Submitted To AECOM Canada Ltd.
189 Wyld Street Suite 103, North Bay, Ontario P1B 1Z2
On Behalf of the Ontario Ministry of Transportation

Highway 112
Bridge Rehabilitation – Site No. 47-020
Blanche River Bridge
GWP 5105-12-00

FINAL FOUNDATION INVESTIGATION REPORT

Date: May 21, 2014
Ref. N^{o}: 13/05/13073-F2

Geocres No. 41P-57

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Final Foundation Investigation Report

Prepared by:

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Property and Confidentiality

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Attention: **Mr. Al Rose**

REVISION AND PUBLICATION REGISTER		
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1 hard copy	File

1 INTRODUCTION

LVM | Merlex Ltd. has been retained by AECOM Canada Ltd., on behalf of the Ministry of Transportation of Ontario (MTO), to carry out a foundation investigation to supply subsurface data for the design of a protection system to be implemented at the Blanche River Bridge during the proposed rehabilitation, which includes conversion to semi integral abutments. The bridge is located on Highway 112, some 2.9 km north of Highway 11, in the Township of Marquis/Pacaud. The existing structure is a single span concrete deck, steel girder bridge some 42 m in length.

The foundation investigation location was specified by the MTO in the Terms of Reference for extra work under Agreement No. 5012-E-0025. The terms of reference for the scope of work are outlined in LVM | Merlex Ltd.'s Proposal P-13-022, dated February, 2013. The purpose of this investigation was to determine the subsurface conditions in the area of the bridge approaches in order to provide factual subsurface information and design recommendations for a protection system to be implemented during rehabilitation activities. LVM | Merlex Ltd. investigated the foundation area by the drilling of boreholes, carrying out in-situ tests, and performing laboratory testing on select samples.

2 SITE DESCRIPTION

The Blanche River Bridge is located on Highway 112, between approximately Stations 12+640 to 12+682, Township of Marquis/Pacaud (Site No. 47-020). The topography at the site is generally of low to moderate relief. The existing highway embankment currently supports two undivided lanes of highway, running in a south-north direction. The Blanche River flows from west to east at the bridge location. A visual review of the highway at the north and south approaches indicates that, in general, the approaches are in fair to poor condition, see Photo Essay, Appendix 4. The existing 42 m single span steel girder bridge was constructed in 1986.

Infrastructure at the bridge location consists of overhead wires to the east and west sides of the highway embankment.

2.1 SITE PHYSIOGRAPHY AND SURFICIAL GEOLOGY

This project is located in the Geomorphic Sub-province known as the Temiskaming Clay Plain. The topography along this section of Highway 112 is generally flat to slightly rolling. Organic terrain was also observed. Within the specific project area overburden consists primarily of silts and clays underlain by sands and gravels.

Bedrock in the area, as indicated on OGS Map 2506, is of the Early Precambrian Felsic Igneous and Metamorphic Rocks which consists of granitic rocks, syenite, pegmatite, and unsubdivided migmatites.

3 INVESTIGATION PROCEDURES

The field work for this investigation was carried out during the period of October 3rd to November 21st, 2013, during which four (4) sampled boreholes were advanced. Two boreholes were advanced at each end of the bridge: one through the existing approach slab and the second a short distance beyond the end of the approach slab.

The field investigation was carried out using a truck mounted CME drilling rig equipped with hollow stem augers, standard augers, and routine geotechnical sampling equipment. Prior to mobilizing the auger drill to the site, the concrete approach slabs were core drilled, where required, with an electric core drill. Soil samples were obtained at the borehole locations at regular intervals of depth using the standard 50 mm O.D. split spoon sampler advanced in accordance with the Standard Penetration Test (SPT) procedures (ASTM D-1586). The SPT method involves advancing a 50 mm O.D. split spoon sampler with the force of a 63.5 kg hammer freely dropping 760 mm, mounted in a trip (automatic) hammer. The number of blows per 300 mm penetration was recorded as the "N" value. All samples taken during this investigation were stored in labeled airtight containers for transport to our North Bay laboratory for visual examination and select laboratory testing.

Groundwater conditions in the open boreholes were observed during the advancement of and immediately following, completion of the individual boreholes. Two 19 mm diameter standpipes were installed in select boreholes prior to backfilling to allow further monitoring of the shallow groundwater level. All open boreholes were backfilled upon completion with compacted auger cuttings in the general order they were removed and bentonite pellet backfill was added to the boreholes to bring them up to grade in accordance with Ontario Regulation 903. At the borehole(s) through the embankment, the upper portion of the hole, where necessary, was backfilled with an asphalt cold patch to seal the existing asphalt surface.

The field work for this investigation was under the full time direction of a senior member of our engineering staff, who was responsible for locating the boreholes, clearing the borehole locations of underground services, in-situ sampling and testing operations, logging of the boreholes, labeling and preparation of samples for transport to our North Bay laboratory, plus overall drill supervision. All samples received a visual confirmatory inspection in our laboratory. Laboratory testing of select samples included routine testing for natural moisture content determination and particle size analysis, as well as specific gravity testing. The results of the laboratory testing are presented on the individual Record of Borehole Sheets (Appendix 2), with a summary of results presented on the laboratory sheets in Appendix C (Figures Nos. L-1 to L-5).

The location of the individual boreholes were determined in the field using highway chainage (established by others) and offset relative to highway centerline. The MTO co-ordinates, northing and easting, were then established for the boring locations. Elevations contained in this report are referenced to a geodetic datum established by others.

4 SUBSURFACE CONDITIONS

Details of the subsurface conditions revealed by the investigation program are presented on the enclosed Record of Borehole Logs (Appendix 2) and on Drawing No. 2 (Appendix 3). Please note that stratigraphic delineation presented on the borehole logs and soil strata plot are the results of non-continuous sampling, response to drilling progress, the results of SPT, and field observations. Typically such boundaries represent transitions from one zone to another and are not an exact demarcation of specific geological unit. Additional consideration should be given to the fact that subsurface conditions may vary markedly between adjacent boreholes and beyond any specific boring location, and are shown on the drawings for illustration purposes only.

4.1 BLANCHE RIVER BRIDGE

A plan and profile illustrating the borehole locations and stratigraphic sequences is shown on Drawing No. 2, Appendix 3. During the course of the exploration program, four (4) sampled boreholes were put down at this site, as follows;

- Borehole No. 1 was advanced to the north of the north approach slab to the left of centerline.
- Borehole No. 2 was advanced behind the north abutment to the right of centerline.
- Borehole No. 3 was advanced behind the south abutment to the left of centerline, and
- Borehole No. 4 was advanced to the south of the south approach slab to the right of centerline.

At the time of the subsurface investigation, the ground surface elevations at Boreholes Nos. 1 to 4 were recorded at 274.9, 274.9, 274.8, and 274.7 m, respectively.

4.1.1 Pavement Structure

At surface at Borehole Nos. 1 and 4, a pavement structure consisting of 100 mm of asphalt and 150 mm crushed gravel was penetrated. At Borehole Nos. 2 and 3, a pavement structure consisting of 150 to 175 mm of asphalt overlying a concrete slab some 200 to 225 mm thick was encountered.

4.1.2 Embankment Fill

Underlying the pavement structure at Borehole Nos. 1 to 4, a deposit of fill consisting of a mix of brown sand trace to some silt, some to with gravel was penetrated. The natural moisture content measured on samples of this deposit was in the order of 2 to 12%. Gradation analyses were carried out on six (6) samples of this deposit, the results of which indicated 15 to 30% gravel size particles, 63 to 78% sand size particles, and 5 to 12% silt and clay size particles (Figure No. L-1, Appendix 3). Based on SPT ‘N’ values of 5 to 69 blows per 300 mm penetration, the compactness of this deposit was described as loose to very dense, generally dense. This deposit was encountered to depths of 3.7, 5.8, and 2.1 m below grade at Borehole Nos. 1, 3, and 4, respectively (elevations 271.2, 269.0, and 272.6 m, respectively). Auger

refusal was encountered in this deposit at a depth of 7.5 m below grade at Borehole No. 2 (elevation 267.4 m).

4.1.3 Silt Fill

Underlying the embankment fill at Borehole No. 1, a deposit of fill consisting of brown silt with sand, with clay, trace gravel was penetrated. The natural moisture content measured on the sample of this deposit was in the order of 22%. Based on a SPT 'N' value of 27 blows per 300 mm penetration, the compactness of this deposit was described as compact. This deposit was encountered to a depth of 4.3 m below grade (elevation 270.6 m).

4.1.4 Silty Sand

Underlying the silt fill at Borehole No. 1, a deposit of brown to grey silty sand, some gravel was penetrated. The natural moisture content measured on samples of this deposit was in the order of 8 to 12%. Based on SPT 'N' values of 29 blows per 300 mm penetration to 50 blows per 100 mm penetration, the compactness of this deposit was described as compact to very dense. Auger refusal was encountered in this deposit at a depth of 7.6 m below grade (elevation 267.3 m).

4.1.5 Silty Clay

Underlying the embankment fill at Borehole Nos. 3 and 4, a deposit of grey silty clay trace sand trace gravel was penetrated. The natural moisture content measured on samples of this deposit was in the order of 15 to 37%. Hydrometer analyses were carried out on two (2) samples of this deposit, the results of which indicated 0 to 2% gravel size particles, 1 to 11% sand size particles, 40 to 49% silt size particles, and 38 to 59% clay size particles (Figure No. L-2, Appendix 3). Atterberg Limits testing was carried out on two (2) samples of this deposit, the results of which indicated a Liquid Limit in the order of 34 to 56% and a Plastic Limit in the order of 18 to 24% (Figure No. L-4, Appendix 3). Based on the results of the Atterberg Limits testing, this deposit was described as a silty clay of low to high plasticity (CL to CH). Based on SPT 'N' values of 5 to 21 blows per 300 mm penetration, the consistency of this deposit was estimated as firm to very stiff. This deposit was encountered to depths of 6.7 and 4.9 m below grade at Borehole Nos. 3 and 4, respectively (elevations 268.1 and 269.8 m, respectively).

4.1.6 Silt

Underlying the silty clay at Borehole Nos. 3 and 4, a deposit of grey silt some sand to sandy, trace clay was penetrated. The natural moisture content of measured on samples of this deposit was in the order of 26 to 36%. Hydrometer analyses were carried out on two (2) sample of this deposit, the results of which indicated 0% gravel size particles, 17 to 38% sand size particles, 57 to 77% silt size particles, and 5 to 6% clay size particles (Figure No. L-3, Appendix 3). Based on SPT 'N' values of 5 to 11 blows per 300 mm penetration, the compactness of this deposit was described as loose to compact, generally loose. This deposit was encountered to a depth of 10.4 m below grade at Borehole Nos. 3 and 4 (elevations 264.4 and 264.3 m, respectively).

4.1.7 Sand

Underlying the silt at Borehole Nos. 3 and 4, a deposit of grey sand some to with silt was penetrated. The natural moisture content measured on samples of this deposit was in the order of 19 to 23%. Based on STP 'N' values of 5 to 12 blows per 300 mm penetration, this deposit was described as loose to compact, generally loose. Sampling was terminated in this deposit at a depth of 12.6 m below grade at Borehole Nos. 3 and 4 (elevations 262.2 and 262.1 m, respectively).

4.1.8 Previous Investigations

A previous foundation investigation, W.P. 35-80-02, was carried out at this location in 1985 by C. Mirza Engineering Inc. The results of the previous investigation indicated the subsurface soils at the north approach consisted of silty clay fills overlying granite gneiss bedrock at between elevations 266.3 to 268.8 m. The subsurface soils at the south approach consisted of silty clay fill overlying silty clay, overlying silty sands to sand deposits. Bedrock was encountered at elevation 255.2 m at the south approach (see Enclosure No. 7, Appendix 5). Based on Contract No. 86-207, the bridge was founded on deep foundations (H piles driven to refusal) at the south abutment and on a shallow foundation bearing on bedrock at the north abutment (see Enclosure No. 8, Appendix 5).

4.2 GROUNDWATER DATA

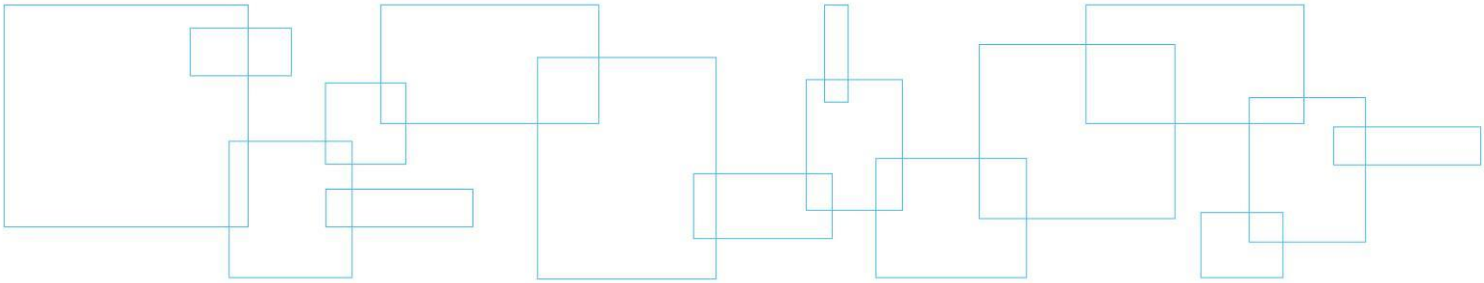
Measurements of the groundwater table and cave-in levels were undertaken, where possible, in the open boreholes during the advance of the individual borings and upon completion. Piezometers were installed in Borehole Nos. 1 and 3 to obtained stabilized water levels. These levels are recorded on the individual Record of Borehole Log Sheets (Appendix B).

The groundwater levels in Borehole Nos. 1 to 4 were measured at elevations between 268.5 to 268.7 m. The water level in the Blanche River was measured at elevation 269.4 m in November 2013.

The groundwater and river water levels will fluctuate seasonally/yearly.

Appendix 1 Key Plan

Drawing No. 1 Key Plan



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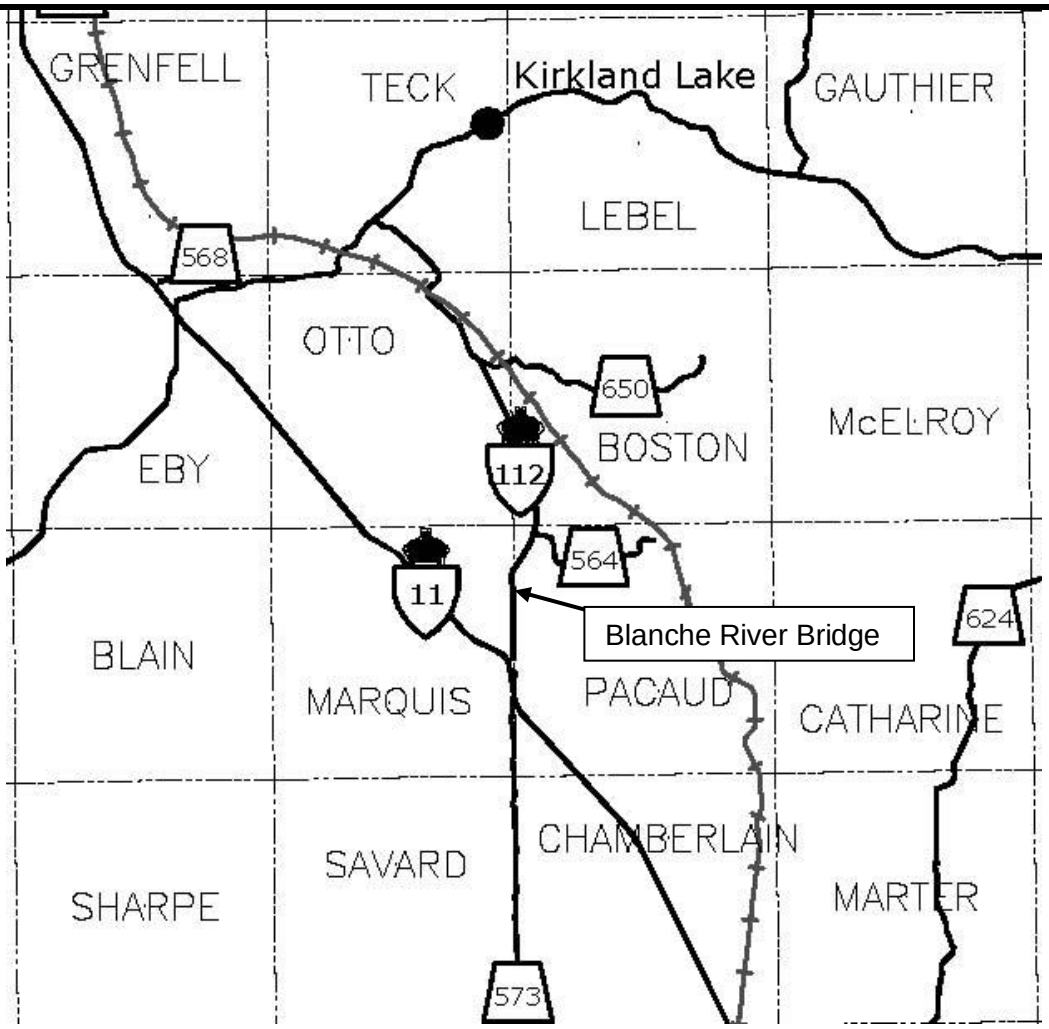
KEY PLAN

Drawing No. 1

NOT TO SCALE



FINAL
FOUNDATION INVESTIGATION REPORT
GWP 5105-12-00

Highway 112

Blanche River Bridge

Reference No: 13/05/13073-F2

May 2014

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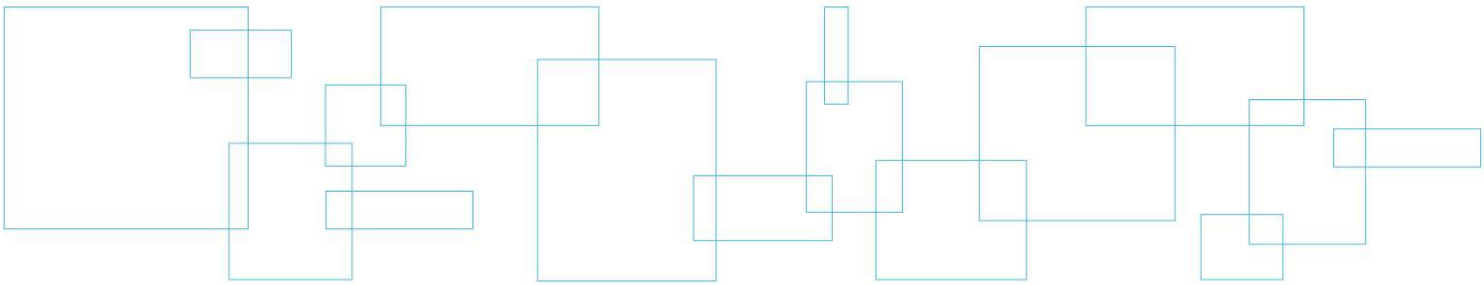
Appendix 2 Subsurface Data

Enclosure No. 1 List of Abbreviations and Symbols
Enclosure Nos. 2 to 5 Record of Borehole Sheet



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LIST OF ABBREVIATIONS & DESCRIPTION OF TERMS

The abbreviations and terms, used to describe retrieved samples and commonly employed on the borehole logs, on the figures and in the report are as follows:

1. ABBREVIATIONS

AS Auger Sample
CS Chunk Sample
DS Denison type sample
FS Foil Sample
NFP No Further Progress
PH Sampler advanced by hydraulic pressure
PM Sampler advanced by manual pressure
RC Rock core with size & percentage of recovery
SS Split Spoon
ST Slotted Tube
TO Thin-walled, open
TP Thin-walled, piston
WS Wash Sample
Rec % recovery from individual run of rock core
RQD Rock quality designation (%)

2. PENETRATION RESISTANCE/"N"

Dynamic Cone Penetration Test (DCPT):

A continuous profile showing the number of blows for each 300 mm of penetration of a 50 mm diameter 60° cone attached to AW rod driven by a 63 kg hammer falling 760 mm.

Plotted as —•—•—•—•

Standard Penetration Test (SPT) or "N" Values

The number of blows of a 63 kg hammer falling 760 mm required to advance a 50 mm O.D. drive open sampler 300 mm.

3. SOIL DESCRIPTION

a) *Cohesionless Soils:*

"N" (blows/0.3 m)	*Relative Density*
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

b) *Cohesive Soils:*

Undrained Shear Strength (kPa)	*Consistency*
Less than 12	very soft
12 to 25	soft
25 to 50	firm
50 to 100	stiff
100 to 200	very stiff
over 200	hard

3. SOIL DESCRIPTION (Cont'd)

c) Cohesive Soils:

RQD (%)	*Classification*
Less than 25	Very poor quality
25 to 50	Poor quality
50 to 75	Fair quality
75 to 90	Good quality
90 to 100	Excellent quality

d) *Method of Determination of Undrained Shear Strength of Cohesive Soils:*

+ 3.2 - Field Vane test in borehole. The number denotes the sensitivity to remoulding.

D - Laboratory Vane Test

¨ - Compression test in laboratory

For a saturated cohesive soil the undrained shear strength is taken as one-half of the undrained compressive strength.

e) *Soil Moisture:*

Moisture	*Described as*
Dry	Below optimum moisture content
Moist	Near optimum moisture content
Wet	Above optimum moisture content

4. TERMINOLOGY

Terminology used for describing soil strata is based on the proportion of individual particle sizes present in the samples (please note that, with the exception of those samples subject to a grain-size analysis, all samples were classified visually and the accuracy of visual examination is not sufficient to determine exact grain sizing):

Trace, or occasional	Less than 10%
Some	10 to 20%
With	20 to 30%
Adjective (i.e. silty or sandy)	30 to 40%
And (i.e. sand and gravel)	40 to 60%

Terminology for cobbles and boulders is based on auger response and field observations:

Occasional	Obstructions encountered in borehole, however advance is not impeded
Numerous	Obstructions are essentially continuous over drilled length

SAMPLE DESCRIPTION NOTES:

1. **FILL:** The term fill is used to designate all man-made deposits of natural soil and/or waste materials. The reader is cautioned that fill materials can be very heterogeneous in nature and variable in depth, density and degree of compaction. Fill materials can be expected to contain organics, waste materials, construction materials, shot rock, rip-rap, and/or larger obstructions such as boulders, concrete foundations, slabs, abandoned tanks, etc.; none of which may have been encountered in the borehole. The description of the material penetrated in the borehole therefore may not be applicable as a general description of the fill material on the site as boreholes cannot accurately define the nature of fill material. During the boring and sampling process, retrieved samples may have certain characteristics that identify them as 'fill'. Fill materials (or possible fill materials) will be designated on the Borehole Logs. If fill material is identified on the site, it is highly recommended that testpits be put down to delineate the nature of the fill material. However, even through the use of testpits defining the true nature and composition of the fill material cannot be guaranteed. Fill deposits often contain pockets or seams of organics, organically contaminated soils or other deleterious material that can cause settlement or result in the production of methane gas. It should be noted that the origins and history of fill material is frequently very vague or non-existent. Often fill material may be contaminated beyond environmental guidelines and the material will have to be disposed of at a designated site (i.e. registered landfill). Unless requested or stated otherwise in this report, fill material on this site has not been tested for contaminants however, environmental testing of the fill material can be carried out at your request. Detection of underground storage tanks cannot be determined with conventional geotechnical procedures.

2. **TILL:** The term till indicates a material that is an unstratified, glacial deposit, heterogeneous in nature and, as such, may consist of mixtures and pockets of clay, silt, sand, gravel, cobbles and/or boulders. These heterogeneous deposits originate from a geological process associated with glaciation. It must be noted that due to the highly heterogeneous nature of till deposits, the description of the deposit on the borehole log may only be applicable to a very limited area and therefore, caution must be exercised when dealing with a till deposit. When excavating in till, contractors may encounter cobbles/boulders or possibly bedrock even if they are not indicated on the borehole logs. It must be appreciated that conventional geotechnical sampling equipment does not identify the nature or size of any obstruction.

3. **BEDROCK:** Auger refusal may be due to the presence of bedrock, but possibly could also be due to the presence of very dense underlying deposits, boulders or other large obstructions. Auger refusal is defined as the point at which an auger can no longer be practically advanced. It must be appreciated that conventional geotechnical sampling equipment does not differentiate between nature and size of obstructions that prevent further penetration of the boring below grade. Bedrock indicated on the borehole logs will be labeled 'possibly' or 'probable' etc. based on the response of the boring and sampling equipment, surrounding topography, etc. Bedrock can be proven at individual borehole locations, at your request, by diamond core drilling operations or, possibly, by testpits. It must also be appreciated that bedrock surfaces can be, and most times are, very erratic in nature (i.e. sheer drops, isolated rock knobs, etc.) and caution must be used when interpreting subsurface conditions between boreholes. A bedrock profile can be more accurately estimated, at the clients' request, through a series of closely positioned unsampled auger probes combined with core drilling.

4. **GROUNDWATER:** Although the groundwater table may have been encountered during this investigation and the elevation noted in the report and/or on the record of boreholes, it must be appreciated that the elevation of the groundwater table will fluctuate based upon seasonal conditions, localized changes, erratic changes in the underlying soil profile between boreholes, underlying soil layers with highly variable permeabilities, etc. These conditions may affect the design and type and nature of dewatering procedures. Cave-in levels recorded in borings give a general indication of the groundwater level in cohesionless soils however, it must be noted that cave-in levels may also be due to the relative density of the deposit, drilling operations etc.

ENCLOSURE NO.:2 (Pg. 1 of 1)

METRIC

RECORD OF BOREHOLE NO. 1

L|V|M

REFERENCE 13/05/13073-F2 DATUM Geodetic LOCATION N 5317796.9 E 378072.5 - Twp of Marquis/Pacaud, Station 12+692 ORIGINATED BY JL

PROJECT GWP 5136-12-00, Highway 112 - Blanche River Bridge BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2013 October 3 TIME (Completed) CHECKED BY MAM

DATE (Completed) 2013 October 3

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
274.9	Ground Surface										
0.0	100 mm asphalt 150 mm crushed gravel										
	FILL - sand trace silt with gravel brown, dry (compact/dense)		1	SS	34				○		30 65 (5)
			2	SS	28		274		○		
			3	SS	36		273		○		
			4	SS	50				○		28 63 (9)
			5	SS	36		272		○		
271.2											
3.7	FILL - mix of silt with sand with clay trace gravel brown, wet (compact)		6	SS	27		271		○		
270.6											
4.3	SILTY SAND some gravel brown, moist (compact/dense)		7	SS	29		270		○		
	grey		8	SS	50/100 mm	▽▼	269		○		
							268				
267.3			9	SS	25/25 mm	▽			○		
7.6	Auger Refusal End of Borehole										

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+ 3, × 3 : Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1) 13/10/3 5:15:00 PM	7.5 ▽	-
2) 13/10/4 7:35:00 AM	6.2 ▽	-
3) 13/10/4 1:00:00 PM	6.2 ▼	-

MEL-GEO 13073-F2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/5/20

L|V|M
120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

ENCLOSURE NO.:3 (Pg. 1 of 1)

METRIC

RECORD OF BOREHOLE NO. 2

L|V|M

REFERENCE 13/05/13073-F2 DATUM Geodetic LOCATION N 5317791.9 E 378078.4 - Twp of Marquis/Pacaud, Station 12+686 ORIGINATED BY JL

PROJECT GWP 5136-12-00, Highway 112 - Blanche River Bridge BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2013 November 21 TIME (Completed) CHECKED BY MAM

DATE (Completed) 2013 November 21

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
274.9	Ground Surface										
0.0	150 mm Asphalt 225 mm Concrete										
	FILL - sand trace silt with gravel brown, dry (compact/very dense)		1	AS					○		
			2	SS	34		274		○		
			3	SS	69		273		○		
			4	SS	52		272		○		
			5	SS	40				○		
			6	SS	23		271		○		
			7	SS	38		270		○		
	moist		8	SS	39		269		○		
267.4							268				
7.5	Auger Refusal End of Borehole										

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

$+^3$, $\times^3$: Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

	Date (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1)		-	-
2)		-	-
3)		-	-

MEL-GEO 13073-F2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/5/20

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120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

ENCLOSURE NO.:4 (Pg. 1 of 2)

METRIC

RECORD OF BOREHOLE NO. 3

REFERENCE 13/05/13073-F2 DATUM Geodetic LOCATION N 5317743.5 E 378083.1 - Twp of Marquis/Pacaud, Station 12+638 ORIGINATED BY JL

PROJECT GWP 5136-12-00, Highway 112 - Blanche River Bridge BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2013 October 3 TIME (Completed) CHECKED BY MAM

DATE (Completed) 2013 October 3

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
274.8	Ground Surface										
0.0	175 mm asphalt 200 mm concrete										
	FILL - sand trace silt some to with gravel brown, dry (loose/dense)		1	SS	29		274				
			2	SS	29						15 78 (7)
			3	SS	50		273				
			4	SS	28		272				
			5	SS	20						21 74 (5)
			6	SS	7		271				
			7	SS	5		270				17 77 (6)
	moist										
269.0							269				
5.8	SILTY CLAY some sand trace gravel grey, wet (firm)		8	SS	3	▼					2 11 49 38
268.1							268				
6.7	SILT some sand to sandy, trace clay grey, wet (loose/compact)		9	SS	11	▽	267				
			10	SS	5		266				0 38 57 5
	Continued Next Page						265				

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

$+^3$, $\times^3$: Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1) 13/10/3 5:50:00 PM	6.8 ▽	-
2) 13/10/4 7:30:00 AM	6.4 ▽	-
3) 13/10/4 1:00:00 PM	6.4 ▼	-

MEL-GEO 13073-F2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/5/20

L|V|M
120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

METRIC

RECORD OF BOREHOLE NO. 3

L|V|M

REFERENCE 13/05/13073-F2 DATUM Geodetic LOCATION N 5317743.5 E 378083.1 - Twp of Marquis/Pacaud, Station 12+638 ORIGINATED BY JL

PROJECT GWP 5136-12-00, Highway 112 - Blanche River Bridge BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2013 October 3 TIME (Completed) CHECKED BY MAM

DATE (Completed) 2013 October 3

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES						
	Continued from Previous Page										
264.4											
10.4	SAND some to with silt										
	grey, wet										
	(loose)		11	SS	5		264				
							263				
262.2			12	SS	7						
12.6	End of Borehole										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)

MEL-GEO 13073-F2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/5/20

L|V|M
120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

ENCLOSURE NO.:5 (Pg. 1 of 2)

METRIC

RECORD OF BOREHOLE NO. 4

L|V|M

REFERENCE 13/05/13073-F2 DATUM Geodetic LOCATION N 5317736.6 E 378089.3 - Twp of Marquis/Pacaud, Station 12+630 ORIGINATED BY JL

PROJECT GWP 5136-12-00, Highway 112 - Blanche River Bridge BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2013 October 4 TIME (Completed) CHECKED BY MAM

DATE (Completed) 2013 October 4

ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
274.7	Ground Surface										
0.0	100 mm asphalt 150 mm crushed gravel FILL - sand trace silt trace gravel brown, dry (dense/very dense)		1	SS	43		274				
			2	SS	58						
			3	SS	50/50 mm		273				23 65 (12)
272.6											
2.1	SILTY CLAY trace sand grey, moist (firm/very stiff)		4	SS	21		272				
			5	SS	5						
			6	SS	10		271				0 1 40 59
269.8			7	SS	8		270				
4.9	SILT some sand trace clay grey, wet (loose)		8	SS	5	▽	269				
			9	SS	6		268				
			10	SS	5		267				0 17 77 6
	Continued Next Page						266				
							265				

COMMENTS

The stratification lines represent approximate boundaries. The transition may be gradual.

+ 3, × 3 : Numbers on right refer to Sensitivity
Numbers on left refer to values greater than 120 kPa

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (yy/mm/dd)/Time	Water Depth (m)	Cave In (m)
1) 13/10/4 12:40:00 PM	6.2 ▽	7.2 ▨
2)	- ▽	-
3)	- ▼	-

MEL-GEO 13073-F2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/5/20

L|V|M
120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

ENCLOSURE NO.:5 (Pg. 2 of 2)

METRIC

RECORD OF BOREHOLE NO. 4

L|V|M

REFERENCE 13/05/13073-F2 DATUM Geodetic LOCATION N 5317736.6 E 378089.3 - Twp of Marquis/Pacaud, Station 12+630 ORIGINATED BY JL

PROJECT GWP 5136-12-00, Highway 112 - Blanche River Bridge BOREHOLE TYPE Truck Mounted CME 45B - Hollow Stem Augers COMPILED BY AT

CLIENT AECOM Inc. DATE (Started) 2013 October 4 TIME (Completed) CHECKED BY MAM

DATE (Completed) 2013 October 4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES						
	Continued from Previous Page										
264.3											
10.4	SAND some to with silt										
	grey, wet						264				
	(loose/compact)		11	SS	6						
							263				
262.1			12	SS	12						
12.6	End of Borehole										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m^3

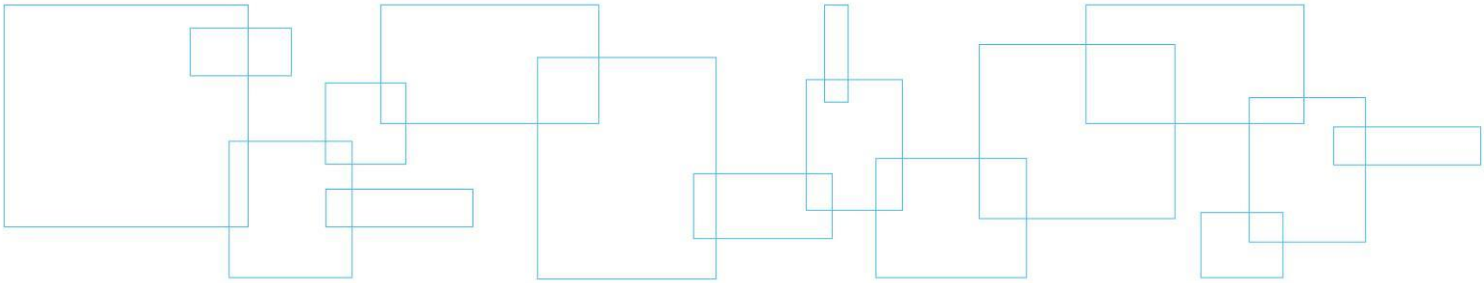
REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)

MEL-GEO 13073-F2 - BOREHOL LOGS.GPJ MEL-GEO.GDT 14/5/20

L|V|M
120 Progress Court, North Bay, On P1A 0C2 Phone: (705)476-2550 Fax: (705)476-8882 Email: northbay@lvm.ca

Appendix 3 Lab Data

Drawing No. 2:	Borehole Location and Soil Strata
Figure Nos. L-1 to L-3:	Grain Size Distribution Curves
Figure No. L-4	Atterberg Limits Summary Chart
Figure No. L-5:	Lab Test Summary Sheet



LVM | MERLEX

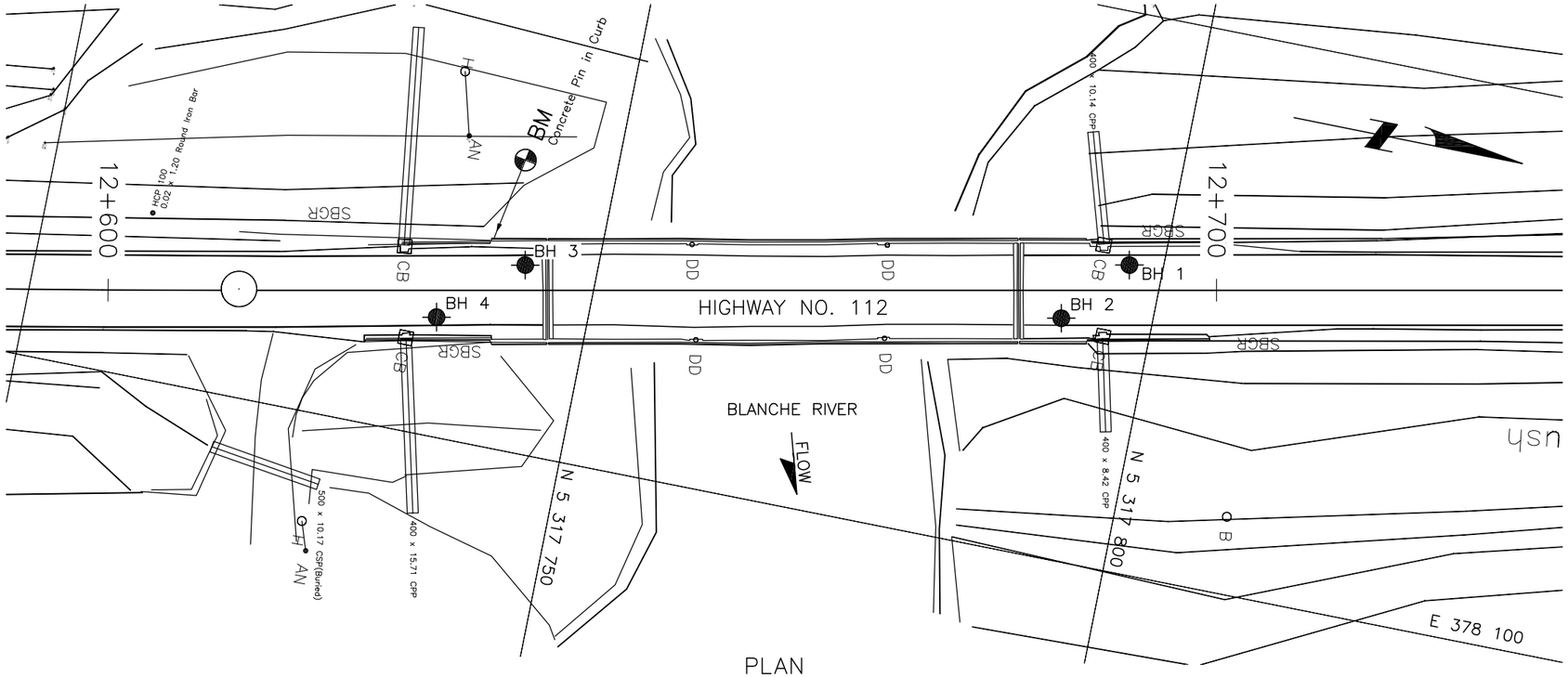
CONT. No.
XXXX–XXXX

GWP. No.
5105–12–00

N

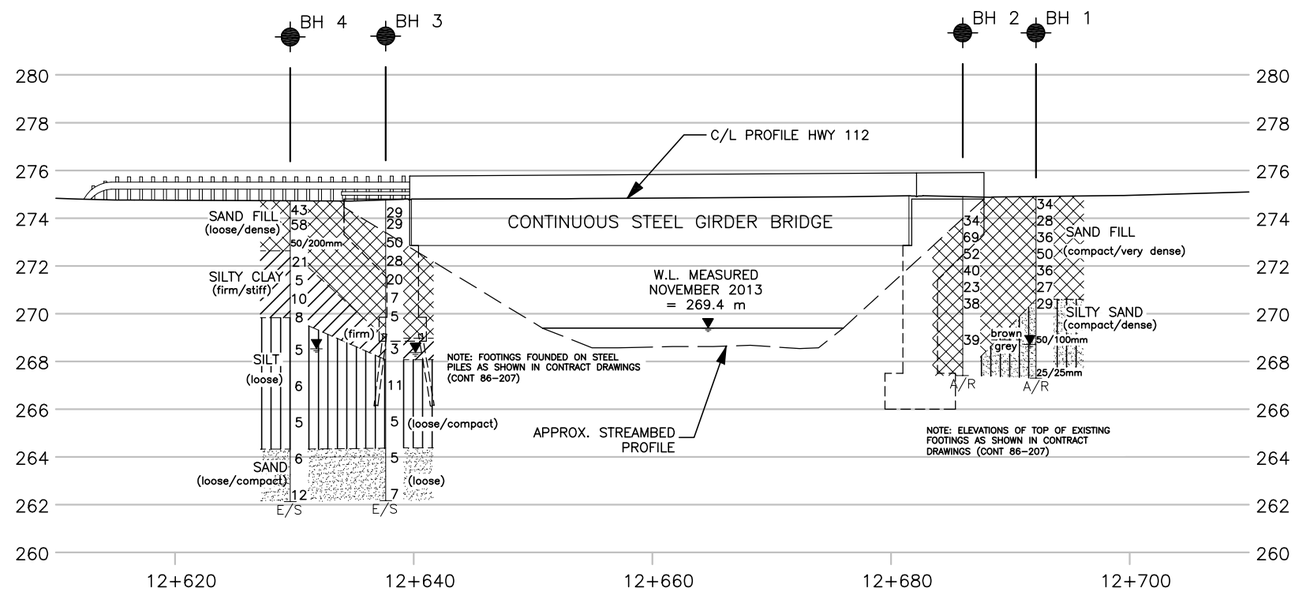
DRAWING
2

HWY 112
BLANCHE RIVER BRIDGE (SITE 47–020)
MARQUIS/PACAUD TOWNSHIP
BOREHOLE LOCATIONS & SOIL STRATA



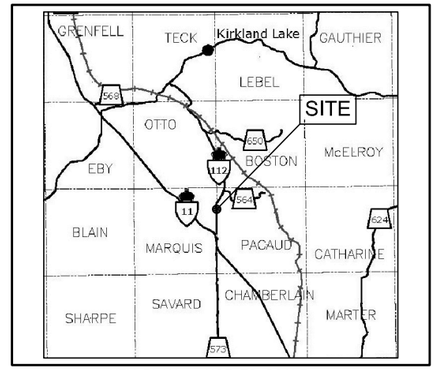
PLAN

5m SCALE 5m HOR



C/L PROFILE

5m SCALE 5m HOR
2.5m 2.5m VER



KEY PLAN – NOT TO SCALE

LEGEND

- Borehole
- N — Blows/0.3 m (Std Pen Test, 475 J/blow)
- DCPT — Blows/0.3 m (60° Cone, 475 J/blow)
- Water Level at Time of Investigation
- A/R — Auger Refusal at Elevation
- E/S — End of Sampling

Borehole No.	Elev.	O/S	Co–ordinates Northerly	Co–ordinates Easterly
Borehole No. 1	274.9	2.3 m Lt	5317796.9	378072.5
Borehole No. 2	274.9	2.5 m Rt	5317791.9	378078.4
Borehole No. 3	274.8	2.3 m Lt	5317743.5	378083.1
Borehole No. 4	274.7	2.4 m Rt	5317736.6	378089.3

NOTE 1: This drawing is for subsurface information only. Surface details and features are for conceptual illustration. The proposed structure location is shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.

NOTE 2: The boundaries between soil strata have been established at the borehole locations only. The boundaries illustrated and stratigraphy between boreholes on this drawing are assumed based on borehole data and may vary. They are intended for design only.

REVISIONS	DATE	BY	DESCRIPTION
	JAN 2014	RG	DRAFT REPORT
	MAY 2014	IK	REV. 01

HWY NO. 112 – MARQUIS/PACAUD TOWNSHIP

GEOCRES NO.: 41P–57

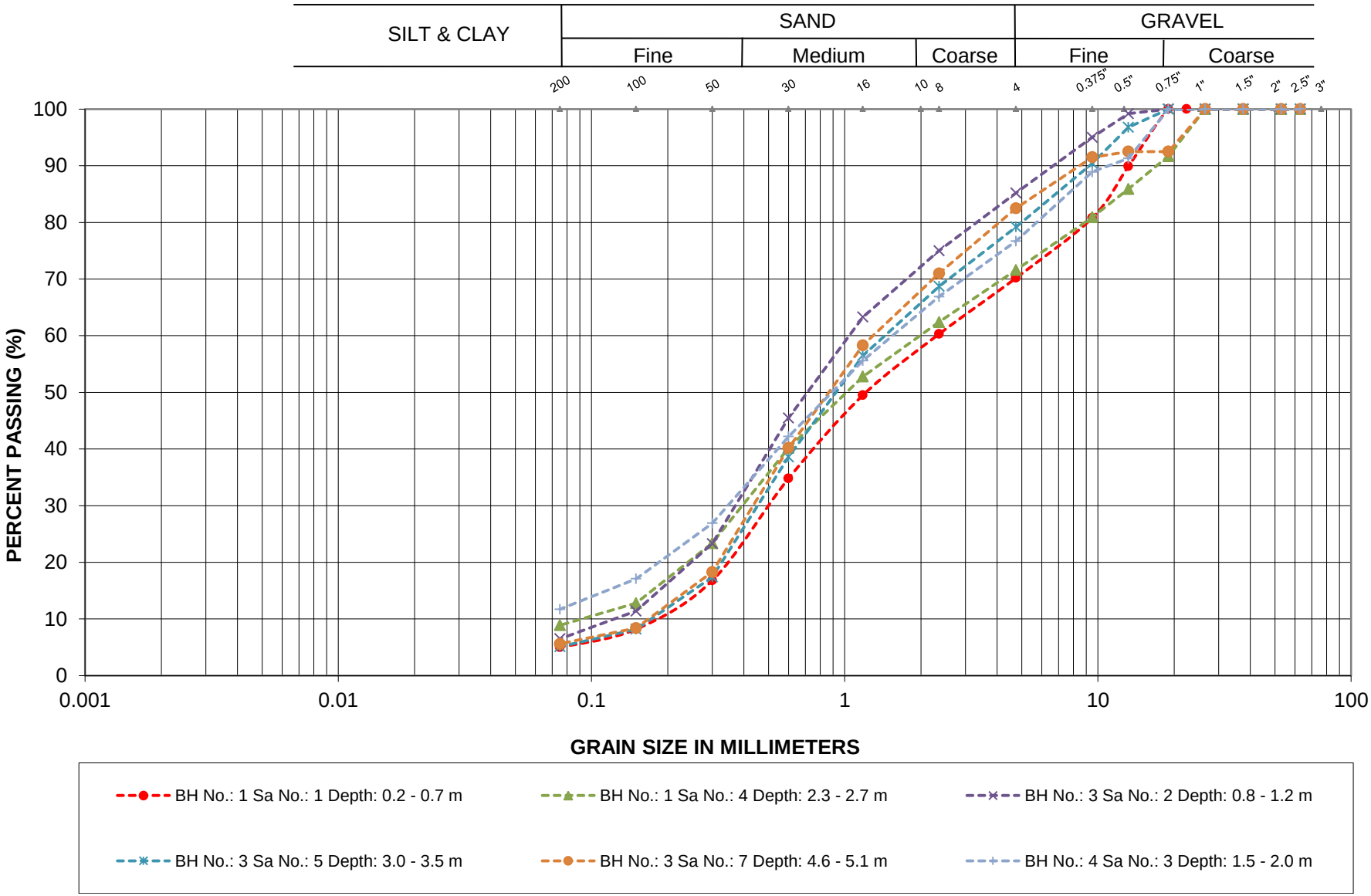
L|V|M REF. NO.: 13/05/13073–F2

DRAWN: RG | CHECKED: AT | DATE: JANUARY 2014

Reference No.: 13/05/13073-F2
Date: May 2014

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 5105-12-00
LOCATION: Hwy 112, Blanche River

EMBANKMENT FILL

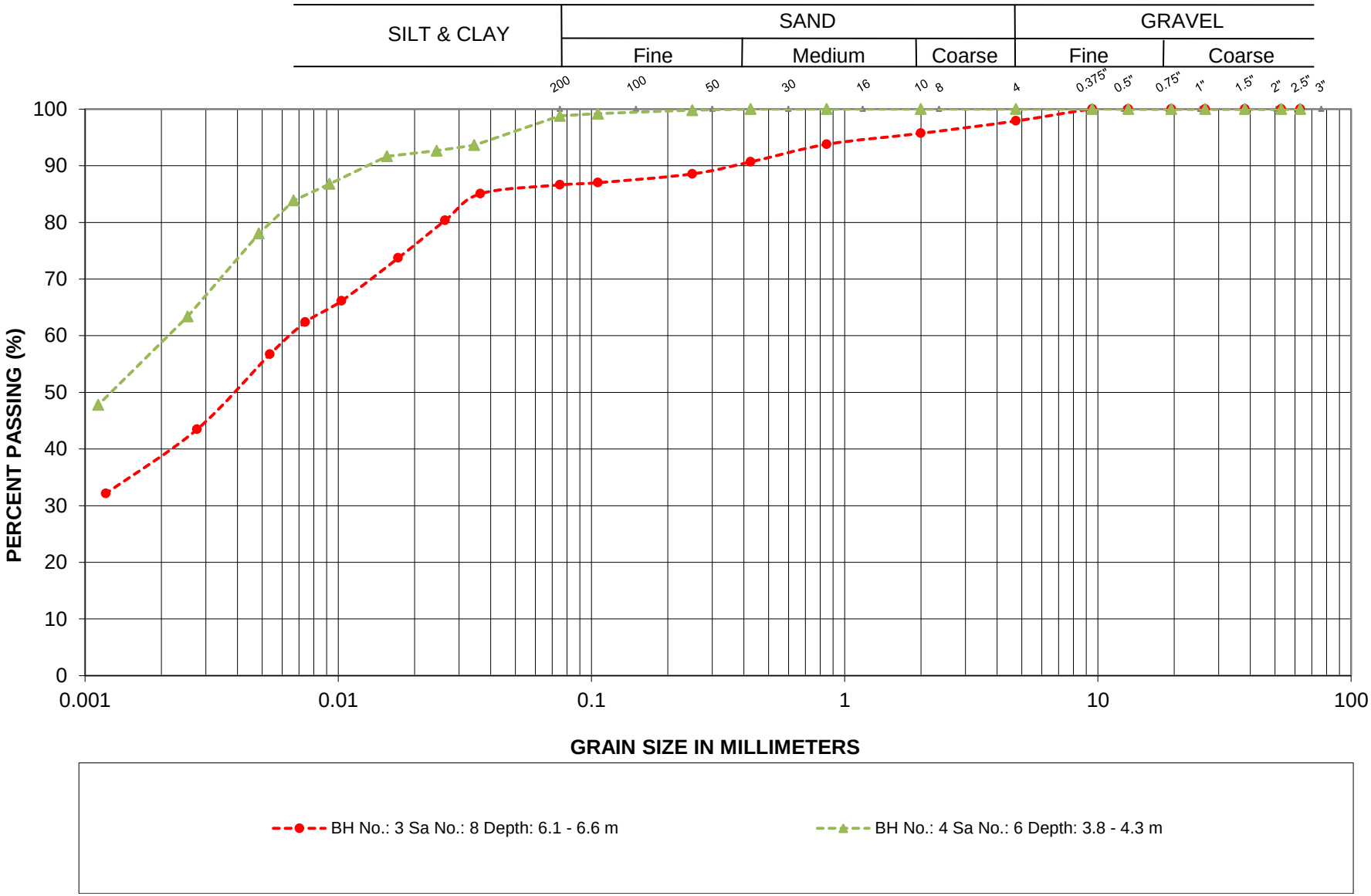
LVM | MERLEX

FIGURE L-1

Reference No.: 13/05/13073-F2
Date: May 2014

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 5105-12-00
LOCATION: Hwy 112, Blanche River

SILTY CLAY

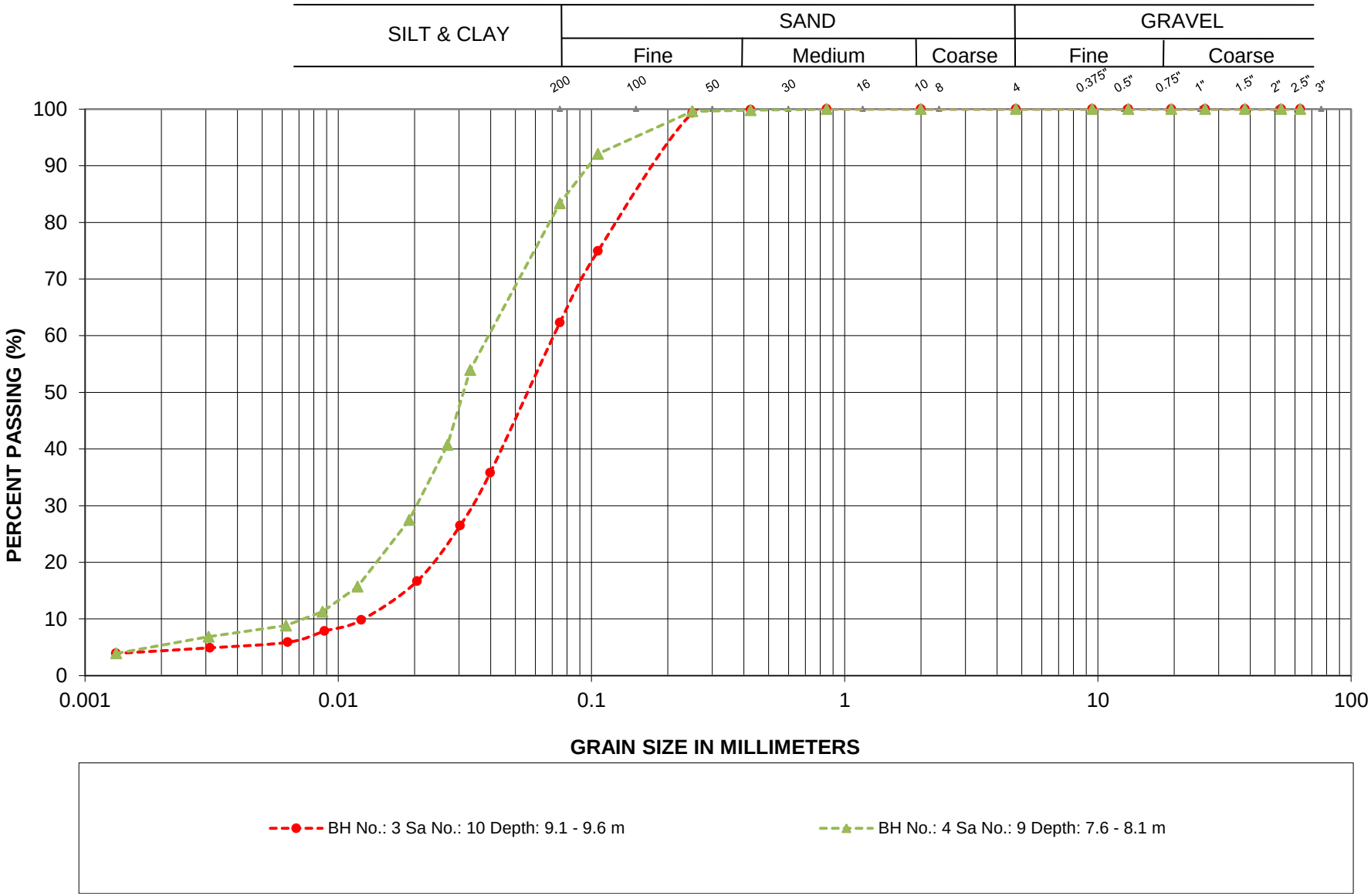
LVM | MERLEX

FIGURE L-2

Reference No.: 13/05/13073-F2
Date: May 2014

LVM | MERLEX

GRAIN SIZE ANALYSIS



G.W.P.: 5105-12-00
LOCATION: Hwy 112, Blanche River

SILT

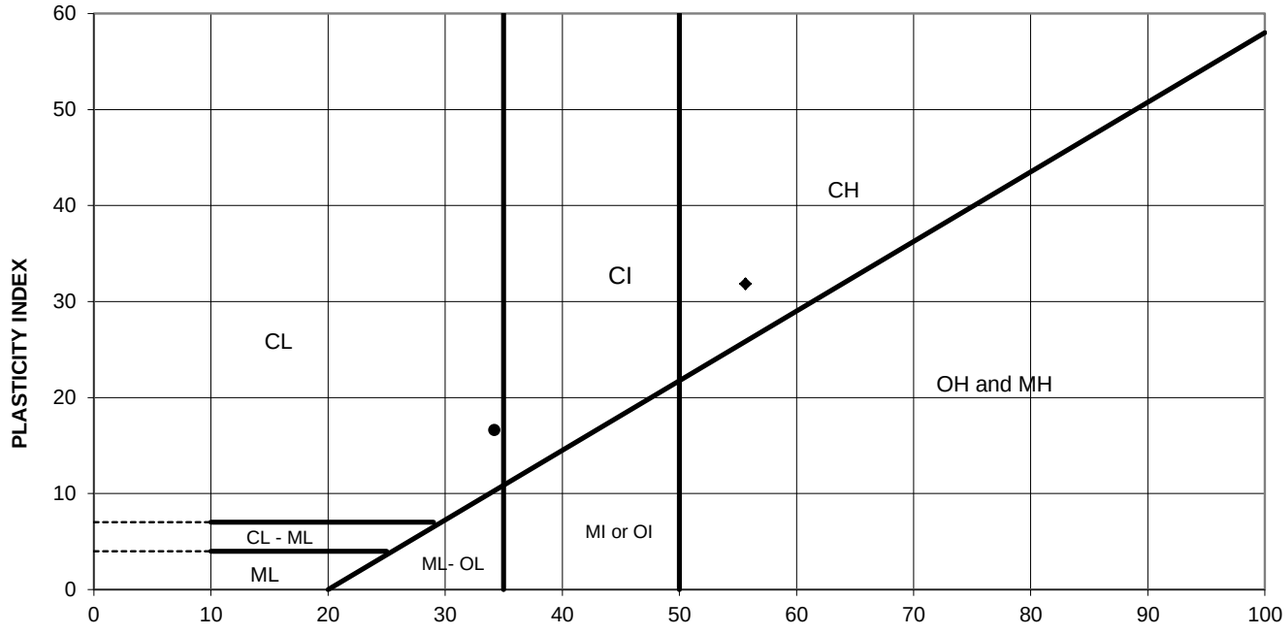
LVM | MERLEX

FIGURE L-3

ATTERBERG LIMITS TEST RESULTS

FIGURE L-4

ATTERBERG INDICES



SYMBOL	BH	Sa. No.	Depth(m)	Elev.(m)	Liquid Limit	Plastic Limit	Plasticity Index	NMC %
●	3	8	6.1	268.7	34.2	17.6	16.6	37.8
◆	4	6	3.8	270.9	55.7	23.8	31.8	27.9

Date: May-14
Project: Hwy 112, Blanche River
G.W.P: 5105-12-00

Prep'd: AT
Chkd: MAM
Ref. No.: 13/05/13073-F2

LVM | MERLEX

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Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
1	1	0.2	30	65	5		2.2				34			
	2	0.8					2.1				28			
	3	1.5					2.5				36			
	4	2.3					4.7				50			
	5	3.1	28	63	9		6.0				36			
	6	3.8					22.0				27			
	7	4.6					12.4				29			
	8	6.1					7.7				50/100 mm			
	9	7.6					11.1				25/25 mm			
2	1	0.3					3.8							
	2	0.8					4.0				34			
	3	1.5					2.0				69			
	4	2.3					2.9				52			
	5	3.1					3.6				40			
	6	3.8					4.1				23			
	7	4.6					4.1				38			
	8	6.1					11.3				39			
3	1	0.3					1.9				29			
	2	0.8	15	78	7		2.0				29			
	3	1.5					2.6				50			
	4	2.3					3.3				28			
	5	3.05	21	74	5		3.3				20			
	6	3.81					3.4				7			
	7	4.6	17	77	6		12.1				5			
	8	6.1	2	11	49	38	37.8	34.2	17.6	16.6	3			
	9	7.6					26.0				11			

LVM | MERLEX

Laboratory Tests - Summary Sheet

Borehole No.	Sample No.	Depth	Grain Size Analysis				NMC	Atterberg Limits			SPT 'N'	USCS	Unit Weight (kN/m3)	Remarks
			Gravel Size (%)	Sand Size (%)	Silt Size (%)	Clay Size (%)		LL (%)	PL (%)	IP (%)				
3	10	9.1	0	38	57	5	28.5				5			Non Plastic (NP)
	11	10.7					22.2				5			
	12	12.2					19.2				7			
4	1	0.2					2.2				43			
	2	0.8					2.6				58			
	3	1.5	23	65	12		4.5				50/50 mm			
	4	2.3					15.8				21			
	5	3.1					25.9				5			
	6	3.8	0	1	40	59	27.9	55.7	23.8	31.8	10			
	7	4.6					34.4				8			
	8	6.1					36.4				5			
	9	7.6	0	17	77	6	26.5				6			Non Plastic (NP)
	10	9.1					27.1				5			
	11	10.67					22.93				6			
	12	12.19					20.12				12			

Appendix 4 Photo Essay

Enclosure No. 6: Photo Essay

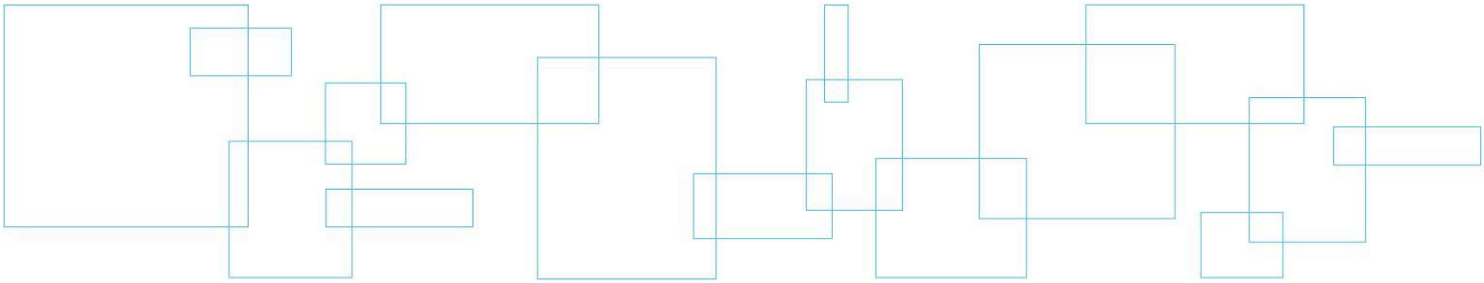
Existing Bridge – Looking South	Photo: 1

Existing Bridge – Looking North	Photo: 2

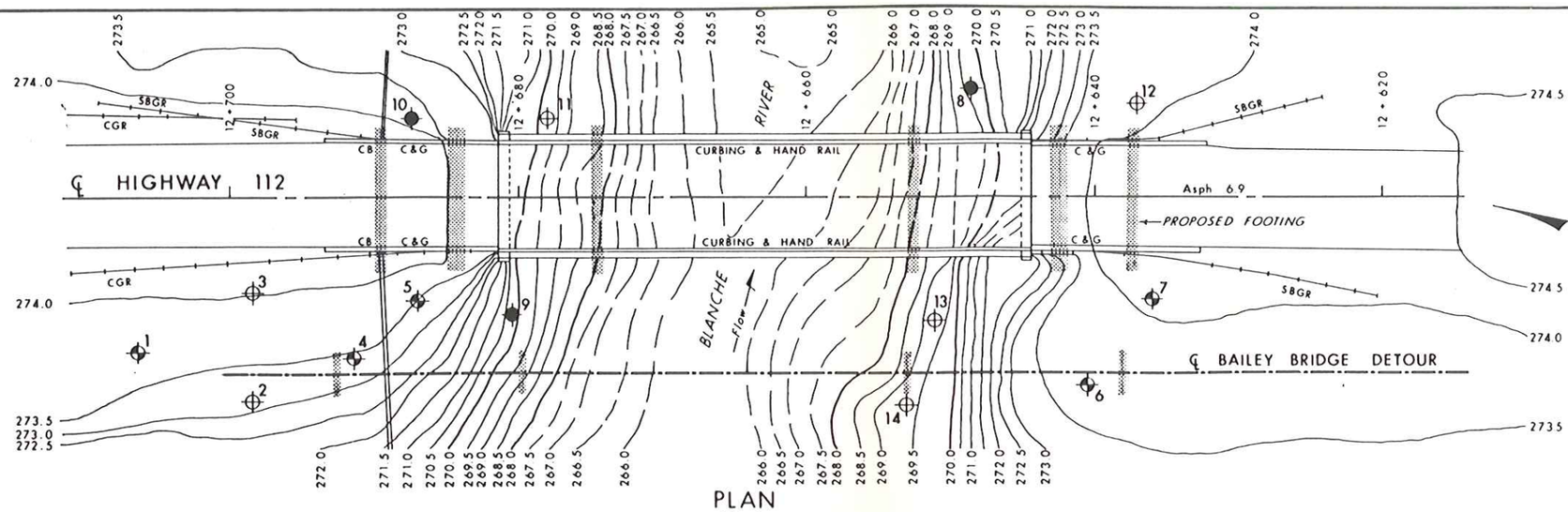
Project: Hwy 112 – Blanche River Bridge	Photos Provided By: LVM Date: October 2013

Appendix 5 Historical Data

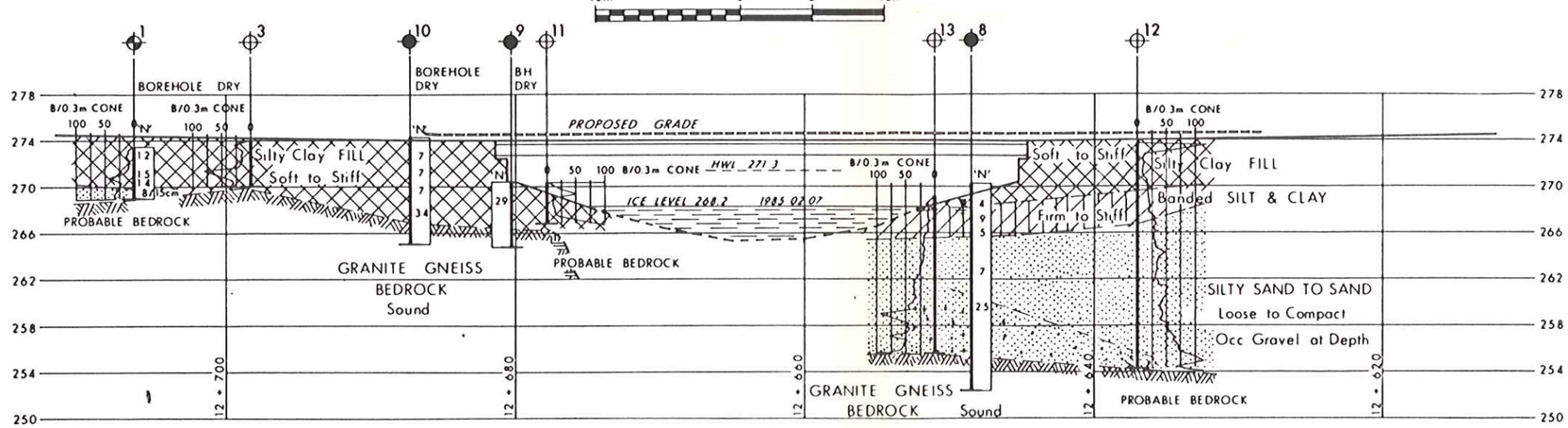
Enclosure No. 7 and 8: Historical Drawings



LVM | MERLEX

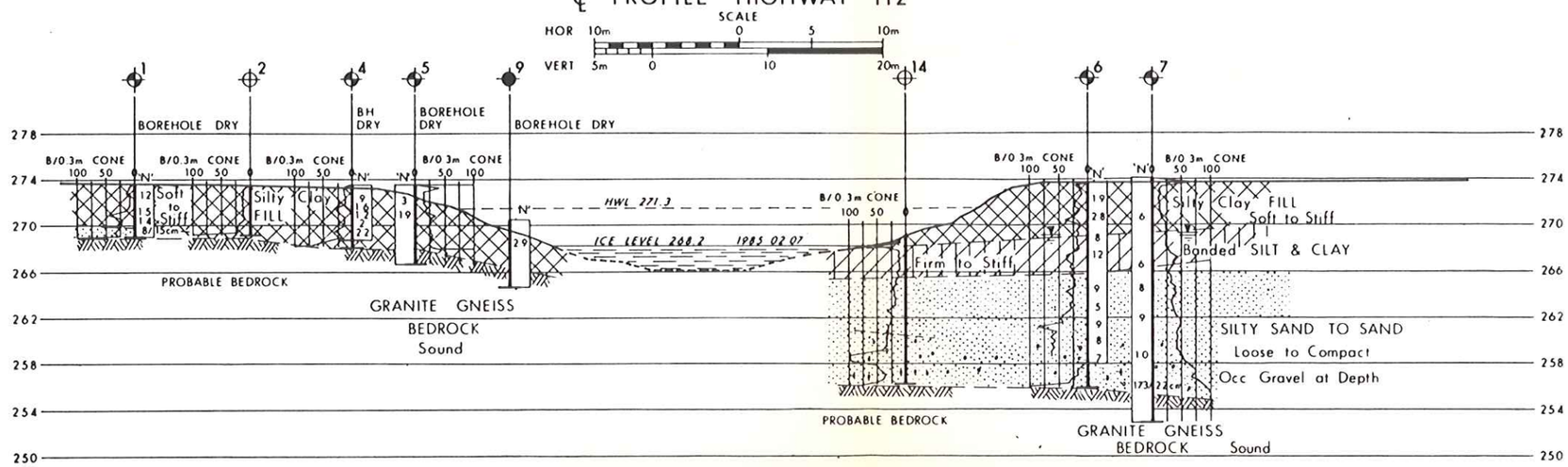


PLAN
SCALE 10m 0 5 10m



℄ PROFILE HIGHWAY 112

SCALE
HOR 10m 0 5 10m
VERT 5m 0 10 20m



℄ PROFILE BAILEY BRIDGE DETOUR

SCALE
HOR 10m 0 5 10m
VERT 5m 0 10 20m

REF No E-9024-1; 1984 11

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

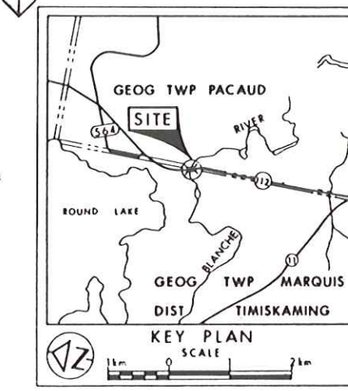
BM 268.752
13mm Drill Bit in Rock
19.0 Lt 12+682.0

CONT No
WP No 35-80-02

BLANCHE RIVER BRIDGE

BORE HOLE LOCATIONS & SOIL STRATA

C. MIRZA ENGINEERING INC.
GEOTECHNICAL SPECIALISTS



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L at time of investigation 1985 02 08
- Borehole Dry - Upon Completion

No	ELEVATION	STATION	OFFSET
1	273.5	12+706	10.7 Lt
2	273.1	12+698	14.0 Lt
3	274.0	12+698	6.5 Lt
4	273.4	12+692	11.0 Lt
5	273.5	12+687	7.0 Lt
6	273.6	12+640	13.0 Lt
7	274.0	12+636	7.0 Lt
8	270.2	12+648	7.5 Rt
9	270.3	12+680	8.0 Lt
10	274.2	12+688	5.5 Rt
11	270.3	12+678	5.5 Rt
12	273.8	12+637	6.5 Rt
13	269.2	12+651	8.5 Lt
14	269.2	12+653	14.5 Lt

NOTE
The boundaries between soil strata have been establ
only at Bore Hole locations. Between Bore Holes
boundaries are assumed from geological evidenc

NOTE: The complete foundation investigation and design r
this project and other related documents may be examined
Engineering Materials Office, Downsview. Information con
this report and related documents is specifically exclud
accordance with the conditions of Section 102-2 of F

REV	DATE	BY	DESCRIPTION

Geocres No

HWY No 112			DIST 14
SUBM'D RY	CHECKED CM	DATE 1985 02	SITE 47-
DRAWN SQA	CHECKED CM	APPROVED	DWG 358

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO

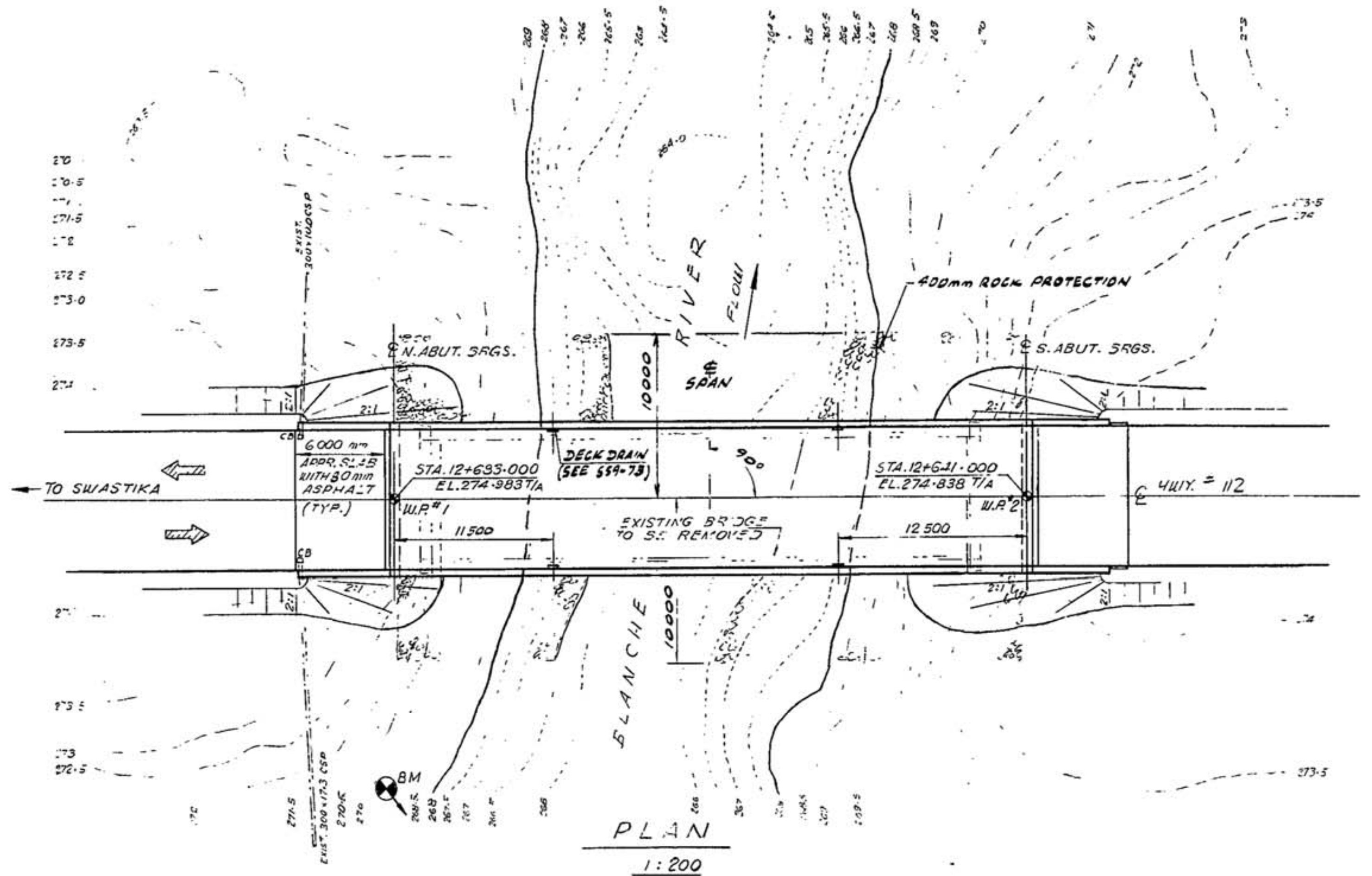
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

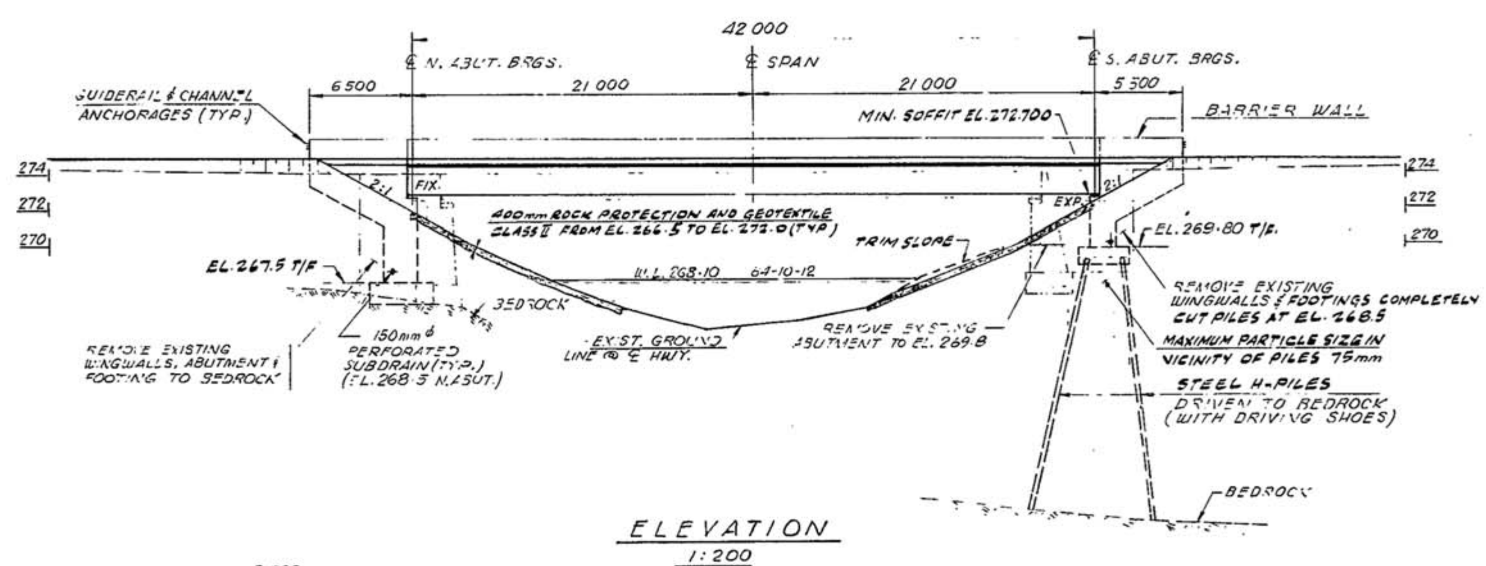
DIST. 14 HWY. 112
CONT No 86-207
WP No 35-80-02

BLANCHE RIVER BRIDGE GENERAL ARRANGEMENT

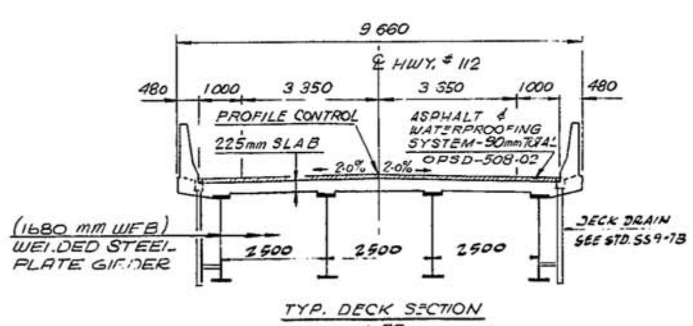
SHEET 9



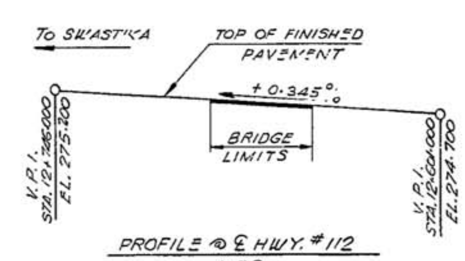
PLAN
1:200



ELEVATION
1:200



TYP. DECK SECTION
1:75



PROFILE @ ℄ HWY. # 112
N.T.S.

NOTES

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED.
BARS MARKED WITH THE SUFFIX 'C' DENOTE COATED BARS.

CLASS OF CONCRETE

FOOTINGS — 20 MPa
REMAINDER — 30 MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS — 100 ± 25 mm
ABUTMENTS, WINGWALLS:
FRONT FACE — 80 ± 20 mm
BACK FACE — 70 ± 20 mm
DECK:
TOP — 70 ± 20 mm
BOTTOM — 40 ± 10 mm
REMAINDER UNLESS OTHERWISE NOTED 70 ± 20mm

CONSTRUCTION NOTES

THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO A TOLERANCE OF ±3 mm.

LIST OF DRAWINGS:

47-20-1 GENERAL ARRANGEMENT
-2 BORE HOLE LOCATIONS & SOIL STRATA
-3 FOOTINGS
-4 NORTH ABUTMENT
-5 SOUTH ABUTMENT
-6 STRUCTURAL STEEL
-7 SPLICE DETAILS & BEARINGS
-8 DECK
-9 BARRIER WALL
-10 6000mm APPROACH SLAB
-11 JOINT ANCHORAGE & ARMOURING
-12 BRIDGE DATE & SITE NUMBER DATA
-13 AS CONSTRUCTED ELEV. & DIM.
-14 STANDARD DETAILS
-15 QUANTITIES-STRUCTURE I
47-20-16 QUANTITIES-STRUCTURE II

LIST OF ABBREVIATIONS

W.P. = WORKING POINT
T/F = TOP OF FOOTING
T/A = TOP OF ASPHALT
F.F. = FRONT FACE
B.F. = BACK FACE
W.L. = WATER LEVEL

BM 268.752
13 mm DRILL BIT IN ROCK
19.0 LT 12+682.0

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

CIVIL R.O. LAW
D.G. SPROULE

REVISIONS DATE	BY	DESCRIPTION

DESIGN	CHECK K.Z.S.	LOADING OHBDC	DATE 85.08
DRAWING L.S.	CHECK D.G.S.	SITE No 47-447-[illegible]	DWG 1