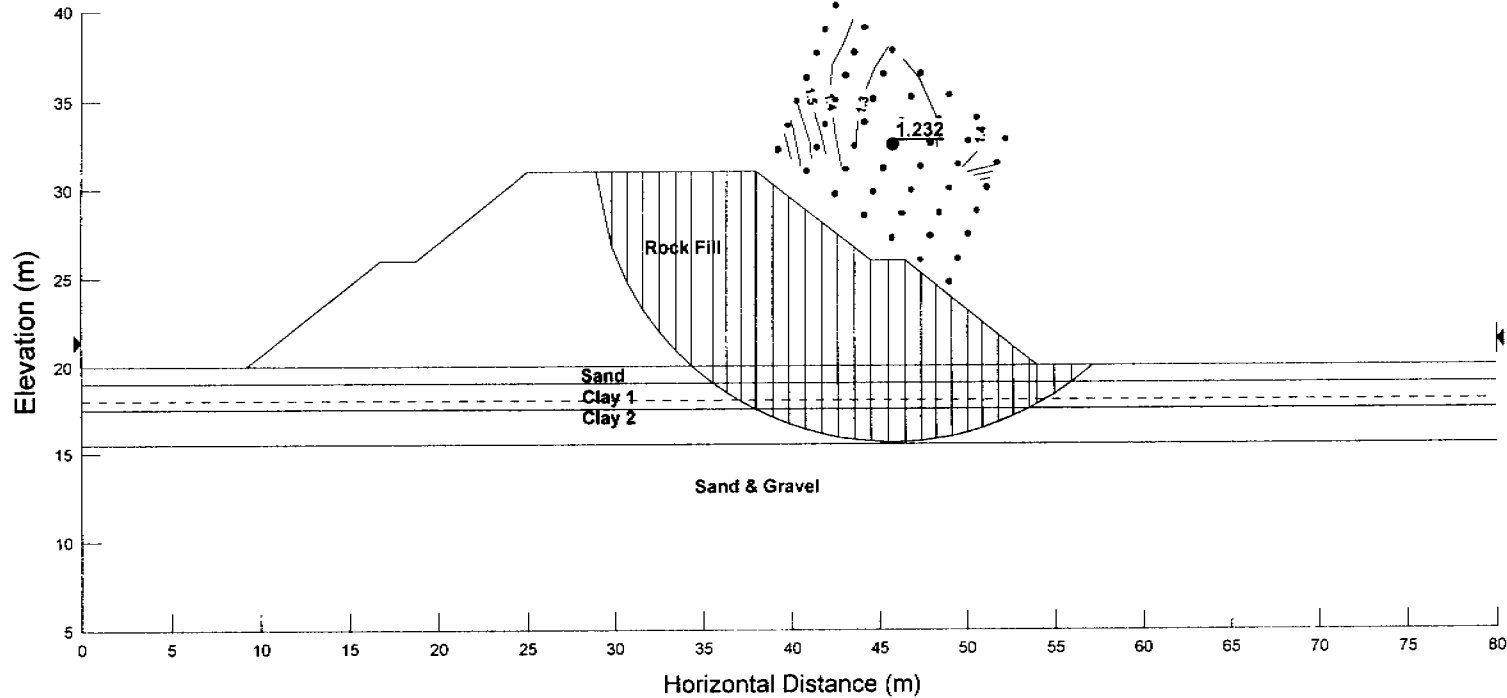
Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model S=f(depth)
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Mohr-Coulomb
 Unit Weight 19
 Cohesion 35
 Phi 0

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 11 metre embankment height, 1.25:1 side slopes
 6 metre high, 2 metre long bench
 N_S11H.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

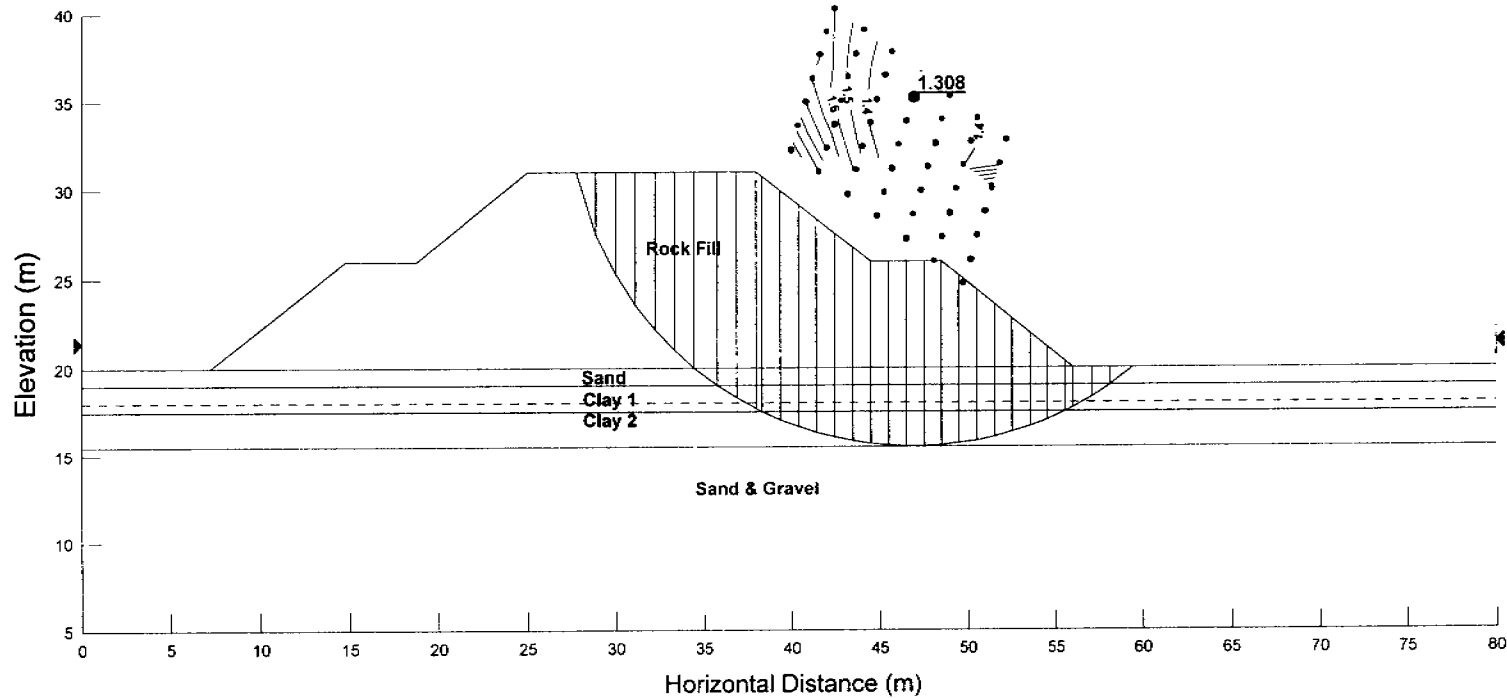
Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model S=f(depth)
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Mohr-Coulomb
 Unit Weight 19
 Cohesion 35
 Phi 0

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 11 metre embankment height, 1.25:1 side slopes
 6 metre high, 4 metre long bench
 N_S11H1.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

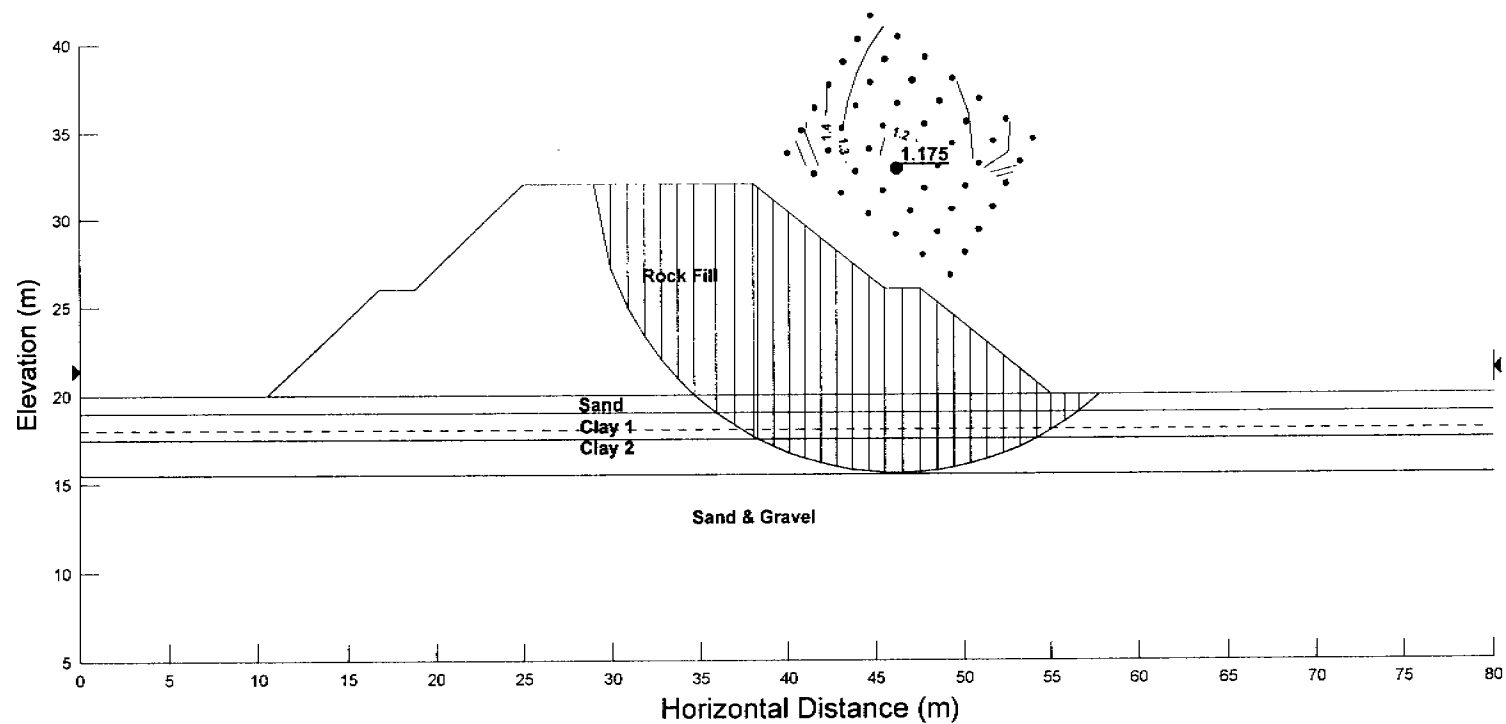
Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model S=f(depth)
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Mohr-Coulomb
 Unit Weight 19
 Cohesion 35
 Phi 0

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 12 metre embankment height, 1.25:1 side slopes
 6 metre high, 2 metre long bench
 N_S12H.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

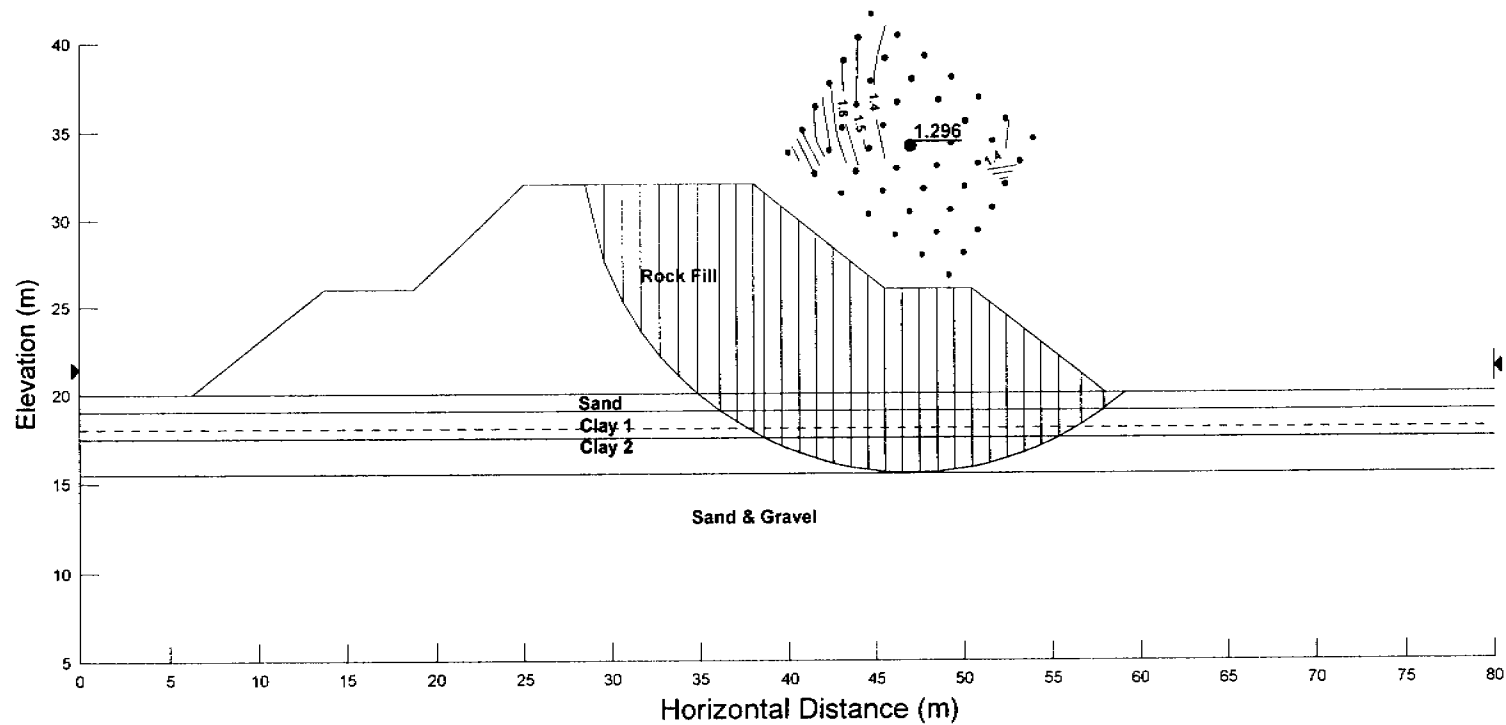
Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model S=f(depth)
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Mohr-Coulomb
 Unit Weight 19
 Cohesion 35
 Phi 0

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 12 metre embankment height, 1.25:1 side slopes
 6 metre high, 5 metre long bench
 N_S12H1.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

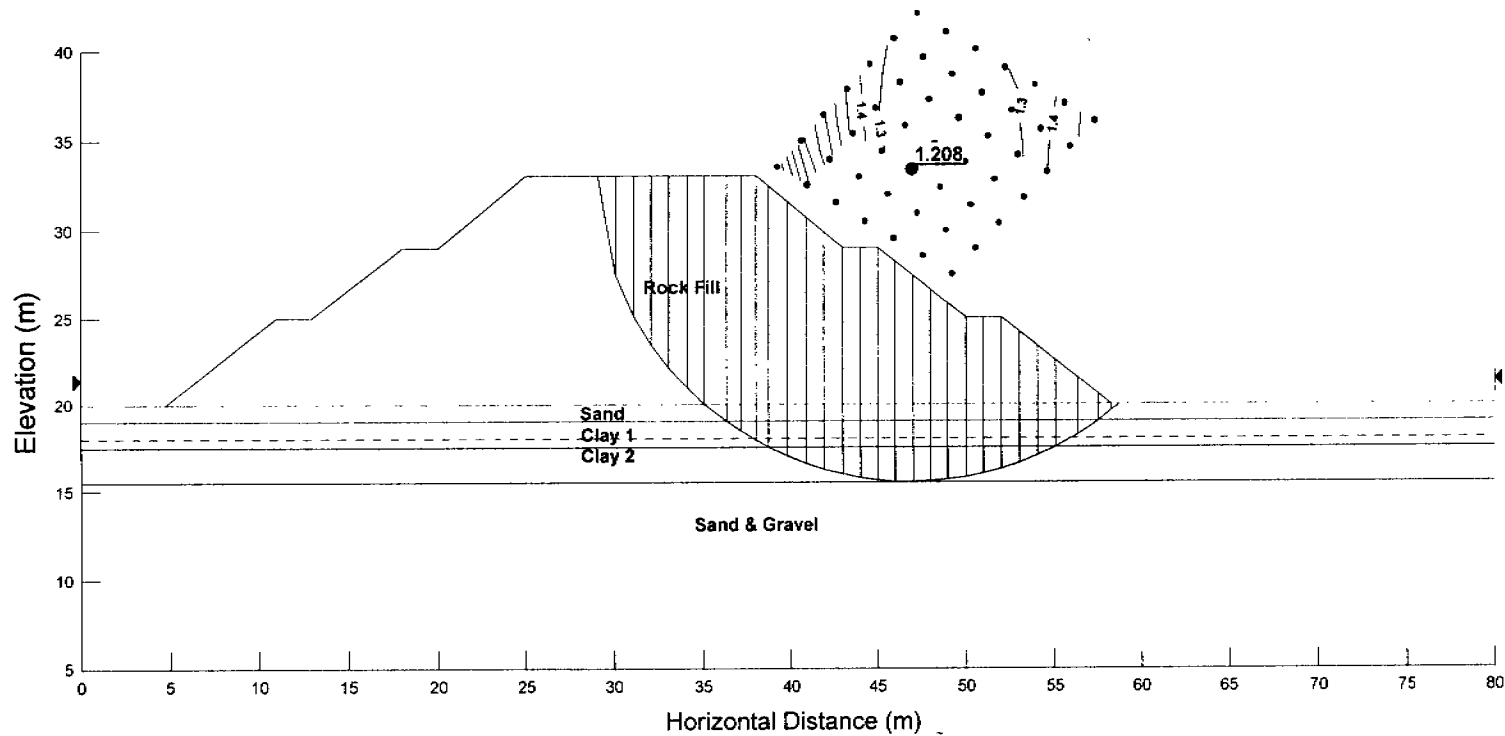
Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model S=f(depth)
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Mohr-Coulomb
 Unit Weight 19
 Cohesion 35
 Phi 0

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 13 metre embankment height, 1.25:1 side slopes
 5 metre high and 4 metre high, 2 metre long benches
 N_S13H.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

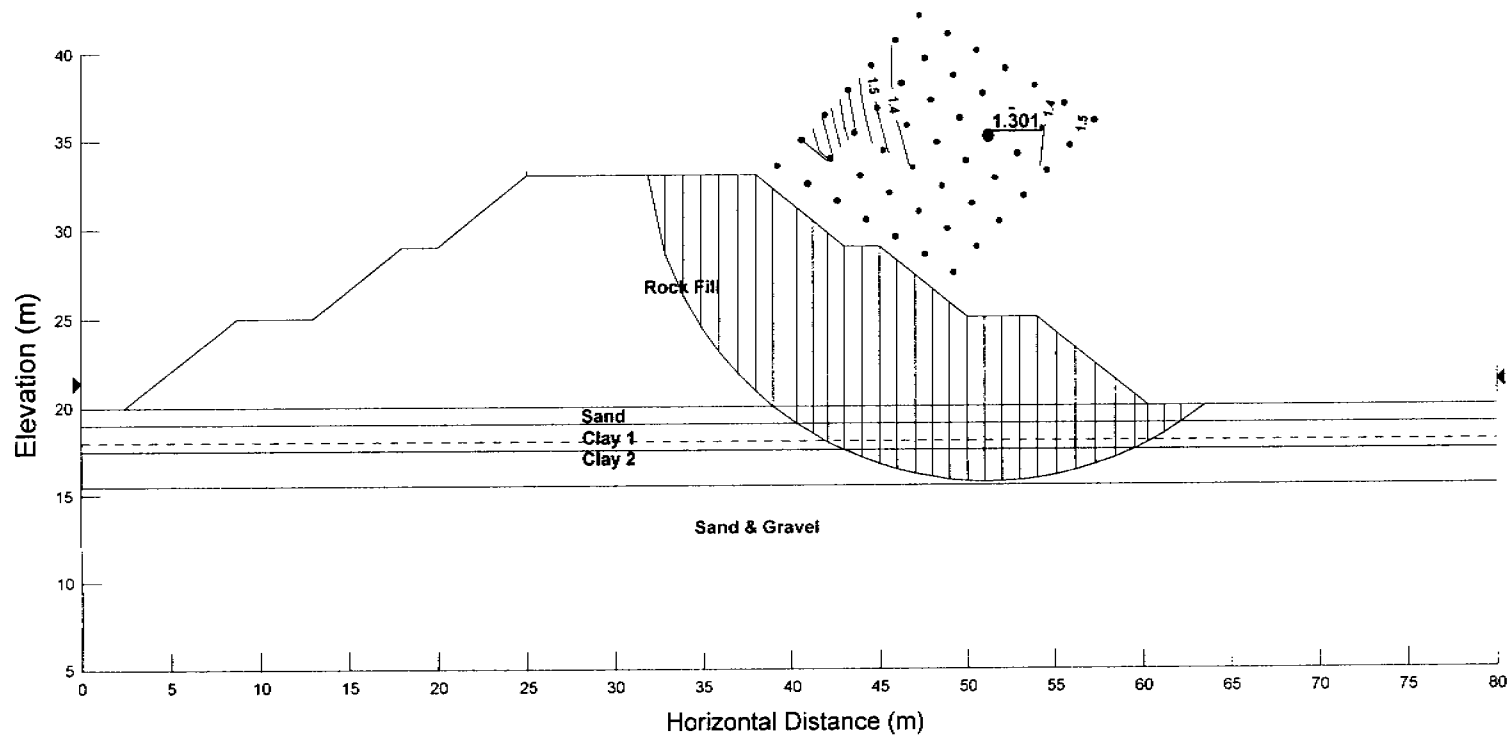
Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model $S=f(\text{depth})$
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Mohr-Coulomb
 Unit Weight 19
 Cohesion 35
 Phi 0

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

Slope Stability - Total Stress Analysis
 Trout Creek - Highway 11 (F-98179-B/G)
 Northbound Lane, South Abutment
 13 metre embankment height, 1.25:1 side slopes
 5 metre high, 4 metre long and 4 metre high, 2 metre long benches
 N_S13H1.SLP



Rock Fill
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 42

Sand
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 32

Clay 1
 Soil Model S=f(depth)
 Unit Weight 19
 Cv 60
 Rate of Increase -16.67
 Cv - Minimum 35
 Ch/Cv Ratio 1

Clay 2
 Soil Model Mohr-Coulomb
 Unit Weight 19
 Cohesion 35
 Phi 0

Sand & Gravel
 Soil Model Mohr-Coulomb
 Unit Weight 20
 Cohesion 0
 Phi 39

OVERSIZE DRAWING

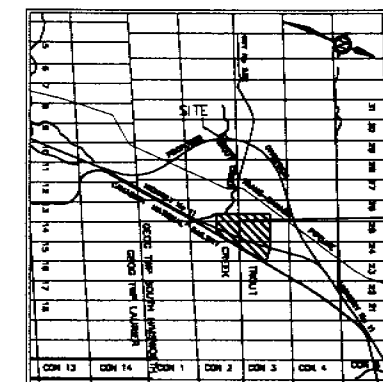
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No 509-11/174-0
DRAWING No S1
CONT No
WP No 768-93-01

PROPOSED CROSSING
TROUT CREEK AND
HIGHWAY 11 SBL

SHEET
1 OF 1

Marshall Macklin Monaghan
Limited
Consulting Engineers - Surveyors - Planners



KEY PLAN
N.T.S.

GENERAL NOTES:

1. CLASS OF CONCRETE
FOOTING 30 MPa
REMAINDER 50 MPa (HPC)
2. CLEAR COVER TO REINFORCING STEEL
FOOTINGS 100±25
DECK: TOP 70±20
BOTTOM 40±20
REMAINDER UNLESS OTHERWISE NOTED 70±20
3. REINFORCING STEEL
REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH PREFIX S DENOTES STAINLESS STEEL BARS.
TENSION LAP LENGTHS NOT INDICATED ON CONTRACT DRAWINGS SHALL BE CLASS B.
HOOKS AND BENDS FOR REINFORCING STEEL SHALL BE DETAILED ACCORDING TO CHBDC-91 UNLESS SHOWN OTHERWISE. THE FOLLOWING SHALL APPLY:
(a) STANDARD HOOKS WITH MINIMUM BEND DIAMETERS SHALL BE USED FOR STIRRUPS AND TIES, ACCORDING TO CLAUSE B-14.1.
(b) OTHER BARS HAVE STANDARD HOOKS WITH BEND DIAMETERS ACCORDING TO CLAUSE C8-14.1.
4. CONSTRUCTION NOTES
THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESSES FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.

APPLICABLE STANDARD DRAWINGS

OPSD 3906.02 BRIDGE DECK WATERPROOFING
OPSD 3906.03 WATERPROOFING DETAILS
OPSD 902.09 EMBEDDED CONNECTION FOR NEW STRUCTURES
OPSD 3501.00 GRANULAR BACKFILL REQUIREMENTS
OPSD 4010.00 GUIDERAIL AND CHANNEL ANCHORAGE
OPSD 3912.00 LIGHTING POLE BASE DETAILS

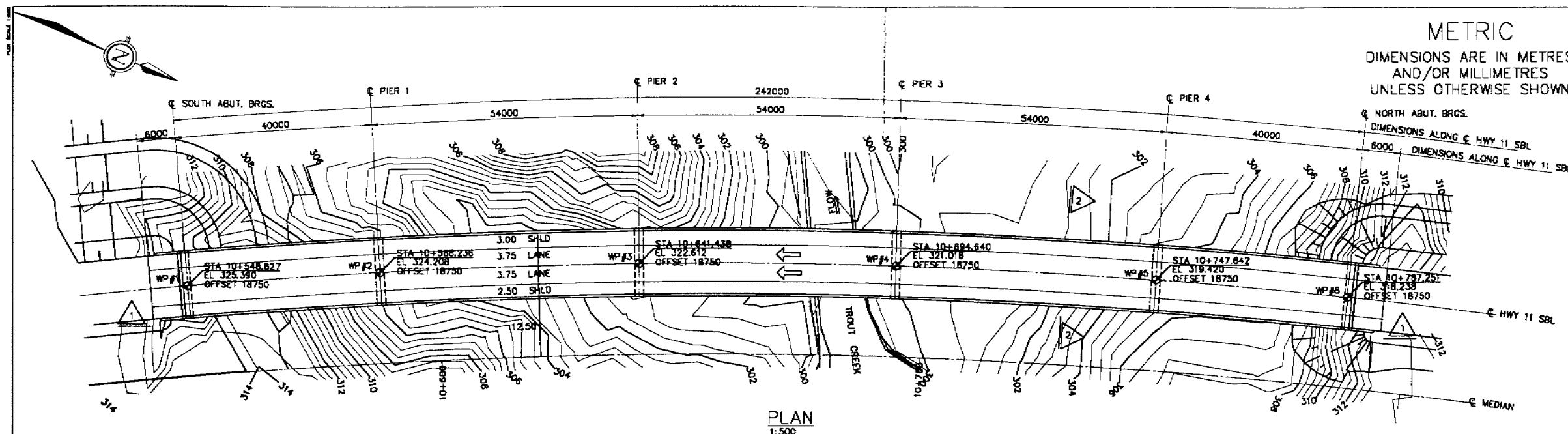
DRAWING LIST

- S1 GENER ARRANGEMENT
- S2 BOREHOLE LOCATIONS & SOIL STRATA
- S3 FOUNDATION LAYOUT & FOOTING REINF.
- S4 NORTH ABUTMENT
- S5 SOUTH ABUTMENT
- S6 WINGWALLS
- S7 PIER 1
- S8 PIER 2
- S9 PIER 3
- S10 PIER 4
- S11 STRUCTURAL STEEL I
- S12 STRUCTURAL STEEL II
- S13 STRUCTURAL STEEL III
- S14 STRUCTURAL STEEL IV
- S15 DECK DETAILS
- S16 DECK REINFORCEMENT I
- S17 DECK REINFORCEMENT II
- S18 DECK REINFORCEMENT III
- S19 JOINT ANCHORAGE AND ARMOURING
- S20 BARRIER WALL W/O RAILING PERFORMANCE LEVEL 3
- S21 6000mm APPROACH SLAB
- S22 AS CONSTRUCTED ELEV. & DIM.
- S23 STANDARD DETAILS
- S24 ELECTRICAL EMBEDDED WORK
- S30 QUANTITIES STRUCTURE I
- S31 QUANTITIES - STRUCTURE II

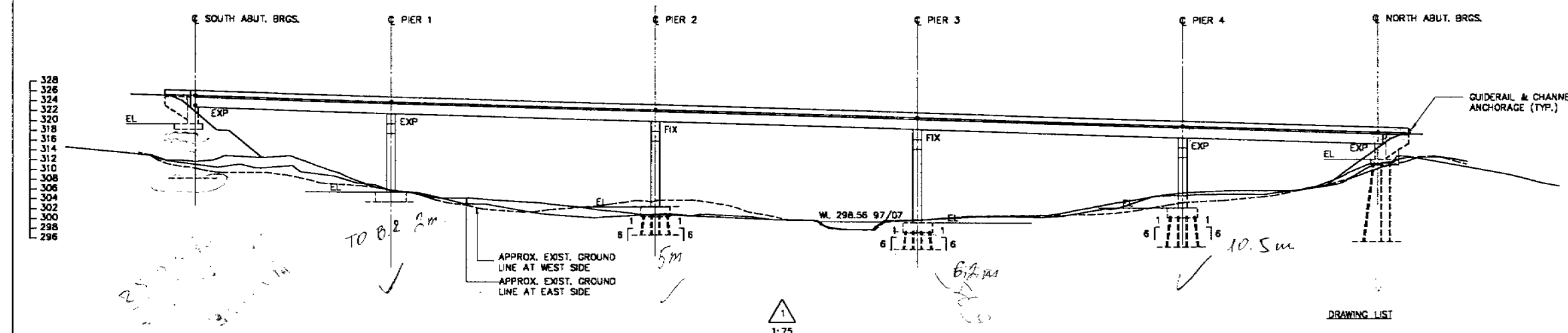
WORKING POINTS				
WP	T/P ELEV.	HWY 11 SBL STATION	NORTHING	EASTING
1				
2				
3				
4				
5				
6				

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	N.E. CHK.	CODE	LOAD	DATE JULY 1998
DRAWN	S.M. CHK.	SITE	STRUCT.	SCHEME DWG 51

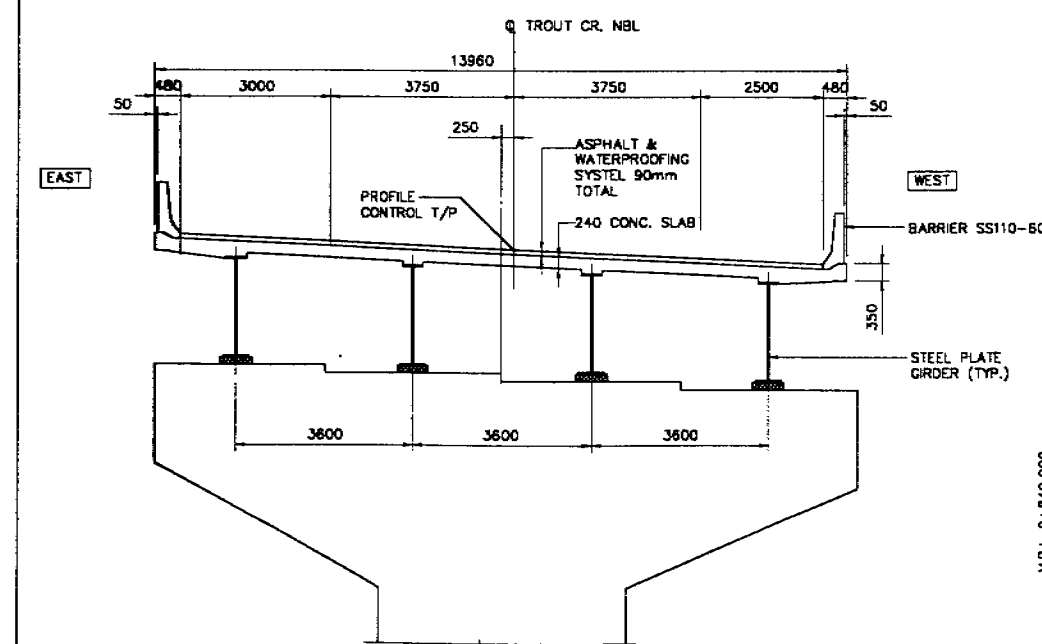
DATE PLOTTED: 10:43 MAR 8 1999



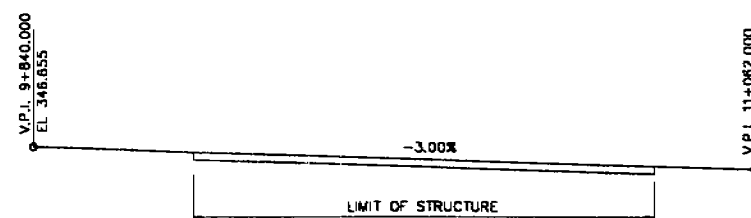
PLAN
1:500



1
1:75



2
1:75



PROFILE OF HIGHWAY 11 SBL
N.T.S.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

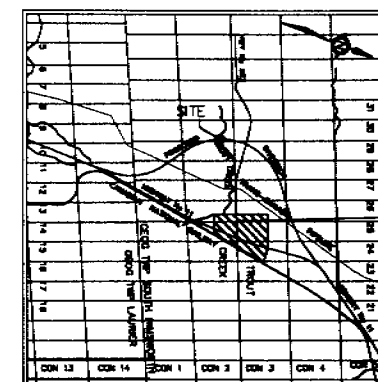
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No 509-11/174-0
DRAWING No S1
CONT No
WP No 768-93-01

PROPOSED CROSSING
TROUT CREEK AND
HIGHWAY 11 NBL

SHEET
1 OF 1

Marshall Macklin Monaghan
Limited
Consulting Engineers - Surveyors - Planners



KEY PLAN
N.T.S.

GENERAL NOTES:

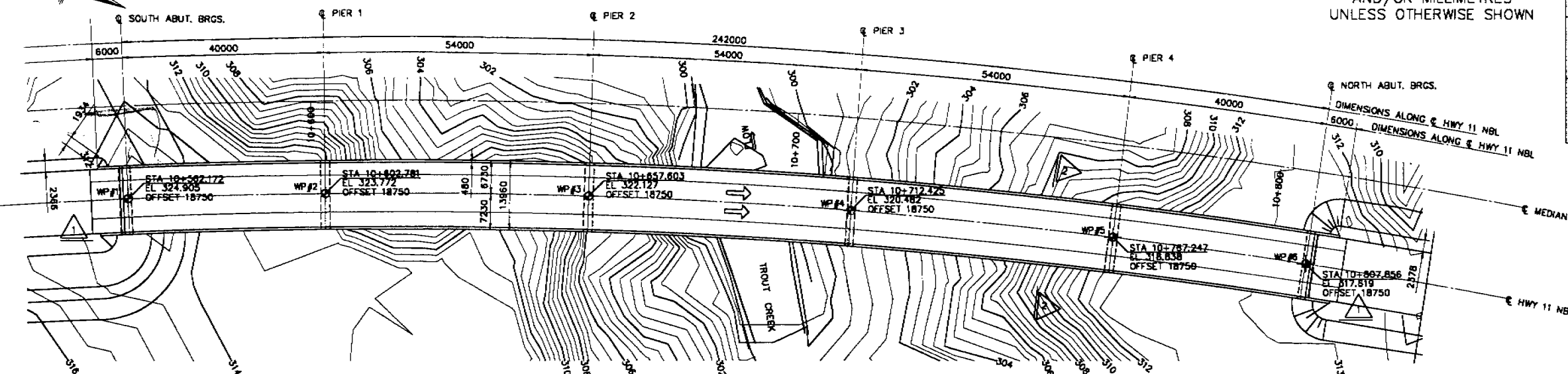
- CLASS OF CONCRETE
FOOTING 30 MPa
REMAINDER 50 MPa (HPC)
- CLEAR COVER TO REINFORCING STEEL
FOOTINGS 100±25
DECK: TOP 70±20, BOTTOM 40±20
REMAINDER UNLESS OTHERWISE NOTED 70±20
- REINFORCING STEEL
REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH PREFIX S DENOTES STAINLESS STEEL BARS.
TENSION LAP LENGTHS NOT INDICATED ON CONTRACT DRAWINGS SHALL BE CLASS B.
HOOKS AND BENDS FOR REINFORCING STEEL SHALL BE DETAILED ACCORDING TO OHBDC-91 UNLESS SHOWN OTHERWISE. THE FOLLOWING SHALL APPLY:
(a) STANDARD HOOKS WITH MINIMUM BEND DIAMETERS SHALL BE USED FOR STIRRUPS AND TIES, ACCORDING TO CLAUSE 8-14.1.
(b) OTHER BARS HAVE STANDARD HOOKS WITH BEND DIAMETERS ACCORDING TO CLAUSE 8-14.1.
- CONSTRUCTION NOTES
THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESSES FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.

APPLICABLE STANDARD DRAWINGS

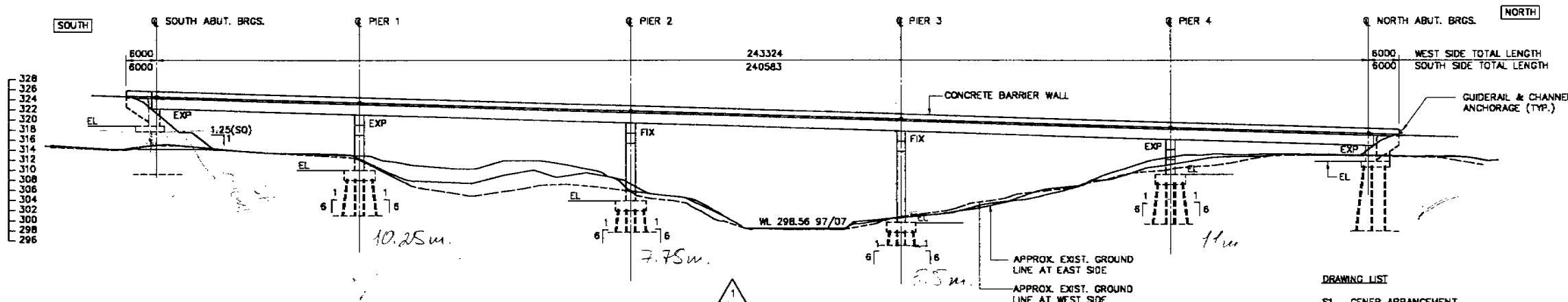
- OPSD 3908.02 BRIDGE DECK WATERPROOFING
OPSD 3908.03 WATERPROOFING DETAILS
OPSD 902.09 EMBEDDED CONNECTION FOR NEW STRUCTURES
OPSD 3501.00 GRANULAR BACKFILL REQUIREMENTS
OPSD 4010.00 GUIDERAIL AND CHANNEL ANCHORAGE
OPSD 3912.00 LIGHTING POLE BASE DETAILS

DATE	BY	DESCRIPTION
DESIGN N.E. CHK.	CODE	LOAD
DRAWN S.M. CHK.	SITE	STRUCT. SCHEME
		DATE JULY 1998
		DWG S1

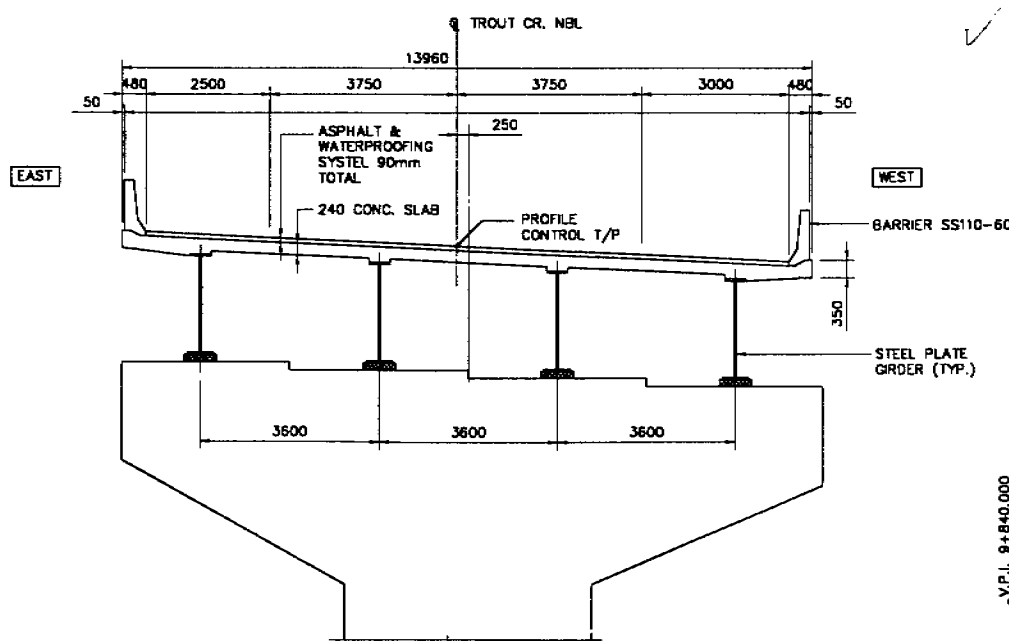
DATE PLOTTED: 10:43 MAR 8 1999



PLAN
1:500



1
1:75



WP	T/P ELEV.	HWY 11 NBL STATION	NORTHING	EASTING
1	324.915	10+562.172	5 091	315
2	323.772	10+602.781	5 091	315
3	322.127	10+657.603	5 091	315
4	320.482	10+712.425	5 091	315
5	318.838	10+767.247	5 091	315
6	317.819	10+807.856	5 091	315

PROFILE OF HIGHWAY 11 NBL
N.T.S.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

G.I.-30 SEPT. 1976

DOCUMENT MICROFILMING IDENTIFICATION

GEOCREs No. 51E-178/31E-179

DIST. 54 REGION

W.P. No. 774-93-00 (c)

CONT. No.

W. O. No.

STR. SITE No. 44-371

HWY. No. 11

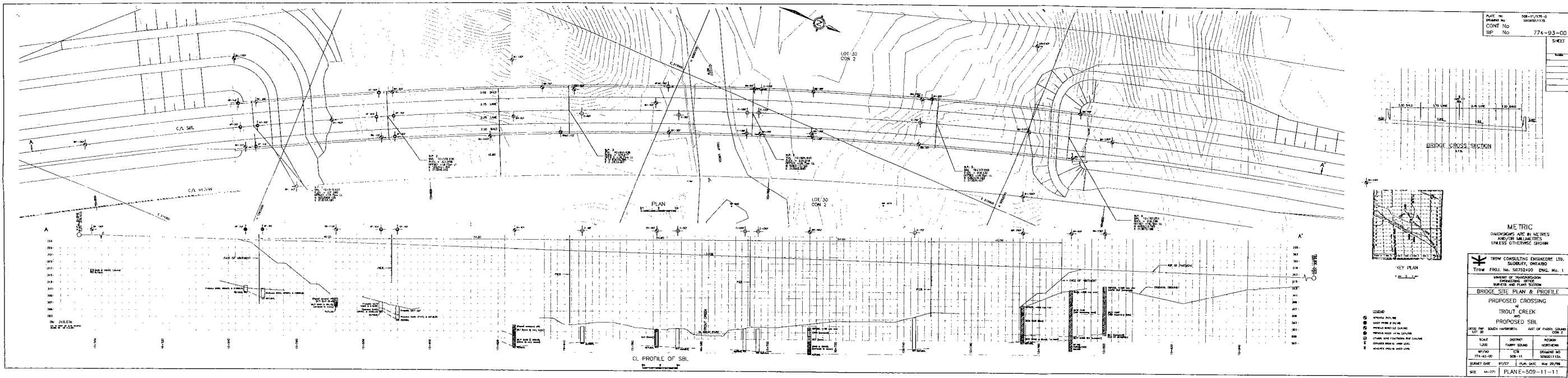
LOCATION Trout CREEK, NBL + SBL

WATER CROSSING

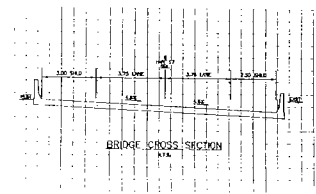
No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

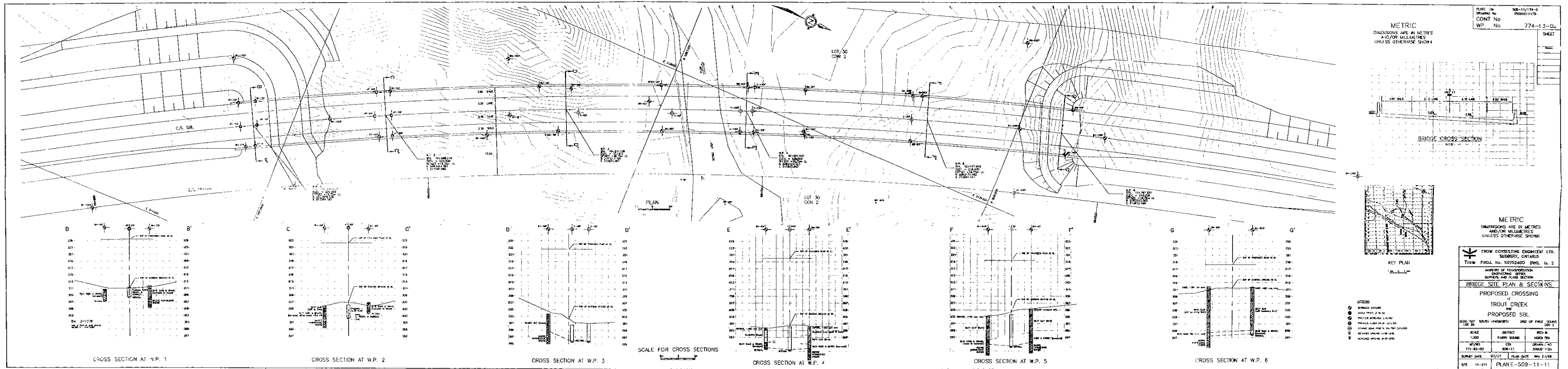


PAGE No. 774-93-00
CONT No. 1
SHEET 1



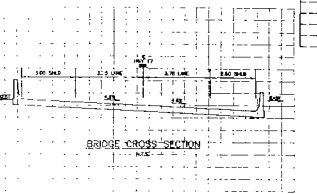
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

TROW CONSULTING ENGINEERS LTD. SUDBURY, ONTARIO			
Trow PROJ. No. 50732400 ENG. No. 1			
MINISTRY OF TRANSPORTATION ONTARIO SURVEY AND PLANT SECTION			
BRIDGE SITE PLAN & PROFILE			
PROPOSED CROSSING AT TROUT CREEK PROPOSED SBL			
DATE PREP.	SOURCE MATERIALS	DATE OF FIELD SURVEY	COM. J.
1/20/00	1/20/00	1/20/00	
SCALE	DISTRICT	REGION	
1:200	PLANT SECTION	ONTARIO	
BY/AD	CHK	DATE/NO	
774-93-00	508-11	50801111A	
DATE/CHK	BY/CHK	DATE/CHK	
6/1/00	6/1/00	6/1/00	
SHEET 1 OF 1			



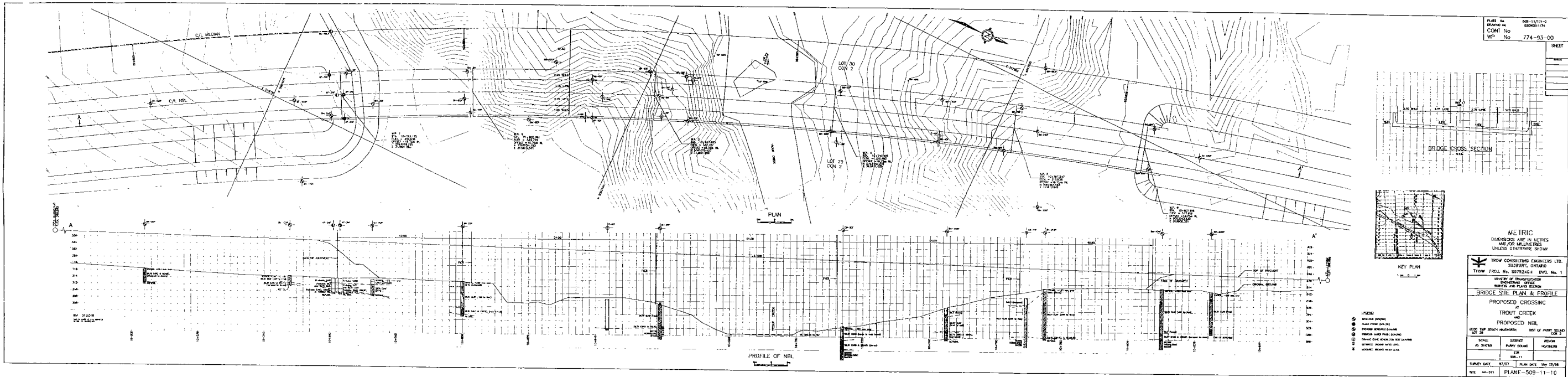
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DATE: 08-11/75-6
DRAWING No: 080011175
CONT No: 774-13-01
SHEET: 1

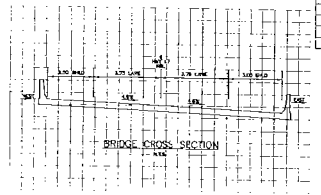


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

TROW CONSULTING ENGINEERS LTD. SUSSEX, ENGLAND			
TROW PROJ. No. 50752460 DWG. No. 2			
MINISTRY OF TRANSPORTATION CONSTRUCTION, 2000 SUSSEX AND FLEET			
BRIDGE SITE PLAN & SECTIONS			
PROPOSED CROSSING			
TROUT CREEK PROPOSED SBL			
SHEET 1 OF 2			
SCALE	DATE	DESIGNER	CHECKED
1:100	08-11	08-11	08-11
SHEET 1 OF 2	08-11	08-11	08-11
SITE: 44-371 PLANE: 509-11-11			



PLAN No. 608-11/71-0
SHEET No. 0000011174
CONT No. 774-93-00



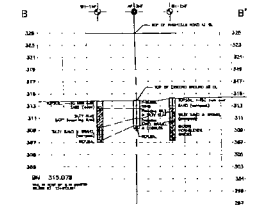
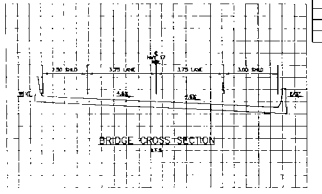
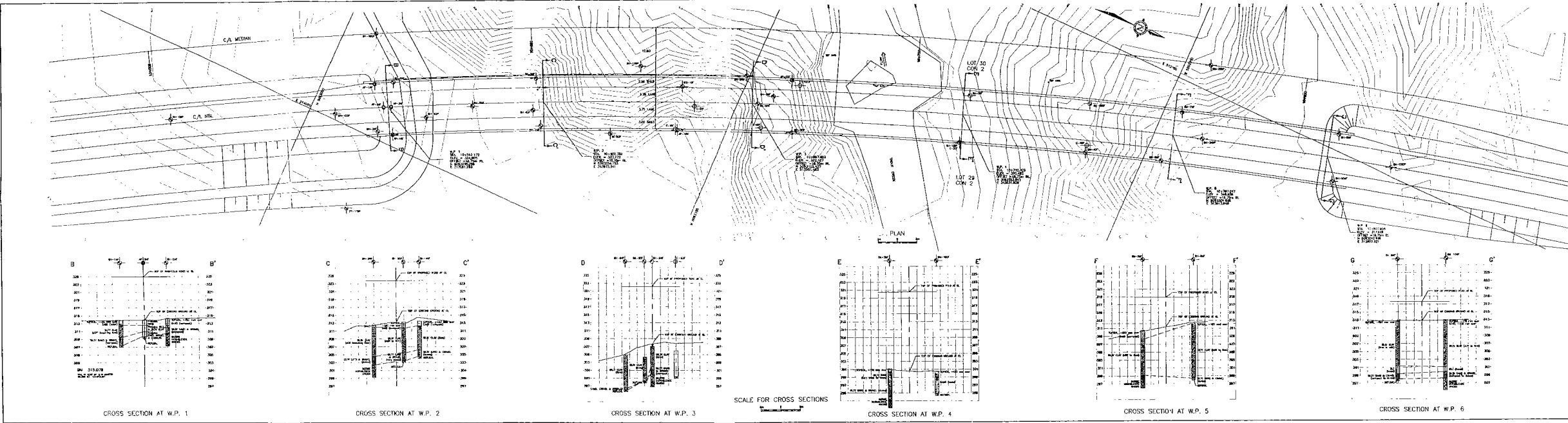
METRIC
DIMENSIONS ARE IN METRES
UNLESS OTHERWISE SHOWN

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
PROJ. NO. 507/24-0 (PWS. No. 1)

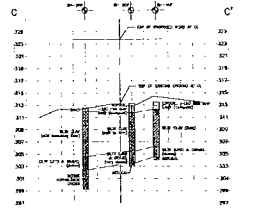
BRIDGE SITE PLAN & PROFILE
PROPOSED CROSSING
AT
TROUT CREEK
PROPOSED NB

SCALE: AS SHOWN
SUBJECT: PLANNING
DRAWN: MTH/STW
CHECKED: JCK
DATE: 02-11

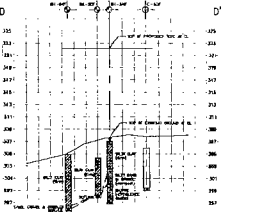
SURVEY DATE: 07/97
PLAN DATE: May 20/98
SHEET: 44-371
PLANE-508-11-10



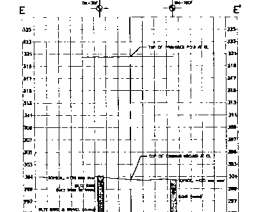
CROSS SECTION AT W.P. 1



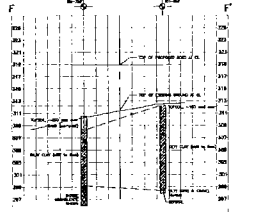
CROSS SECTION AT W.P. 2



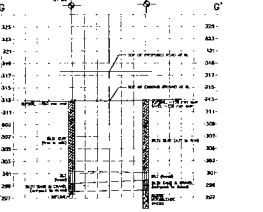
CROSS SECTION AT W.P. 3



CROSS SECTION AT W.P. 4



CROSS SECTION AT W.P. 5



CROSS SECTION AT W.P. 6

SCALE FOR CROSS SECTIONS

PLATE No. 509-11/174-0
CONT No. 774-93-00
WP No. 774-93-00

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

FROM CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
PROJ. No. 509/24-04 DWS, No. 2

BRIDGE SITE PLAN & SECTIONS
PROPOSED CROSSING
TROUT CREEK
PROPOSED NBL

SCALE: AS SHOWN
DISTANCE: 1000 METRES
DATE: 1977
PLAN DATE: MAY 28/79

SHEET 44-101 PLANE-509-11-10