Trow

Foundation Investigation Report
Highway Platform Widening, Highway 11
Station 11+350 to Station 11+450,
Township of Chamberlain
W.P. 109-98-00
MTO District 53, New Liskeard

Prepared for:

MINISTRY OF TRANSPORTATION
447 McKeown Avenue, Suite 301
NORTH BAY, Ontario
P1B 9S9
and
D.F. ELLIOTT CONSULTING ENGINEERS LTD.
36 Lakeshore Road, Box 2525
NEW LISKEARD, Ontario
P0J 1P0

Trow Consulting Engineers Ltd.

1074 Webbwood Drive
Sudbury, Ontario P3C 3B7
Telephone: (705) 674-9681
Facsimile: (705) 674-8271

Geocres No. 41P-28
S08131G/K4
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Part 1 Foundation Investigation

1.0 INTRODUCTION

This report presents the results of a geotechnical foundation investigation completed by Trow Consulting Engineers Ltd. ("Trow") for a proposed highway platform widening and a subsequent grade raise of up to approximately 200 mm. Originally, the embankment was to be widened and the existing culvert was to be extended to accommodate a proposed north bound passing lane on Highway 11. The proposed platform widening and grade raise is located near Englehart, Ontario, at approximately Station 11+400, Chamberlain Township, Ministry of Transportation of Ontario ("MTO") District 53 (New Liskeard).

The original north bound passing lane was proposed from Station 10+220 (Dack Township) to 13+390 (Chamberlain Township). Trow issued to the MTO a Draft Foundation Investigation Report (Trow No. S08131G/F), dated November 13, 2000, addressing the original proposed widening and culvert extension. Since issuing the above-mentioned draft report, the limits for the north bound passing lane were altered. The new limits of the passing lane are from Station 10+800 (Dack Township) to Station 11+200 (Chamberlain Township). As a result of reducing the length of the passing lane, the original Draft Foundation Investigation Report issued by Trow (Trow No. S08131G/F) was revised accordingly. In addition, the following investigation was undertaken along the new limits to bring the existing shoulders and roundings to current design specifications.

1.1 Site Description

The site is located in the Township of Chamberlain, on Highway 11, approximately 3.4 km north of the junction of Highways 11 and 560 (near the Town of Englehart), in the District of Timiskaming. The approximate stationing of the site is from Sta. 11+350 to 11+450, Chamberlain Township, with the centre of the valley located at about Sta. 11+400, as indicated on the Site Plan, Drawing 4 in Appendix I.

In the vicinity of the site, the terrain is generally flat on either side of the stream bed. The surrounding area contains a few mature trees (predominantly deciduous) located along the edges of the adjacent farmer's fields. Single family dwellings and various farm buildings are situated on the northeast and southwest quadrants of the site.

The stream bed has steep walls with shrubs and grasses as the primary vegetative cover. The side wall slope of the stream bed on the right (east) side of the highway embankment ranges from 1.75H:1V to 2.5H:1V. The width of the stream bed on the right (east) side is approximately 40 m at the top, and about 5 m at the base, with a maximum depth of about 8 m. The river bed is straight in the immediate vicinity of the highway embankment and intersects the centreline of the highway with a skew of approximately 20°.

The stream flows to the east with an average depth of 250 mm under normal flow conditions. The current culvert is a 3400 mm diameter structural plate pipe constructed in 1996 by tunnelling into the side of the embankment. The original contract drawings state that the culvert diameter was to be 3200 mm, however, field measurements undertaken by D.F. Elliott Consulting Engineers Ltd. ("D.F. Elliott") suggest that the actual culvert diameter may be 3400 mm. Prior to 1996, there was a concrete box culvert, approximately 3930 mm wide by 1620 mm high, located about 7 m south of the plate pipe. Upon completion of the steel plate pipe culvert, the concrete box culvert was filled with non-shrink grout, and abandoned in place. The concrete box culvert was abandoned as a result of centreline cracking of the culvert. A portion of the plan view supplied with the contract drawings for the culvert replacement (Contract 50-96-1041) was copied and included as Drawing 4, in Appendix I.

The highway crosses the valley via an earth fill embankment, where the culvert is located in the centre of the valley. The construction date of the embankment is unknown, however, the current highway alignment is known to be in existence for the last 50 years. Numerous maintenance asphalt patches were placed over the roadway platform to accommodate settlement of the embankment. The side slopes of the existing embankment are approximately 2H:1V, and covered with grasses and small shrubs. As part of the culvert replacement work in 1996, rip rap protection was placed at the lower portion of the side slope in the vicinity of the new pipe culvert. Road side ditches that flow along both sides of the highway empty into the stream from both sides of the embankment. Rip rap was also placed along these ditches as part of the reparations completed in 1996.

In addition to Drawings 1, 2, 3 and 4 (from project SO 8131G/G, DWG. No. 3), four (4) photographs depicting the described site conditions are provided in Appendix I.

1.2 Geological Setting

According to OGS Map 2555, the bedrock beneath the site is a foliated tonalite suite ranging in composition from tonalite to granodiorite (foliated to massive) that is Neo to Mesoarchean in age. The overburden soils are mainly glaciolacustrine deposits (OGS Map 2543) comprised of silt and clay with minor amounts of sand. Soil deposition occurred in a low energy environment such as a basin or in quiet water.

1.3 Investigative Procedures

1.3.1 General

The following section of the report describes the investigative procedures adopted for the geotechnical assessment of the proposed highway platform widening. The procedures used during the investigation and the properties of the overburden soils obtained from in-situ and laboratory testing methods are described below.

1.3.2 Previous Investigation

Trow previously completed a geotechnical investigation at this site (Trow report S07015G, dated July 29, 1996) for the MTO with respect to replacing the original concrete box culvert with the existing steel plate culvert using tunnelling methods. Two boreholes (BH-1 and BH-2) were situated at the culvert location as part of this previous investigation. The boreholes were advanced on July 11, 1996, from the top of the embankment, through the embankment, and into the underlying native soil in an effort to determine the feasibility of tunnelling through the embankment. Findings obtained from the previous investigation are referenced in this report.

The previous boreholes were advanced using a track mounted CME-55 drill, equipped with solid and hollow stem augers, supplied by Master Soils Investigations. Soil samples were obtained by using a 51 mm OD split spoon sampler in conjunction with standard penetration tests at approximately 1.5 m intervals. The standard penetration test 'N' values, together with the blows from dynamic cone penetration tests, were recorded during advancement of the boreholes.

Two undisturbed, thin walled "Shelby" tube samples (50 mm diameter), were obtained from the grey silty clay deposit. Both boreholes were used to conduct field vane tests in the cohesive soils to measure the in-situ undrained shear strength. Torque measurements were made using two calibrated scales on a calibrated lever arm threaded to the drill rods. The field vane had dimensions of 152 mm long by 70 mm diameter, not including the 45° point.

All of the recovered soil samples were sealed in the field to prevent moisture loss and transported to Trow's Sudbury laboratory for detailed visual examination, routine moisture content determination and classification.

Details of the soil and groundwater conditions encountered in the boreholes are shown on the Record of Borehole Logs in Appendix II. The borehole logs were reformatted from those presented in the original report (Trow report S07015G) to conform with the format currently utilized by the MTO. However, the information on the logs remains the same. The additional standard data sheet, included with the logs, provides further details on soil descriptions for classification purposes. The locations of the previous boreholes are shown on Drawing 1, Site Plan (Appendix I). The borehole positions were originally referenced to the nearby guard rail posts, and as a result, no stations or UTM co-ordinates were obtained. The boreholes were positioned on the current site plan using the guard rail posts locations supplied with the current survey information. This approach to obtaining UTM co-ordinates assumes that the guard rail post positions have not changed between the two investigations. Furthermore, the original report assumes an elevation of 100.0 m for the top of the asphalt (at the centreline of highway) and at the centre of existing concrete box culvert. The borehole depths were referenced to this datum. Within the development of the current centreline profile and Drawings 1 and 2, it was assumed that this elevation had not varied appreciably between the two investigations, and the borehole elevations were correlated utilizing the survey information supplied by the prime consultant, D.F. Elliott, at this point.

1.3.3 Current Investigation

The current field investigation for the proposed culvert extension was carried out on April 28, 2000, and September 19, 2000. The investigation consisted of three boreholes advanced through the overburden soils, at the toe of the existing embankment. Borehole BH-21A, drilled on April 28, 2000, was advanced utilizing a bombardier mounted CME-55 drill, equipped with solid and hollow stem augers, supplied by a soils drilling contractor, Colbar Resources. Borehole BH-20 was advanced using a tripod mounted Winki drill, also supplied by Colbar Resources. Borehole BH-21B was advanced later, on September 19, 2000, next to BH-21A utilizing a CME-55 drill, supplied by Marathon Drilling Ltd. Soil samples were obtained by using a 51 mm OD split-spoon sampler in conjunction with standard penetration tests at approximately 0.75 mm and 1.5 m intervals. The standard penetration test 'N' values, together with the blow counts from dynamic cone penetration tests, were recorded and used to assess the compaction of the overburden soils.

One undisturbed, 50 mm diameter, thin walled "Shelby" tube sample was obtained in the cohesive soil deposit from Borehole BH-21A, in addition to two 70 mm diameter thin walled "Shelby" tube samples from Borehole BH-21B. Field vane measurements were completed in both boreholes throughout the cohesive soil stratum to establish the in-situ undrained shear strength. Torque was measured by using two calibrated scales on a calibrated lever arm threaded to the drill rods. The field vane had dimensions of 152 mm long by 70 mm diameter, not including the 45° point. Dynamic cone penetration measurements were made from the bottom of the sampled portion of Borehole BH-21A down to refusal. Results from dynamic cone penetration tests indicate changes in soil denseness with respect to increasing depth.

All of the recovered soil samples were logged and then sealed in the field to prevent moisture loss, and transported to Trow's Sudbury laboratory for detailed visual and tactile examination, identification, and laboratory testing.

After completing the boreholes, the water levels were measured and then the boreholes were backfilled with auger cuttings. Details of the soil and groundwater conditions encountered in the boreholes are given on the borehole logs in Appendix II. An additional standard data sheet included with the logs provides further details on soil descriptions for classification purposes. The borehole locations are presented on Drawings 1 and 2 (Appendix I). The locations and surface elevations of the boreholes were established by survey crews from D.F. Elliott.

1.3.4 Pavement Design Investigation

Shallow probeholes were advanced through the surface of the existing roadway as part of the Geotechnical/Pavement Investigation. The geotechnical borehole logs of the four probeholes relevant to this foundation investigation are included in Appendix II. Probehole positions were established by pacing from station markings painted on the road surface. The probeholes were advanced using a truck mounted CME 45 drill rig using solid stem augers. Depths were measured down the probehole upon completion. Auger samples were taken from the granulars in the road base and the underlying native materials from selected probeholes. All of the

recovered soil samples were sealed to prevent moisture loss and transported to Trow's Sudbury laboratory for detailed visual examination and classification.

1.3.5 Laboratory Program

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

- Natural moisture content determinations (LS 701);
- Grain size distribution analyses (LS 702);
- Atterberg limits (LS 703 and LS 704);
- 1-dimensional consolidation test;
- Laboratory vane tests.

The grain size distribution curves for selected soil samples are presented on Figure 1. The results of Atterberg Limit tests are shown on the Plasticity Chart on Figure 2. Shear strength, moisture contents and Atterberg limits are plotted with respect to depth on Figure 3. The consolidation test results are shown on Figures 4 and 5. Figures 1 to 5 are provided in Appendix III.

1.4 Subsurface Conditions

Soil sections, longitudinal, as well as at the centreline of the culvert (centre of valley), are plotted on Drawings 1 and 2. Drawing 2 also contains cross sections of the highway embankment at Stations 11+350 (approximately 50 m south of the culvert) and 11+450 (approximately 50 m north of the culvert). Based on the borehole data, the following soil types were encountered at this site in descending order:

- Fill (Asphalt, Sand and Gravel);
- Fill (Silt);
- Alluvial Clayey Silt;
- Silty Clay.

Characteristics of the above soils observed in the boreholes and probeholes are summarized below.

1.4.1 Fill (Asphalt, Sand & Gravel)

The embankment had asphalt, gravel, and sand layers from the surface of the asphalt (approximate elevation of 210 m) to a depth of about 2.9 m. Boreholes BH-1 and BH-2 advanced from the top of the existing roadway along the shoulders encountered some of these layers. The four geotechnical/pavement probeholes intersected all of the relevant layers in this investigation. A layer of asphalt, 550 mm thick, was followed by a 250 mm thick layer of compact, moist, brown crushed gravel with sand, meeting OPSS Granular "B" specifications. Beneath the Granular "B" fill was a 400 mm thick layer of compact brown medium sand, with a

trace of gravel. The brown sand meets OPSS Select Subgrade Material (SSM) specifications. A second layer of asphalt, 300 mm thick, occurred below the sand. The second asphalt layer was underlain by 800 mm of compacted, moist, brown coarse sand with some silt and gravel. Below the coarse sand was a brown medium sand with gravel, and a trace of silt, meeting OPSS Granular "B" specifications. The brown medium sand had occasional cobble and silt inclusions.

1.4.2 Fill (Silt)

Beneath the upper granulars, Boreholes BH-1 and BH-2 encountered silt fill that was grey in colour with brown staining, in a moist to wet state. The silt fill extended from beneath the granular fill at a depth of approximately 2.9 m to a depth of about 6.0 m to 6.5 m (elevation about 204 m). Samples obtained from the boreholes contained traces of granulars and organics. Also, the samples indicated that the silt was previously disturbed. Random pockets of clay were present. The recovered silt fill samples were similar in composition to the underlying silty clay stratum.

1.4.3 Alluvial Silty Clay

A 1.8 m thick surficial layer of grey alluvial silty clay occurred at BH-20. This borehole was located at the outlet of the existing culvert at the centre of the valley. The alluvial silty clay contained organics with a trace of sand and gravel. This soil unit was generally in a soft condition and was similar in appearance to the underlying silty clay stratum.

1.4.4 Silty Clay

The base unit for all boreholes was a moist grey silty clay with medium to high plasticity. Silt seams were encountered below an approximate elevation of 197 m. These seams (varves) were about 1.0 cm to 3.5 cm thick.

The moisture contents ranged between 25% to 67%, depending on the silt content and consistency of the individual sample. Liquid limits ranged between 39% to 68% with plastic limits between 19% to 23%, resulting in plasticity indices from 20% to 45%. From these results, the silty clay can be classified as having medium plasticity (CI) to high plasticity (CH).

Standard penetration resistance "N" values ranging from 2 to 4 were obtained in the silty clay. In-situ field vane and laboratory shear vane testing, in addition to the SPT values, were used to determine the undrained shear strength. These measurements indicate that the silty clay had a uniform soft/firm consistency, with undrained shear strengths of about 24 kPa to 28 kPa between depths of about 3 m to 23 m. Sensitivity, the measure of peak shear strength to remoulded strength, ranged between 4 and 5, indicating that the clay is moderately sensitive. The undrained shear strength profile, which includes shear strength data from all boreholes, is shown on Figure 3 (Appendix III). The undrained shear strength values measured beneath the existing roadway were not significantly different from the undrained shear strength measured adjacent to the roadway.

Borehole BH-20 was terminated within this silty clay unit at a depth of 5.2 m (elevation of 196.7 metres). Sampling in Boreholes BH-21A and BH-21B was concluded at a depth of 23.5 m (elevation of 181.8 m) within the silty clay unit. A dynamic cone was pushed hydraulically, with little to no resistance, to a depth of 26.8 m below existing grade (elevation of 178.6 m), at which point a dynamic cone penetration value of +69 blows/150 mm was noted. For the purpose of this report, it was assumed that the silty clay stratum extended to the cone refusal elevation of 178.6 m.

A one-dimensional consolidation test was performed on a sample of silty clay extruded from a thin walled Shelby tube. The sample was obtained from Borehole BH-21A at a depth of approximately 6 m (about elevation 199 m). Consolidation results are presented on Figures 4 and 5 (Appendix III). The silty clay material is slightly overconsolidated with a preconsolidation stress of about 160 kPa and an existing overburden stress of approximately 60 kPa. At stress increments of between 20 kPa to 100 kPa above the overburden stress, the coefficient of volume compressibility (m_v) is 0.107 MPa^{-1}. The coefficient of consolidation shown in Figure 5 decreases with increasing stress. At the overburden stress for the sample (~60 kPa), the coefficient of consolidation (c_v) is 8.5 m^2/yr.

1.5 Groundwater Conditions

The groundwater depth in Borehole BH-20 was near the grade level and consistent with the water level observed in the creek (at about elevation 201.9 m). Also, sloughing in the borehole occurred to a depth of 200 mm below existing grade upon completion of drilling. The groundwater table may vary seasonally.

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

Yours truly,

Trow Consulting Engineers Ltd.

A. Zerwer, Ph.D.
Geotechnical Specialist

A.J. Schell, M.Sc., P. Eng.
Branch Manager/Sr. Geotechnical Engineer

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

Encls.

AZ:jol/mto/8131G-K4 Final-Chamberlain Jan. Feb. 5

APPENDIX I

Drawings and Photographs

METRIC

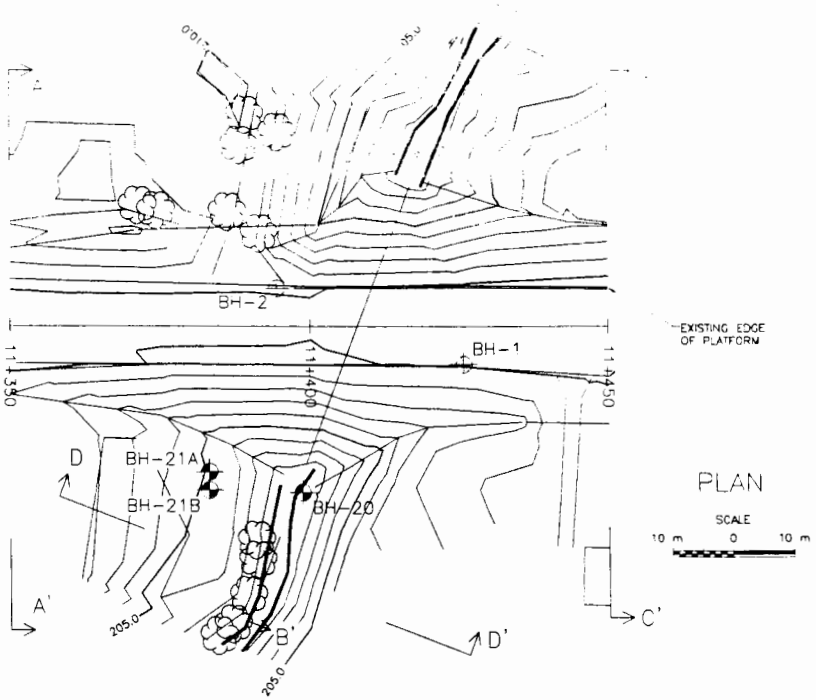
DIMENSIONS ARE IN METRES AND OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
WP No 109-98-00

HIGHWAY PLATFORM WIDENING
STATION 11+350 to 11+450
TOWNSHIP OF CHAMBERLAIN
BOREHOLE LOCATIONS & CENTRELINE PROFILE

SHEET 1 OF 4

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
Trow PROJ. No. SOB131G/K DWG. No. 1



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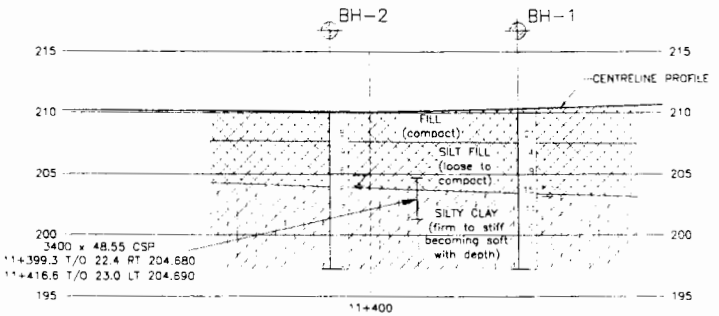

℄ PROFILE OF HIGHWAY 11

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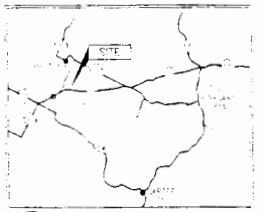

KEY PLAN
NOT TO SCALE

LEGEND

Borehole

Previous Borehole (July/96)

Estimated Water Level

No.	ELEVATION	STATION	OFFSET
BH-1	209.96	11+425.6	6.4 m RT
BH-2	209.94	11+394.3	8.2 m LT
BH-20	201.91	11+398.6	27.4 m RT
BH-21A	205.29	11+382.9	24.0 m RT
BH-21B	205.30	11+382.9	27.0 m RT

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office. Overview information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

DRAWING NOT TO BE SCALED

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DESIGN: J.B. CHK: A.R. MGR:			DATE: A.G. 2001
DRAWN: M.C. CHK:			

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

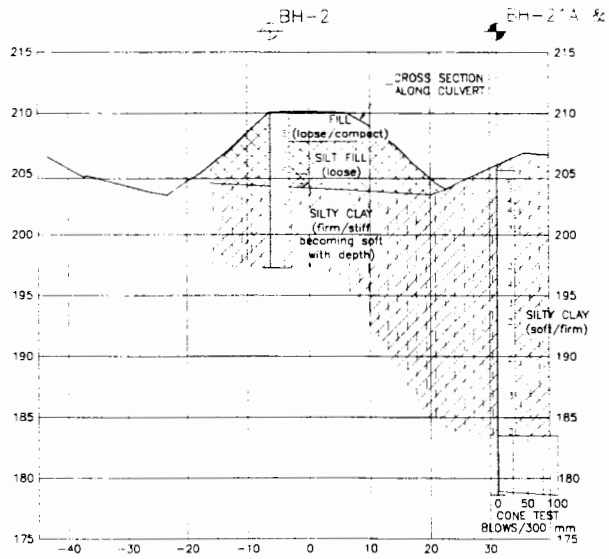
CONT No
WP No 109-98 00

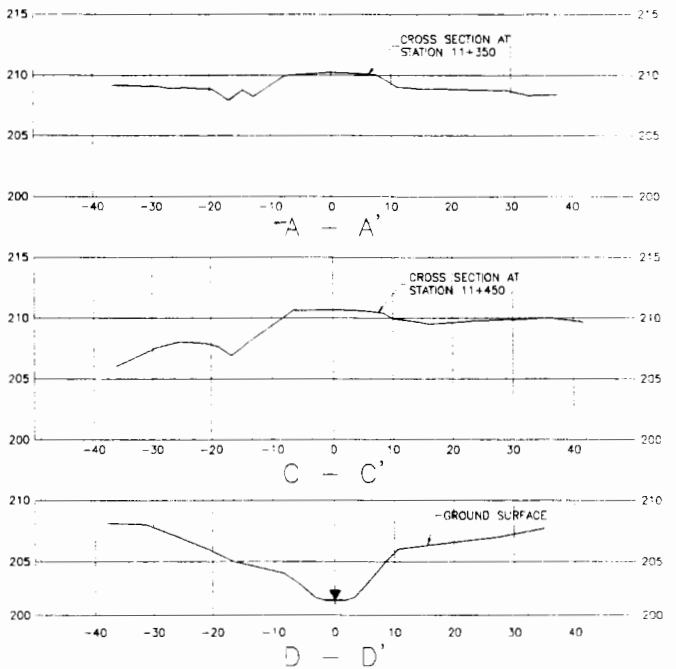
TOWNSHIP OF CHAMBERLAIN

SHEET 2 OF 4

TROW CONSULTING ENGINEERS LTD. SUDBURY, ONTARIO

Trow PROJ. No. 50813(3)/K DWG. No. 2





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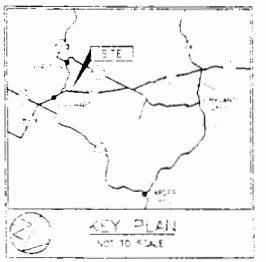

LEGEND

- Borehole
- Previous Borehole (July/95)
- Estimated Water Level

No.	ELEVATION	STATION	OFFSET
BH-1	209.98	11+425.8	8.4 m RT
BH-2	209.94	11+394.3	6.2 m LT
BH-2B	201.91	11+398.6	27.4 m RT
BH-2A	205.29	11+382.9	24.0 m RT
BH-2B	205.30	11+382.9	27.0 m RT

NOTE

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DRAWING NOT TO BE SCALED
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REVISIONS

DATE	BY	DESCRIPTION

DESIGN E.T. CHK CODE DATE AUG. 2001

METRIC

DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN

DIST: 55 HWY: 17

CONT No

WP No 109-98-00

HIGHWAY PLATFORM WIDENING
STATION 11+350 to 11+450
TOWNSHIP OF CHAMBERLAIN
CROSS SECTIONS AT STATIONS
11+375, 11+400 & 11+425

SHEET 3 OF 4

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO

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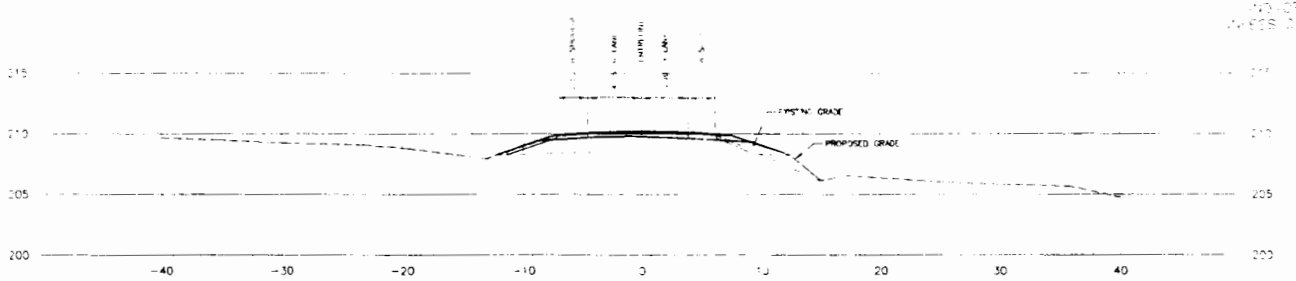

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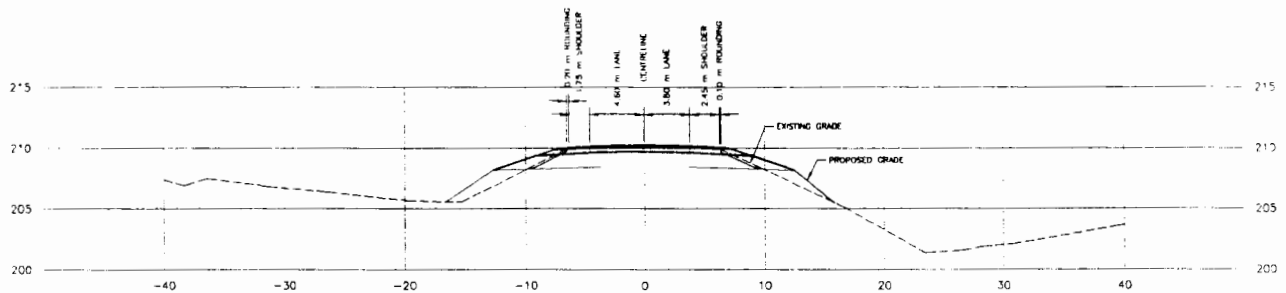

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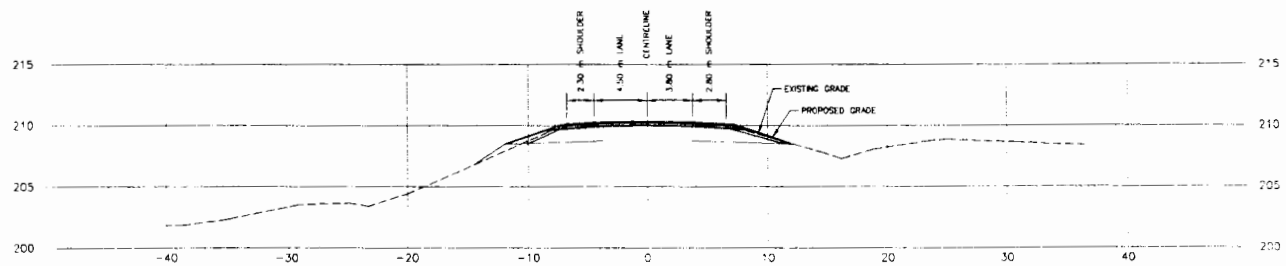

EXISTING & PROPOSED CROSS SECTION AT STATION 11+425

SCALE

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NOTES

1) DRAWING PRODUCED BY REFERENCING DRAWINGS PROVIDED BY D.F. ELLIOT CONSULTING ENGINEERS LTD.

2) DIMENSIONS REFER TO EXISTING ROADWAY.

-= NOTE =-

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

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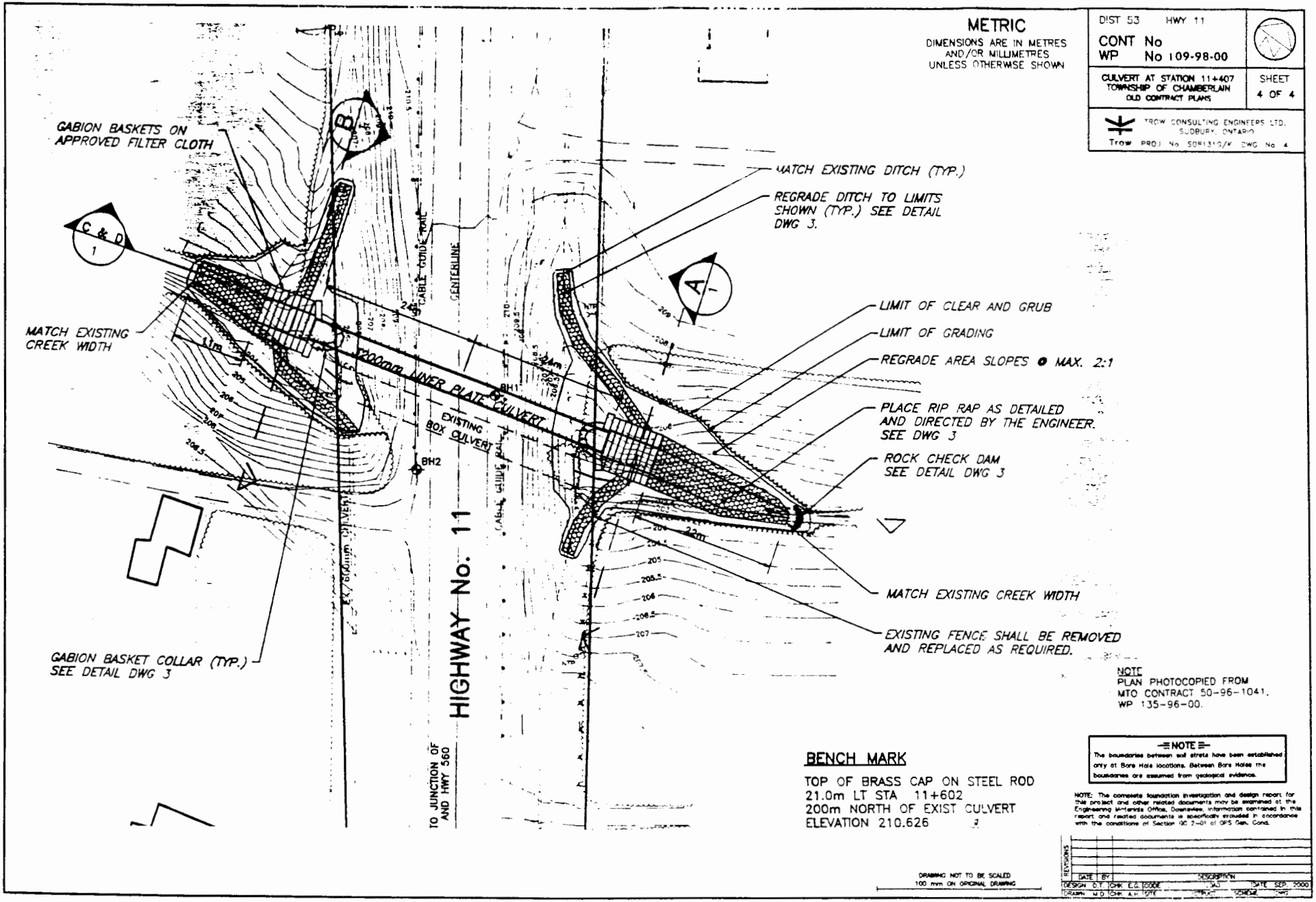
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WP No 109-98-00
CULVERT AT STATION 11+407
TOWNSHIP OF CHAMBERLAIN
OLD CONTRACT PLANS
SHEET 4 OF 4
TROW CONSULTING ENGINEERS LTD. SUDBURY, ONTARIO
Trow PROJ No. SDR1310/K DWG No 4
GABION BASKETS ON APPROVED FILTER CLOTH
MATCH EXISTING DITCH (TYP.)
REGRADE DITCH TO LIMITS SHOWN (TYP.) SEE DETAIL DWG 3.
LIMIT OF CLEAR AND GRUB
LIMIT OF GRADING
REGRADE AREA SLOPES @ MAX. 2:1
PLACE RIP RAP AS DETAILED AND DIRECTED BY THE ENGINEER. SEE DWG 3
ROCK CHECK DAM SEE DETAIL DWG 3
MATCH EXISTING CREEK WIDTH
EXISTING FENCE SHALL BE REMOVED AND REPLACED AS REQUIRED.
MATCH EXISTING CREEK WIDTH
GABION BASKET COLLAR (TYP.) SEE DETAIL DWG 3
1200mm MINER PLATE CULVERT
EXISTING BOX CULVERT
CABLE GUIDE RAIL
CENTERLINE
BH1
BH2
HIGHWAY No. 11
TO JUNCTION OF HWY 560 AND HWY 560
C & D 1
A 1
B 1
NOTE
PLAN PHOTOCOPIED FROM MTO CONTRACT 50-96-1041, WP 135-96-00.
BENCH MARK
TOP OF BRASS CAP ON STEEL ROD
21.0m LT STA 11+602
200m NORTH OF EXIST CULVERT
ELEVATION 210.626
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically provided in accordance with the conditions of Section GC 7-01 of OPS Gen. Cond.
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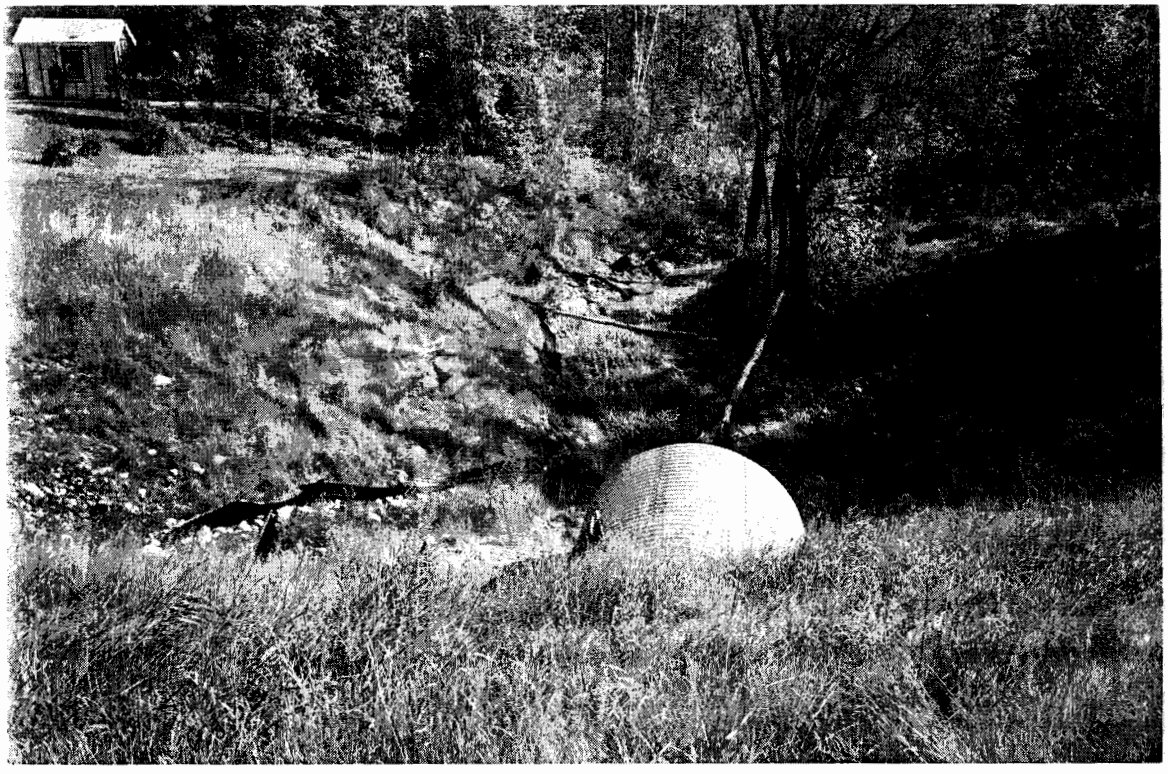
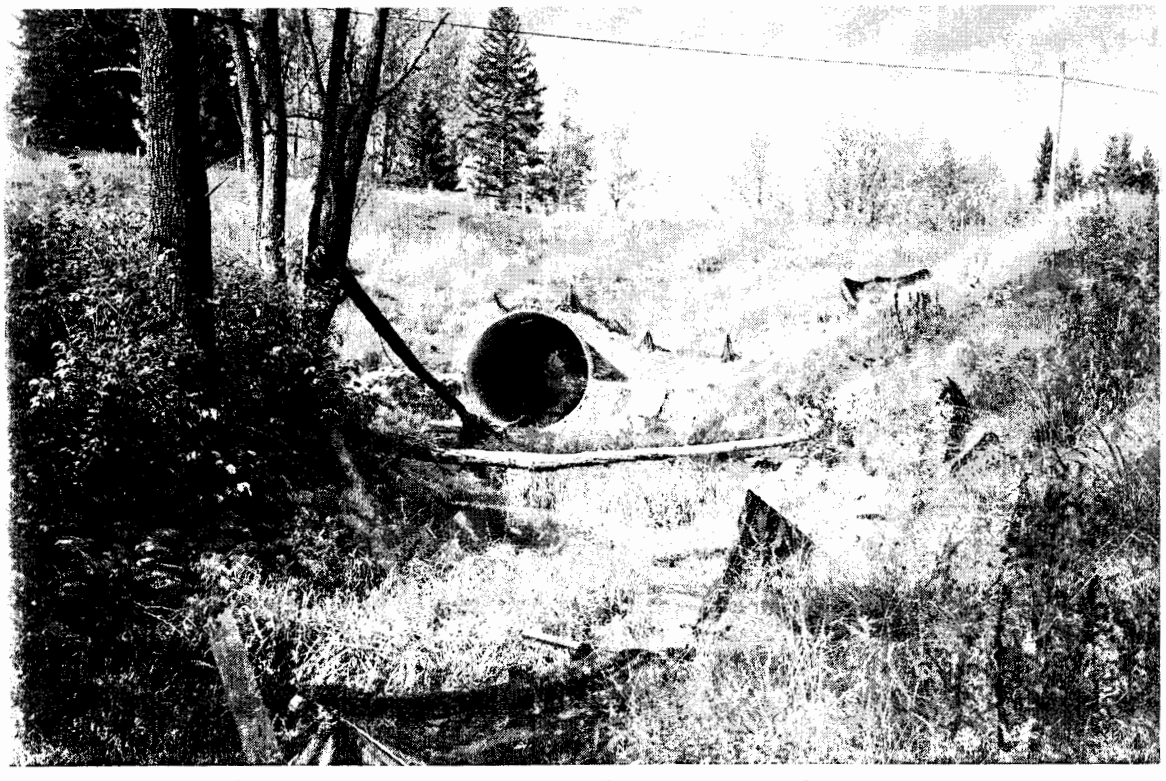
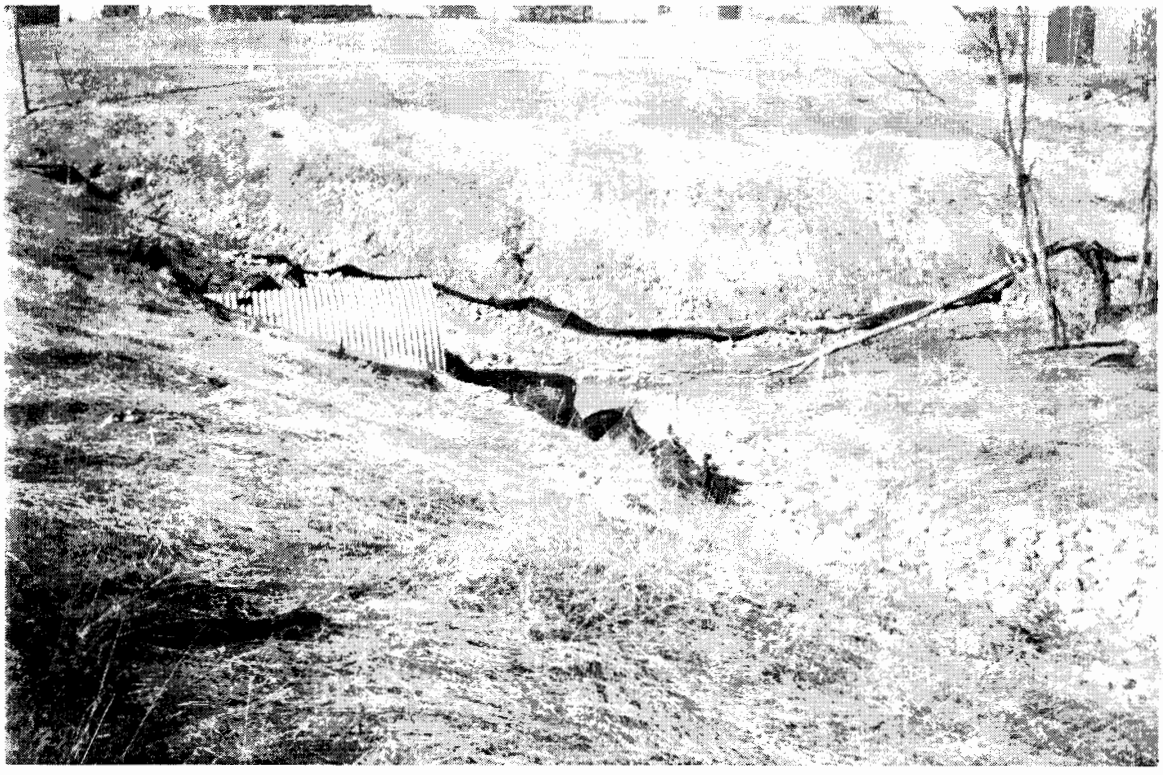


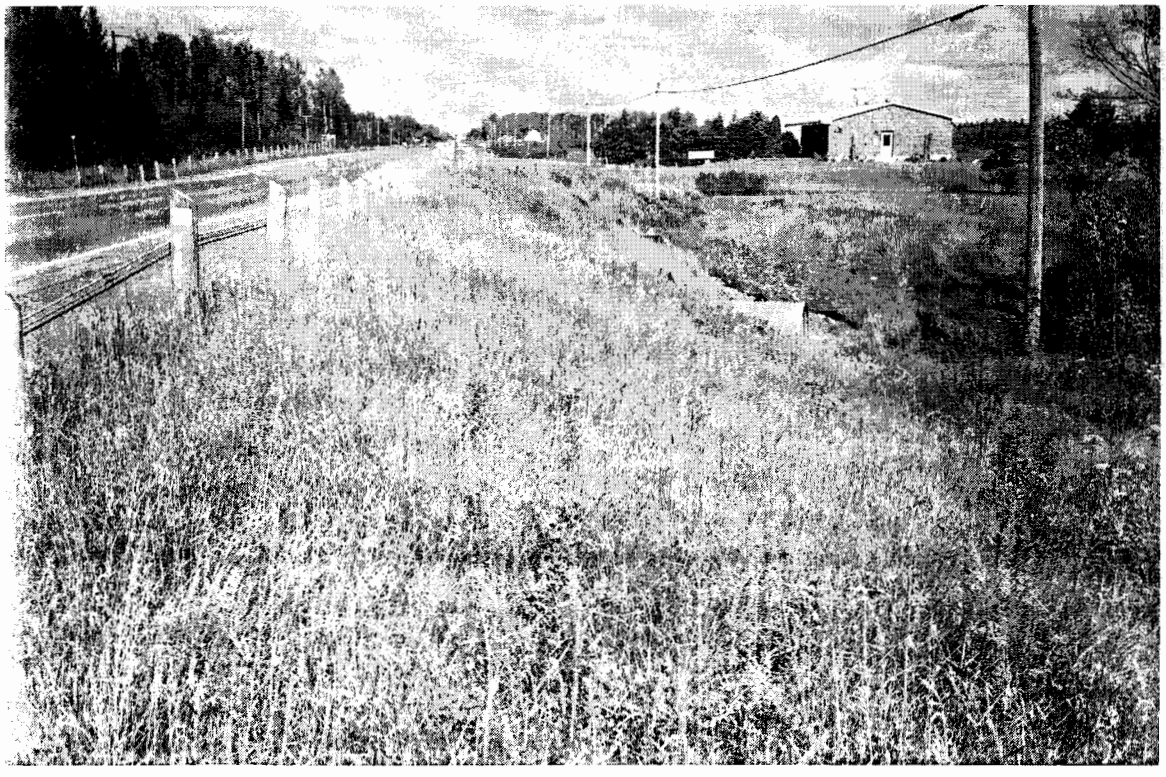
Photograph 3: ~ Station 11+407 – Looking east from top of the existing embankment at culvert outlet and creek gully.



Photograph 4: ~ Station 11+407 – Looking west towards existing culvert and embankment from the creek gully.



Photograph 1: ~ Station 11+350 – Looking north/east. Culvert and creek gully.



Photograph 2: ~ Station 11+407 – Looking north at the existing eastern embankment slope. (Note the culvert outlet at the toe of the slope.)

APPENDIX II

Borehole Logs

RECORD OF BOREHOLE BH-1

1 OF 1

METRIC

W.P. 109-98-00 LOCATION 5 302 126.5 N. 386 043.0 E ORIGINATED BY S.M.

DIST 53 HWY 11 BOREHOLE TYPE Hollow Stem Auger / CME 55 COMPILED BY M.D.

DATUM Geodetic DATE July 11, 1996 CHECKED BY L.B.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (○ UNCONFINED QUICK TRIAXIAL, ● UNCONFINED QUICK TRIAXIAL, + FIELD VANE LAB SHEAR, ⊗ FIELD VANE LAB SHEAR)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
209.96	GROUND SURFACE										
0.00	**FILL**, mostly sand & gravel, moist, brown, occasional cobbles and small silt inclusions. (compact)		1	SS	21		209				
207.46							208				
2.50	**SILT FILL,** grey with brown stains, moist to wet, trace of granulars & organics, odd pockets of clay. (loose to compact)		2	SS	4		207				
			3	SS	9		206				
							205				
203.36			4	SS	15		204				0% 2% 98%
6.60	**SILTY CLAY,** stratified with silt seams, grey, saturated. (firm/stiff becoming soft with depth)		5	SS	11		203				0% 8% 92%
							202				
			6	SS	0		201	+S=3			
							200			53	
			7	SS	0		199	+S=5			
							198				
197.16			8	SS	1						
12.80	END OF BOREHOLE										

Notes:
1) This borehole forms part of Highway 11, Northbound Passing Lane & Culvert, at station ~11+407, Township of Chamberlain.
2) Borehole located at station ~11+425.6, ~6.4 m right of centreline as referenced to Highway 11.
3) Water level was at ~4.8 m & hole was open to ~10.3 m depth on completion.

MTO4 S08131GK.GPJ 08/01/01

RECORD OF BOREHOLE BH-2

1 OF 1

METRIC

W.P. 109-98-00 LOCATION 5 302 092.9 N, 386 046.1 E ORIGINATED BY S.M.

DIST 53 HWY 11 BOREHOLE TYPE Hollow Stem Auger / CME 55 COMPILED BY M.D.

DATUM Geodetic DATE July 11, 1996 CHECKED BY L.B.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE ⊗ LAB SHEAR) (20 40 60 80)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT (wp — w — wl) WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
209.94	GROUND SURFACE										
0.00	**FILL**, mostly sand & gravel, moist, brown, occasional cobbles & small silt inclusions. (loose/compact)		1	SS	8		209				
207.49							208	×	○		
2.45	**SILT FILL**, grey with brown stains, moist to wet, odd pockets of clay. (loose)		2	SS	9		207	×	○		
							206				
			3	SS	6		205	×	○		
203.84							204				
6.10	**PEATY TOPSOIL**, ~75 mm thick over **SILTY CLAY**, stratified with wet silt layers, grey/brown, saturated. (firm/stiff becoming soft with depth)		4	SS	6		203	×	○		
			5	SS	7		202	×	○		0% 2% 98%
							201				
			6	TW			200	+S=4	○	16.70	
			7	TW			199		○	17.10	
							198				
197.14			8	SS	2			×	○		
12.80	END OF BOREHOLE										

Notes:
1) This borehole forms part of Highway 11, Northbound Passing Lane & Culvert, at station ~11+407, Township of Chamberlain.
2) Borehole located at station ~11+394.3, ~6.3 m left of centreline as referenced to Highway 11.
3) Water level was at ~5.9 m & hole was open to ~8.6 m depth on completion.

MTO4 S08131GK.GPJ 08/01/01

RECORD OF BOREHOLE BH-20

1 OF 1

METRIC

W.P. 109-98-00 LOCATION 5 302 112.0 N, 386 074.0 E ORIGINATED BY S.M.

DIST 53 HWY 11 BOREHOLE TYPE Tripod mounted / Winki Drill COMPILED BY M.D.

DATUM Geodetic DATE April 28, 2000 CHECKED BY L.B.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE ⊗ LAB SHEAR) (20 40 60 80)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT (wp — w — wl) WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
201.91	GROUND SURFACE										
0.00	**ALLUVIAL SILTY CLAY**, with ORGANICS & a trace of SAND & GRAVEL at ~0.6 m depth, grey, wet. (soft)		1	SS	3		201				
			2	SS	1						
200.11			3	SS	3		200				0% 1% 99%
1.80	**SILTY CLAY**, grey, wet, medium plasticity. (soft)		4	SS	2				58		
			5	SS	2		199	+S=4			
							198				
196.73			6	SS	2		197		67		
5.18	END OF BOREHOLE										

Notes:
1) This borehole forms part of Highway 11, Northbound Passing Lane & Culvert, at station ~11+407, Township of Chamberlain.
2) Borehole located at station ~11+398.6, ~27.4 m right of centreline as referenced to Highway 11.
3) Water level was at surface & hole was open to ~0.2 m depth on completion.

MTO4 S08131GK.GPJ 08/01/01

RECORD OF BOREHOLE BH-21A

1 OF 1

METRIC

G.W.P. 109-98-00 | LOCATION 5 302 096.5 N, 386 078.2 E | ORIGINATED BY S.M.

DIST 53 HWY 11 | BOREHOLE TYPE Hollow stem augers / CME-55 | COMPILED BY M.D.

DATUM Geodetic | DATE April 28, 2000 | CHECKED BY L.B.

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
205.29 GROUND SURFACE											
0.00	**TOPSOIL**, ~100 mm over **SILTY CLAY**, grey, moist, medium to high plasticity, with thick SILT seams below ~7.6 m depth. (soft/firm)		1	SS	6		205				0% 2% 98%
			2	SS	7		204				
			3	SS	4		203				
			4	SS	4		202	+S=4	68 57		
			5	SS	3		201		55		
			6	TW			200				
			7	SS	2		199	+S=4		17.20	
			8	SS	4		198		54		
			9	SS	3		197				
			10	SS	2		196	+S=4	51		
			11	SS	2		195				
			12	SS	3		194				
			13	SS	2		193	+S=4			
183.50							192				
21.79	END OF SAMPLING						191				
							190				
							189	+S=4			
							188				
							187				
							186				
							185				
							184				
178.62							183				
26.67	END OF CONE TEST NO FURTHER PENETRATION						182				
							181				
							180				
							179				

Notes:

1) This borehole forms part of Highway 11, Northbound Passing Lane & Culvert, at station ~11+407, Township of Chamberlain.

2) Borehole located at station ~11+382.9, ~24.0 m right of centreline as referenced to Highway 11.

3) Dynamic cone pushed with little resistance from ~21.8 m to ~26.7 m depth. Dynamic cone penetration test value at ~26.7 m depth was 69 blows for ~0.15 m.

RECORD OF BOREHOLE BH-21B

1 OF 1

METRIC

G.W.P. 109-98-00 | LOCATION 5 302 097.9 N, 386 067.2 E | ORIGINATED BY S.M.

DIST 53 HWY 11 | BOREHOLE TYPE Hollow stem augers / CME-55 | COMPILED BY M.D.

DATUM Geodetic | DATE September 19, 2000 | CHECKED BY L.B.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) × / CONE PENETRATION TEST — 20 40 60 80	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT wp ⊢○⊣ wl	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB SHEAR 20 40 60 80	WATER CONTENT (%) 10 20 30 40	kN/m³	GR SA (SI & CL)
205.30	GROUND SURFACE										
0.00	**TOPSOIL**, ~100 mm over **SILTY CLAY**, grey, moist, medium to high plasticity, with thick SILT seams below ~7.6 m depth. (soft/firm)						205				
							204				
							203				
							202				
							201				
							200	+S=5			
							199				
							198				
							197				
							196	+S=5			
							195				
							194				
							193				
							192				
			1	TW			191				
							190				
							189				
							188	+S=4			
							187				
							186				
							185				
							184				
							183	+S=5			
181.83			2	TW			182				
23.47	END OF BOREHOLE										

Notes:
1) This borehole forms part of Highway 11, Northbound Passing Lane & Culvert, at station ~11+407, Township of Chamberlain.
2) Borehole located at station ~11+382.9, ~27.0 m right of centreline as referenced to Highway 11.

MTO4 S08131GK.GPJ 01/29/02

11+400	4.4 RT ℄	D-050
0 - 300	Br Cr Gr W Sa, Moist, Comp	
300 - 1.7	Br F Sa Tr Gr, Moist, Comp	
1.7 - 2.0	Br Si W Gr & Sa, Wet, L	
11+400	13.0 RT ℄	D-3.0
0 - 150	Br Org W Sa(y) Gr	
150 - 1.6	Br Si(y) Cl some Sa W Gr, Moist, Firm **11SA#19**	
	w @ 150 - 1.6 = 24% **CL/SM**	
% Passing	4.75 mm = 92.6	
	75 μm = 59.3	
	20 μm = 38.5	
	5 μm = 21.0 **LSFH**	
	2 μm = 13.0	
	"k" Factor = 0.41	
W_L=26.0%	W_p=15.6% I_p = 10.4%	

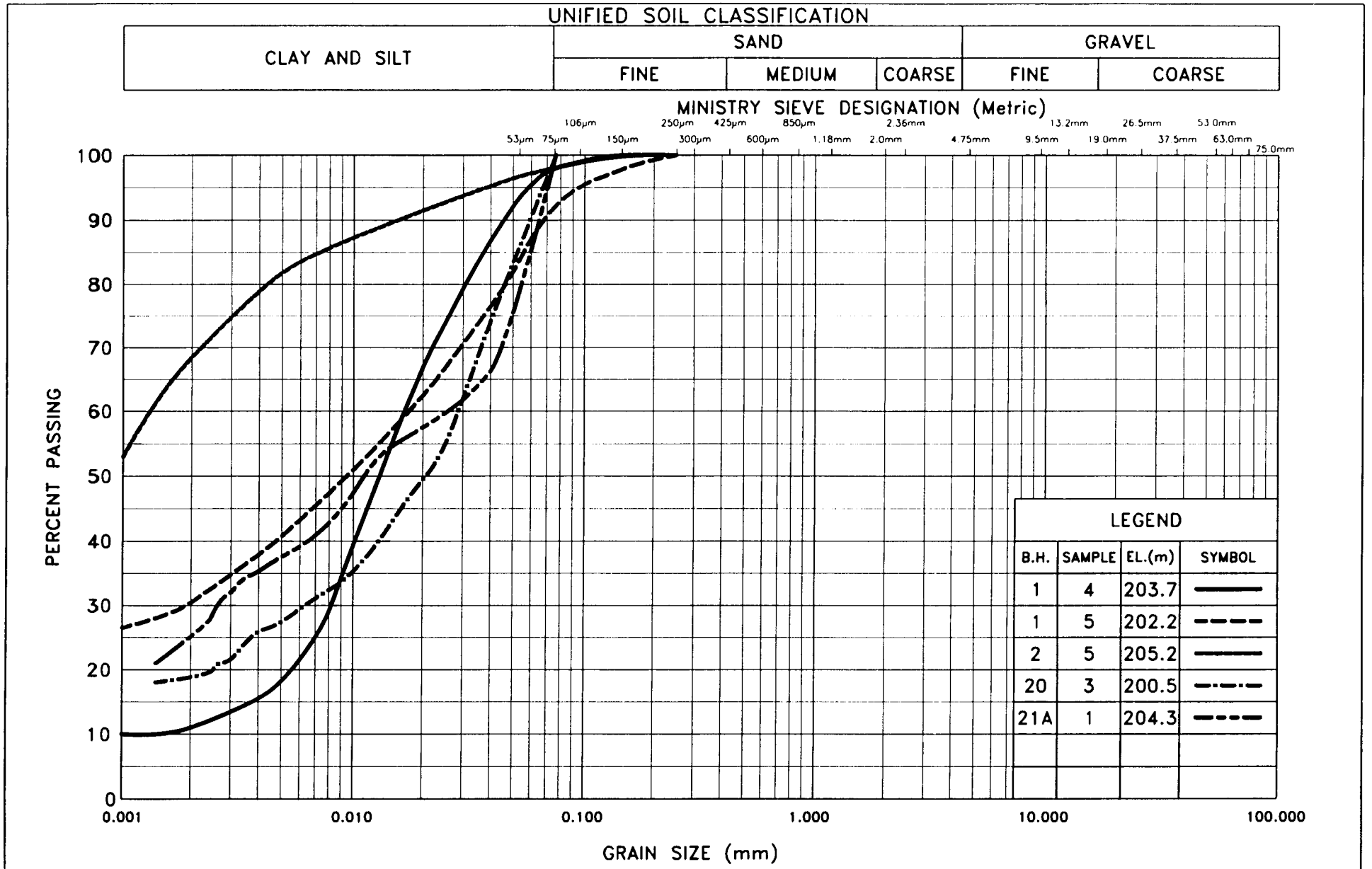
11+411	2.0 LT ℄	D-025
0 - 550	Asph	
550 - 700	Br Cr Gr W Sa, Moist, Comp **11RI#63**	
	Not Accep Granular "A"	
	94.6% PASSING 13.2 mm	
	89.9% PASSING 9.5 mm	
	82.9% PASSING 4.75 mm	
	64.4% PASSING 1.18 mm	
	35.5% PASSING 300 μm	
	Accep Granular "B" Type I	
700 - 1.1	Br Med Sa Tr Gr, Moist, Comp **11RI#64**	
	Not Accep Granular "B" Type I	
	16.8% PASSING 75 μm	
	Accep SSM	
1.1 - 1.4	Asph	
1.4 - 2.2	Br Co Sa W Gr Si(y), Moist, Comp **11RI#65**	
	No testing required	
2.2 - 2.5	Br Med Sa W Gr Tr Si, Moist, Comp **11RI#66**	
	Accep Granular "B" Type I	
2.5 - 2.9	Br Sa W Gr Tr Si, Moist, Comp **11RI#67**	
	Accep Granular "B" Type I	

11+411	5.0 LT ℄	D-075
0 - 380	Br Cr Gr W Sa, Moist, Comp	
380 - 750	Br Sa W Gr some Stn Tr Si, Moist, Comp	
750 - 1.4	Br Med Sa Tr Gr Tr Si, Wet, Soft	
1.4 - 2.0	Br F Sa, Wet, L	

APPENDIX III

Laboratory Test Results

PLOTTED: 2001/07/31 - 16:25



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

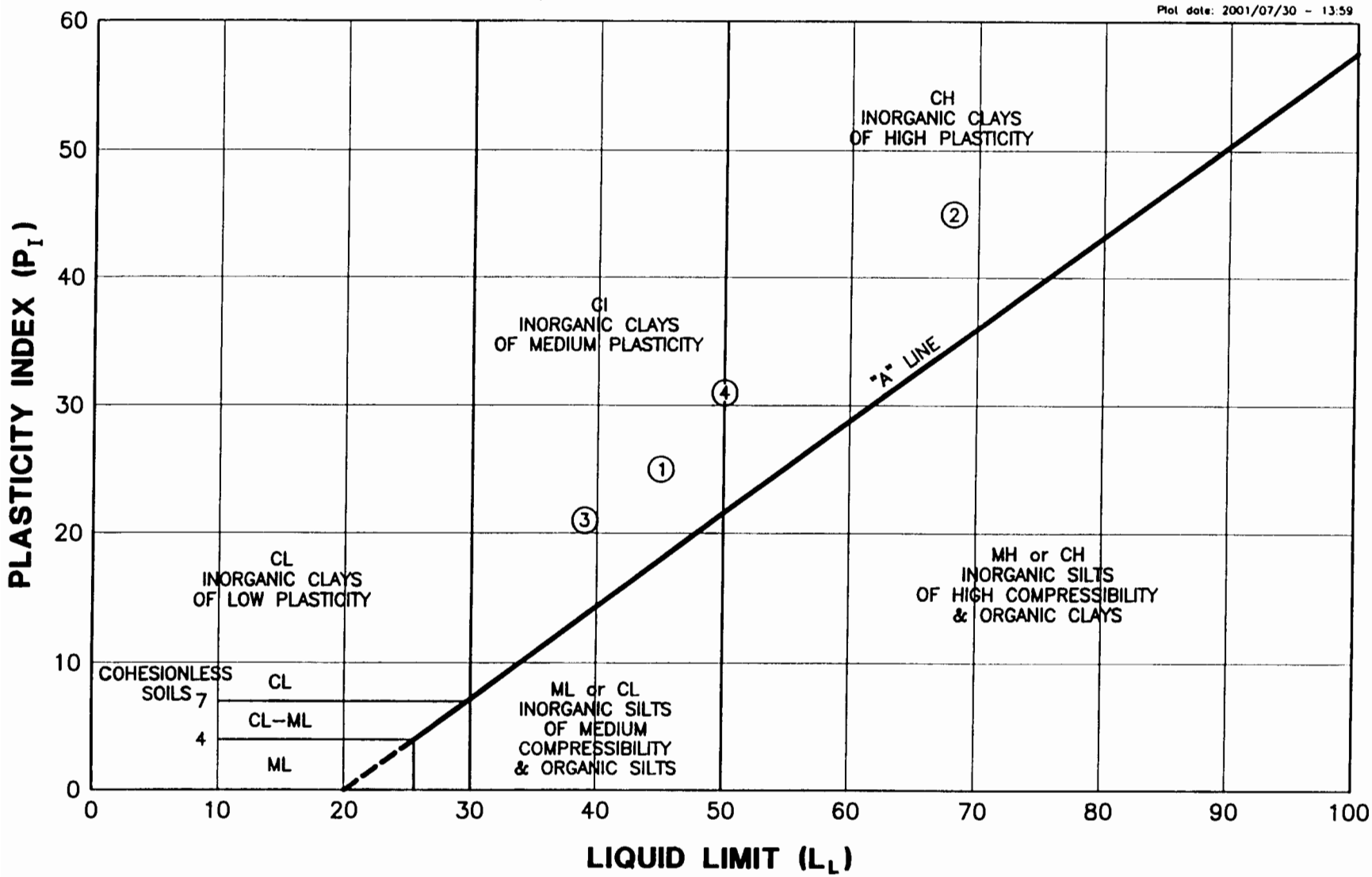
BH-1, SS-4, SILT FILL
BH-1, SS-5, SILTY CLAY
BH-2, SS-5, SILTY CLAY
BH-20, SS-3, ALLUV. SILTY CLAY
BH-21A, SS-1, SILTY CLAY

FIG. No 1

G.W.P. 109-98-00

ATTERBERG LIMITS - PLASTICITY CHART

SYMBOL	DESCRIPTION	LL	PI
①	BH-20, SS-4	45	25
②	BH-21, SS-3	68	45
③	BH-21, SS-8	39	21
④	BH-21, SS-11	50	31



PROJ. No. S08131G/K

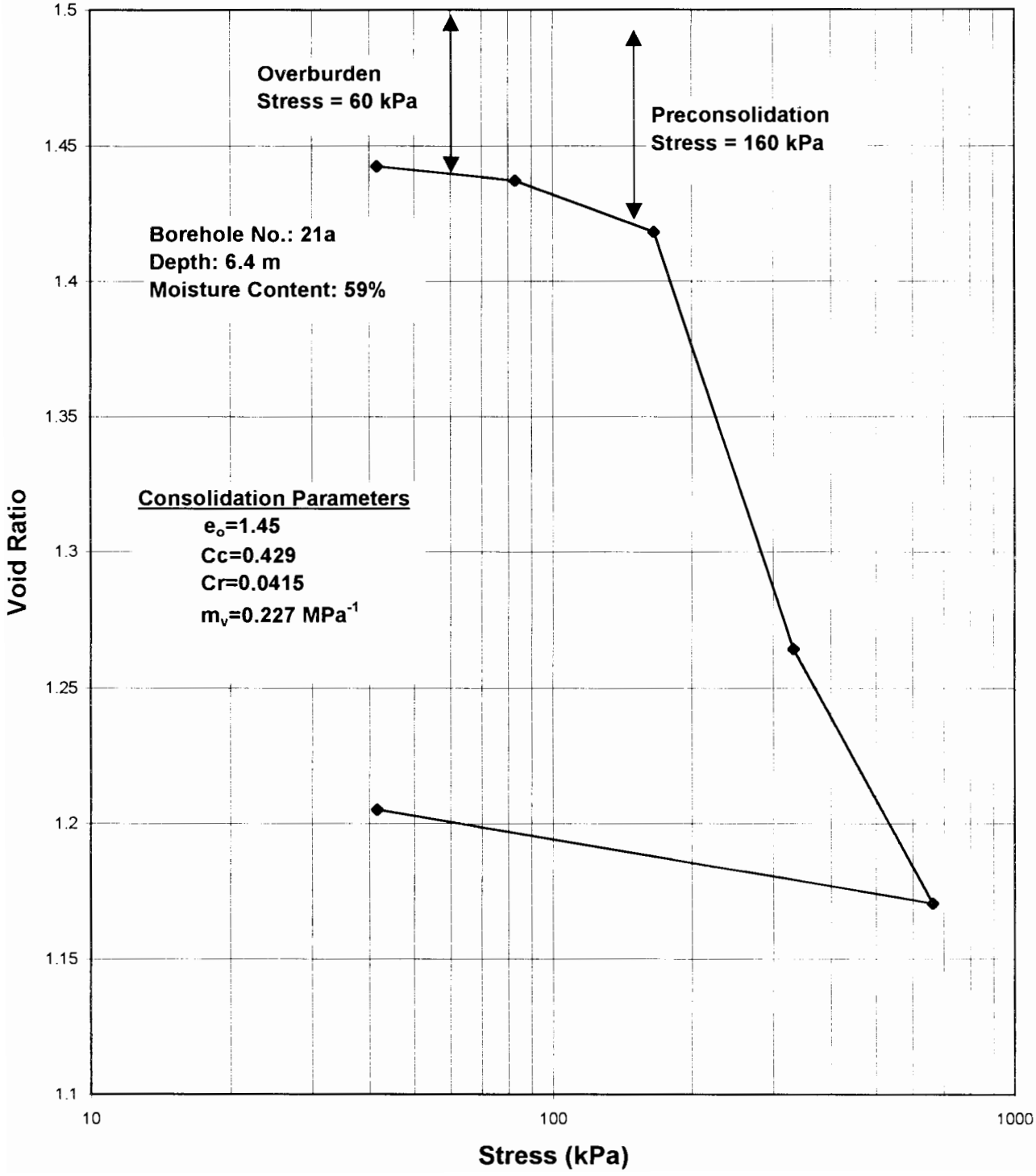
FIG. No. 2

TROW

WP No 109-98-00
PROJ No S08131G/K

Consolidation Test Results
BH 21

Figure 4



WP No 109-98-00
PROJ No S08131G/K

Coefficient of Consolidation
BH 21a

Figure 5