FOUNDATION INVESTIGATION & DESIGN REPORT
PROPOSED CULVERT REPLACEMENT
HWY 101, APPROXIMATELY 4.36KM EAST OF HIGHWAY 67
GERMAN TWP, ONTARIO
MTO NE REGION CONTRACT #5006-E-0070
ASSIGNMENT #6
GWP # 5056-03-00GEOCRES #42A-72

Submitted to:

Ministry of Transportation
North East Region, Engineering Office
Geotechnical Section
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North Bay, Ontario P1B 9S9

Submitted by:

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26 May 2008
TB7206006-II

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1.0 INTRODUCTION

AMEC Earth & Environmental, a division of AMEC Americas Limited (AMEC), Consulting Geotechnical, Construction Quality Control and Environmental Engineers, was retained by the Ministry of Transportation (North East Region) to conduct a foundation investigation and Detail Design for the replacement of a culvert on Highway 101, approximately 4.36 km east of Highway 67, in German Township, Ontario. Municipal Road (formerly Hwy 67) is located 15.6 km west of Highway 577, placing the culvert at 11.24 km west of Highway 577. The approximate site location is shown on Dwg. No. 1 in Appendix A.

Seven (7) boreholes, with a total drilling length of approximately 48 m in the vicinity of the existing culvert were specified by the MTO. Authorization to proceed with this investigation was signed by the Regional / Branch Director of MTO dated 2nd of January 2008 and faxed on January 4th, 2008. The work was carried out by AMEC according to the MTO Northeastern Region Terms of Reference Agreement #5006-E-0070 Assignment #6; Foundation Investigation and Design for Culvert replacement on Hwy 101, 4.3 km east of Hwy 67.

Subsurface information from previous projects that was available was reviewed prior to carrying out the fieldwork for this project. The following information was reviewed at the MTO Foundation Library (GEOCRES), in Downsview, and used in preparing this report wherever applicable.

- "***Foundation Design Report, Temporary Detour Bridge, North Driftwood River Bridge, Site No. 39E-131Highway 101, 14.2 km West of Hwy 11, District 53, New Liskeard, WP 316-85-02***", AGRA Earth & Environmental, TZ97003, March 24, 1998.
- "***Soil Investigation at Fredrickhouse Bridge Site, Highway No. 101, West of Matheska, New Liskeard District, Ont***", Racey, MacCallum and Associates Limited, Reference S-500/T-1446, 26 January, 1959.
- ***"Foundation Investigation Report for North Driftwood Creek Bridge at Highway 101, WP316-85-02, Site 39E-131, District 53, New Liskeard",*** Shaheen & Peaker Limited, Project SP1538, December 16, 1996.
- ***"Foundation Investigation Report for Matheson Creek Bridge, WP316-85-03, Site 39E-85, District 53, New Liskeard",*** Ministry of Transportation Ontario, GeoCres 42A-47, April 03, 1997.

The investigation was carried out by means of a limited number of boreholes, in-situ tests and laboratory tests on selected samples. The factual results of the soil conditions encountered in the boreholes and laboratory tests are presented in this report.

2.0 SITE DESCRIPTION

The site for the foundation investigation is on Highway 101, approximately 4.36 km east of Highway 67, in German Township. Hwy 67 (now Municipal Road) is located 15.6 km west of Highway 577, placing the culvert approximately 11.24 km west of Highway 577.

A 1000 mm diameter CSP culvert crosses under Hwy 101. The highway at this location runs on top of an embankment built up above the surrounding grade. The culvert lies across Hwy 101 near the base of the embankment. The fill height at the culvert location is approximately 5m, Highway 101 at this location is two lanes with gravel shoulders and a post and wire guardrail. The embankment slopes were sparsely treed and snow-covered at the timer of the fieldwork. Typical photographs can be found in Appendix C.

The replacement culvert will be a 1000 mm diameter pipe culvert. At this location, a detour or temporary widening/staged excavation is not an option for replacement due to property and utility constraints. It is expected, according to MTO, that the culvert will be replaced either in the current location using roadway protection (cut and cover with temporary shoring) or by using jack and bore at a location adjacent to the existing culvert.

3.0 GEOLOGY

Surficial Geological mapping by Richard et al. (1985) indicates that the project site is underlain by deepwater glaciolacustrine deposits of the Barlow-Ojibway Formation. These deposits consist of laminated to varved silts and clays which were deposited in proglacial Lake Ojibway Barlow.

In the vicinity of the culvert, organic deposits comprising peat and muck are anticipated to overlie more recent stream or alluvial deposits of clayey silt to gravel.

Previous geotechnical investigations carried out to the east of the project site indicate the depth to bedrock to be in the order of 37 to 40 m, comprising Archean aged mafic metavolcanic rock and intermediate metavolcanic rock, described as massive flows. Previous geotechnical investigations carried out to the west of the project site indicate the depth to bedrock to be in the order of 15 m, comprising sandstone. The location of the contact between the rock types is unknown.

4.0 INVESTIGATION PROCEDURES

4.1 Field Investigation

In accordance with the Terms of Reference for this investigation, seven (7) borehole locations (BH 1 to BH 7) were staked and cleared.

Three boreholes were drilled through the existing road embankment and sampled from the top of the highway embankment to verify embankment fill material and soil conditions below the culvert for potential roadway protection (cut and cover with temporary shoring) should the culvert be replaced by open excavation at its current location. The three deep boreholes extended to between 12.2 m and 13.0 m below existing road grade.

Four additional shallow holes (extending to a depth of 3 m were drilled north and south of the existing roadway embankment, at the base of the embankment.

The boreholes were drilled at the locations indicated in Table 1 of the RFP, as shown below:

TABLE 1 – Field and Laboratory Testing Requirements

Borehole	Location & Approximate Offset	Depth (m)	SPT	FVT *	LS-701	LS-702	LS-703 *	LS-704 *
JB-1	18+252	12.0	16 @ 0.75m	2	6	2	1	1
JB-2	18+262	12.0	16 @ 0.75m	2	6	2	1	1
JB-3	18+272	12.0	16 @ 0.75m	2	6	2	1	1
JB-4	18+252, 18.7m RT	3.0	N/A	0	2	1	0	0
JB-5	18+252, 17.7m LT	3.0	N/A	0	2	1	0	0
JB-6	18+262, 18.7m RT	3.0	N/A	0	2	1	0	0
JB-7	18+262, 17.7m LT	3.0	N/A	0	2	1	0	0
Totals	7	48	48	6	22	10	3	3

The fieldwork was performed over the period February 12th to March 24th, 2008. Prior to drilling, utility locates were carried out. Boreholes 1 through 3 were drilled by Abraflex Environmental and Geotechnical Drilling, using a track-mounted drilling rig. Boreholes 4 through 7 were advanced using hand augering equipment, supplied by AMEC, and auger samples were obtained. As well, split spoons were taken at depth in Boreholes 5 through 7.

Traffic control was provided by Levert Personnel Resources Inc.

The borehole locations are presented on Drawing No. 1 & 2 in Appendix A.

The borehole investigation was carried out under the full-time supervision of experienced geotechnical personnel from AMEC.

Soil samples were taken at 0.75m intervals in Boreholes 1, 2 and 3 during the performance of Standard Penetration Test (SPT) in accordance with ASTM D1586. This consisted of freely dropping a 63.5 kg (140 lbs.) hammer for a vertical distance of 0.76 m (30 inches) to drive a 51 mm (2 inches) diameter O.D. split-barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m (12 inches) was recorded as SPT 'N' value of the soil which indicated the consistency of cohesive soils or the relative density of non-cohesive soils.

One borehole (BH 3) encountered soft to very soft clay soils through which MTO Field Vane Testing was carried out.

In Boreholes 4 through 7, auger samples were taken from the boreholes to depths of between 1.8 m and 2.4 m below existing site grade. Below those depths, penetration testing was carried out to a depth of 3 m. The penetration tests were carried out using hand sampling equipment, driving a standard split spoon sampler with a 32 kg hammer. The N values were subsequently adjusted to reflect Standard Penetration test results.

Soil samples were normally collected from each soil layer exposed in the boreholes for laboratory inspection and testing.

Upon completion of drilling, the boreholes that were deeper than 3 m were backfilled with bentonite in accordance with the general requirements of Ministry of the Environment Regulation 903 as indicated on the Records of Boreholes.

The soil samples were transported to AMEC's Soil Laboratory in Hamilton for further examination and laboratory soil testing. The program of laboratory testing included grain size analysis, Liquid and Plastic Limits, and moisture content determination.

The results of the in-situ and laboratory tests are presented in the corresponding Records of Boreholes (Appendix A) and Laboratory Test Results (Appendix B).

AMEC will retain the soil samples for a period of one year after completion of the Project, unless otherwise advised in writing by the Ministry.

4.2 Laboratory Tests

In accordance with the Terms of Reference for this investigation representative soil samples were subjected to laboratory testing in AMEC's Soil Laboratory in Hamilton for soil classification. The following tests were conducted:

- In-situ water content determination (26);
- Grain size distribution analysis (10); and
- Liquid and Plastic Limits (3).

The results of the laboratory tests are included in the Record of Boreholes in Appendix A. The grain size distribution curves and Liquid / Plastic Limits are shown in Appendix B.

5.0 SUB-SURFACE CONDITIONS

The general soil profile through the road embankment consisted of sand and gravel over sand, silty sand, sandy silt and silt. Two of the three boreholes were terminated within these materials. Underlying the silty sand to sandy silt in the third borehole, very soft to firm clayey silt to clay was encountered, and extended to the maximum depth investigated.

To the north and south of the road embankment, three of the four boreholes encountered topsoil underlain by silt and sand. In the fourth borehole, peat was encountered to a depth of 1.8 m, underlain by silty sand.

Groundwater was encountered in all boreholes, the levels ranging from at grade to 1.9 m below existing grade.

The stratigraphic units and groundwater conditions at the borehole locations are discussed in the following sections. Detailed information is provided in the Record of Boreholes (Appendix A).

The following summary is to assist the designers of the project with an understanding of the anticipated soil conditions across the site. However, it should be noted that the soil and groundwater conditions may vary between the borehole locations.

5.1 Topsoil/Peat

In three of the four boreholes drilled off the road embankment (BH's 4 through 6, to the north and south of the embankment), between 150 mm and 300 mm of topsoil was encountered. Some peat was interlayered with the topsoil. In Borehole 7, 1.8 m of peat was encountered from grade. A trace of silty fine sand was observed within the peat layer below a depth of 1.0 m. **It should be noted that the thickness of topsoil/peat varied considerably across the project limits.**

5.2 Sand and Gravel / Sand Fill

From the existing road shoulder grade, the boreholes put down through the embankment encountered sand and gravel and sand fill. In Borehole 1, sand and gravel and sand fill were encountered to a depth of 4.5 m. In Boreholes 2 and 3 a distinct layer of sand and gravel fill extended to 0.8 m below road grade, and was underlain by sand fill to depths of 6.9 m and

5.3 m, respectively. A trace to some organic matter was noted within the fill, along with traces of silt

The SPT 'N' values of the sand and gravel / sand fill varied considerably from 2 blows for 0.3 m to 50 blows for no penetration, indicating very loose to very dense relative density. **The fill soils could contain some cobbles / boulders as some stone pieces were noticed in the recovered soil samples**.

The results of laboratory tests conducted on soil samples are as follows:

Moisture content (%):	3 to 33
Plastic Limit:	non-plastic
Liquid Limit:	non-plastic

The moisture contents are plotted on the Records of Boreholes in Appendix A.

5.3 Silty Sand / Sandy Silt / Sand / Silt

Underlying the sand fill in each of Boreholes 1, 2 and 3, and below the topsoil/peat in Boreholes 4 through 7, silty sand to sandy silt, silt and sand were encountered. These deposits extended to at least the maximum depths investigated in Boreholes 1 and 4 through 7, and to depths of 11.4 m and 9.9 m below grade in Boreholes 2 and 3, respectively.

The deposits ranged from brown to grey and contained traces to some clay at depth. The SPT 'N' values through the silty sand to sandy silt, silt and sand ranged from 5 to 17 blows for 0.3 m (loose to compact relative density).

The result of laboratory test conducted on one sample is as follows:

Natural moisture content (%):	18 to 31	
Grain size (8 samples):	Gravel (%):	0
	Sand (%):	25 to 88
	Silt (%):	9 to 49
	Clay (%):	6 to 34

The moisture contents are plotted on the Records of Boreholes in Appendix A. The grain size distribution curves are presented in Figures B1 to B8 in Appendix B.

5.4 Silty Clay

Silty clay was encountered underlying the silty sand to sandy silt in Boreholes 2 and 3. Each of these boreholes was terminated within the silty clay.

The SPT 'N' values of the silty clay ranged from 0 to 3 blows per 0.3 m (very soft to soft consistency). Two MTO field vanes resulted in shear strengths of 12 and 21 kPa (soft consistency).

The results of laboratory tests conducted on soil samples are as follows:

Natural moisture content (%):	38 and 43	
Plastic Limit (2 samples):	17 and 18	
Liquid Limit (2 samples):	35 and 37	
Grain size (2 samples):	Gravel (%):	0
	Sand (%):	3 and 11
	Silt (%):	14 and 26
	Clay (%):	71 and 75

The plasticity indices are plotted on Figure No. B11 in Appendix B and the grain size distribution curves are presented in Figures B9 and B10 in Appendix B.

5.5 Groundwater

The groundwater level in each open borehole was observed during drilling and measured upon completion of drilling. The measured groundwater levels are shown in the Record of Boreholes (Appendix A).

Groundwater levels were encountered in all the boreholes as follows:

Borehole No.	Groundwater Depth below Existing Ground Surface / Elev, (m)	Notes
JB1	5.3 / 100.9	caved at 6.4m
JB2	6.1 / 99.8	caved at 9.7m
JB3	11.9 / 93.8	open to depth
JB4	2.0 / 100.6	open to depth
JB5	1.7 / 99.5	caved at 2.4m
JB6	0 / 101.9	caved at 1.5m
JB7	0 / 100.9	caved at 2.1m

It should be noted that the groundwater at the site would fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to major weather events / water levels in the creek.

6.0 DISCUSSION & RECOMMENDATIONS

The site for the foundation investigation is on Highway 101, approximately 4.36 km east of Highway 67, in German Township.

A 1000 mm diameter CSP culvert crosses under Hwy 101. The highway at this location runs on top of an embankment built up above the surrounding grade. The culvert lies across Hwy 101 near the base of the embankment. Although no plans or profiles are available in the culvert area, it is understood that the fill height at the culvert location is approximately 4.9 m.

The replacement culvert will be a 1000 mm diameter pipe culvert. At this location, a detour or temporary widening/staged excavation is not an option for replacement due to property and utility constraints. According to the TOR, it is expected that the culvert will be replaced either in the current location using roadway protection (cut and cover with temporary shoring) or by using jack and bore at a location adjacent to the existing culvert.

6.1 Foundation Design

Comparison of Roadway protection (cut and cover with temporary shoring) (Existing Culvert Location) or Jack and Bore (New Location)

Construction Technique	Description	Advantages	Disadvantages	Risks / Consequences	Cost Comparison
Roadway protection (cut and cover with temporary shoring)	Shored excavation to replace existing csp.	- Use of standard excavation and construction equipment. - No specialist contractor is required. - Maintain the existing culvert location.	- Disruption to traffic by opening only one lane. - Will require roadway protection (cut and cover with temporary shoring) - trench box or similar, to maintain traffic flow. A sliding trench box can be used. Traffic signalling will be required for one lane traffic. - Temporary dewatering and / or detouring of the existing water way will be required. - Will require rebuilding of embankment fills and road. - Remove and replace post & wire guardrail.	- Embankment fill comprises fine-grained cohesionless soils. Could result in wide excavation (flattened side slopes) to prevent slough/cave.	Medium

Construction Technique	Description	Advantages	Disadvantages	Risks / Consequences	Cost Comparison
Jack & Bore	Bore underneath embankment and jack new pipe into place at adjacent location. Will require jacking and receiving pits.	- No disruption to traffic flow. -Will have to construct staging area for equipment at base of embankment.	- Requires specialist contractor (Contractor specializing in tunnelling) and specialized equipment. - Will require dewatering of jacking & receiving pits. - Permanent diversion of water way into and out of new culvert location. Larger area of disturbance.	- Soil conditions based on limited borehole data. Risk of encountering cobbles/boulders, which may complicate jack & bore operations. - Jack & bore through wet to saturated fine-grained soils/ May result in construction difficulties with the stability of the bore face. - Jack & bore below loose embankment soils. May result in settlement within embankment.	High

Alternatively, consideration could also be given to re-lining the existing csp culvert using either the same diameter csp or a slightly smaller steel pipe liner. The former would require that the section of csp be cut lengthwise and inserted into the existing culvert. Once in place, the new csp could be sealed along the cut (resulting in a slightly smaller culvert diameter), and any space between the two pipes grouted. The latter would involve placement of a slightly smaller diameter pipe into the existing csp and grouting between the two.

Based on the comparison of the two construction alternatives presented in the RFP, it is recommended that culvert replacement be carried out at the existing culvert location using roadway protection (cut and cover with temporary shoring).

The culvert size and invert elevation are anticipated to be the same. There is no road grade increase proposed. Therefore no increased stresses in the soil beneath and surrounding the culvert are anticipated.

Based on the conditions encountered in the boreholes drilled for this investigation, the soils at the culvert invert consist of compact to loose native sandy silt to silty sand and compact sand fill. These soils should be capable of supporting the proposed new culvert at the existing location. The following design parameters may be used:

Factored Geotechnical Resistance at ULS	210 kPa
Geotechnical Reaction at SLS	110 kPa

All organic soils and other deleterious materials must be removed from beneath the new culvert limits. All such materials should be excavated and wasted. The subgrade should be proofrolled and inspected. Upon approval, compacted granular fill can be used to restore subgrade level.

6.2 Dewatering and Channel Diversion during Construction

The founding elevation of the culvert is anticipated to lie below or just above the groundwater table. **Water inflows should be anticipated into any excavations below grade. Significant sloughing and caving of temporary excavation slopes should be anticipated.** Dewatering will be required during construction to provide a stable working platform. Dewatering may be in the form of trenches or augered wells, with sump pumping to draw the water level down to at least 0.5 m below the bottom of the excavation.

Channel diversion will also be required. This could be accomplished by using a temporary cofferdam structure to divert flows to the east or west of the culvert location.

6.3 Excavation and Backfill

Excavation, bedding and cover for the pipe culvert should conform to OPSD 802.034. Reconstruction of the embankment slopes should match the existing slopes and materials, having a maximum slope of 2H:1V.

A depth of frost treatment of 2.4 m should be used at this site.

Culvert inlet and outlet treatments should comply with MTO Standards. Reference should be made to SP 421S01 for culvert installation by using roadway protection (cut and cover with temporary shoring).

6.4 Construction Comments

Any excavations should be carried out in accordance with the latest edition of the Ontario Occupational Health and Safety Act and its regulations (i.e. Occupational Health and Safety Act O.Reg. 213/91).

Based on the information in the boreholes, the sand fill and native sandy silt / silty sand should be considered to be Type 4 soils.

The road protection system should be embedded a minimum of 1m below the road base to prevent base heave. **Dewatering should proceed ahead of the excavation operation.**

6.4.1 Non Standard Special Provisions

Non Standard Special Provision should be included in the contract documents, to alert prospective Contractors to specific conditions. Suggested wording regarding groundwater conditions and the potential for cobbles within the till, may be found in Appendix D.

6.5 Construction Inspection

It is recommended that a quality control programme of inspection and testing be carried out during the construction phase of the project to confirm that the conditions encountered are consistent with design assumptions; and to confirm that the various project specifications and material requirements and handling are followed.

7.0 CLOSURE

The sub-soil information and recommendations contained in this report should be used solely for the purpose of foundation assessment of this site.

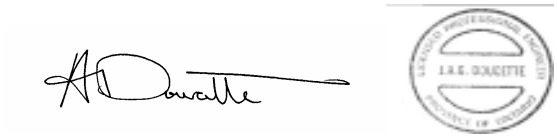
AMEC should be retained to review the recommendations provided in this report, once the details of the project are finalized and prior to the final design stage of the project.

The Limitations of Report, as quoted on the following page, is an integral part of this report.

We trust that the information presented in this report is complete within our terms of reference. If there are any further questions concerning this report, please do not hesitate to contact our office.

Sincerely,

AMEC Earth & Environmental,
A division of AMEC Americas Limited



Jane Doucette, P.Eng.
Senior Geotechnical Engineer

Prapote Boonsinsuk, Ph.D., P.Eng.
Project Reviewer

George Chow, P.Eng.
Designated Principal Contact

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the testholes.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report relating to potential construction problems and possible methods of construction are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

The benchmark and elevations mentioned in this report were obtained strictly for use by this office in the geotechnical design of the project. They should not be used by any other party for any other purpose.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AMEC Earth & Environmental accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

DRAWINGS

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

AGREEMENT No.
5006-E-0070

Geocres 42A-72

FOUNDATION INVESTIGATION
PROPOSED CULVERT REPLACEMENT
HWY 101, APPROX. 4.36 KM EAST OF HWY 67
GERMAN TWP, ONTARIO
ASSIGNMENT 6

TB7206006
DRAWING 1

Dwg. Title:
Borehole Location Plan / Cross Section A-A'

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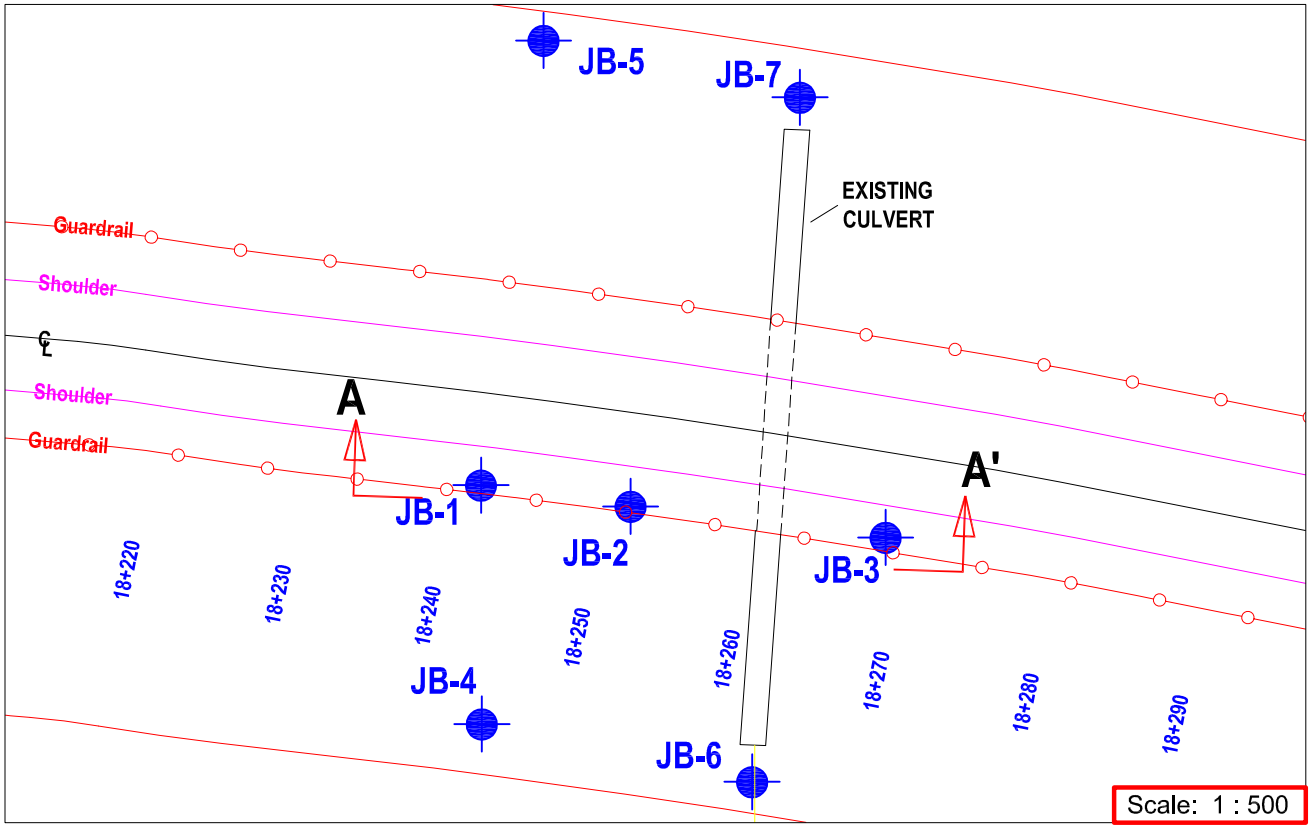


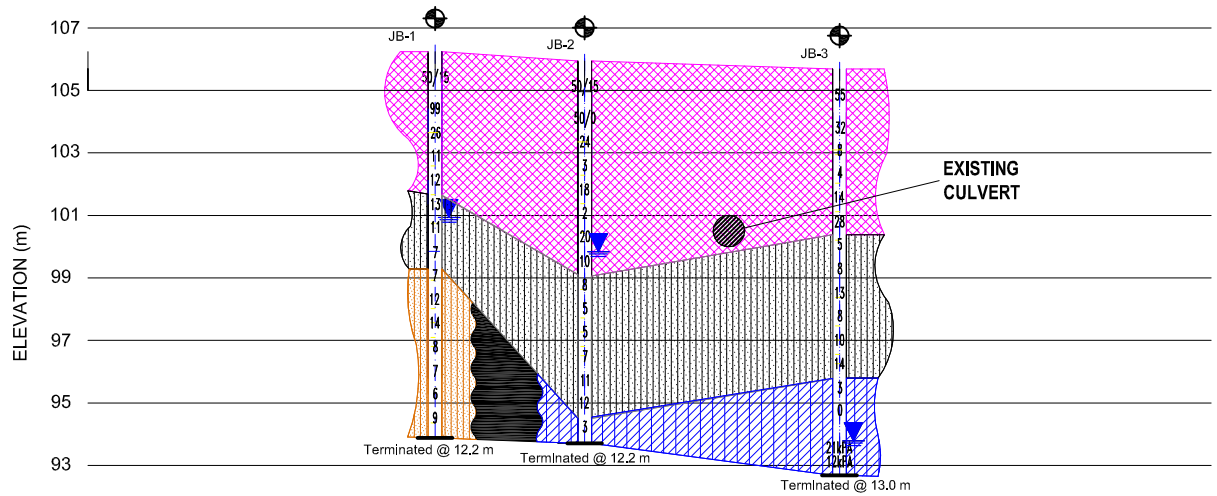
KEY PLAN

LEGEND

JB-1 BOREHOLE LOCATION

WATER LEVEL

BOREHOLE	LOCATION		ELEVATION (m)
	STATION	OFFSET	
JB-1	18 + 252	-	106.24
JB-2	18 + 262	-	105.94
JB-3	18 + 272	-	105.70
JB-4	18 + 252	18.7 m RT	102.59
JB-5	18 + 252	17.7 m LT	101.20
JB-6	18 + 262	18.7 m RT	101.89
JB-7	18 + 262	17.7 m LT	100.90



PROFILE

Scale: Horizontal 1 : 500
Vertical 1 : 250

NOTES:
1. The boundaries between soil strata have been established only at borehole locations. Between boreholes, the boundaries are assumed from geological evidence and may be subject to considerable error.
2. All elevations shown are referred to a temporary benchmark of 100.00 m (Invert of culvert on north side of Hwy 101)

SOIL STRATIGRAPHY

- Sand & Gravel to Sand Fill
- Silt and Sand
- Sandy Silt / Silty Sand
- Silty Clay
- Unknown

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

AGREEMENT No.
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FOUNDATION INVESTIGATION
PROPOSED CULVERT REPLACEMENT
HWY 101, APPROX. 4.36 KM EAST OF HWY 67
GERMAN TWP, ONTARIO
ASSIGNMENT 6

TB7206006
DRAWING 2

Dwg. Title:
Borehole Location Plan / Cross Section B-B'

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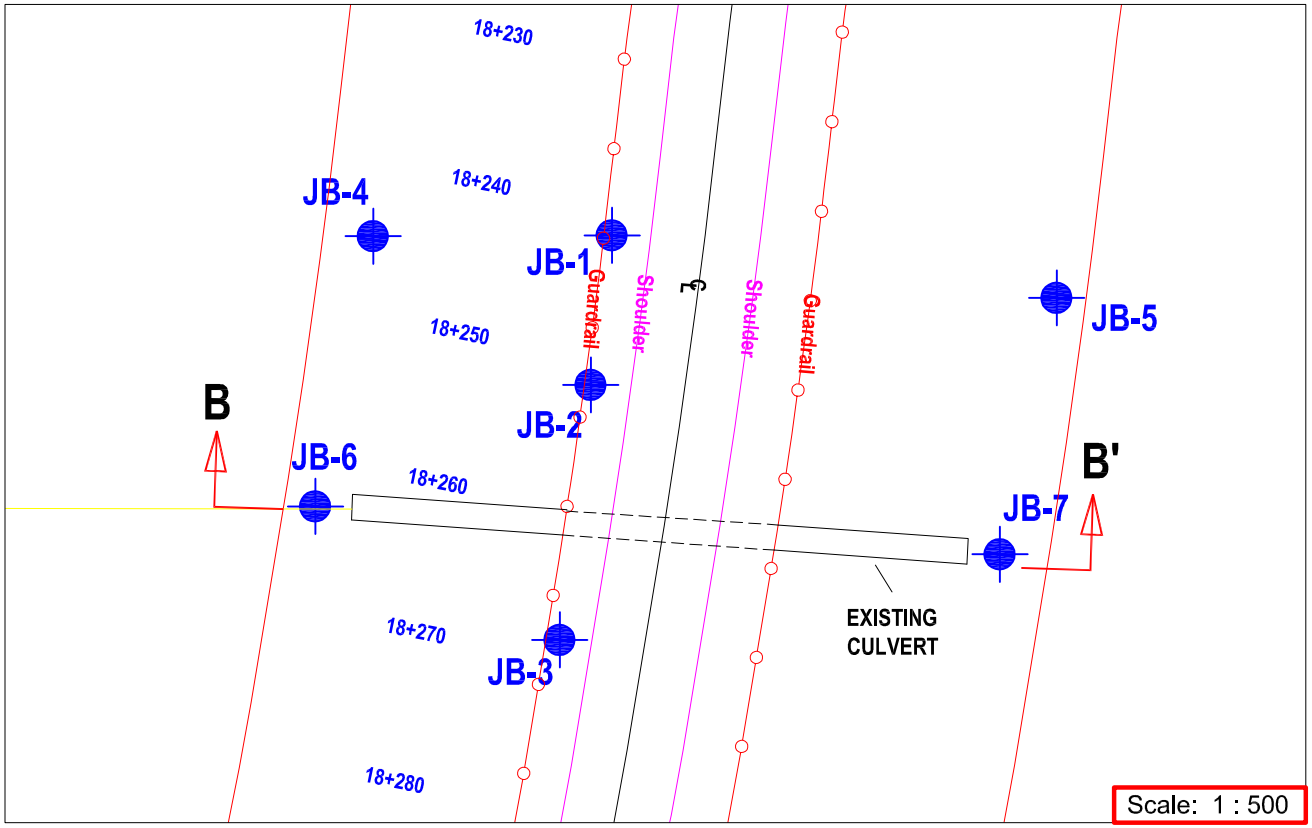
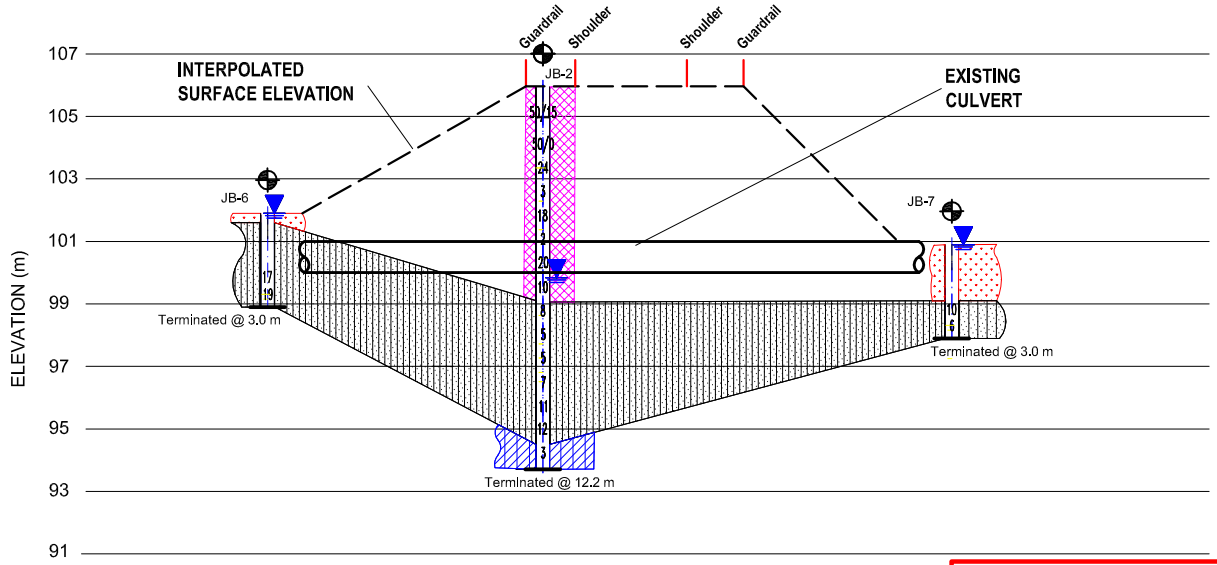


KEY PLAN



PROFILE

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JB-1 BOREHOLE LOCATION

WATER LEVEL

BOREHOLE	LOCATION		ELEVATION (m)
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JB-5	18 + 252	17.7 m LT	101.20
JB-6	18 + 262	18.7 m RT	101.89
JB-7	18 + 262	17.7 m LT	100.90

NOTES:
1. The boundaries between soil strata have been established only at borehole locations. Between boreholes, the boundaries are assumed from geological evidence and may be subject to considerable error.
2. All elevations shown are referred to a temporary benchmark of 100.00 m (Invert of culvert on north side of Hwy 101)

SOIL STRATIGRAPHY

- Topsoil / Peat
- Sand & Gravel to Sand Fill
- Sandy Silt / Silty Sand
- Silt and Sand
- Silty Clay
- Unknown

APPENDIX A

RECORD OF BOREHOLE No JB-1 1 OF 1

PROJECT Culvert Replacement - Hwy 101, German Twp, ON LOCATION Stn. 18+252; approx 3m south of centreline ORIGINATED BY as

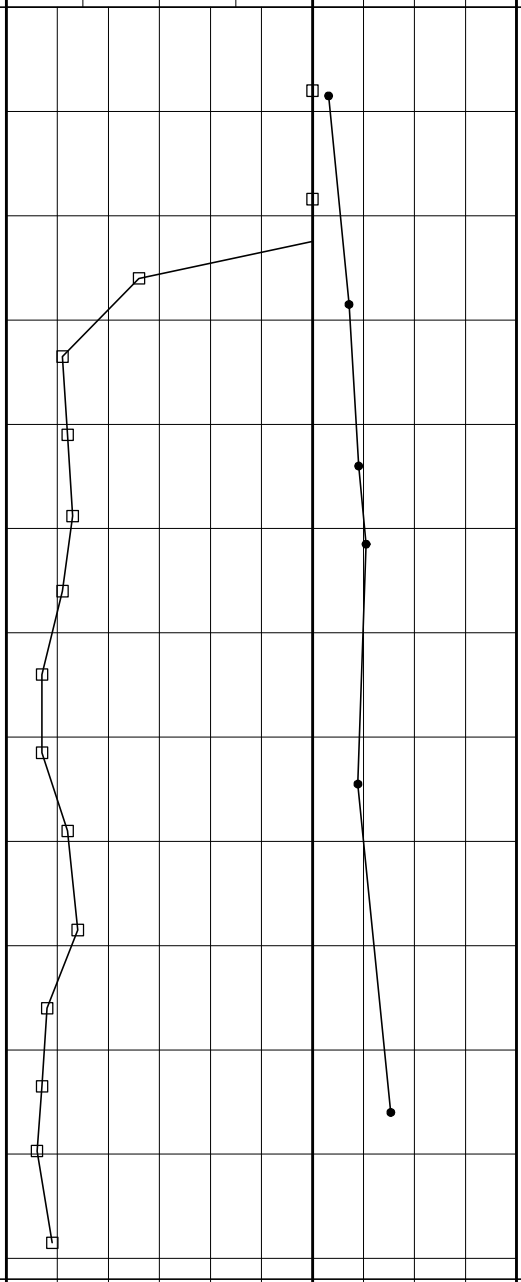
CLIENT Ministry of Transportation Ontario Geocres 42A-72 COMPILED BY lc

JOB NO. TB7206006 DATE 21 February 2008 CHECKED BY hs

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	OBSERVATIONS & REMARKS
106.2 / 0.0	**SAND & GRAVEL TO SAND FILL** Brown, moist, very dense to compact.		1	AU				
			2	SS	50/15cm		1	
			3	SS	99		2	
			4	SS	26		3	
			5	SS	11			
101.7			6	SS	12		4	**SS#6** Non-plastic
4.5	**SANDY SILT TO SILTY SAND** Brown, moist to wet, compact to loose.		7	SS	13	▽	5	
			8	SS	11			
99.4			9	SS	7		6	
6.8	**SAND** Brown, some silt at approximately 9.1mbgs, wet, loose to compact.		10	SS	7		7	**SS#10** 75 µm to 4.75 mm -- 81 % 2 µm to 75 µm -- 12 % <2 µm -- 7 %
			11	SS	12		8	
			12	SS	14		9	
96.3			13	SS	8			
9.9	**SILT AND SAND** Grey, some clay, wet, loose.		14	SS	7		10	
			15	SS	6		11	**SS#16** 75 µm to 4.75 mm -- 57 % 2 µm to 75 µm -- 9 % <2 µm -- 34 %
94.0			16	SS	9		12	
12.2	**BOREHOLE TERMINATED**							Upon completion: Borehole caved to 6.4 mbgs and water to 5.3 mbgs. Borehole backfilled with bentonite.

STANDARD PENETRATION TEST □
DYNAMIC PENETRATION TEST ■

SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✥ LAB VANE



RECORD OF BOREHOLE No JB-2

1 OF 1

PROJECT Culvert Replacement - Hwy 101, German Twp, ON
LOCATION Stn. 18+255; approx 3m south of centreline
ORIGINATED BY as

CLIENT Ministry of Transportation Ontario
Geocres 42A-72
COMPILED BY lc

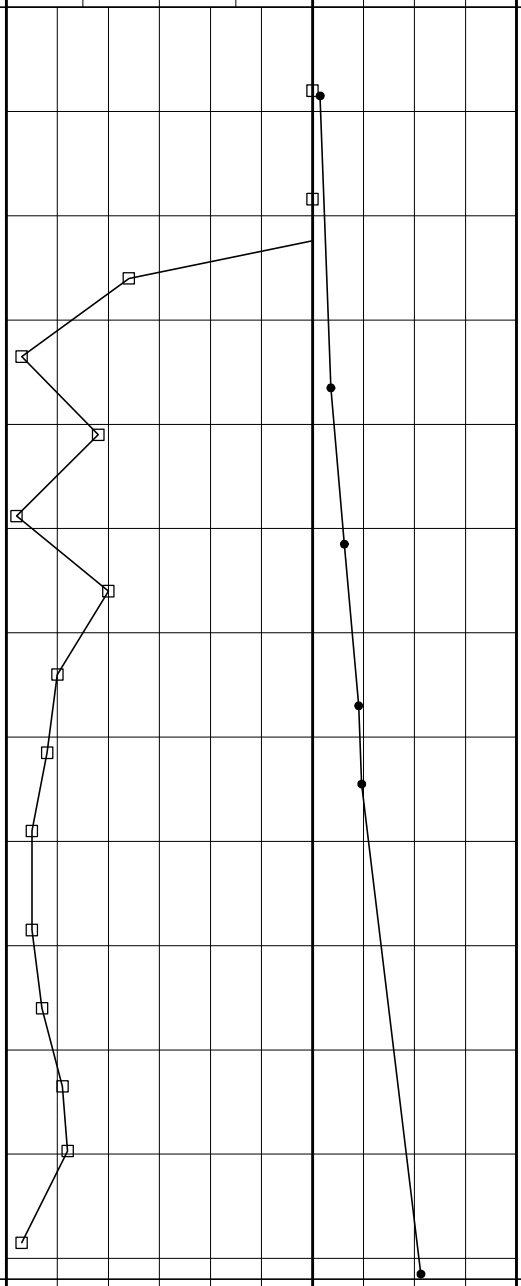
JOB NO. TB7206006
DATE 20 February 2008
CHECKED BY hs

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	DEPTH (m)	OBSERVATIONS & REMARKS
105.9						
0.0	**SAND & GRAVEL FILL** Brown, moist.	1	AS			
105.2						
0.8	**SAND FILL** Brown, trace gravel, cobbles?, trace organics at approximately 4.6mbgs, moist to wet, very dense to very loose.	2	SS	50/15cm	1	
		3	SS	50/0cm	2	
		4	SS	24	3	
		5	SS	3		
		6	SS	18	4	
		7	SS	2	5	
		8	SS	20		
		9	SS	10	6	
99.1						
6.9	**SILTY SAND** Grey, wet, very loose to compact.	10	SS	8	7	**SS#10** 75 µm to 4.75 mm -- 62 % 2 µm to 75 µm -- 32 % <2 µm -- 6 %
		11	SS	5	8	
		12	SS	5	9	
		13	SS	7		
		14	SS	11	10	**SS#15** LL - 35 % PL - 17 % PI - 18 %
		15	SS	12	11	**SS#16** 75 µm to 4.75 mm -- 11 % 2 µm to 75 µm -- 14 % <2 µm -- 75 %
94.6						
11.4	**SILTY CLAY** Grey, some Sand, wtpl, soft.	16	SS	3	12	
93.7						
12.2	**BOREHOLE TERMINATED**					Upon completion: Borehole caved to 9.7 mbgs and water to 6.1 mbgs. Borehole backfilled with bentonite.

GROUND WATER CONDITIONS

STANDARD PENETRATION TEST □
DYNAMIC PENETRATION TEST ■

SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✥ LAB VANE



WATER CONTENT (%)

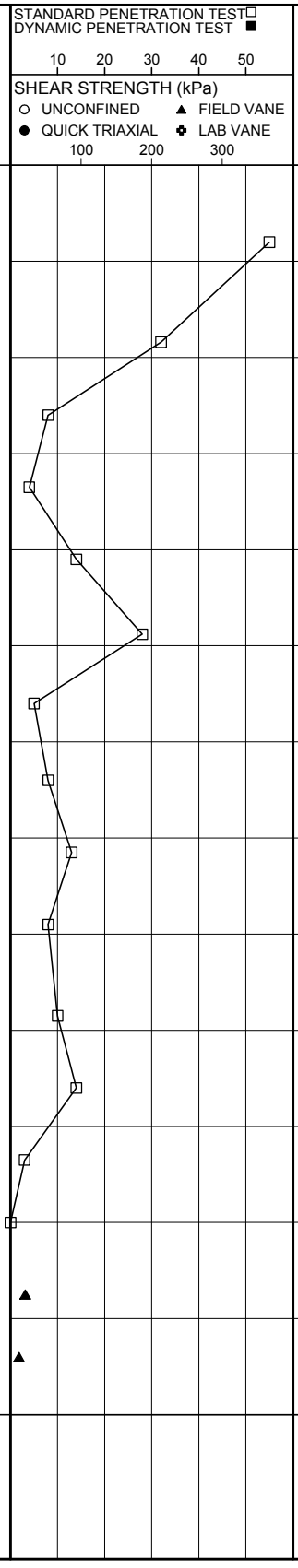
RECORD OF BOREHOLE No JB-3 1 OF 1

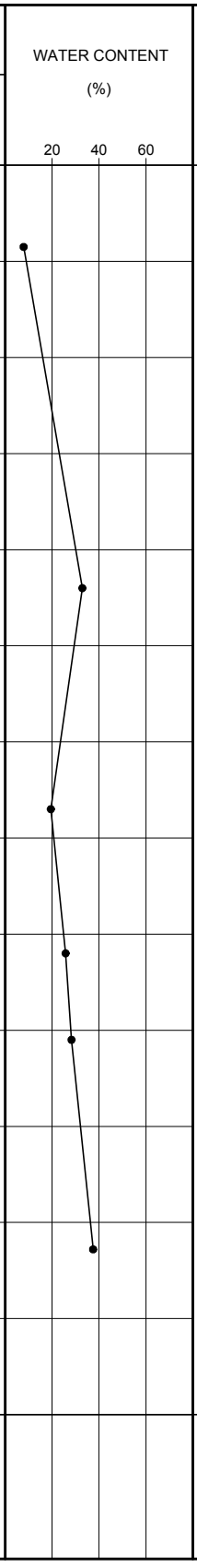
PROJECT Culvert Replacement - Hwy 101, German Twp, ON LOCATION Stn. 18+272; approx 3m south of centreline ORIGINATED BY as

CLIENT Ministry of Transportation Ontario Geocres 42A-72 COMPILED BY lc

JOB NO. TB7206006 DATE 12 February 2008 CHECKED BY hs

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	OBSERVATIONS & REMARKS
105.7								
0.0	**SAND & GRAVEL FILL** Brown, moist.		1	AS				
104.9								
0.8	**SAND FILL** Brown, trace silt and organics at approximately 3.8mbgs, moist to wet, very dense to very loose.		2	SS	55		1	
			3	SS	32		2	
			4	SS	8		3	
			5	SS	4		4	
			6	SS	14		5	
100.5			7	SS	28			
5.3	**SILTY SAND TO SANDY SILT** Grey to Brown, wet, trace clay, loose to compact.		8	SS	5		6	
			9	SS	8			
			10	SS	13		7	
			11	SS	8		8	**SS#11** 75 µm to 4.75 mm -- 25 % 2 µm to 75 µm -- 49 % <2 µm -- 26 %
			12	SS	10		9	
95.9			13	SS	14			
9.9	**SILTY CLAY** Grey, apl to wtpl, very soft to firm.		14	SS	3		10	
			15	SS	0		11	**SS#15** 75 µm to 4.75 mm -- 3 % 2 µm to 75 µm -- 26 % <2 µm -- 71 % LL - 37 % PL - 18 % PI - 19 %
				VANE		▽	12	
92.7				VANE				
13.0	**BOREHOLE TERMINATED**						13	Upon completion: Borehole open and water to 11.9 mbgs. Borehole backfilled with bentonite.





RECORD OF BOREHOLE No JB-4

1 OF 1

PROJECT Culvert Replacement - Hwy 101, German Twp, ON
LOCATION Stn. 18+252; approx 18m south of centreline Geocres 42A-72
ORIGINATED BY jf
CLIENT Ministry of Transportation Ontario
COMPILED BY jdo
JOB NO. TB7206006
DATE 24 March, 2008
CHECKED BY hs

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST □ / DYNAMIC PENETRATION TEST ■ (10 20 30 40 50) SHEAR STRENGTH (kPa) ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✤ LAB VANE (100 200 300)	WATER CONTENT (%) (20 40 60)	OBSERVATIONS & REMARKS
102.6										
0.0	150 mm **TOPSOIL**, over yellow-brown to light grey **SILT AND FINE SAND**, trace of clay below 1.8 m±, wet.		1	AS						
			2	AS						
			3	AS						
			4	AS			1			
			5	AS						**SS#7** 75 µm to 4.75 mm -- 72 % 2 µm to 75 µm -- 21 % <2 µm -- 7%
			6	AS		▽	2			
99.6			7	AS						
3.0	**BOREHOLE TERMINATED**						3			Upon completion: Borehole open; water level to 2.0 mbgs.

RECORD OF BOREHOLE No JB-5

1 OF 1

PROJECT Culvert Replacement - Hwy 101, German Twp, ON
LOCATION Stn. 18+252; approx 18m north of centreline
ORIGINATED BY jf

CLIENT Ministry of Transportation Ontario
Geocres 42A-72
COMPILED BY jdo

JOB NO. TB7206006
DATE 24 March, 2008
CHECKED BY hs

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST □ / DYNAMIC PENETRATION TEST ■ (10 20 30 40 50) SHEAR STRENGTH (kPa) ○ UNCONFINED ▲ FIELD VANE ● QUICK TRIAXIAL ✥ LAB VANE (100 200 300)	WATER CONTENT (%) (20 40 60)	OBSERVATIONS & REMARKS
101.2										
0.0	200 mm **TOPSOIL/PEAT**; over yellow-brown to light grey **SILTY FINE SAND**; occasional roots to 1.0 m±, trace clay below 1.0 m±, wet.		1	AS		▽	1			
			2	AS						
			3	AS						
			4	AS			2			
			5	AS						**SS#6** 75 µm to 4.75 mm -- 88 % 2 µm to 75 µm -- 14 % <2 µm -- 8 %
98.2			6	SS	13			□		
3.0	**BOREHOLE TERMINATED**						3			Upon completion: Borehole caved to 2.4 mbgs; water level to 1.7 mbgs.

RECORD OF BOREHOLE No JB-6

1 OF 1

PROJECT Culvert Replacement - Hwy 101, German Twp, ON
LOCATION Stn. 18+262; approx 18m south of centreline Geocres 42A-72
ORIGINATED BY jf
CLIENT Ministry of Transportation Ontario
COMPILED BY jdo
JOB NO. TB7206006
DATE 24 March, 2008
CHECKED BY hs

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	OBSERVATIONS & REMARKS
101.9								
0.0	300 mm **TOPSOIL** with **PEAT and ROOTS**, over dark brown to grey **SILTY SAND** to **SILT and SAND**, trace to some peat in upper 0.6 m±, trace of Gravel and coarse Sand, wet, compact.		1	AS				
			2	AS				
			3	AS				
			4	AS			1	
			5	SS	17		2	**SS#6** 75 µm to 4.75 mm -- 66 % 2 µm to 75 µm -- 28 % <2 µm -- 6 %
98.9			6	SS	19			
3.0	**BOREHOLE TERMINATED**						3	Upon completion: Borehole caved to 1.5 mbgs; water level at ground surface.

STANDARD PENETRATION TEST □
DYNAMIC PENETRATION TEST ■
SHEAR STRENGTH (kPa)
○ UNCONFINED ▲ FIELD VANE
● QUICK TRIAXIAL ✤ LAB VANE
10 20 30 40 50
100 200 300

WATER CONTENT (%)
20 40 60

RECORD OF BOREHOLE No JB-7

1 OF 1

PROJECT Culvert Replacement - Hwy 101, German Twp, ON
LOCATION Stn. 18+262; approx 18m north of centreline
ORIGINATED BY jf

CLIENT Ministry of Transportation Ontario
Geocres 42A-72
COMPILED BY jdo

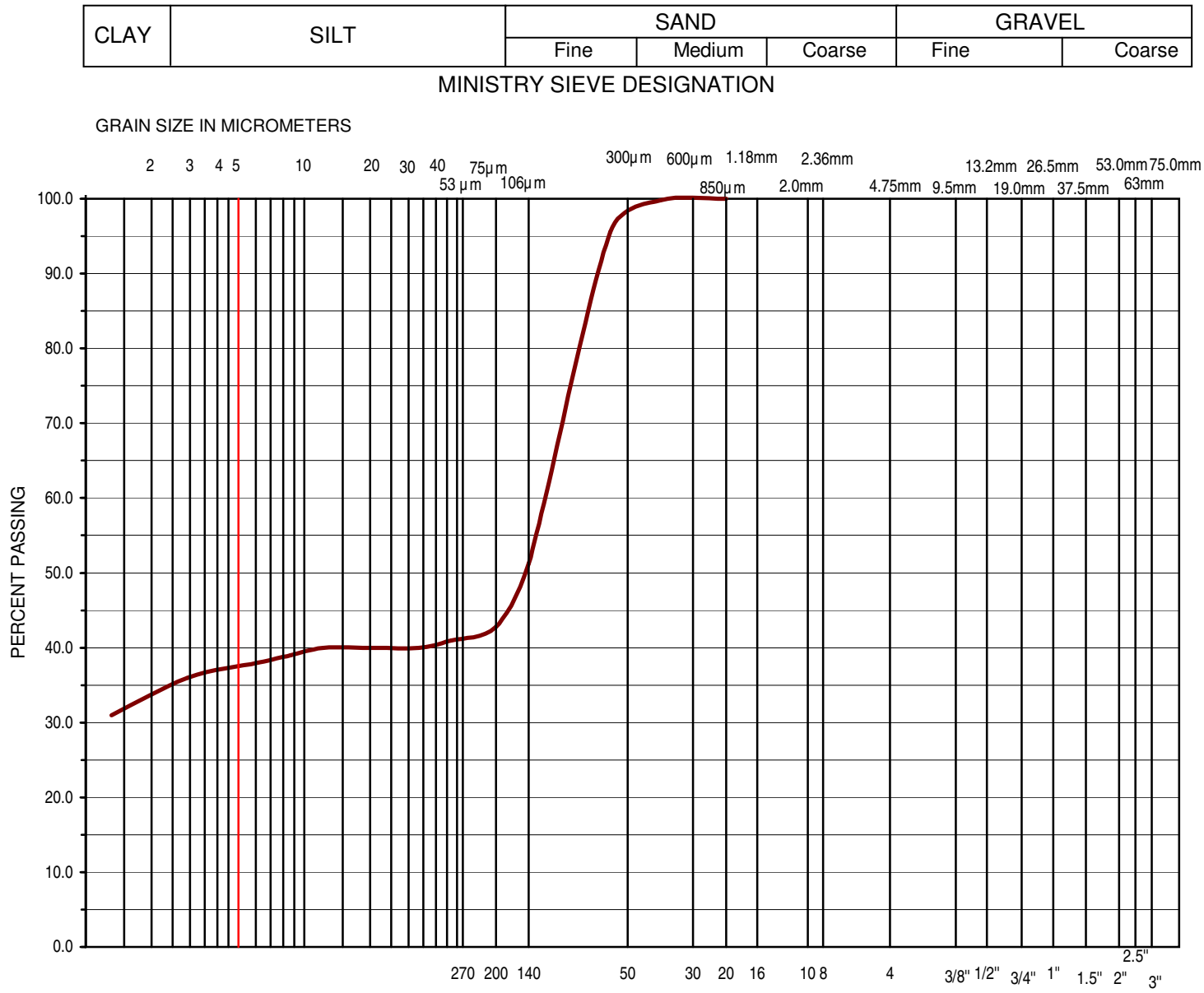
JOB NO. TB7206006
DATE 24 March, 2008
CHECKED BY hs

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	STANDARD PENETRATION TEST ○ / DYNAMIC PENETRATION TEST ■ (10 20 30 40 50) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL ▲ FIELD VANE ✤ LAB VANE (100 200 300)	WATER CONTENT (%) (20 40 60)	OBSERVATIONS & REMARKS
100.9										
0.0	**PEAT** Trace Silty Fine Sand below 1.0 m±, moist to wet.		1	AS						
			2	AS						
			3	AS			1			
			4	AS						
99.1			5	AS						
1.8	**SILTY FINE SAND** Grey, wet, loose.		6	SS	10		2			**SS#7** 75 µm to 4.75 mm -- 51 % 2 µm to 75 µm -- 41 % <2 µm -- 8 %
97.9			7	SS	6					
3.0	**BOREHOLE TERMINATED**						3			Upon completion: Borehole caved to 2.1 mbgs; water level at ground surface.

APPENDIX B

UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B1



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	100.00
0.425	99.80
0.25	95.60
0.106	51.20
0.075	42.80
0.0470	40.98
0.0334	39.98
0.0211	39.98
0.0122	39.98
0.0086	38.98
0.0061	37.98
0.0029	35.98
0.0013	30.98

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72

Clayey Sand, Trace Silt

BH 1-16

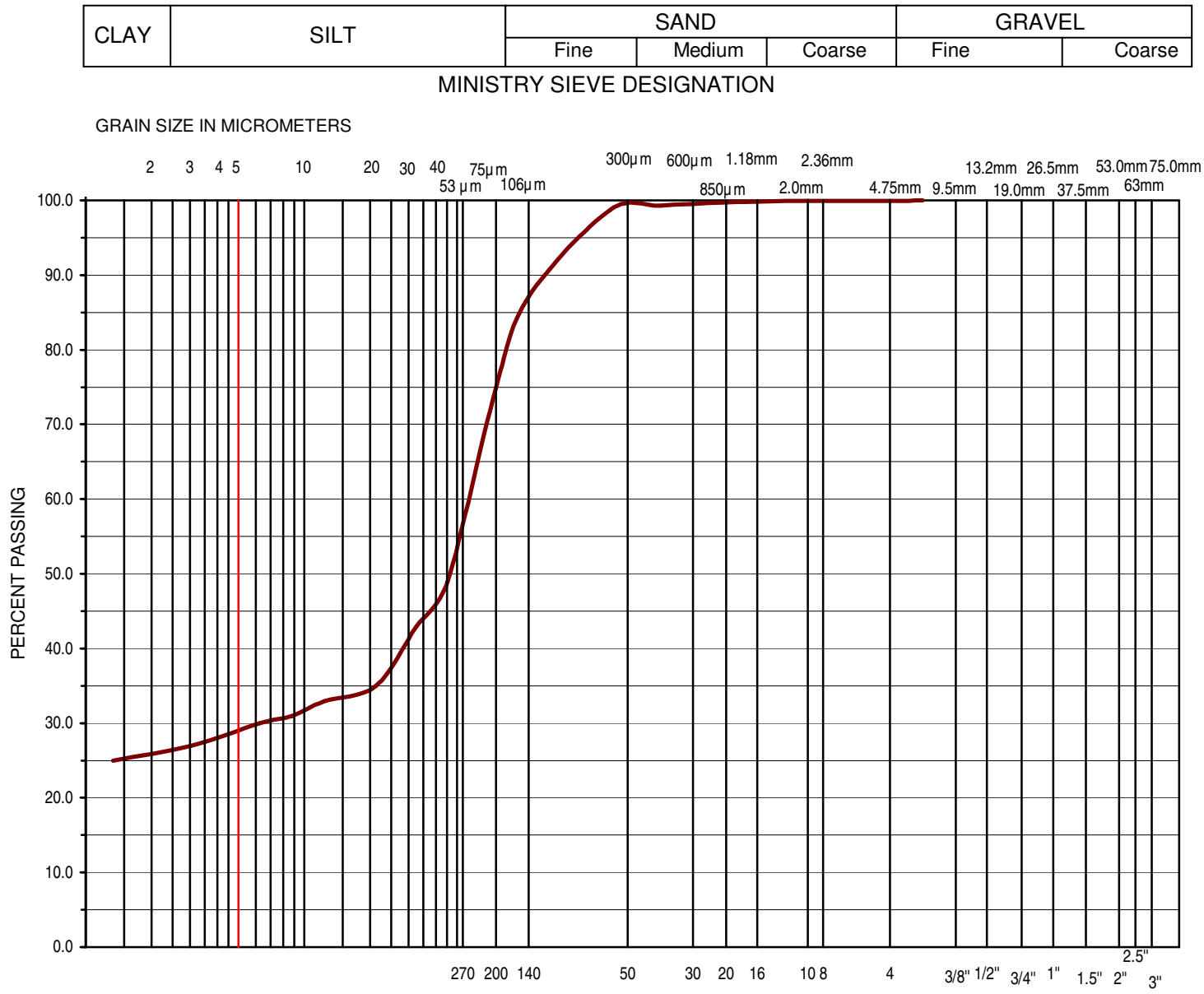
Lab No. S104 | **TB7206006** | **March 28, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B2



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	99.9
2	99.9
0.85	99.70
0.425	99.30
0.25	98.70
0.106	87.12
0.075	74.93
0.0452	48.93
0.0326	42.94
0.0212	34.95
0.0123	32.95
0.0088	30.95
0.0062	29.96
0.0030	26.96
0.0013	24.96

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72
Sandy, Clayey Silt
BH 3-11

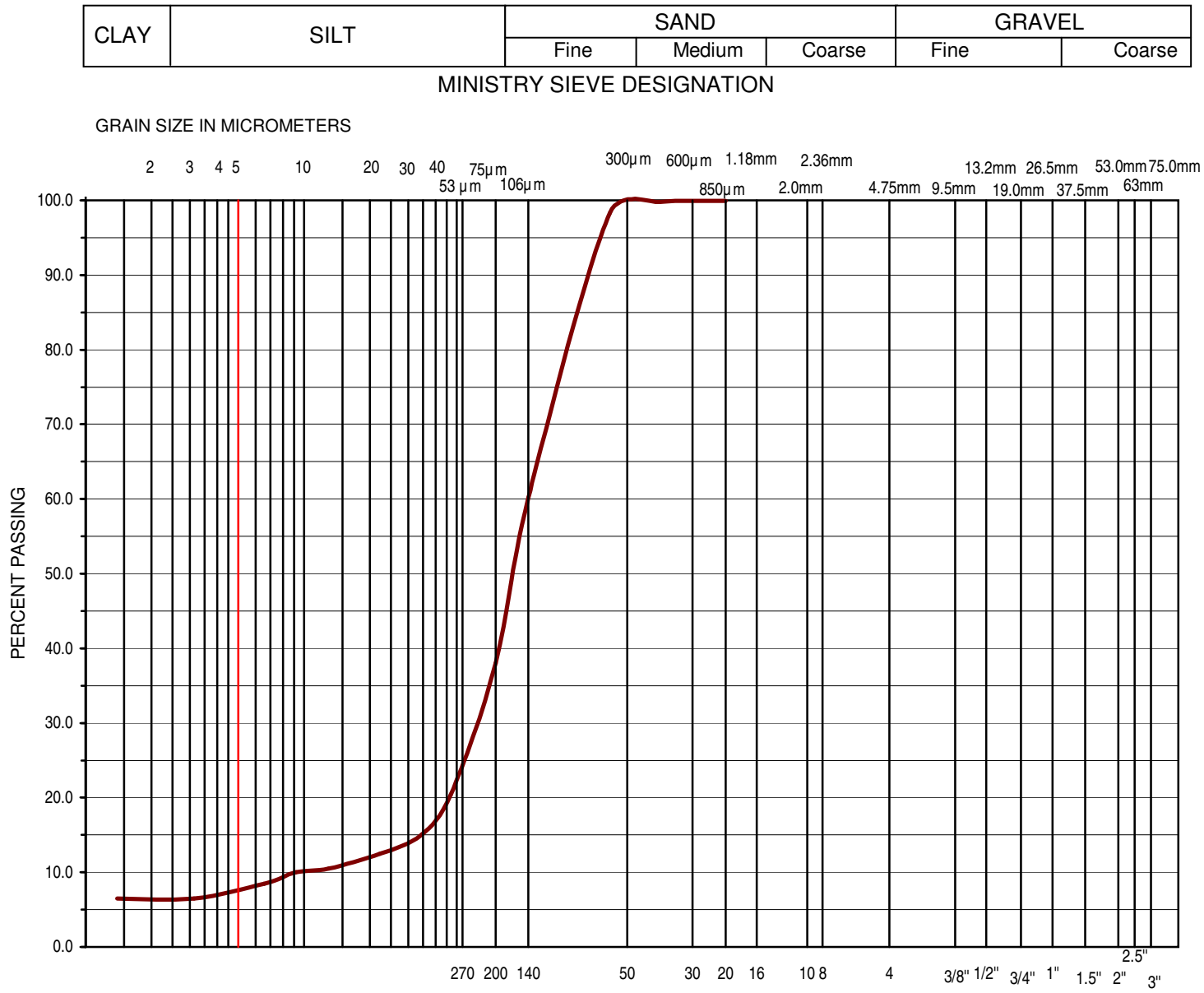
Lab No. S104 | **TB7206006** | **March 28, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B3



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.95
0.425	99.78
0.25	98.28
0.106	60.19
0.075	37.99
0.0470	20.49
0.0345	14.99
0.0222	12.49
0.0129	10.49
0.0092	9.99
0.0066	8.49
0.0031	6.50
0.0014	6.50

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72

Silty Sand, Trace Clay

BH 2-10

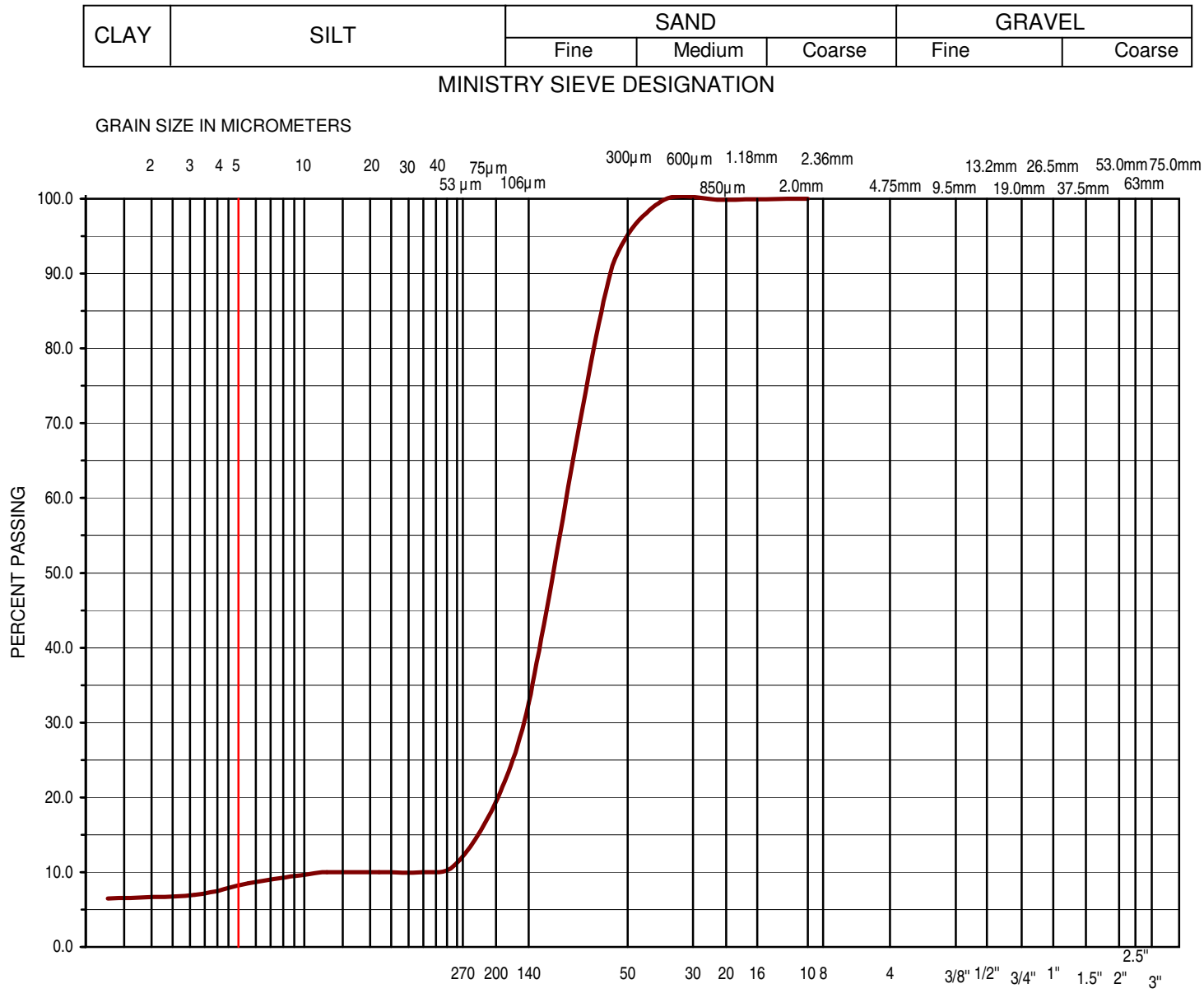
Lab No. S104 **TB7206006** **March 28, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B4



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.88
0.425	99.57
0.25	90.00
0.106	32.60
0.075	19.40
0.0488	10.99
0.0347	9.99
0.0220	9.99
0.0127	9.99
0.0092	9.50
0.0055	8.50
0.0032	7.00
0.0013	6.50

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72

Sand, Some Silt, Trace Clay

BH 1-10

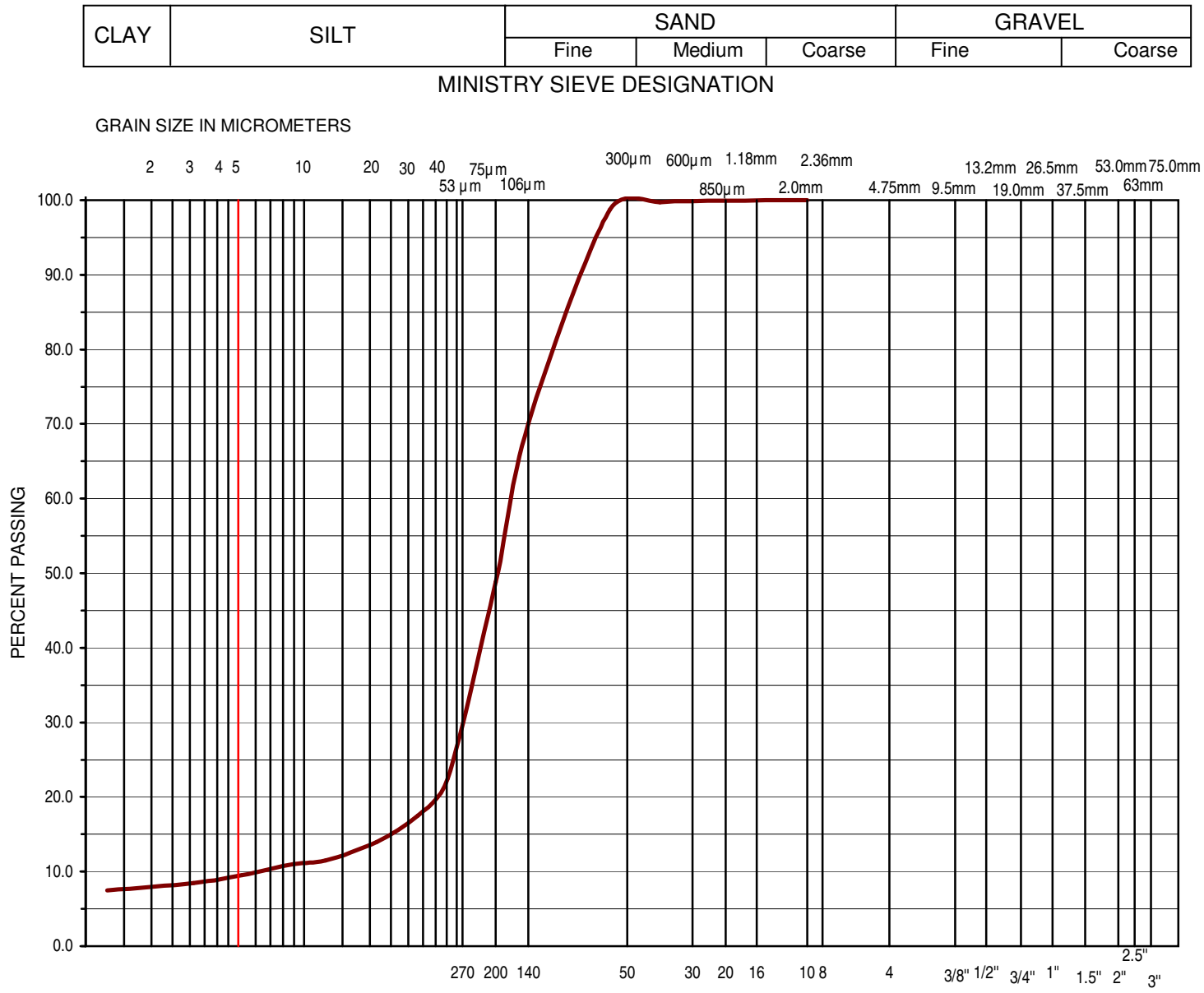
Lab No. S104 | **TB7206006** | **March 31, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B5



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.94
0.425	99.72
0.25	98.75
0.106	70.00
0.075	48.80
0.0453	22.49
0.0331	17.49
0.0214	13.99
0.0126	11.49
0.0089	10.99
0.0052	9.50
0.0031	8.50
0.0013	7.50

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72
Silt and Sand, Trace Clay

BH 7-7

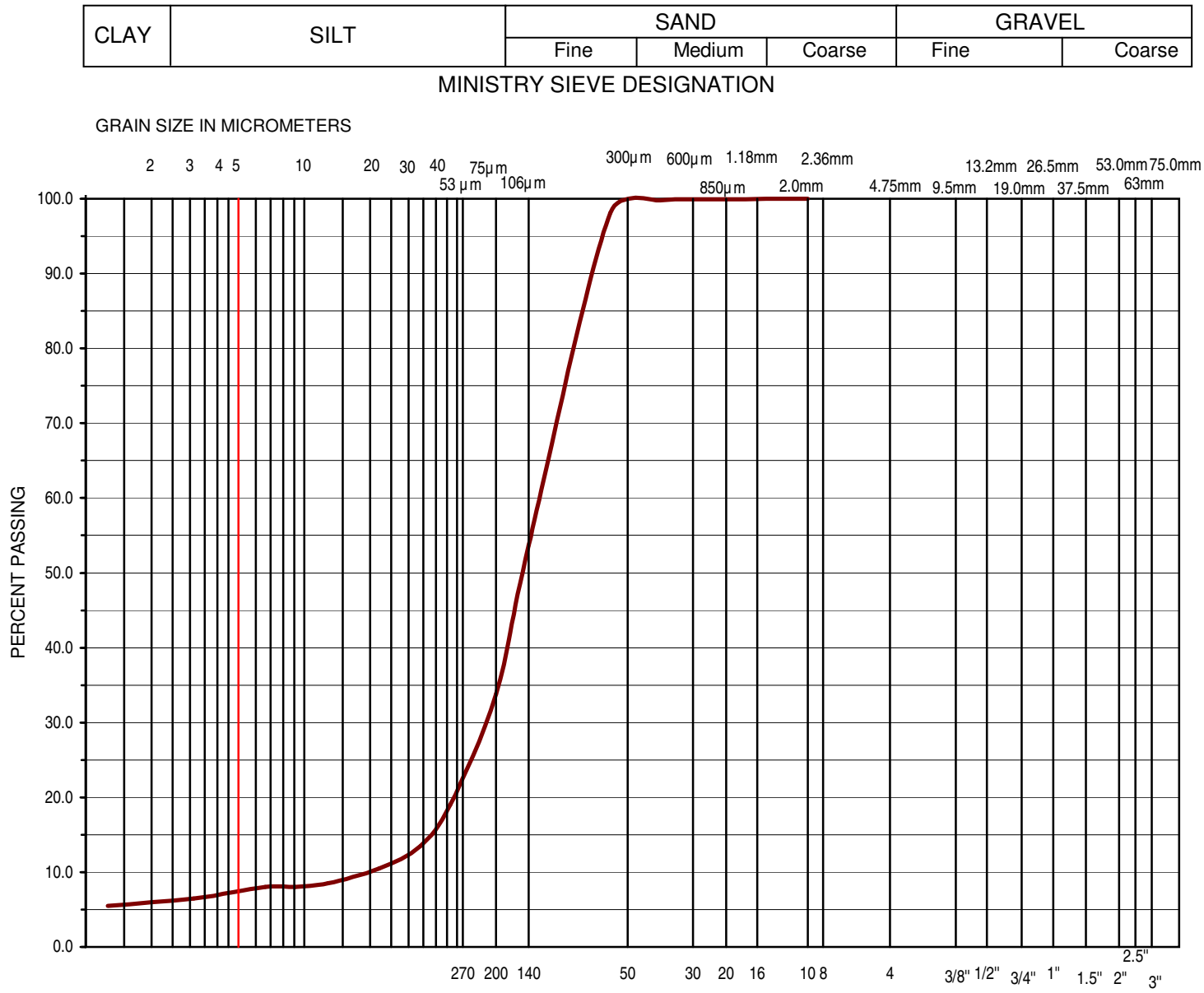
Lab No. S104 | **TB7206006** | **March 31, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B6



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.95
0.425	99.81
0.25	98.10
0.106	53.70
0.075	33.80
0.0464	18.99
0.0340	13.49
0.0219	10.49
0.0128	8.50
0.0091	8.00
0.0066	8.00
0.0031	6.50
0.0013	5.50

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72

Silty Sand, Trace Clay

BH 6-6

Lab No. S104 **TB7206006** **March 31, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

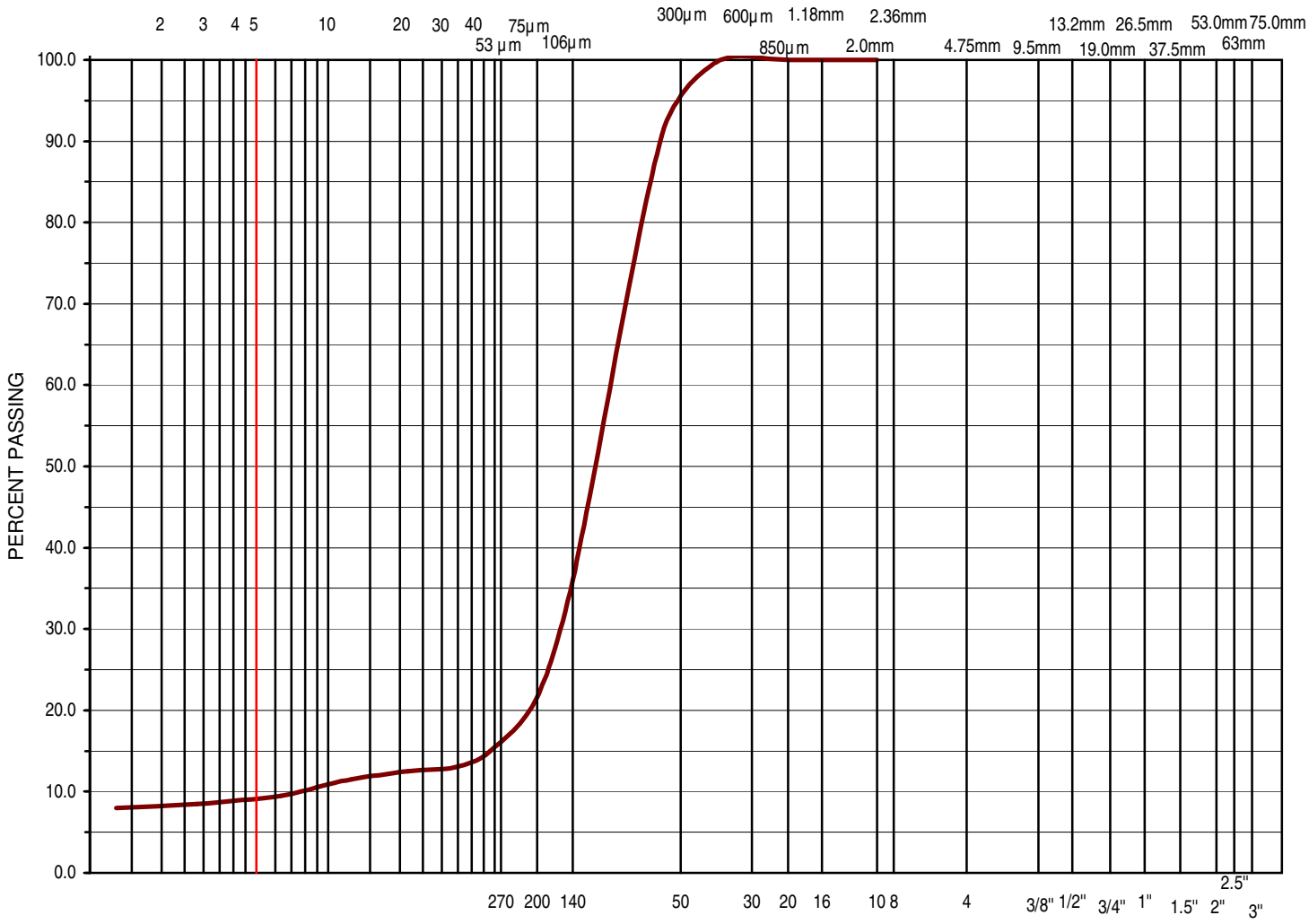
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B7

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION

GRAIN SIZE IN MICROMETERS



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.97
0.425	99.70
0.25	90.70
0.106	36.00
0.075	21.60
0.0476	14.99
0.0341	12.99
0.0216	12.49
0.0126	11.49
0.0089	10.49
0.0063	9.50
0.0028	8.50
0.0013	8.00

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72

Sand, Some Silt, Trace Clay

BH 5-6

Lab No. S104 | **TB7206006** | **March 31, 2008**

Prepared: K. Zavitz

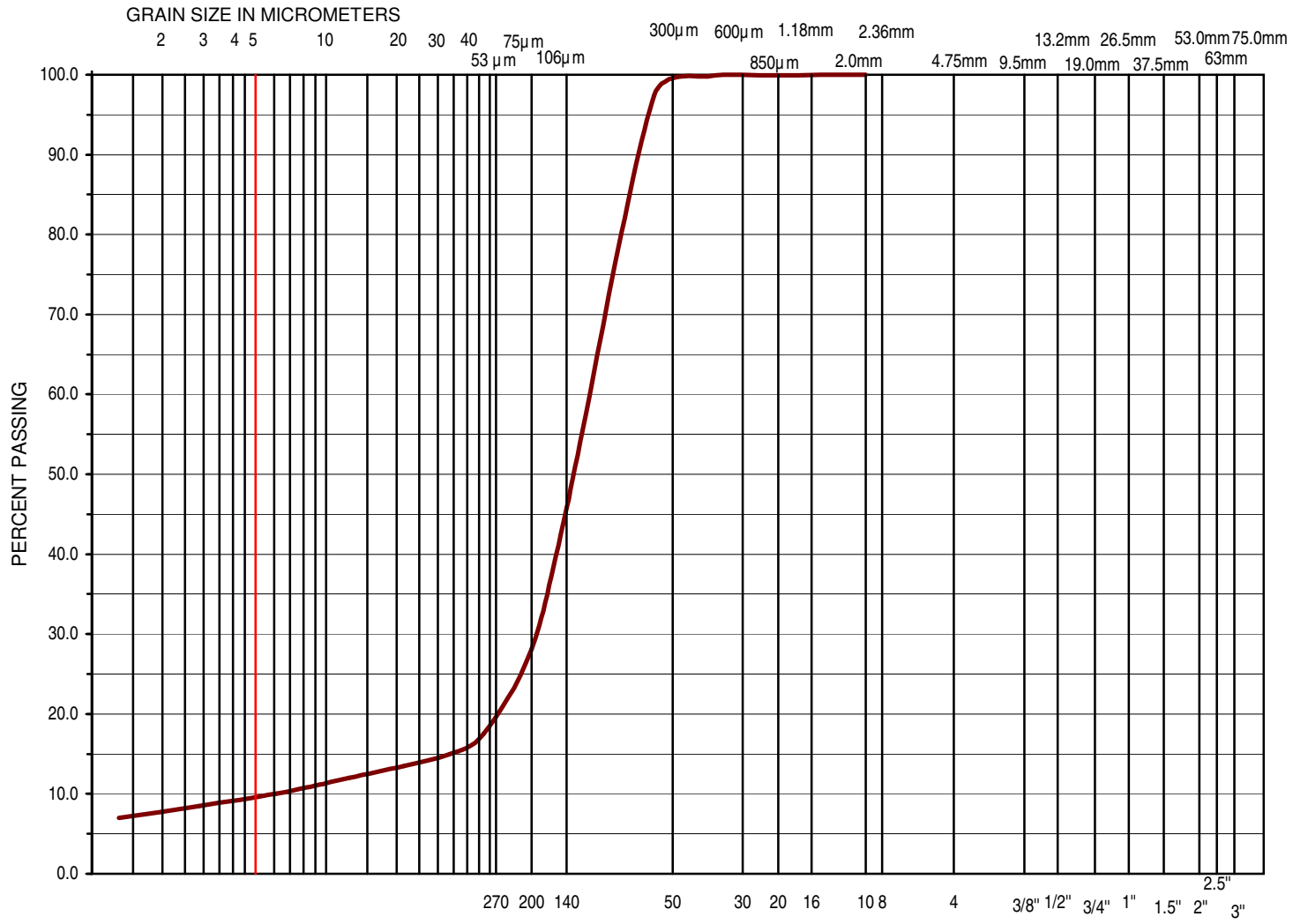
Checked: T. Hawkins

UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B8

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	99.94
0.425	99.79
0.25	97.39
0.106	45.79
0.075	28.10
0.0469	17.49
0.0337	14.99
0.0215	13.49
0.0125	11.99
0.0089	10.99
0.0061	9.99
0.0029	8.49
0.0013	7.00

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72

Silty Sand, Trace Clay

BH 4-7

Lab No. S104 | **TB7206006** | **March 31, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

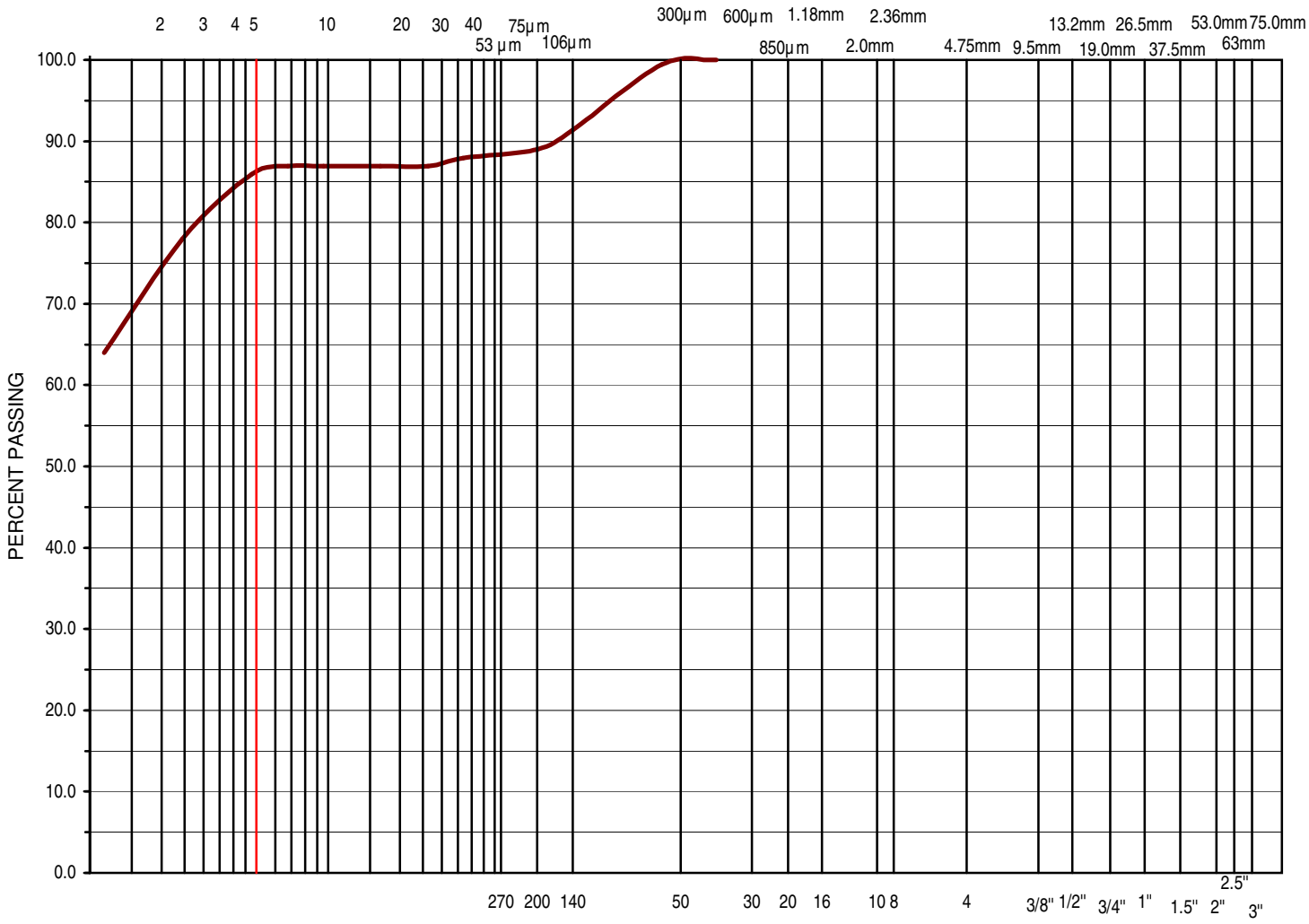
UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B9

CLAY	SILT	SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION

GRAIN SIZE IN MICROMETERS



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	100.00
0.425	100.00
0.25	99.40
0.106	91.40
0.075	89.00
0.0368	87.95
0.0262	86.95
0.0166	86.95
0.0096	86.95
0.0068	86.95
0.0048	85.95
0.0024	77.96
0.0011	63.97

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72
Clay, Some Silt & Sand

BH 2-16

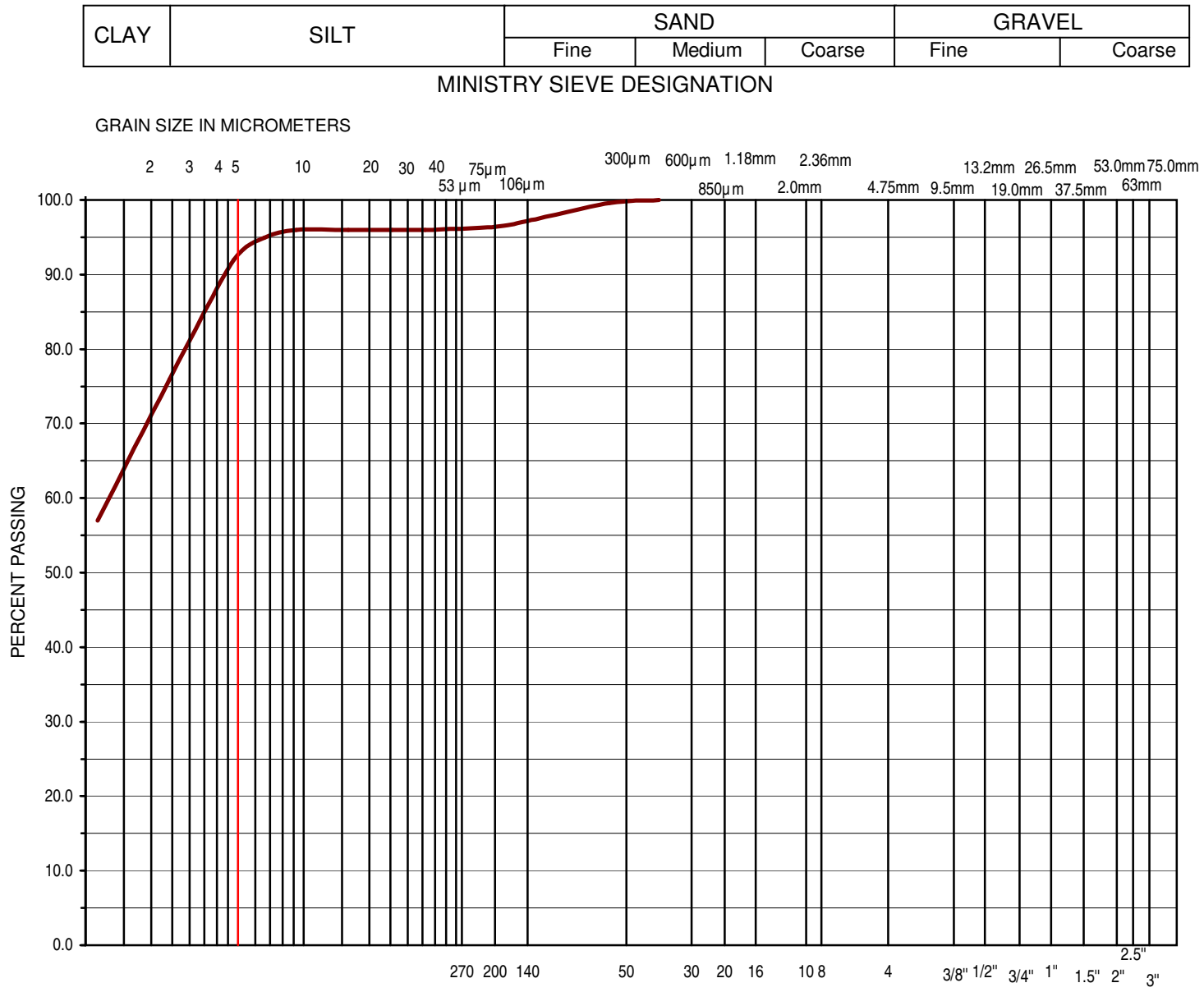
Lab No. S104 | **TB7206006** | **March 28, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

UNIFIED SOIL CLASSIFICATION SYSTEM

Enclosure: B10



Particle Size (mm)	Percent Passing
75	100.0
63	100.0
37.5	100.0
26.5	100.0
19	100.0
16	100.0
13.2	100.0
9.5	100.0
6.7	100.0
4.75	100.0
2	100.0
0.85	100.00
0.425	100.00
0.25	99.60
0.106	97.20
0.075	96.40
0.0359	95.95
0.0254	95.95
0.0160	95.95
0.0093	95.95
0.0066	94.95
0.0048	91.95
0.0024	75.96
0.0011	56.97

amec

Culvert Replacement - Hwy 101 German Twp, ON GEOCRES 42A-72

Silty Clay

BH 3-15

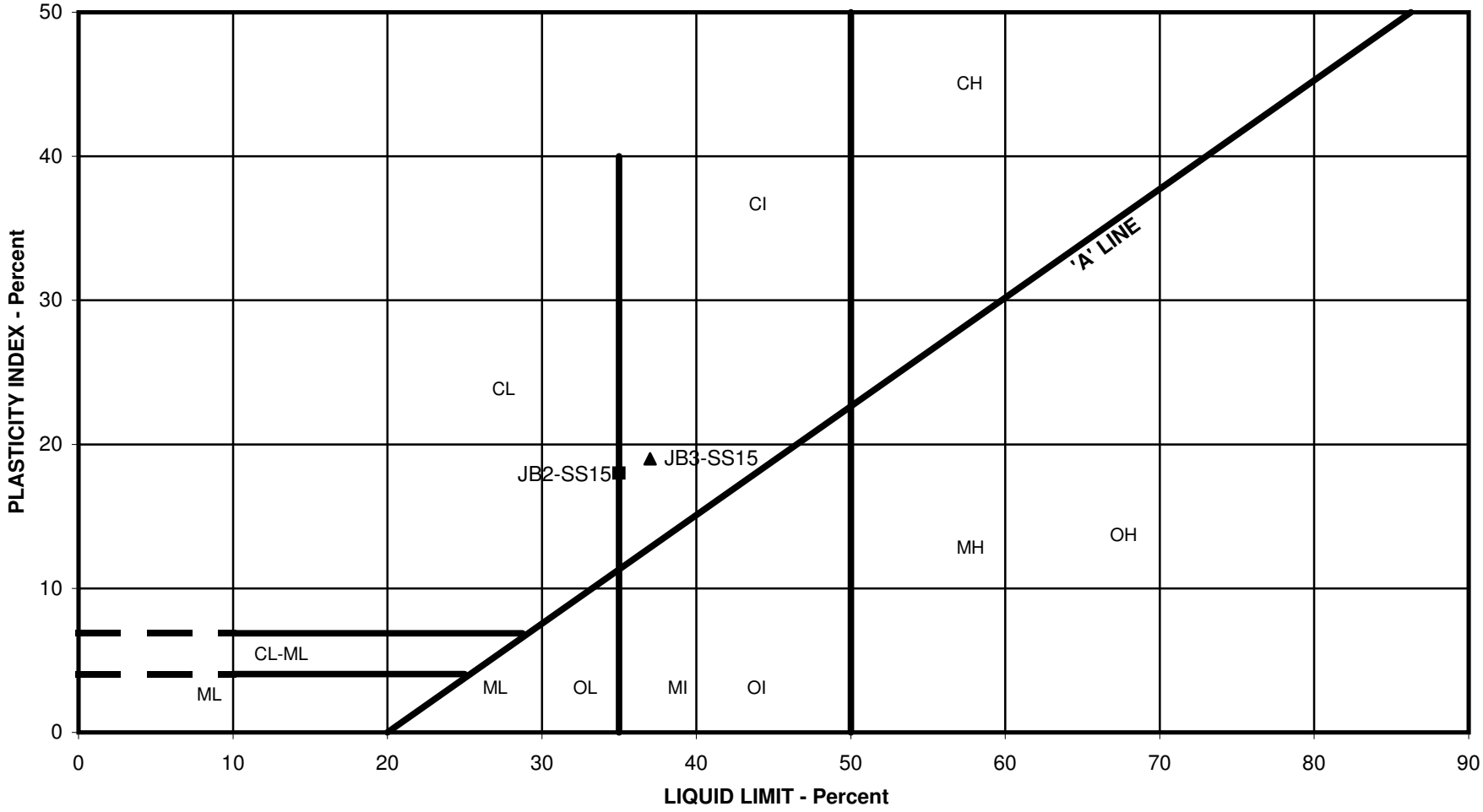
Lab No. S104 | **TB7206006** | **March 28, 2008**

Prepared: K. Zavitz

Checked: T. Hawkins

PLASTICITY CHART - S104

BH2-SS15: LL = 35, PL = 17, PI = 18 BH3-15: LL = 37, PL = 18, PI = 19
JB1-SS6: Non-plastic



Project Number: TB7206006
Culvert Replacement - Hwy 101, German Twp, ON
Date: 04 March 2008

APPENDIX C

APPENDIX C - PHOTOGRAPHIC RECORD

PROJECT NO. TB7206006

PROJECT Culvert Repllacement, MTO NE Region Agreement #5006-E-0070

LOCATION Hwy. 101, 4.3km East of Hwy 67, German Twp., ON **Page** C1

PHOTOGRAPH	1

Description

Hwy 101 - Looking East

PHOTOGRAPH	2

Description

Hwy 101 - Looking West

APPENDIX C - PHOTOGRAPHIC RECORD

PROJECT NO. TB7206006

PROJECT Culvert Repllacement, MTO NE Region Agreement #5006-E-0070

LOCATION Hwy. 101, 4.3km East of Hwy 67, German Twp., ON **Page** C2

PHOTOGRAPH	3

Description

Hwy 101 - North Slope

PHOTOGRAPH	4

Description

Hwy 101 - South Slope

APPENDIX D

NON STANDARD SPECIAL PROVISIONS

- Based on conditions encountered during the Foundation Investigation, water inflows should be anticipated into any excavations below grade. Significant sloughing and caving of temporary excavation slopes should be anticipated unless, adequate dewatering techniques and proper roadside protection (cut and cover with temporary shoring) are used.

- The nature of the native glacial deposit indicates that cobbles and boulders should be anticipated during auguring. This could result in reduced production rates.