

SASKATCHEWAN HIGHWAYS AND TRANSPORTATION

GEOLOGY OF THE ST LOUIS BRIDGE SITE AREA

Report 0166-002

October 31, 1997

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Attention: Mr. P Jorge Antunes P. Eng.

Re: Geology of the ST Louis bridge site area

Dear Mr. Antunes

Enclosed are four copies of the "Geology of the ST Louis bridge site area". I am enclosing an additional copy for Dr. Karl Sauer which you can pass on to him.

If you have any queries or require additional copies of the report, please contact me.

Sincerely yours,

E.A. Christiansen P.Eng., P. Geol.



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Geol.		<i>[Signature]</i>

SUMMARY

The ST Louis bridge site area was glaciated at least six times as indicated by the presence of six tills including the lower and upper tills of the Dundurn Formation, till of the Warman Formation, lower and upper tills of the Floral Formation, and till of the Battleford Formation. The glacial lake sediments were laid down distal to the Prince Albert delta which was deposited 11500-11000 years ago. The upper terrace is correlative with the Fort a la Corne delta which was deposited 11000-10200 years ago. The lower terrace is correlative with the Nipawin delta which was deposited 10200-9500 years ago.

The Hatfield valley aquifer is in the upper sands and gravels of the Empress Group, and it underlies most of ST Louis bridge site area. In the Hoey area, wells in this aquifer are flowing artesian, whereas a well east of ST Louis is a nonflowing artesian well. Groundwater occurs also in the upper sands and gravels of the Floral Formation, but it has a limited areal extent. The South Saskatchewan River valley was eroded into the lower silt and clay unit of the Floral Formation which is thought to be the cause of slope instability along the valley in the ST Louis bridge site area.

TABLE OF CONTENTS

	<u>Text</u>	Page
1.	INTRODUCTION -----	1
	1.1 Objective -----	1
	1.2 Location -----	1
	1.3 Previous work -----	1
	1.4 Present work -----	1
2.	GEOMORPHOLOGY -----	3
3.	BEDROCK STRATIGRAPHY -----	3
4.	GLACIAL STRATIGRAPHY -----	3
	4.1 Empress Group -----	3
	4.2 Sutherland Group -----	5
	4.2.1 Dundurn Formation -----	5
	4.2.2 Warman Formation -----	7
	4.3 Saskatoon Group -----	7
	4.3.1 Floral Formation -----	7
	4.3.2 Battleford Formation -----	8
	4.3.3 Glacial lake sediments -----	8
	4.3.4 Upper terrace sediments -----	8
	4.3.5 Lower terrace sediments -----	9
5.	STRUCTURE -----	9
6.	AGE OF HOLOCENE SEDIMENTS -----	9
	6.1 Phase 1. Deposition of glacial lake sediments -----	9
	6.2 Phase 2. Formation of upper terrace -----	10
	6.3 Phase 3. Formation of lower terrace -----	10
7.	GROUNDWATER -----	10
8.	LITERATURE CITED -----	10

Illustrations

Page

Figure

1. Stratigraphic chart -----	4
------------------------------	---

Table

1. Index of borehole logs -----	2
2. Carbonate content of till -----	6

Drawing

0166-002-01. Map showing the location of cross sections -----	In back
0166-002-02. Cross section A-A' -----	In back
0166-002-03. Cross section B-B' -----	In back
0166-002-04. Cross section C-C' -----	In back

Appendix

A. Geologic logs compiled in this study -----	12
B. Carbonate content of tills -----	21

1. INTRODUCTION

1.1 Objective

The objective of the investigation is to provide a geological framework for locating a new ST Louis bridge site.

1.2 Location

The ST Louis bridge site area is shown in Drawing 0166-002-01. An index of the map numbers is given in Table 1.

1.3 Previous work

Previous work on the geology of the ST Louis bridge site area includes a map and cross sections by Meneley (1967) and maps and cross sections by Christiansen (1979). Pedological soils were mapped by Mitchell et al. (1944). Electric logs and driller's logs for boreholes 1, 2, 3, 9, and 12 (Drawing 0166-002-01; Table 1) were obtained from the Saskatchewan Research Council.

1.4 Present study

Cutting samples, detailed field logs, and geophysical logs including gamma-ray, spontaneous potential, single point resistance, and caliper were provided by the Saskatchewan Highways and Transportation (SHT) for boreholes 101 to 108 (Table 1, Appendix A). The cutting samples were examined and described with the aid of the field logs and geophysical logs. Till samples were collected for carbonate analyses (Appendix B) to aid in the identification of the stratigraphic units. Utilizing the field logs, geophysical logs, carbonate analyses, cutting sample descriptions, the geological logs were compiled

Table 1. Index of borehole logs in cross sections A-A', B-B', and C-C'.*

SHT NO.	NAME	DLS	EASTING	NORTHING	MAP NO.
101	SHT ST Louis bridge	SW-04-25-45A-27-W2	446200.297	5861299.934	4
102		SW-13-25-45A-27-W2	446182.077	5862520.129	5
103		SE-10-13-45-27-W2	445515.000	5864321.907	7
104		SE-01-25-45-27-W2	445879.276	5866635.517	8
105		NE-08-19-45-26-W2	447414.485	5865661.165	13
106		SE-01-01-46A-27-W2	447702.076	5864467.075	10
107		SE-09-35-45A-27-W2	446095.870	5863783.301	6
108		SE-03-06-46A-26-W2	448580.620	5864438.149	11
	SRC Hoey	NE-16-07-45A-26-W2			1
	FFIB RM of ST Louis	C-11-12-45A-27-W2			2
	SWC Boyer, Lucien	NW-08-24-45A-27-W2			3
	SRC Red Deer Hill	SW-04-24-46-27-W2			9
	FFIB Galloway, Matt	NW-05-05-46A-26-W2			12

* NAD 27 UTM ZONE 13

and were used to construct three cross sections (Drawings 0166-002-02, 03, 04).

2. GEOMORPHOLOGY

In the ST Louis bridge site area, the South Saskatchewan River is flanked by lower and upper terraces and a glacial lake plain which covers the upland beyond the terraces. The elevations of the lower and upper terraces and the glacial lake plain are 433, 442-448, and 466-472 m, respectively. The lower terrace is a cut and fill terrace, whereas the upper terrace is a cut terrace with little or no fill. The nature of the terrace deposits will be discussed below under the heading "Glacial stratigraphy".

3. BEDROCK STRATIGRAPHY

In borehole 101-(Drawings 0166-002-02, 03), the bedrock is composed of 74 m of noncalcareous, gray, marine silty clay of the Lea Park Formation and Upper Colorado Group. The lower 10 m is petroliferous with a sharp increase in the gamma-ray count which is interpreted as the top of the Lower White Speckled Shale.

4. GLACIAL STRATIGRAPHY

The glacial deposits are composed of Empress, Sutherland, and Saskatoon groups (Fig. 1). The nomenclature is from Christiansen (1992).

4.1 Empress Group

The Empress Group is between bedrock and the oldest till. The

TIME UNITS		STRATIGRAPHIC UNITS			
		GROUP	FORMATION	DEPOSIT	
QUATERNARY	HOLOCENE	SASKATOON		16 LOWER TERRACE SAND AND GRAVEL	
				15 UPPER TERRACE SAND AND GRAVEL	
	PLEISTOCENE			14 GLACIAL LAKE CLAY, SILT, SAND	
	BATTLEFORD		13 TILL		
	FLORAL		12 UPPER TILL		
			11 UPPER SAND AND GRAVEL		
			10 LOWER SILT AND CLAY		
			9 LOWER TILL		
			8 LOWER SAND AND GRAVEL		
	EMPRESS		WARMAN	7 TILL	
				6 SAND	
	SUTHERLAND	DUNDURN	5 UPPER TILL		
			4 LOWER TILL REPEATED		
			4 LOWER TILL		
			3 UPPER SAND AND GRAVEL		
			2 LOWER CLAY, SILT, AND SAND		
CRETACEOUS		MONTANA	LEA PARK FM.+ U. COLORADO GROUP	1 CLAY	

Figure 1. Stratigraphic chart. Nomenclature of the glacial deposits from Christiansen (1992).

Empress Group in the study area is composed of lower and upper units. The lower unit is composed of less than 1 to 40 m of clay, silt, and sand in a depression at borehole 102 (Drawing 0166-002-03). The upper unit is composed of less than 1 to 53 m of sand and gravel (Drawings 0166-002-02, 03). This unit is in the Hatfield valley which has been traced from the Manitoba - Saskatchewan border to the Saskatchewan - Alberta border. The gravel includes igneous and metamorphic clasts indicating a glacial origin. The contact between the Lea Park Formation and the Upper Colorado Group and the Empress Group is an erosional unconformity.

4.2 Sutherland Group

The Sutherland Group is between the Empress and Saskatoon groups (Fig. 1) and is composed of the Dundurn and Warman formations.

4.2.1 Dundurn Formation

The Dundurn Formation is composed of lower and upper till units. The lower unit is composed of less than 1 to 69 m of till in borehole 101 (Drawings 0166-002-02, 03). The absence of the Empress Group at borehole 101 suggests that the group was eroded. The absence of stratified deposits between till of the lower Dundurn Formation and bedrock suggests that the depression was formed by glacial rather fluvial erosion. Consequently, the ice-thrust depression module was used rather than a fluvial valley one to explain the origin of this feature. The upper till of the Dundurn Formation ranges in thickness from 3 to 26 m. The carbonate contents of the Dundurn Formation, lower till, and upper till are 36.55 +/- 4.15, 37.70 +/- 1.94, and 36.21 +/- 4.56 mL CO₂/g, respectively (Table 2). The contacts between the Empress Group and the Dundurn Formation and between the lower and upper till units are nonconformable.

Table 2. Carbonate content of tills in the St. Louis bridge site area.

Stratigraphic Unit	Number of Samples	Mean mL CO ₂ /g	Standard Deviation mL CO ₂ /g
Battleford Formation	8	53.49	10.47
Floral Formation, upper till	33	59.61	6.02
Floral Formation, lower till	22	57.39	11.95
Floral Formation	55	58.73	8.95
Saskatoon Group	63	58.06	9.32
Warman Formation	6	21.40	1.34
Dundurn Formation, upper till	50	36.21	4.56
Dundurn Formation, lower till	15	37.70	1.94
Dundurn Formation	65	36.55	4.15
Sutherland Group	71	35.27	5.81

4.2.2 Warman Formation

The Warman Formation was encountered only in borehole 107 where the formation is represented by 6 m of sand and 9 m of clayey, gypsiferous, olive gray till. The mean carbonate content of the till is $21.40 \pm 1.34 \text{ mL CO}_2/\text{g}$ which is significantly different from the carbonate content of the Dundurn Formation (Table 2). The contact between the Dundurn and Warman formations is unconformable.

4.3. Saskatoon Group

4.3.1 Floral Formation

The Floral Formation, in ascending order, is composed of a lower sand and gravel unit, a lower till unit, a lower silt and clay unit, an upper sand and gravel unit, and an upper till unit (Fig. 1). The lower sand and gravel unit is restricted to borehole 3 (Drawing 0166-002-02). The unit is composed of 4 m of sand and gravel.

The lower till unit is composed of less than 1 to 18 m of till and minor amounts of stratified material. The mean carbonate content of the lower till of the Floral Formation is $57.39 \pm 11.95 \text{ mL CO}_2/\text{g}$. The contact between the Warman and Tower till of the Floral Formation is nonconformable.

The lower silt and clay unit is between the lower till unit and the upper sand and gravel unit (Fig. 1). Where the upper sand gravel unit is missing, the silt and clay unit is between the lower and upper till units (Drawings 0166-002-02 - 04). The lower silt and clay unit is less than 1 to 11 m thick and is composed of silt, clay, and silty diamicton. The contact between the lower till and the lower silt and clay units is thought to be conformable.

The upper sand and gravel is between the lower silt and clay and upper till units in boreholes 106 and 12 (Drawings 0166-002-03, 04). The unit is composed of less than 1 to 22 m of sand and gravel. The upper till unit is composed of less than 1 m to 23 m of sandy till and minor amounts of stratified sediments. The upper part of the unit is jointed and stained. The mean carbonate content of the upper till of the Floral Formation is $59.61 +/ - 6.02 \text{ mL CO}_2/\text{g}$. This is significantly higher than the carbonate content of tills in the Dundurn and Warman formations.

4.3.2 Battleford Formation

The Battleford Formation is composed of less than 1 to 10 m of soft, massive, unstained till which has a mean carbonate content of $53.49 +/ - 10.47$. The contact between the upper till of the Floral Formation and the Battleford Formation is nonconformable.

4.3.3 Glacial lake sediments

The glacial lake sediments are composed of less than 1 to 37 m of sediment that grades upward from clay to silt to sand. North of the South Saskatchewan River, upper sands were reworked into dunes.

4.3.4 Upper terrace sediments

The upper terrace, which is extensive along both sides of the South Saskatchewan River (Drawing 0166-002-01), was eroded for the most part through the glacial lake sediments into the Battleford Formation and upper till of the Floral Formation (Drawings 0166-002-02, 03, 04). The upper terrace sediments are composed of a basal lag gravel and

sand less than 1 to 2 m thick. The elevation of the upper terrace is about 442-448 m.

4.3.5 Lower terrace sediments

Remnants of the lower terrace occur on the inside of meanders along the river (Drawing 0166-002-01) where they are protected from river erosion. In borehole 103 (Appendix A; Drawings 0166-002-02, 04), the lower terrace sediments are composed of 9 m of gravel, sand, and silt. The elevation of the base and top of the lower terrace sediments at this site is about 424 and 433 m, respectively.

5. STRUCTURE

The top of the Lower White Speckled Shale in borehole 101 is at an elevation of 283 m. This marker was considered to be too deep for the purpose of this study; consequently, the bedrock surface was used as a base of exploration for the remaining boreholes.

6. AGE OF HOLOCENE SEDIMENTS

6.1 Phase 1. Deposition of glacial lake sediments

According to Christiansen et al. (1995), the South and North Saskatchewan rivers emptied into Lake Saskatchewan to form the Prince Albert delta 11500-11000 years ago. While sands and gravels were being deposited in the delta, progressively finer silts and clays were being deposited in the ST Louis bridge site area. As the delta prograded toward the study area, sands were deposited on the silts and clays forming an upward coarsening of the glacial lake sediments in the study area.

6.2

Phase 2. Formation of upper terrace

According to elevations, the upper terrace is correlative with the Fort a la Corne delta which was deposited 11000-10200 years ago (Christiansen et al., 1995). During the formation of the upper terrace, most of the glacial lake sediments deposited in phase 1 were removed by fluvial erosion. Phase 2 represents the initial formation of the South Saskatchewan River valley in the ST Louis bridge site area.

6.3

Phase 3. Formation of lower terrace

The thick lower terrace sediments in the ST Louis bridge site area are thought to be correlative with the thick terrace deposits (Lost River Alloformation) in the Saskatchewan River valley west of Nipawin. According to Christiansen et al. (1995), this alloformation was deposited 10500-9500 years ago.

7.

GROUNDWATER

The Hatfield valley aquifer is one of the most productive aquifers in Saskatchewan. The valley is about 15 km wide and is known to extend from Manitoba to Alberta. Two flowing artesian wells (0166-002-02, 03, wells 2, 3) occur in the Hatfield valley aquifer in the study area. An artesian well occurs in the upper sand and gravel unit (Drawing 0166-002-03, well 12).

8.

LITERATURE CITED

Christiansen, E.A. 1979. Geology of the Prince Albert region, Saskatchewan. E.A. Christiansen Consulting Ltd. Report 0016-004 for Saskatchewan Municipal Affairs.

- Christiansen, E.A. 1992. Pleistocene stratigraphy of the Saskatoon area, Saskatchewan, Canada: an update. Canadian Journal of Earth Sciences, 29: 1767-1778.
- Christiansen, E.A., Sauer, E.K., and Schreiner, B.T. 1995. Glacial Lake Saskatchewan and Lake Agassiz deltas in east-central Saskatchewan with special emphasis on the Nipawin delta. Canadian Journal of Earth Sciences, 32:334-348.
- Meneley, W.A. 1967. Geology and groundwater resources of the Melfort area (73-A), Saskatchewan. Saskatchewan Research Council, Geology Division Map No. 6.
- Mitchell, J., Moss, H.C., and Clayton, J.S. 1944. Soil survey of southern Saskatchewan from Township 1 to 48, inclusive. Soil Survey Report No. 12, University of Saskatchewan, Saskatoon, Saskatchewan.

Appendix A. Geologic logs compiled for this study.

SHT 73-A/13 1997
 ST LOUIS BRIDGE 101
 SW-04-25-45A-27-W2
 13:446200E/5861300N
 BOREHOLE

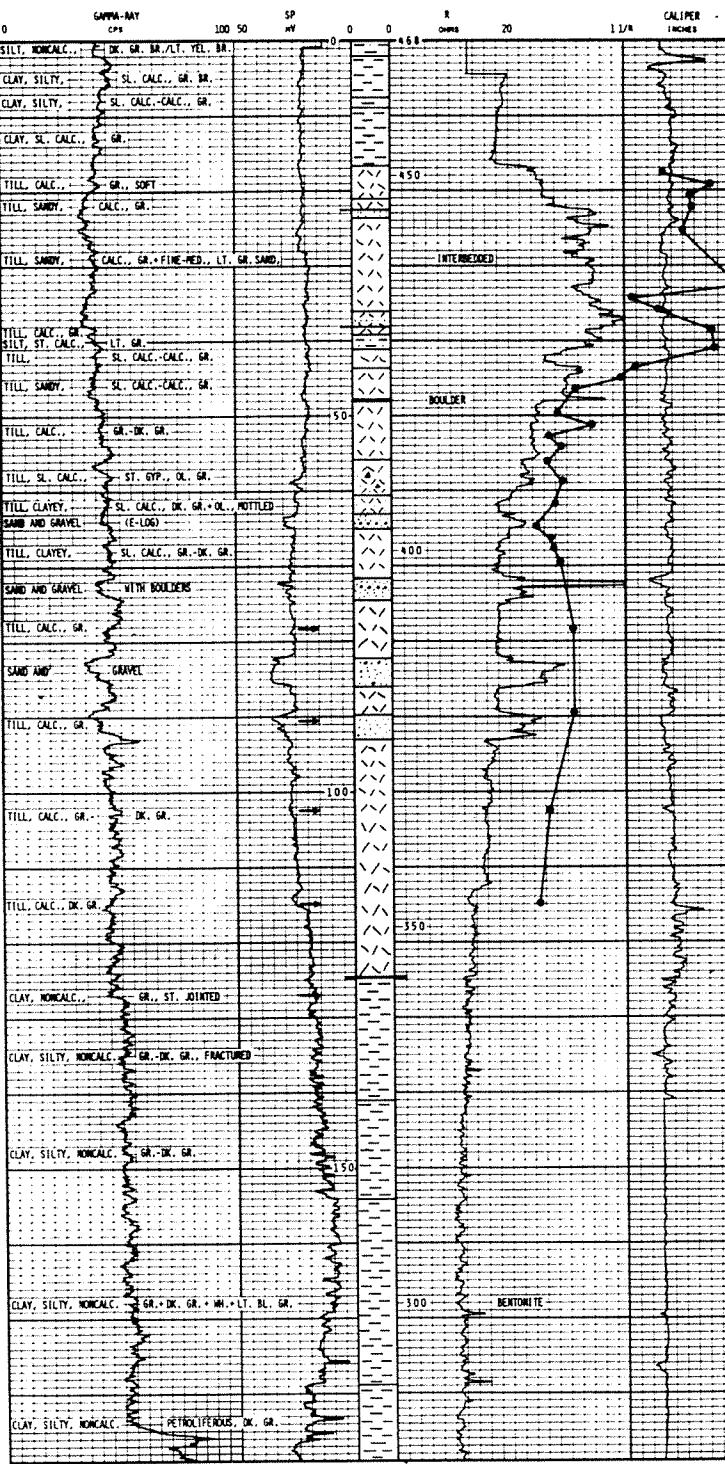
BOREHOLE NO.	101	HTS 73-A-13
LAND LOCATION	SW-04-25-45A-27-W2	
UTM COORD	13-265200 2975-3861200 034N	
GRID ELEV	457.5020 m	
DATE DRILLED	JUL 11 TO AUGUST 11 1997	
CORE PLATE	1000	MICROSCHEMELICH AT 25°C
CORE HEAD	1000	MICROSCHEMELICH AT 25°C
SPECIFIC GRAVITY HEAD		
SUPERVISOR	L. SIEHLAK	
TESTING SUPERVISOR		
LOGGED BY	L. SIEHLAK	
INSTRUMENT	WICO 1500	
PROBE ELECTRIC		
PROBE GAMMA		
PROBE CALIPER		
DATA LOGGED	AUGUST 13	1997
TIME OF LOGGING	1300 hrs	to 1500 hrs
DRILL OPERATOR	R. MILLER	
CONTRACTOR	ESSY OPERATOR: R. MITCHELL	
REMARKS		

PROJECT	ST LOUIS BRIDGE SITE		
CONTROL SECTION	2-12		
STATION	OFFSET		
CUTTING SAMPLE INTERVAL	1.5 m		
CORE SAMPLE INTERVAL			
FORM			
CASING DEPTH			
CASING WALL THICKNESS			
WATER OR BRINE LEVEL			
ABOVE	SHOTGUN		
BIT SIZE	3 1/2" VALVE		
INTERVAL	0-150.0 m		
BIT SIZE	3 1/2" VALVE		
INTERVAL			
TYPE OF DRILL BIT	1250 FAILING		
DEPTH	SCALE	SPEED	
0	100 m	50 HV	15 m/min
100	100 m	50 HV	15 m/min
200	100 m	50 HV	15 m/min
300	100 m	50 HV	15 m/min

GAMMA TIME CONSTANT (S) 5 SECOND

GEOLGY BY E.A. CHRISTIANSEN 23/09/97

CUTTING SAMPLE DESCRIPTION

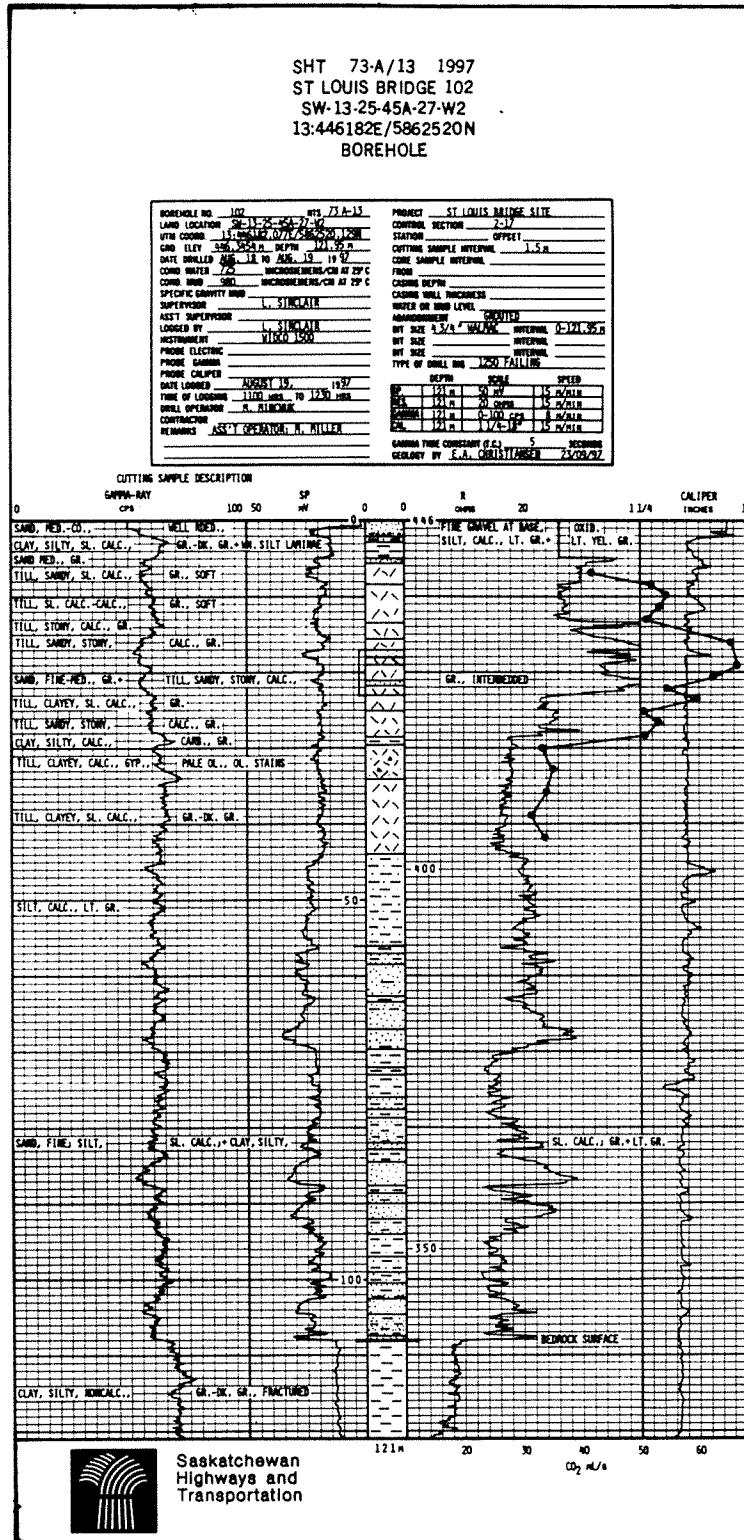


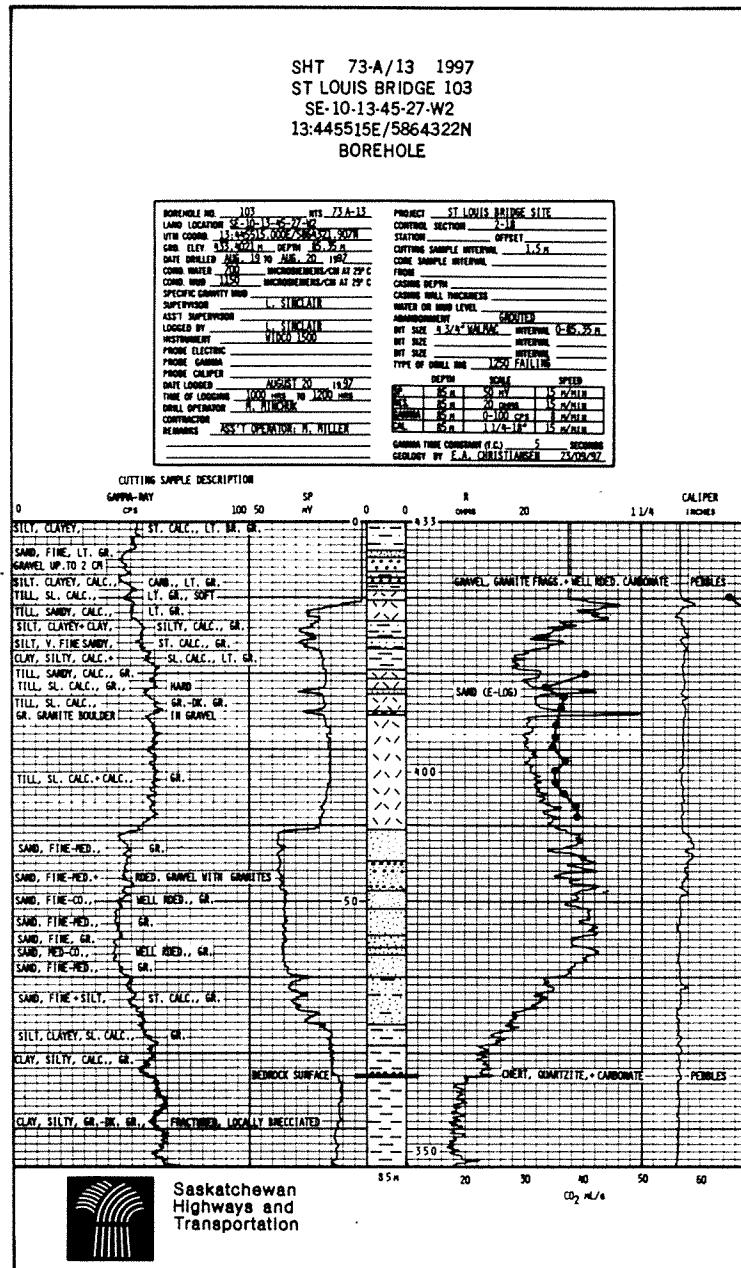
189m 20 30 40 50 60



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→ CORE





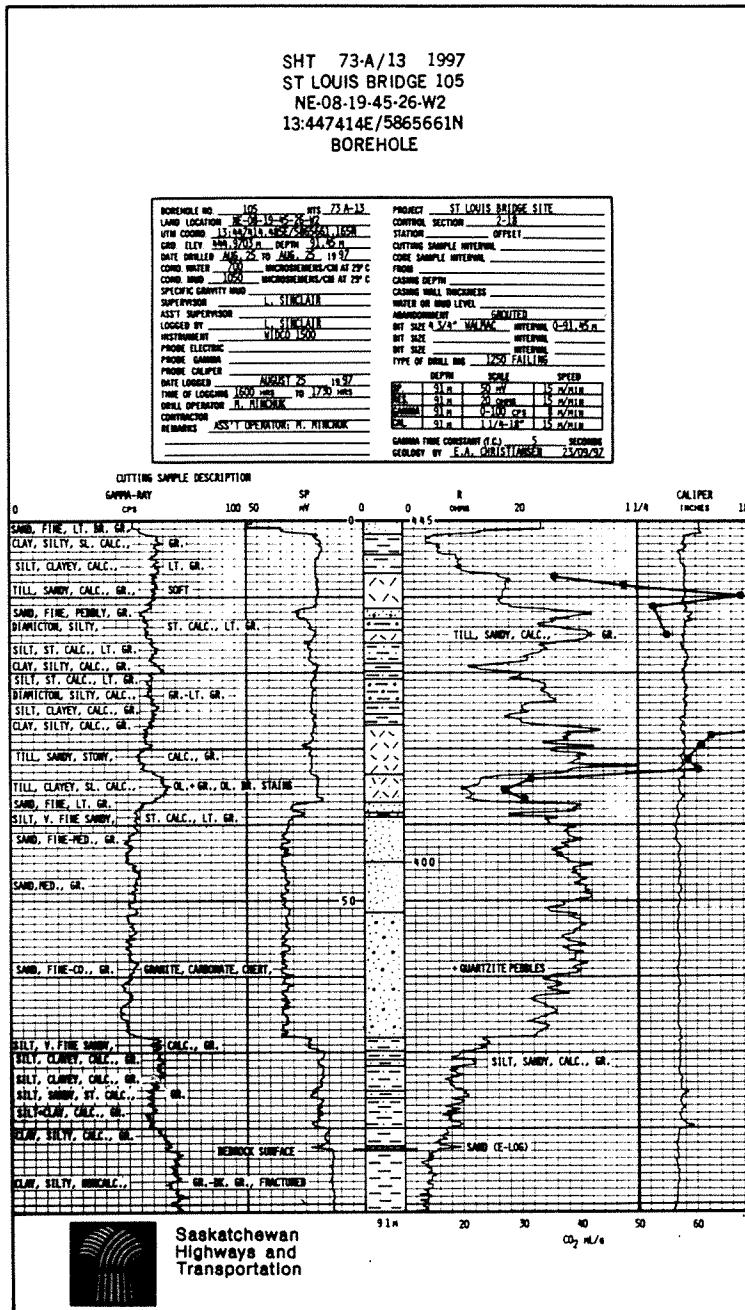
SHT 73-A/13 1997
 ST LOUIS BRIDGE 104
 SE-01-25-45-27-W2
 13:44:58.79E/5866636N
 BOREHOLE

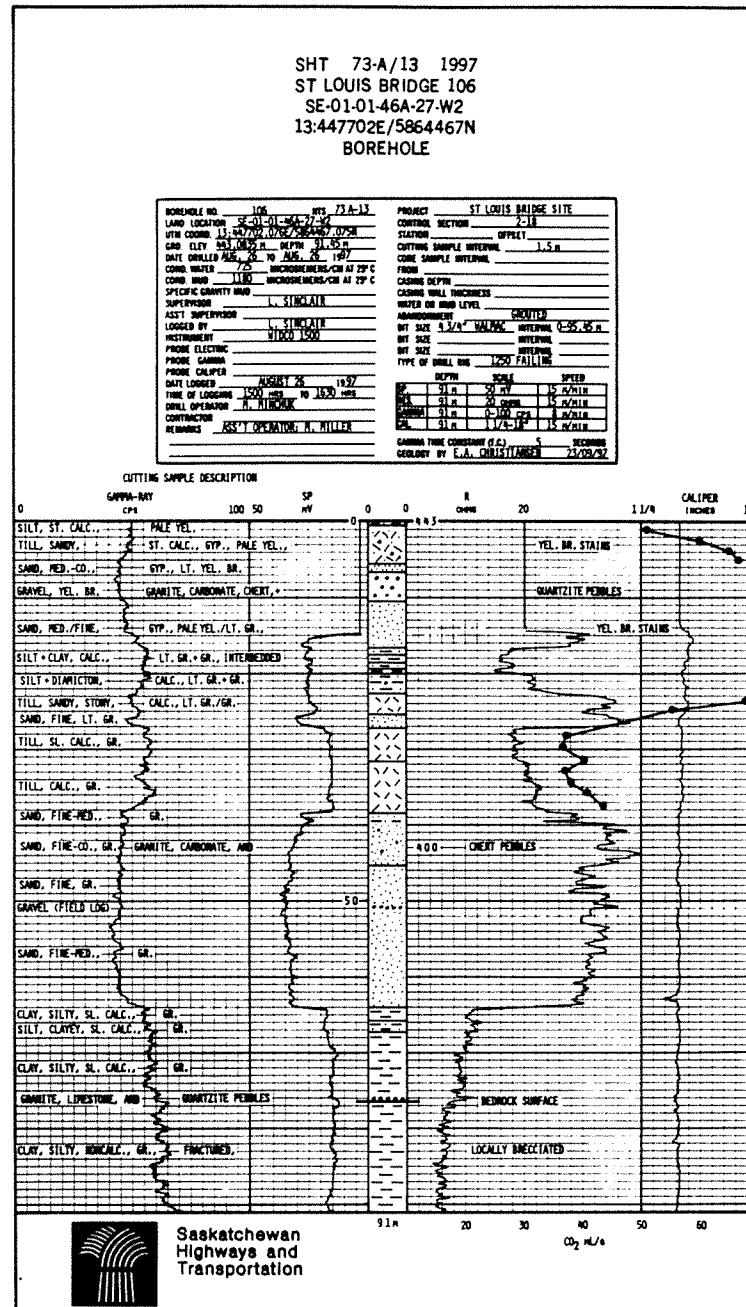
BOREHOLE NO.	104	WELL NO.	73-A-13	PROJECT	ST LOUIS BRIDGE SITE
LAND LOCATION	SE-01-25-45-27-W2	SECTION	2-18	SECTION	2-18
HTH CODE	13:44:58.79E/5866636N	STATION	00000000	STATION	00000000
GRO. CLEY	555.6605 ft	DEPTH	121.35 ft	CUTTING SAMPLE INTERVAL	1.5 ft
DATE DRILLED	JULY 20 1997	DATE DRILLED	JULY 20 1997	CORE SAMPLE INTERVAL	
CORE WATER	NO	INCHES	0 INCHES	FROM	
CORE AIR	NO	INCHES	0 INCHES	TO	
SPECIFIC GRAVITY (SG)	2.65	INCHES	0 INCHES	CASING DEPTH	
SUPERVISOR	L. SINCLAIR	INCHES	0 INCHES	LOGGING SHELL THICKNESS	
ASST. SUPERVISOR		INCHES	0 INCHES	WATER OR OIL LEVEL	
LOGGED BY	K. KELLY	INCHES	0 INCHES	ADMISSIONS	GRANTED
TESTER		INCHES	0 INCHES	BT SIZE	1 1/2" X 10' MAX
PROBE ELECTRIC		INCHES	0 INCHES	BT SIZE	1 1/2" X 10' MAX
PROBE GAMMA		INCHES	0 INCHES	BT SIZE	1 1/2" X 10' MAX
PROBE CALIPER		INCHES	0 INCHES	BT SIZE	1 1/2" X 10' MAX
DATE LOGGED	AUGUST 21 1997	INCHES	0 INCHES	TYPE OF HULL RIG	1250' FAILING
TIME OF LOGGING	10:00 AM - 11:00 AM	INCHES	0 INCHES	DEPTH	
DATA LOGGED	N. KELLY	INCHES	0 INCHES	FOOT	
CONTRACTOR		INCHES	0 INCHES	INCHES	
REMARKS	ASST. OPERATOR: K. KELLY	INCHES	0 INCHES	CAIRNS THREE CORNERS (G.C.)	5
		INCHES	0 INCHES	REGULAR	
		INCHES	0 INCHES	GEOLGY BY	E.A. CHRISTENSEN
		INCHES	0 INCHES		25/08/97

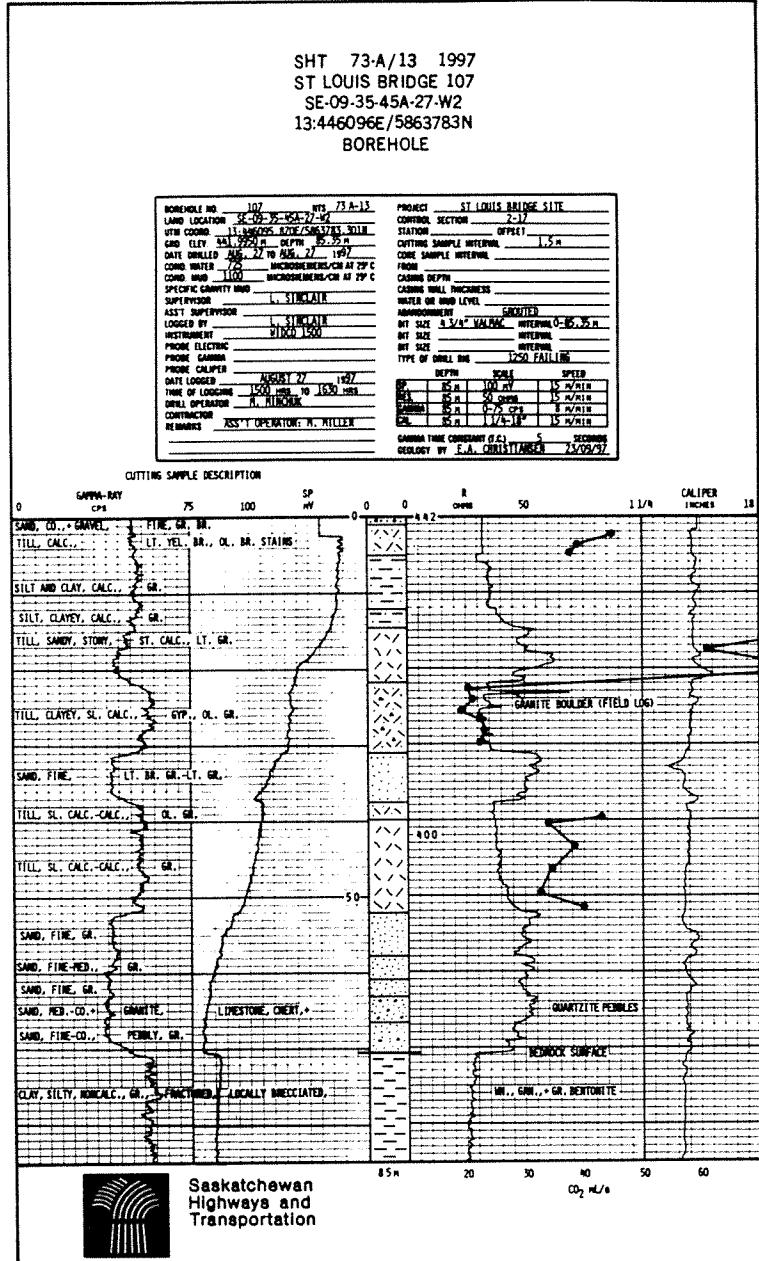
CUTTING SAMPLE DESCRIPTION

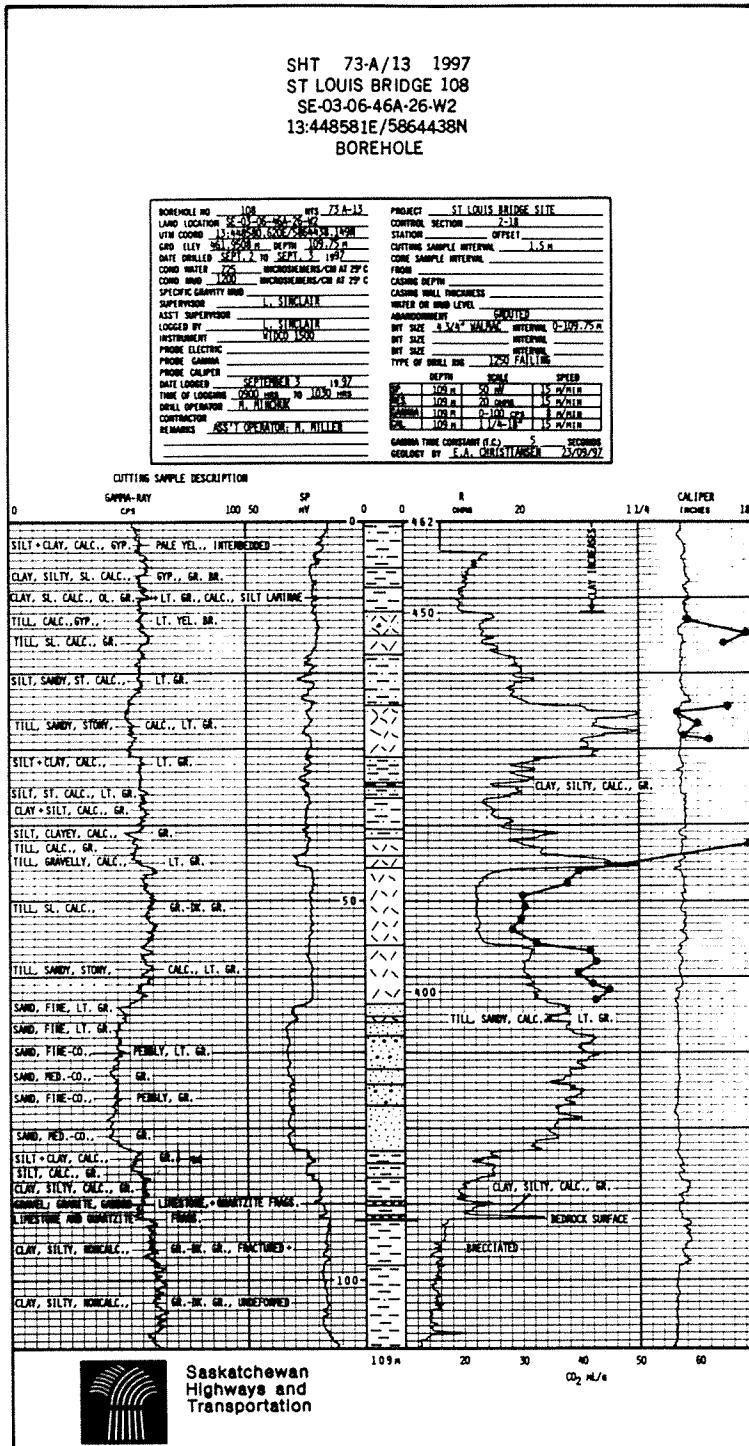
DEPTHS (ft)	DESCRIPTION
0 - 10	SAND, FINE-GR., CO., GRAY, LT. GR., GL.
10 - 20	SAND, RED-GR., PURPLE, LT. GR., LT. YEL. GR.
20 - 30	CLAY, SILTY, ST. CALC., LT. YEL. GR.
30 - 40	SILT, CLAYEY, ST. CALC., LT. YEL. GR.
40 - 50	CLAY, SILTY, CALC., LT. GR.
50 - 60	SILT, CALC., GR.
60 - 70	SILT, CLAYEY, CALC., GR.
70 - 80	SILT, V. FINE SANDY, LT. GR.
80 - 90	SILT, SANDY, CALC., GR.
90 - 100	SILT, SANDY, CALC., GR.
100 - 110	SILT, SAND, AND PEBBLES, GR.
110 - 120	SAND, FINE-GR., GR.
120 - 121.35	GRANITE, CARBONATE, CHEST.
121.35 - 122	SAND, FINE-GR., GR.
122 - 123	SAND, FINE-RED., GR.
123 - 124	WT. SILTY SAND BEADS
124 - 125	TILL, CLAYEY, ST. CALC., LT. GR., GR., POTTLED
125 - 126	SAND, FINE, GR.
126 - 127	SAND, FINE, GR.
127 - 128	SAND, FINE-GR., GR.
128 - 129	GRANITE, CARBONATE, CHEST.
129 - 130	SAND, FINE-RED., GR.
130 - 131	SAND, FINE, GR.
131 - 132	SAND, FINE-RED., GR.
132 - 133	Pebbly, GR.
133 - 134	SAND, FINE, GR.
134 - 135	SAND, FINE-RED., GR.
135 - 136	PEBBLY, GR.
136 - 137	SOIL LAYER
137 - 138	SAND, FINE-GR., GR.
138 - 139	GRANITE, CARBONATE, CHEST.
139 - 140	SILT, CLAYEY, ST. CALC., LT. GR., GR.
140 - 141	SAND, FINE-GR., GR.
141 - 142	SAND, FINE-RED., GR.
142 - 143	GRANITE, CARBONATE, CHEST.
143 - 144	SILT, CLAYEY, ST. CALC., LT. GR., GR.
144 - 145	SAND, FINE-GR., GR.
145 - 146	SILT, CLAYEY, ST. CALC., LT. GR., GR.
146 - 147	SAND, FINE-RED., GR.
147 - 148	GRANITE, CARBONATE, CHEST.
148 - 149	SILT, CLAYEY, ST. CALC., LT. GR., GR.
149 - 150	SAND, FINE-GR., GR.
150 - 151	SILT, CLAYEY, ST. CALC., LT. GR., GR.
151 - 152	SAND, FINE-RED., GR.
152 - 153	GRANITE, CARBONATE, CHEST.
153 - 154	SILT, CLAYEY, ST. CALC., LT. GR., GR.
154 - 155	SAND, FINE-GR., GR.
155 - 156	SILT, CLAYEY, ST. CALC., LT. GR., GR.
156 - 157	SAND, FINE-RED., GR.
157 - 158	GRANITE, CARBONATE, CHEST.
158 - 159	SILT, CLAYEY, ST. CALC., LT. GR., GR.
159 - 160	SAND, FINE-GR., GR.
160 - 161	SILT, CLAYEY, ST. CALC., LT. GR., GR.
161 - 162	SAND, FINE-RED., GR.
162 - 163	GRANITE, CARBONATE, CHEST.
163 - 164	SILT, CLAYEY, ST. CALC., LT. GR., GR.
164 - 165	SAND, FINE-GR., GR.
165 - 166	SILT, CLAYEY, ST. CALC., LT. GR., GR.
166 - 167	SAND, FINE-RED., GR.
167 - 168	GRANITE, CARBONATE, CHEST.
168 - 169	SILT, CLAYEY, ST. CALC., LT. GR., GR.
169 - 170	SAND, FINE-GR., GR.
170 - 171	SILT, CLAYEY, ST. CALC., LT. GR., GR.
171 - 172	SAND, FINE-RED., GR.
172 - 173	GRANITE, CARBONATE, CHEST.
173 - 174	SILT, CLAYEY, ST. CALC., LT. GR., GR.
174 - 175	SAND, FINE-GR., GR.
175 - 176	SILT, CLAYEY, ST. CALC., LT. GR., GR.
176 - 177	SAND, FINE-RED., GR.
177 - 178	GRANITE, CARBONATE, CHEST.
178 - 179	SILT, CLAYEY, ST. CALC., LT. GR., GR.
179 - 180	SAND, FINE-GR., GR.
180 - 181	SILT, CLAYEY, ST. CALC., LT. GR., GR.
181 - 182	SAND, FINE-RED., GR.
182 - 183	GRANITE, CARBONATE, CHEST.
183 - 184	SILT, CLAYEY, ST. CALC., LT. GR., GR.
184 - 185	SAND, FINE-GR., GR.
185 - 186	SILT, CLAYEY, ST. CALC., LT. GR., GR.
186 - 187	SAND, FINE-RED., GR.
187 - 188	GRANITE, CARBONATE, CHEST.
188 - 189	SILT, CLAYEY, ST. CALC., LT. GR., GR.
189 - 190	SAND, FINE-GR., GR.
190 - 191	SILT, CLAYEY, ST. CALC., LT. GR., GR.
191 - 192	SAND, FINE-RED., GR.
192 - 193	GRANITE, CARBONATE, CHEST.
193 - 194	SILT, CLAYEY, ST. CALC., LT. GR., GR.
194 - 195	SAND, FINE-GR., GR.
195 - 196	SILT, CLAYEY, ST. CALC., LT. GR., GR.
196 - 197	SAND, FINE-RED., GR.
197 - 198	GRANITE, CARBONATE, CHEST.
198 - 199	SILT, CLAYEY, ST. CALC., LT. GR., GR.
199 - 200	SAND, FINE-GR., GR.
200 - 201	SILT, CLAYEY, ST. CALC., LT. GR., GR.
201 - 202	SAND, FINE-RED., GR.
202 - 203	GRANITE, CARBONATE, CHEST.
203 - 204	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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210 - 211	SILT, CLAYEY, ST. CALC., LT. GR., GR.
211 - 212	SAND, FINE-RED., GR.
212 - 213	GRANITE, CARBONATE, CHEST.
213 - 214	SILT, CLAYEY, ST. CALC., LT. GR., GR.
214 - 215	SAND, FINE-GR., GR.
215 - 216	SILT, CLAYEY, ST. CALC., LT. GR., GR.
216 - 217	SAND, FINE-RED., GR.
217 - 218	GRANITE, CARBONATE, CHEST.
218 - 219	SILT, CLAYEY, ST. CALC., LT. GR., GR.
219 - 220	SAND, FINE-GR., GR.
220 - 221	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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222 - 223	GRANITE, CARBONATE, CHEST.
223 - 224	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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225 - 226	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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227 - 228	GRANITE, CARBONATE, CHEST.
228 - 229	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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242 - 243	GRANITE, CARBONATE, CHEST.
243 - 244	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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246 - 247	SAND, FINE-RED., GR.
247 - 248	GRANITE, CARBONATE, CHEST.
248 - 249	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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251 - 252	SAND, FINE-RED., GR.
252 - 253	GRANITE, CARBONATE, CHEST.
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255 - 256	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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257 - 258	GRANITE, CARBONATE, CHEST.
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263 - 264	SILT, CLAYEY, ST. CALC., LT. GR., GR.
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265 - 266	SILT, CLAYEY, ST. CALC., LT. GR., GR.
266 - 267	SAND, FINE-RED., GR.
267 - 268	GRANITE, CARBONATE, CHEST.
268 - 269	SILT, CLAYEY, ST. CALC., LT. GR., GR.
269 - 270	SAND, FINE-GR., GR.
270 - 271	SILT, CLAYEY, ST. CALC., LT. GR., GR.
271 - 272	SAND, FINE-RED., GR.
272 - 273	GRANITE, CARBONATE, CHEST.
273 - 274	SILT, CLAYEY, ST. CALC., LT. GR., GR.
274 - 275	SAND, FINE-GR., GR.
275 - 276	SILT, CLAYEY, ST. CALC., LT. GR., GR.
276 - 277	SAND, FINE-RED., GR.
277 - 278	GRANITE, CARBONATE, CHEST.
278 - 279	SILT, CLAYEY, ST. CALC., LT. GR., GR.
279 - 280	SAND, FINE-GR., GR.
280 - 281	SILT, CLAYEY, ST. CALC., LT. GR., GR.
281 - 282	SAND, FINE-RED., GR.
282 - 283	GRANITE, CARBONATE, CHEST.
283 - 284	SILT, CLAYEY, ST. CALC., LT. GR., GR.
284 - 285	SAND, FINE-GR., GR.
285 - 286	SILT, CLAYEY, ST. CALC., LT. GR., GR.
286 - 287	SAND, FINE-RED., GR.
287 - 288	GRANITE, CARBONATE, CHEST.
288 - 289	SILT, CLAYEY, ST. CALC., LT. GR., GR.
289 - 290	SAND, FINE-GR., GR.
290 - 291	SILT, CLAYEY, ST. CALC., LT. GR., GR.
291 - 292	SAND, FINE-RED., GR.
292 - 293	GRANITE, CARBONATE, CHEST.
293 - 294	SILT, CLAYEY, ST. CALC., LT. GR., GR.
294 - 295	SAND, FINE-GR., GR.
295 - 296	SILT, CLAYEY, ST. CALC., LT. GR., GR.
296 - 297	SAND, FINE-RED., GR.
297 - 298	GRANITE, CARBONATE, CHEST.
298 - 299	SILT, CLAYEY, ST. CALC., LT. GR., GR.
299 - 300	SAND, FINE-GR., GR.
300 - 301	SILT, CLAYEY, ST. CALC., LT. GR., GR.
301 - 302	SAND, FINE-RED., GR.
302 - 303	GRANITE, CARBONATE, CHEST.
303 - 304	SILT, CLAYEY, ST. CALC., LT. GR., GR.
304 - 305	SAND, FINE-GR., GR.
305 - 306	SILT, CLAYEY, ST. CALC., LT. GR., GR.
306 - 307	SAND, FINE-RED., GR.
307 - 308	GRANITE, CARBONATE, CHEST.
308 - 309	SILT, CLAYEY, ST. CALC., LT. GR., GR.
309 - 310	SAND, FINE-GR., GR.
310 - 311	SILT, CLAYEY, ST. CALC., LT. GR., GR.
311 - 312	SAND, FINE-RED., GR.
312 - 313	GRANITE, CARBONATE, CHEST.
313 - 314	SILT, CLAYEY, ST. CALC., LT. GR., GR.
314 - 315	SAND, FINE-GR., GR.
315 - 316	SILT, CLAYEY, ST. CALC., LT. GR., GR.
316 - 317	SAND, FINE-RED., GR.
317 - 318	GRANITE, CARBONATE, CHEST.
318 - 319	SILT, CLAYEY, ST. CALC., LT. GR., GR.
319 - 320	SAND, FINE-GR., GR.
320 - 321	SILT, CLAYEY, ST. CALC., LT. GR., GR.
321 - 322	SAND, FINE-RED., GR.
322 - 323	GRANITE, CARBONATE, CHEST.
323 - 324	SILT, CLAYEY, ST. CALC., LT. GR., GR.
324 - 325	SAND, FINE-GR., GR.
325 - 326	SILT, CLAYEY, ST. CALC., LT. GR., GR.
326 - 327	SAND, FINE-RED., GR.
327 - 328	GRANITE, CARBONATE, CHEST.
328 - 329	SILT, CLAYEY, ST. CALC., LT. GR., GR.
329 - 330	SAND, FINE-GR., GR.
330 - 331	SILT, CLAYEY, ST. CALC., LT. GR., GR.
331 - 332	SAND, FINE-RED., GR.
332 - 333	GRANITE, CARBONATE, CHEST.
333 - 334	SILT, CLAYEY, ST. CALC., LT. GR., GR.
334 - 335	SAND, FINE-GR., GR.
335 - 336	SILT, CLAYEY, ST. CALC., LT. GR., GR.
336 - 337	SAND, FINE-RED., GR.
337 - 338	GRANITE, CARBONATE, CHEST.
338 - 339	SILT, CLAYEY, ST. CALC., LT. GR., GR.
339 - 340	SAND, FINE-GR., GR.
340 - 341	SILT, CLAYEY, ST. CALC., LT. GR., GR.
341 - 342	SAND, FINE-RED., GR.
342 - 343	GRANITE, CARBONATE, CHEST.
343 - 344	SILT, CLAYEY, ST. CALC., LT. GR., GR.
344 - 345	SAND, FINE-GR., GR.
345 - 346	SILT, CLAYEY, ST. CALC., LT. GR., GR.
346 - 347	SAND, FINE-RED., GR.
347 - 348	GRANITE, CARBONATE, CHEST.
348 - 349	SILT, CLAYEY, ST. CALC., LT. GR., GR.
349 - 350	SAND, FINE-GR., GR.
350 - 351	SILT, CLAYEY, ST. CALC., LT. GR., GR.
351 - 352	SAND, FINE-RED., GR.
352 - 353	GRANITE, CARBONATE, CHEST.
353 - 354	SILT, CLAYEY, ST. CALC., LT. GR., GR.
354 - 355	SAND, FINE-GR., GR.
355 - 356	SILT, CLAYEY, ST. CALC., LT. GR., GR.
356 - 357	SAND, FINE-RED., GR.
357 - 358	GRANITE, CARBONATE, CHEST.
358 - 359	SILT, CLAYEY, ST. CALC., LT. GR., GR.
359 - 360	SAND, FINE-GR., GR.
360 - 361	SILT, CLAYEY, ST. CALC., LT. GR., GR.
361 - 362	SAND, FINE-RED., GR.
362 - 363	GRANITE, CARBONATE, CHEST.
363 - 364	SILT, CLAYEY, ST. CALC., LT. GR., GR.
364 - 365	SAND, FINE-GR., GR.
365 - 366	SILT, CLAYEY, ST. CALC., LT. GR., GR.
366 - 367	SAND, FINE-RED., GR.
367 - 368	GRANITE, CARBONATE, CHEST.
368 - 369	SILT, CLAYEY, ST. CALC., LT. GR., GR.
369 - 370	SAND, FINE-GR., GR.
370 - 371	SILT, CLAYEY, ST. CALC., LT. GR., GR.
371 - 372	SAND, FINE-RED., GR.
372 - 373	GRANITE, CARBONATE, CHEST.
373 - 374	SILT, CLAYEY, ST. CALC., LT. GR., GR.
374 - 375	SAND, FINE-GR., GR.
375 - 376	SILT, CLAYEY, ST. CALC., LT. GR., GR.
376 - 377	SAND, FINE-RED., GR.
377 - 378	GRANITE, CARBONATE, CHEST.
378 - 379	SILT, CLAYEY, ST. CALC., LT. GR., GR.
379 - 380	SAND, FINE-GR., GR.
380 - 381	SILT, CLAYEY, ST. CALC., LT. GR., GR.
381 - 382	SAND, FINE-RED., GR.
382 - 383	GRANITE, CARBONATE, CHEST.
383 - 384	SILT, CLAYEY, ST. CALC., LT. GR., GR.
384 - 385	SAND, FINE-GR., GR.
385 - 386	SILT, CLAYEY, ST. CALC., LT. GR., GR.
386 - 387	SAND, FINE-RED., GR.
387 - 388	GRANITE, CARBONATE, CHEST.
388 - 389	SILT, CLAYEY, ST. CALC., LT. GR., GR.
389 - 390	SAND, FINE-GR., GR.
390 - 391	SILT, CLAYEY, ST. CALC., LT. GR., GR.
391 - 392	SAND, FINE-RED., GR.
392 - 393	GRANITE, CARBONATE, CHEST.
393 - 394	SILT, CLAYEY, ST. CALC., LT. GR., GR.
394 - 395	SAND, FINE-GR., GR.
395 - 396	SILT, CLAYEY, ST. CALC., LT. GR., GR.
396 - 397	SAND, FINE-RED., GR.
397 - 398	GRANITE, CARBONATE, CHEST.
398 - 399	SILT, CLAYEY, ST. CALC., LT. GR., GR.
399 - 400	SAND, FINE-GR., GR.
400 - 401	SILT, CLAYEY, ST. CALC., LT. GR., GR.
401 - 402	SAND, FINE-RED., GR.
402 - 403	GRANITE, CARBONATE, CHEST.
403 - 404	SILT, CLAYEY, ST. CALC., LT. GR., GR.
404 - 405	SAND, FINE-GR., GR.
405 - 406	SILT, CLAYEY, ST. CALC., LT. GR., GR.
406 - 407	SAND, FINE-RED., GR.
407 - 408	GRANITE, CARBONATE, CHEST.
408 - 409	SILT, CLAYEY, ST. CALC., LT. GR., GR.
409 - 410	SAND, FINE-GR., GR.
410 - 411	SILT, CLAYEY, ST. CALC., LT. GR., GR.
411 - 412	SAND, FINE-RED., GR.
412 - 413	GRANITE, CARBONATE, CHEST.
413 - 414	SILT, CLAYEY, ST. CALC., LT. GR., GR.
414 -	

E. A. Christiansen Consulting Ltd









Appendix B. Carbonate content of tills.

Saskatchewan Research Council Geoanalytical Services
 125-15 Innovation Blvd., Saskatoon, SK., S7N 2X8
 Phone: 306-933-5426 Fax: 306-933-5656

SHT ST LOUIS BRIDGE #101

M509 E.A. CHRISTIANSEN AUG. 28/97 (34) PG.2673 [0.5 GM BR DIG.]

1 %Ca BY ICP OT97.145

2 %Mg BY ICP

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
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BR2	5.04	1.53	11.61	6.29	17.89	1.85	14.07	28.19	42.26
LS7 1139 17.5	5.92	2.53	19.19	4.37	23.56	4.39	9.78	46.61	56.39
LS7 1140 19.1	6.75	2.90	22.00	4.92	26.91	4.47	11.00	53.43	64.44
LS7 1141 20.6	6.60	2.65	20.10	5.57	25.67	3.61	12.47	48.82	61.29
LS7 1142 22.1	6.85	2.55	19.34	6.61	25.95	2.93	14.79	46.98	61.77
LS7 1144 25.2	6.73	2.43	18.43	6.80	25.23	2.71	15.22	44.77	60.00
LS7 1149 32.8	7.76	2.88	21.85	7.52	29.37	2.90	16.83	53.06	69.90
LS7 1150 34.3	5.48	2.23	16.91	4.50	21.42	3.76	10.08	41.09	51.17
LS7 1151 35.8	6.00	2.43	18.43	4.98	23.41	3.70	11.14	44.77	55.92
LS7 1153 38.5	7.14	2.71	20.56	6.67	27.23	3.08	14.94	49.93	64.87
LS7 1155 41.9	6.78	2.98	22.60	4.66	27.27	4.85	10.44	54.90	65.34
LS7 1156 43.5	5.77	2.14	16.23	5.60	21.83	2.90	12.53	39.43	51.96
LS7 1157 45.0	5.46	2.07	15.70	5.11	20.81	3.07	11.44	38.14	49.58
LS7 1158 46.5	4.72	1.64	12.44	5.04	17.48	2.47	11.27	30.22	41.49
LS7 1160 49.6	4.52	1.41	10.70	5.48	16.18	1.95	12.27	25.98	38.25
LS7 1161 51.1	5.13	1.68	12.74	5.89	18.64	2.16	13.19	30.95	44.14
LS7 1162 52.6	4.34	1.37	10.39	5.20	15.59	2.00	11.63	25.24	36.87
LS7 1163 54.1	4.58	1.45	11.00	5.47	16.47	2.01	12.24	26.72	38.95
LS7 1164 56.0	4.42	1.29	9.78	5.73	15.51	1.71	12.82	23.77	36.58
LS7 1166 58.7	5.03	1.21	9.18	7.58	16.76	1.21	16.96	22.29	39.26
BR2	5.52	1.60	12.14	7.20	19.33	1.69	16.11	29.48	45.59
LS7 1168 61.8	4.40	1.45	11.00	5.02	16.02	2.19	11.23	26.72	37.95
LS7 1170 64.8	4.43	1.07	8.12	6.66	14.77	1.22	14.90	19.71	34.61
LS7 1171 66.3	4.59	1.25	9.48	6.32	15.80	1.50	14.14	23.03	37.17
LS7 1172 67.8	4.48	1.38	10.47	5.51	15.97	1.90	12.32	25.43	37.75
LS7 1173 69.4	4.68	1.35	10.24	6.13	16.37	1.67	13.72	24.87	38.59
LS7 1174 71.3	4.32	1.22	9.25	5.77	15.02	1.61	12.90	22.48	35.38
LS7 1175 71.8	5.21	1.43	10.85	7.12	17.97	1.52	15.94	26.35	42.29
LS7 1177 75.5	4.76	1.47	11.15	5.84	16.99	1.91	13.06	27.08	40.14
LS7 1179 78.5	4.99	1.13	8.57	7.81	16.38	1.10	17.48	20.82	38.30
LS7 1180 80.0	4.64	1.22	9.25	6.56	15.82	1.41	14.69	22.48	37.17
LS7 1186 88.5	4.77	1.14	8.65	7.22	15.87	1.20	16.16	21.00	37.16
LS7 1190 95.4	3.74	1.89	14.34	1.56	15.89	9.20	3.49	34.82	38.31
LS7 1191 96.8	3.52	1.64	12.44	2.04	14.48	6.10	4.56	30.22	34.78

Saskatchewan Research Council Geoanalytical Services
 125-15 Innovation Blvd., Saskatoon, SK., S7N 2X8
 Phone: 306-933-5426 Fax: 306-933-5656
 SHT ST LOUIS BRIDGE #102

M510 E.A. CHRISTIANSEN AUG. 28/97 (19) PG. 2674 [0.5 GM BR DIG.]

1 %Ca BY ICP OT97.148
 2 %Mg BY ICP
 3 Wt% DOLOMITE=COL.2*7.5852
 4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973
 5 TOTAL Wt% CO₃ (COL.3+COL.4)
 6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)
 7 CO₂ FROM CALCITE=COL.4*2.238
 8 CO₂ FROM DOLOMITE=COL.3*2.429
 9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	CO3TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
BR2	5.42	1.65	12.52	6.74	19.26	1.86	15.09	30.40	45.49
LS7 1256 6.9	4.60	1.74	13.20	4.32	17.52	3.05	9.68	32.06	41.74
LS7 1257 8.4	5.80	2.12	16.08	5.76	21.84	2.79	12.88	39.06	51.94
LS7 1258 9.9	5.91	2.30	17.45	5.29	22.74	3.30	11.84	42.38	54.21
LS7 1259 11.4	5.91	2.19	16.61	5.74	22.35	2.89	12.85	40.35	53.20
LS7 1260 13.0	5.65	2.10	15.93	5.46	21.39	2.92	12.23	38.69	50.92
LS7 1262 16.0	7.07	2.82	21.39	6.05	27.44	3.54	13.53	51.96	65.49
LS7 1264 19.1	7.40	2.74	20.78	7.20	27.98	2.89	16.11	50.48	66.60
LS7 1265 20.6	6.80	2.67	20.25	5.99	26.24	3.38	13.40	49.19	62.60
LS7 1266 22.1	5.95	2.32	17.60	5.31	22.91	3.32	11.88	42.74	54.62
LS7 1267 23.6	6.52	2.54	19.27	5.83	25.09	3.31	13.04	46.80	59.83
LS7 1268 25.2	6.07	1.80	13.65	7.75	21.40	1.76	17.34	33.16	50.50
LS7 1269 26.7	5.95	2.15	16.31	6.01	22.32	2.71	13.44	39.61	53.06
LS7 1270 28.2	5.89	1.93	14.64	6.76	21.40	2.16	15.14	35.56	50.70
LS7 1271 30.0	4.07	1.16	8.80	5.39	14.19	1.63	12.06	21.37	33.43
LS7 1273 32.8	4.45	1.11	8.42	6.54	14.96	1.29	14.64	20.45	35.09
LS7 1275 35.8	4.67	0.86	6.52	8.12	14.65	0.80	18.18	15.85	34.02
LS7 1277 38.9	4.19	0.85	6.45	6.96	13.41	0.93	15.59	15.66	31.25
LS7 1279 41.9	4.36	1.04	7.89	6.61	14.50	1.19	14.79	19.16	33.95

Saskatchewan Research Council Geoanalytical Services
 125-15 Innovation Blvd., Saskatoon, SK., S7N 2X8
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 SHT ST LOUIS BRIDGE NO. 103

M529 CHRISTIANSEN SEPT 4/97 (16) PG 2696 [BR DIG]

1 %Ca BY ICP OT97.152
 2 %Mg BY ICP
 3 Wt% DOLOMITE=COL.2*7.5852
 4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973
 5 TOTAL Wt% CO3 (COL.3+COL.4)
 6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)
 7 CO2 FROM CALCITE=COL.4*2.238
 8 CO2 FROM DOLOMITE=COL.3*2.429
 9 TOTAL CO2=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
BR2	5.03	1.62	12.29	5.89	18.18	2.09	13.19	29.85	43.03
LS7 1338 9.9	7.05	2.78	21.09	6.16	27.25	3.42	13.79	51.22	65.01
LS7 1339 11.4	6.78	3.28	24.88	3.43	28.31	7.26	7.67	60.43	68.10
LS7 1345 20.6	4.96	1.36	10.32	6.79	17.10	1.52	15.19	25.06	40.25
LS7 1346 22.1	4.15	1.13	8.57	5.71	14.28	1.50	12.78	20.82	33.60
LS7 1347 23.6	4.62	1.19	9.03	6.64	15.66	1.36	14.86	21.93	36.78
LS7 1348 25.2	4.81	1.01	7.66	7.85	15.51	0.98	17.58	18.61	36.19
LS7 1349 26.7	4.30	1.23	9.33	5.67	15.00	1.64	12.70	22.66	35.36
LS7 1350 28.2	4.36	1.20	9.10	5.95	15.05	1.53	13.31	22.11	35.42
LS7 1351 29.7	4.26	1.18	8.95	5.78	14.73	1.55	12.94	21.74	34.68
LS7 1352 31.3	4.74	1.12	8.50	7.23	15.72	1.18	16.17	20.64	36.81
LS7 1353 32.8	4.38	1.19	9.03	6.04	15.07	1.49	13.52	21.93	35.44
LS7 1354 34.3	4.57	1.07	8.12	7.01	15.12	1.16	15.68	19.71	35.40
LS7 1355 35.8	4.61	1.20	9.10	6.57	15.67	1.38	14.71	22.11	36.82
LS7 1356 37.4	4.87	1.25	9.48	7.02	16.50	1.35	15.70	23.03	38.73
LS7 1357 38.9	4.84	1.29	9.78	6.78	16.56	1.44	15.16	23.77	38.93

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SHT ST LOUIS BRIDGE NO. 104

M528 CHRISTIANSEN SEPT 4/97 (3) PG 2695 [BR DIG]

1 %Ca BY ICP OT97.151

2 %Mg BY ICP

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
--	-----	-----	-------	--------	--------	--------	--------	--------	--------

BR2	5.27	1.56	11.83	6.74	18.57	1.76	15.08	28.74	43.82
LS7 1417 44.5	3.23	0.88	6.67	4.44	11.12	1.50	9.94	16.21	26.16
LS7 1418 46.0	3.53	0.97	7.36	4.82	12.18	1.53	10.79	17.87	28.66

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SHT ST LOUIS BRIDGE 105

M548 CHRISTIANSEN SEPT 17/97 (14) PG 2859 [.500 G BR DIG]

1 %Ca BY ICP OT97.160

2 %Mg BY ICP

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
--	-----	-----	-------	--------	--------	--------	--------	--------	--------

BR2	5.30	1.55	11.76	6.85	18.61	1.72	15.34	28.56	43.90
LS7 1472 7.2	4.01	1.46	11.07	4.00	15.08	2.77	8.96	26.90	35.86
LS7 1473 8.4	5.39	1.92	14.56	5.56	20.12	2.62	12.43	35.37	47.81
LS7 1474 9.9	7.09	3.06	23.21	5.11	28.32	4.54	11.43	56.38	67.81
LS7 1475 11.1	5.98	2.08	15.78	6.37	22.15	2.48	14.26	38.32	52.58
LS7 1478 15.0	6.18	2.22	16.84	6.29	23.13	2.68	14.08	40.90	54.99
LS7 1485 27.3	8.37	3.15	23.89	7.93	31.83	3.01	17.76	58.04	75.79
LS7 1486 28.2	7.19	2.42	18.36	7.99	26.35	2.30	17.89	44.59	62.47
LS7 1487 29.7	6.84	2.47	18.74	6.91	25.65	2.71	15.47	45.51	60.98
LS7 1488 31.3	6.54	2.38	18.05	6.53	24.59	2.76	14.62	43.85	58.47
LS7 1489 32.8	6.65	2.50	18.96	6.31	25.28	3.00	14.13	46.06	60.19
LS7 1990 34.5	4.00	1.03	7.81	5.75	13.56	1.36	12.87	18.98	31.84
LS7 1491 35.8	3.52	0.83	6.30	5.37	11.67	1.17	12.03	15.29	27.32
LS7 1492 37.1	3.93	0.93	7.05	5.99	13.04	1.18	13.40	17.13	30.53

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 SHT ST LOUIS BRIDGE NO.106

M550 CHRISTIANSEN SEPT 17 1997 (13) [BR DIG.]

1 %Ca BY ICP OT97.162
 2 %Mg BY ICP
 3 Wt% DOLOMITE=COL.2*7.5852
 4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973
 5 TOTAL Wt% CO₃ (COL.3+COL.4)
 6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)
 7 CO₂ FROM CALCITE=COL.4*2.238
 8 CO₂ FROM DOLOMITE=COL.3*2.429
 9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
BR1	5.39	1.59	12.06	6.91	18.97	1.74	15.47	29.29	44.77
LS7 1528 1.0	5.77	2.02	15.32	6.09	21.42	2.51	13.64	37.22	50.85
LS7 1529 2.3	6.53	2.55	19.34	5.81	25.15	3.33	13.00	46.98	59.98
LS7 1530 3.8	6.97	2.82	21.39	5.80	27.19	3.69	12.97	51.96	64.93
LS7 1531 5.0	7.37	2.75	20.86	7.08	27.94	2.94	15.85	50.67	66.52
LS7 1543 23.6	7.27	2.95	22.38	6.01	28.39	3.72	13.45	54.35	67.80
LS7 1544 24.9	6.25	2.21	16.76	6.51	23.27	2.58	14.57	40.72	55.29
LS7 1546 28.2	4.77	1.16	8.80	7.14	15.94	1.23	15.97	21.37	37.34
LS7 1547 29.7	4.67	1.14	8.65	6.97	15.62	1.24	15.60	21.00	36.60
LS7 1548 31.3	5.02	1.31	9.94	7.14	17.08	1.39	15.99	24.14	40.12
LS7 1549 32.8	4.70	1.16	8.80	6.96	15.76	1.26	15.58	21.37	36.95
LS7 1550 34.3	4.71	1.27	9.63	6.53	16.17	1.47	14.62	23.40	38.02
LS7 1551 35.8	5.05	1.35	10.24	7.05	17.29	1.45	15.79	24.87	40.66
LS7 1552 37.4	5.53	1.39	10.54	8.09	18.63	1.30	18.10	25.61	43.71

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 SHT ST LOUIS BRIDGE NO.107

M549 CHRISTIANSEN SEPT 18 1997 (20) [BR DIG.]

- 1 %Ca BY ICP OT97.161
- 2 %Mg BY ICP
- 3 Wt% DOLOMITE=COL.2*7.5852
- 4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973
- 5 TOTAL Wt% CO3 (COL.3+COL.4)
- 6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)
- 7 CO2 FROM CALCITE=COL.4*2.238
- 8 CO2 FROM DOLOMITE=COL.3*2.429
- 9 TOTAL CO2=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
BR 2	5.53	1.58	11.98	7.31	19.29	1.64	16.35	29.11	45.46
LS7 1589 2.3	4.94	1.86	14.11	4.68	18.79	3.02	10.47	34.27	44.74
LS7 1590 3.8	6.46	2.49	18.89	5.88	24.77	3.21	13.16	45.88	59.04
LS7 1591 4.9	6.59	2.27	17.22	7.11	24.33	2.42	15.92	41.82	57.74
LS7 1598 16.0	8.16	2.92	22.15	8.36	30.50	2.65	18.70	53.80	72.50
LS7 1599 17.5	7.06	2.36	17.90	7.91	25.82	2.26	17.71	43.48	61.19
LS7 1600 19.1	7.84	3.17	24.05	6.53	30.57	3.68	14.61	58.41	73.01
LS7 1601 20.6	7.85	3.12	23.67	6.76	30.42	3.50	15.13	57.48	72.61
LS7 1602 22.7	2.41	0.75	5.69	2.93	8.62	1.94	6.56	13.82	20.38
LS7 1603 23.6	2.54	0.77	5.84	3.17	9.01	1.84	7.10	14.19	21.29
LS7 1604 25.2	2.26	0.70	5.31	2.76	8.07	1.92	6.18	12.90	19.08
LS7 1605 26.7	2.74	0.76	5.76	3.71	9.48	1.55	8.31	14.00	22.31
LS7 1606 28.2	2.67	0.88	6.67	3.04	9.72	2.19	6.81	16.21	23.03
LS7 1607 29.7	2.75	0.75	5.69	3.78	9.47	1.51	8.46	13.82	22.28
LS7 1613 39.6	5.94	1.06	8.04	10.47	18.51	0.77	23.43	19.53	42.96
LS7 1614 40.4	4.29	1.09	8.27	6.23	14.49	1.33	13.93	20.08	34.02
LS7 1616 43.5	5.03	1.10	8.34	8.03	16.38	1.04	17.98	20.27	38.24
LS7 1618 46.5	4.50	1.01	7.66	7.08	14.74	1.08	15.84	18.61	34.45
LS7 1620 49.6	4.15	1.03	7.81	6.12	13.94	1.28	13.70	18.98	32.68
LS7 1622 51.5	5.29	1.14	8.65	8.52	17.16	1.02	19.06	21.00	40.07

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 SHT ST LOUIS BRIDGE NO 108

M551 CHRISTIANSEN SEPT 18/97 (24) PG 2862 [.500 G BR DIG]

1 %Ca BY ICP OT97.163

2 %Mg BY ICP

3 Wt% DOLOMITE=COL.2*7.5852

4 Wt% CALCITE=(COL.1-(COL.2*1.6486))*2.4973

5 TOTAL Wt% CO₃ (COL.3+COL.4)

6 WT%DOLOMITE/Wt% CALCITE (COL.3/COL.4)

7 CO₂ FROM CALCITE=COL.4*2.238

8 CO₂ FROM DOLOMITE=COL.3*2.429

9 TOTAL CO₂=COL.7+COL.8

	%Ca	%Mg	WT%DO	WT%CAL	C03TOT	D0/CAL	CO2CAL	CO2DOL	CO2TOT
--	-----	-----	-------	--------	--------	--------	--------	--------	--------

BR2	5.41	1.59	12.06	6.96	19.02	1.73	15.59	29.29	44.88
LS7 1652 13.0	6.14	2.61	19.80	4.59	24.39	4.32	10.27	48.09	58.36
LS7 1653 14.5	7.18	3.05	23.13	5.37	28.51	4.31	12.03	56.19	68.22
LS7 1654 16.0	6.55	3.00	22.76	4.01	26.76	5.68	8.97	55.27	64.24
LS7 1659 23.6	7.14	2.76	20.94	6.47	27.40	3.24	14.47	50.85	65.33
LS7 1660 25.2	6.52	2.19	16.61	7.27	23.88	2.29	16.26	40.35	56.61
LS7 1661 26.7	6.46	2.60	19.72	5.43	25.15	3.63	12.15	47.90	60.05
LS7 1662 28.2	6.38	2.37	17.98	6.18	24.15	2.91	13.82	43.67	57.49
LS7 1663 28.7	6.74	2.64	20.02	5.96	25.99	3.36	13.34	48.64	61.99
LS7 1672 42.5	7.63	2.85	21.62	7.32	28.94	2.95	16.38	52.51	68.89
LS7 1673 43.5	5.00	1.28	9.71	7.22	16.93	1.35	16.15	23.58	39.73
LS7 1674 46.5	4.93	1.10	8.34	7.78	16.13	1.07	17.42	20.27	37.69
LS7 1675 48.0	4.01	0.85	6.45	6.51	12.96	0.99	14.58	15.66	30.24
LS7 1676 49.6	4.02	0.86	6.52	6.50	13.02	1.00	14.54	15.85	30.39
LS7 1677 51.1	3.82	0.91	6.90	5.79	12.70	1.19	12.97	16.77	29.73
LS7 1678 52.6	3.61	0.86	6.52	5.47	12.00	1.19	12.25	15.85	28.10
LS7 1679 54.1	4.12	1.00	7.59	6.17	13.76	1.23	13.81	18.42	32.24
LS7 1680 56.5	5.23	1.35	10.24	7.50	17.74	1.36	16.79	24.87	41.66
LS7 1681 58.0	5.38	1.35	10.24	7.88	18.12	1.30	17.63	24.87	42.50
LS7 1682 59.0	4.95	1.28	9.71	7.09	16.80	1.37	15.87	23.58	39.45
BR2	5.55	1.63	12.36	7.15	19.51	1.73	16.00	30.03	46.03
LS7 1683 61.0	5.33	1.32	10.01	7.88	17.89	1.27	17.63	24.32	41.95
LS7 1684 61.8	5.80	1.34	10.16	8.97	19.13	1.13	20.07	24.69	44.76
LS7 1685 63.0	5.35	1.34	10.16	7.84	18.01	1.30	17.55	24.69	42.24

B

4
101

E.A. CHRISTIANSEN
Drawing No. 0166-002-03
Final revision October 14, 1997

5
1026
10710
10611
108

12

B'

500

500

400

300

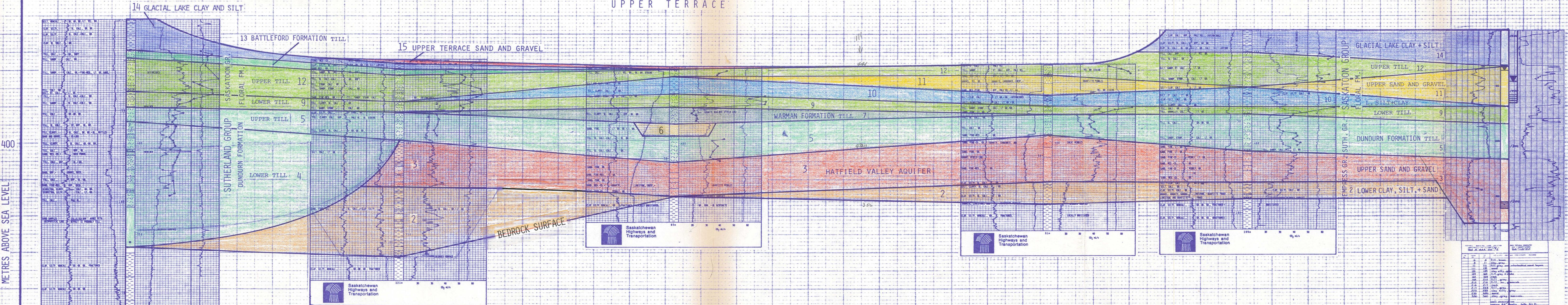
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INTERSECTION A-A'

INTERSECTION A-A'

INTERSECTION C-C'

INTERSECTION C-C'

STRATIGRAPHIC CHART AND EXPLANATION OF NUMBERS

TIME UNITS	STRATIGRAPHIC UNITS		
	GROUP	FORMATION	DEPOSIT
HOLOCENE	SASKATOON	BATTLEFORD	13 TILL
		FLORAL	12 UPPER TILL 11 UPPER SAND AND GRAVEL 10 LOWER SILT AND CLAY 9 LOWER TILL 8 LOWER SAND AND GRAVEL
PLEISTOCENE	SUTHERLAND	WARMAN	7 TILL 6 SAND 5 UPPER TILL
	DUNDURN		4 LOWER TILL
CRETACEOUS	EMPRESS		3 UPPER SAND AND GRAVEL 2 LOWER CLAY, SILT, AND SAND
MONTANA	LEA PARK FM. U. COLORADO GROUP		1 CLAY

EAC REVISED INTERPRETATION OF HOLE 101
NOVEMBER 8, 1997 AFTER RECEIVING CORE
FROM THE SECOND HOLE DRILLED AT SITE
101. SEE APPENDIX A FOR REVISED LOG.

DRAWING 0166-002-03. CROSS SECTION B-B' NORTH TO ST LOUIS AND EAST ALONG
THE SOUTH SIDE OF THE SOUTH SASKATCHEWAN RIVER VALLEY.

LEA PARK FORMATION AND UPPER COLORADO GROUP CLAY

0 1000
METRES
VERTICAL EXAGGERATION
8 X

LIMITATION
EXCEPT AT TESTHOLE SITES WHERE GEOLOGIC LOGS ARE AVAILABLE,
GEOLOGIC CONTACTS ARE INFERRED AND REPRESENT GEOLOGIC
MODELS THAT ARE BELIEVED TO BEST FIT THE INFORMATION.

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Drawing No. 0166-002-03
Drawn By E.A. CHRISTIANSEN
Date SEPTEMBER 29, 1997
REvised OCTOBER 14, 1997

C

500

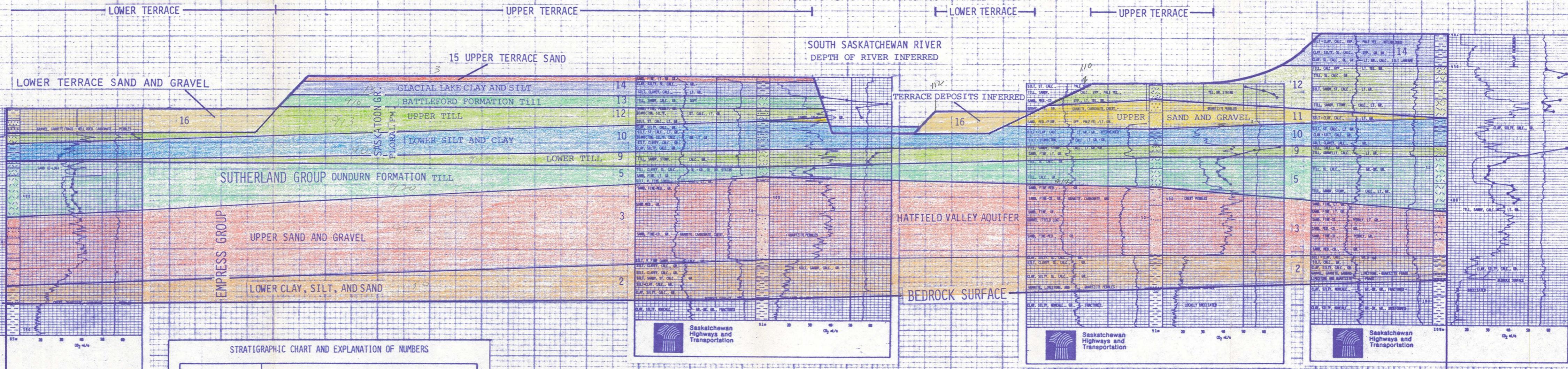
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103

E.A. CHRISTIANSEN
 Drawing No. 0166-002-04
 Final revision October 14, 1997

13
10510
10611
108

500

METRES ABOVE SEA LEVEL



STRATIGRAPHIC CHART AND EXPLANATION OF NUMBERS

TIME UNITS	STRATIGRAPHIC UNITS		
	GROUP	FORMATION	DEPOSIT
QUATERNARY	PLEISTOCENE	SASKATOON	16 LOWER TERRACE SAND AND GRAVEL
			16 UPPER TERRACE SAND AND GRAVEL
			14 GLACIAL LAKE CLAY, SILT, SAND
			13 TILL
			12 UPPER TILL
		WARMAN	11 UPPER SAND AND GRAVEL
			10 LOWER SILT AND CLAY
			9 LOWER TILL
		DUNDURN	8 LOWER SAND AND GRAVEL
			7 TILL
CRETACEOUS	MONTANA	LEA PARK FM. + U. COLORADO GROUP	6 SAND
			5 UPPER TILL
			4 LOWER TILL
			3 UPPER SAND AND GRAVEL
			2 LOWER CLAY, SILT, AND SAND
			1 CLAY

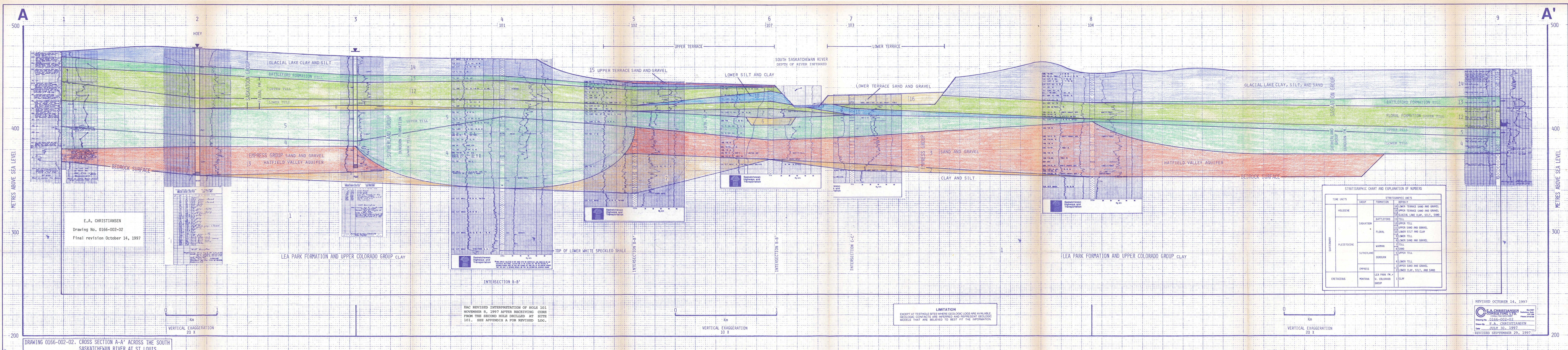
LEA PARK FORMATION AND UPPER COLORADO GROUP CLAY

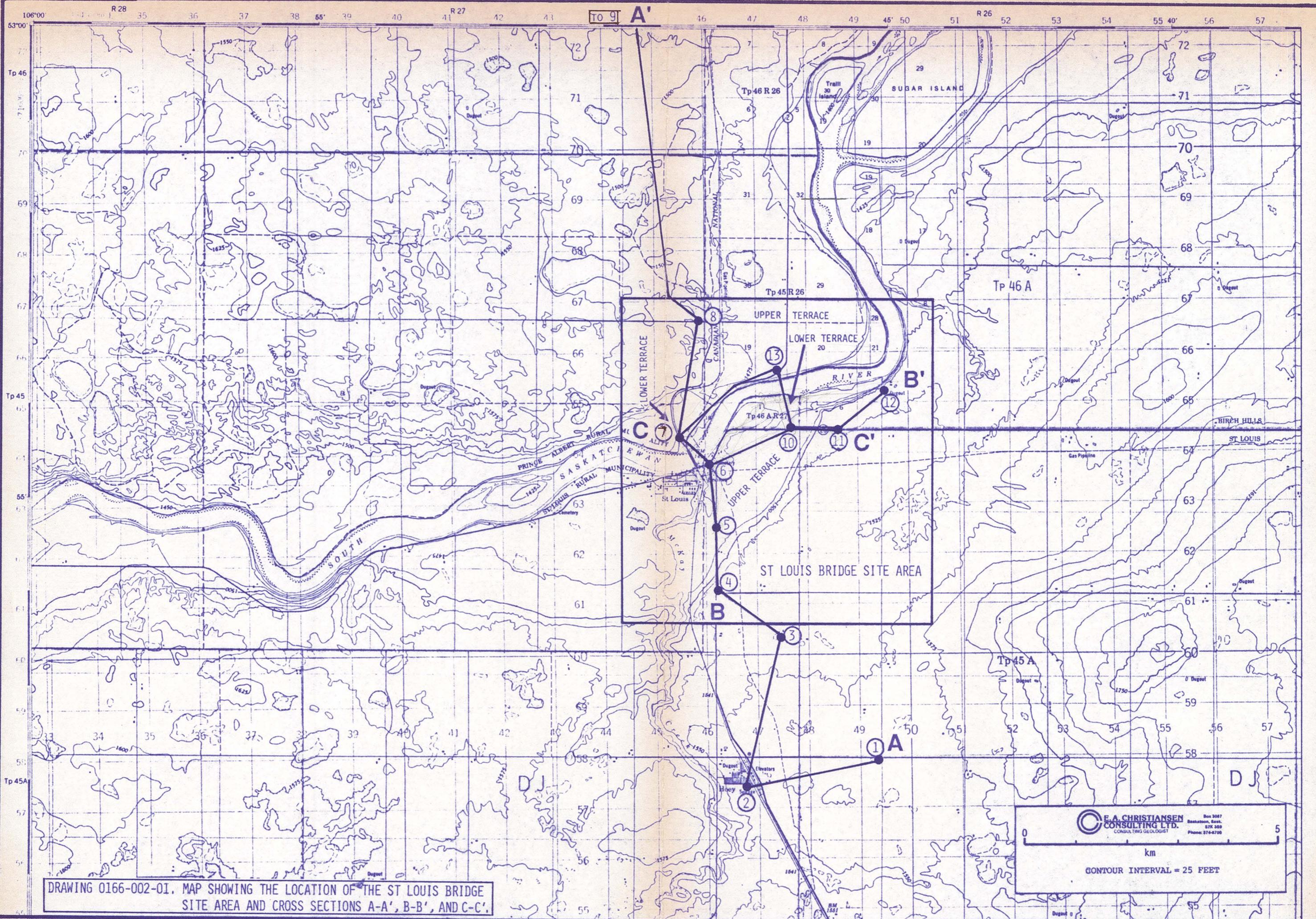
0
1000
METRES
VERTICAL EXAGGERATION
8 X

LIMITATION
 EXCEPT AT TESTHOLE SITES WHERE GEOLOGIC LOGS ARE AVAILABLE,
 GEOLOGIC CONTACTS ARE INFERRED AND REPRESENT GEOLOGIC
 MODELS THAT ARE BELIEVED TO BEST FIT THE INFORMATION.

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 Date SEPTEMBER 30, 1997

REVISED OCTOBER 14, 1997





DRAWING 0166-002-01. MAP SHOWING THE LOCATION OF THE ST LOUIS BRIDGE SITE AREA AND CROSS SECTIONS A-A', B-B', AND C-C'