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INTERIM REPORT SLOPE STABILITY STUDY EAST BANK SOUTH SASKATCHEWAN RIVER OUTLOOK, SASKATCHEWAN PMEL FILE NO. S08-6559 NOVEMBER 19, 2008

PREPARED FOR:

TOWN OF OUTLOOK BOX 518 OUTLOOK, SASKATCHEWAN S0L 2N0

ATTN: MR. TRENT MICHELMAN, ADMINISTRATOR

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1.0 INTRODUCTION

The following interim report has been prepared to present the initial results of a slope stability study currently being conducted to assess the potential for slope instability along the East Bank of the South Saskatchewan River in the Town of Outlook, Saskatchewan.

The Terms of Reference for this investigation were presented in PMEL Proposal No. 0505-4941 dated May 5, 2008. Authorization to perform this work was provided on May 29, 2007.

The field test drilling and soil sampling was performed on August 13 and 15, 2008; August 27, 2008 and September 24, 2008. Groundwater monitoring was performed on September 24, 2008, October 9, 2008 and November 17, 2008.

1.1 <u>Background</u>

The Town of Outlook is located on the east side of the South Saskatchewan River. The Town of Outlook has a number of developments and infrastructure on the east bank of the river bank slope including a Regional Park and swimming pool; the Skytrail Bridge (former CP Rail Bridge); a pump house for potable water; a sewage pumping station; and storm sewer outfalls.

It is understood that the Town of Outlook is concerned with the potential for slope instability and potential effects to existing infrastructure [a regional park and swimming pool; the Skytrail Bridge; a pump house (potable water); a sewage pumping station; and storm sewer outfalls] by slope failures.

The river bank in the study area rises approximately 45 metres above the elevation of the South Saskatchewan River over a distance of approximately 260 metres (i.e., 6:1 horizontal to vertical). Site topography to the north of the Skytrail Bridge is defined by parallel troughs and ridges (i.e., consistent with previous landslide activity).

Utilities in the area include, but are not limited to overhead electrical power, a water force main from the pumphouse to the water treatment plant, storm outfalls and underground natural gas.

Historic bore hole records for the former CP rail bridge (currently the Skytrail Bridge) revealed that the South Saskatchewan River in the area of the study site has been in-filled with approximately 30 metres of river alluvium (i.e., sand, silt and clay). It is anticipated that initial slope instability would have occurred when the South Saskatchewan River had eroded into the clay shale.

For the purpose of this investigation, it is assumed that the existing slope is meta-stable (i.e., at or near a Factor of Safety of 1.0).

2.0 FIELD INVESTIGATION

2.1 <u>Visual Review</u>

A visual review of the study site was conducted on August 5, 2008. Select photographs taken of the subject property have been included in Appendix B, while brief summaries of the observations made during the review are presented in the following sub-sections.

The visual site review revealed the presence of tension cracks at the crest of river bank proximate the east abutment of the Skytrail Bridge; structural distress to the Skytrail Bridge; and cracks and settlement in the asphalt pavement around the Sewage Pumping Station. The presence of tension cracks and structural distress to the Skytrail Bridge are consistent with slope instability.

2.2 <u>Field Test Drilling</u>

Four test holes, located as shown on the Site Plan, Drawing No. S08-6559-1, were dry drilled using our truck-mounted, continuous flight, solid stem auger drill rig. The test holes were 150 mm in diameter and were extended to depths of 14.0 to 52.5 metres below existing ground surface.

Test hole drill logs were compiled during test drilling to record the soil stratification, the groundwater conditions, the position of unstable sloughing soils and the depths at which cobblestones and/or boulders were encountered.

Disturbed samples of auger cuttings, collected during test drilling, were sealed in plastic bags to minimize moisture loss. The soil samples were taken to our laboratory for analysis.

Piezometers (slotted, 50 mm diameter PVC pipe) were installed in each Test Hole for groundwater monitoring purposes.

3.0 FIELD DRILL LOGS

The field drill logs recorded during test drilling have been shown plotted on Drawing Nos. S08-6559-2 to 5B, inclusive.

3.1 Soil Profile

Detailed descriptions of the site stratigraphy are presented on the Test Hole Logs, Drawing Nos. S08-6559-2 through 5B, inclusive, while a stratigraphic section of the site has been shown plotted on Drawing No. S08-6559-6. In general the site stratigraphy consisted of glacial till overlying clay shale.

3.2 Groundwater Conditions, Sloughing

Seepage and sloughing conditions were encountered during test drilling. The depths at which seepage and sloughing conditions were encountered have been shown plotted on the Field Drill Logs, Drawings Nos. S08-6559-2 through 5B, inclusive.

A summary of the measured groundwater elevations recorded during this investigation is presented in Table I. An examination of Table I revealed that the depth to groundwater on November 17, 2008 ranged from 7.8 to 34.9 metres below grade.

Test Hole	Ground Surface	Piezometer Rim	Recorded Groundwater Elevation (metres)			
No.	Elevation (metres)	Elevation (metres)	Sept. 24, 2008	Oct. 9, 2008	Nov. 17, 2008	
08-1	500.2	501.2	483.5	487.8	483.7	
08-2	510.0	511.1	496.4	500.8	500.8	
08-3	525.4	526.6	491.6	NM	490.5	
08-4	494.9	495.7	Dry	486.6	486.9	

TABLE I. RECORDED GROUNDWATER LEVELS

It should be recognized that the recorded water levels have not stabilized. Higher and potentially perched groundwater levels should be expected following piezometer stabilization.

3.3 Cobblestones and Boulders

The glacial till consisted of a heterogeneous mixture of gravel, sand, silt and clay-sized particles. The glacial till strata also contained sorted deposits of the above particle sizes. In addition to the sorted deposits, a random distribution of larger particle sizes in the cobblestone range (60 to 200 mm) and boulder-sized range (larger than 200 mm) should be expected at the subject site.

It should be recognized that the statistical probability of encountering cobblestones and/or boulders in the four small diameter Test Holes drilled at this site was low. Intertill deposits of cobblestones, boulders, boulder pavements and isolated deposits of saturated sand or gravel should be anticipated. The frequency of encountering such deposits will increase proportionately with the number of holes drilled.

4.0 LABORATORY ANALYSIS

The soil classification and index tests performed during this investigation consisted of a visual classification of the soil, water contents, Atterberg limits, and grain size distribution analysis.

The results of the soil classification and index tests conducted on representative samples of soil have been plotted on the drill logs alongside the corresponding depths at which the samples were recovered, as shown on Drawing Nos. S08-6559-2 to 5B, inclusive.

The results of the grain size distribution analyses have been plotted on Drawing Nos. S08-6559-7 to 10, inclusive.

5.0 SLOPE STABILITY

A theoretical slope stability analysis was performed to quantify the Factor of Safety of the East Bank of the South Saskatchewan River in the Town of Outlook, Saskatchewan. The theoretical slope stability analysis was performed using the SLOPE/W computer program available through Geo-Slope International Ltd.¹ The General Limit Equilibrium method was used for all analysis.

5.1 Input for Analysis

5.1.1 <u>Surface Geometry</u>

Horizontal and vertical survey control was performed to establish the plan location and vertical elevation of the test hole locations, as well as one transect of the river bank profile. The results of the elevation survey have been shown plotted on Stratigraphic Section A-A', Drawing No. S08-6559-6.

5.1.2 Soil Stratigraphy

The stratigraphic units as well as the lithologic boundaries were interpreted from the results of the subsurface soils investigation and historic bore hole records for the CP Rail Bridge. The slope was analyzed for composite failure consistent with slope instability in clay shale along the South and North Saskatchewan Rivers.

5.1.3 <u>Piezometric Conditions</u>

The piezometric surface for the slope stability analysis was based on recorded water levels. A hydrostatic pore pressure condition was used for the slope stability analysis.

¹ Geo-Slope International Ltd., 1993. Slope/W User's Manual, A Comprehensive Program for Slope Stability Analysis, Geo-Slope International Ltd., Calgary, Alberta.

5.1.4 Soil Properties

The soil properties obtained during this investigation, as well as the suggested design strength parameters used for the slope stability analysis have been presented in Table II. The design strength parameters were selected to reflect the presence of secondary structures including slickensiding; jointing and breccia; stress history and physical soil properties. These values of soil strength parameters used for analysis were consistent with published soil strength parameters for this geographic region.

Material Type	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Internal Angle of Friction (Degrees)
Alluvium (Sand/Silt)	19.0	0.0	30.0
Glacial Till	21.5	5.0	27.0
Clay Shale (Undisturbed)	18.0	5.0	15.0
Clay Shale (disturbed)	18.0	5.0	6.0

TABLE II. S	OIL PARAMETERS	FOR ANALYSIS
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5.2 <u>Results of Analysis</u>

The results of the stability analysis for the existing slope have been presented in Table III.

Stratigraphic	Inferred Shear Zone Elevation	Calculated
Section	(Metres)	Factor of Safety
A-A'	450	

An examination of Table II revealed the calculated Factor of Safety (FS) for the existing slope is approximately 1.0 and, that the most probable failure zone is deep within the clay shale strata (i.e., 35 metres below existing River Elevation). The Factor of Safety of a slope (FS) is defined as the ratio of the available shear strength of the soil, to the minimum shear strength required to maintain stability. A Factor of Safety of equal to or less than 1 would indicate the potential for slope failure.

6.0 DISCUSSION OF RESULTS

A slope stability study was performed to quantify the existing Factor of Safety of the East Bank of the South Saskatchewan River in the Town of Outlook, Saskatchewan. The stability analysis confirmed that the east bank of the South Saskatchewan River in the Town of Outlook is meta-stable (i.e., at or near a Factor of Safety of 1.0) and that the probable failure mode is a deep seated composite slip surface at nominal Elevation 450 metres (i.e., 35 metres below the river elevation).

Based on the results of the initial test drilling and historic bore hole records for the alluvium deposits in the South Saskatchewan River, the installation of one deep slope indicator located proximate Test Hole No. 08-1, is proposed. The slope indicator will extend to a depth of at least 10 metres below the elevation of the probable slip plane (i.e., to nominal elevation 440 metres). Once installed, the slope indicator would be monitored to more accurately determine the location of the slip plane and to determine the rate of lateral slope movement.

Initial monitoring results will be used in the preparation of design considerations and recommendations for any remedial measures.

7.0 LIMITATIONS

The presentation of the summary of the field drill logs and interim slope stability analysis has been completed as authorized. Four, 150 mm diameter test holes were completed at this site. A field drill log was compiled for each Test Hole during test drilling which, we believe, was representative of the subsurface conditions at the Test Hole locations at the time of test drilling. Variations in the subsurface conditions from that shown on the drill logs at locations other than the exact Test Hole locations should be anticipated.

The Terms of Reference for this slope stability study did not include any environmental assessment of the site. No detectable evidence of environmentally sensitive materials such as hydrocarbon odour was detected during the actual time of the field test drilling program. If, on the basis of any knowledge, other than that formally communicated to us, there is reason to suspect that environmentally sensitive materials may exist, then additional test holes should be drilled and samples recovered for chemical analysis.

The subsurface investigation necessitated the drilling of deep test holes. Each Test Hole was backfilled with auger cuttings at the completion of drilling. Please be advised that some settlement of the backfill material will occur which may leave a depression or an open hole. It is the responsibility of the client to inspect the site and backfill, as required, to ensure that the ground surface at each Test Hole location is maintained level with the existing grade.

This report has been prepared for the exclusive use of the Town of Outlook and their agents for specific application to the east bank in the Town of Outlook, Saskatchewan. It has been prepared in accordance with generally accepted geotechnical engineering practices and no other warranty, express or implied, is made.

Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. PMEL accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

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We trust that this report fulfills your requirements for this project. Should you require additional information, please contact us.

P. MACHIBRODA ENGINEERING LTD.

Frank Hynes, P. Eng., M. Eng.

P. Machiberd \sim

Paul Machibroda, P.Eng., P. Geo, FCSCE

FH/PM:clb

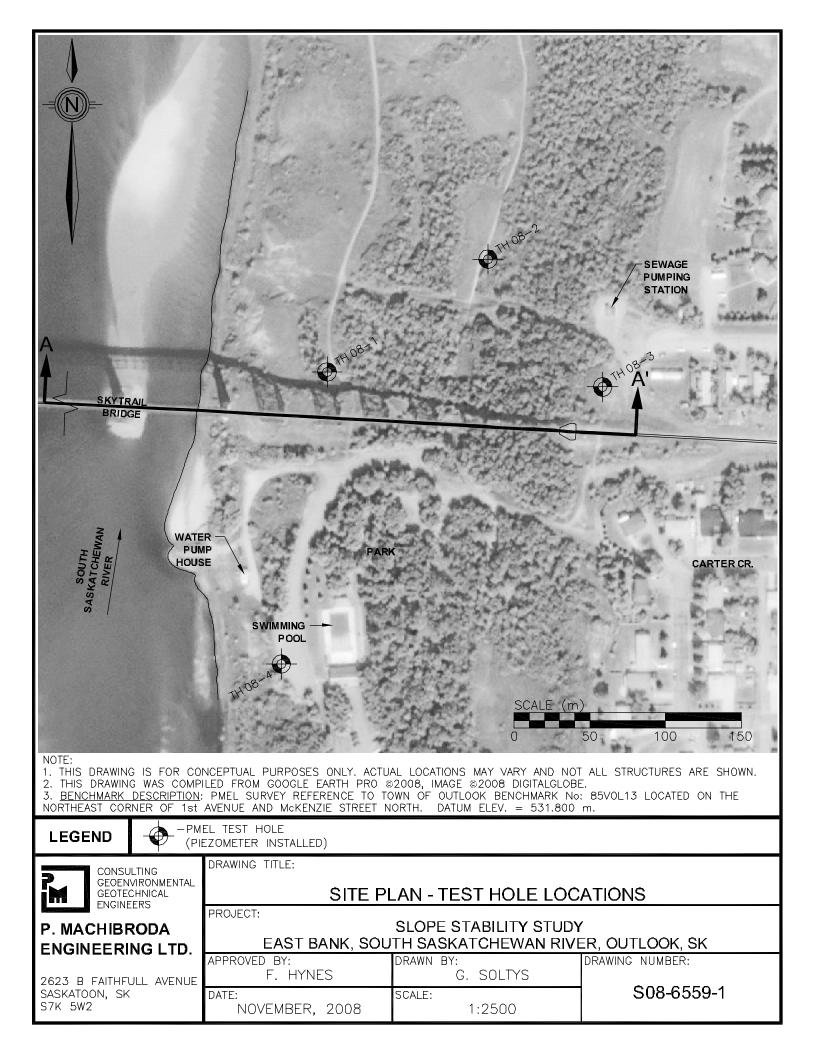
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Geoscientists of Saskatchewan				
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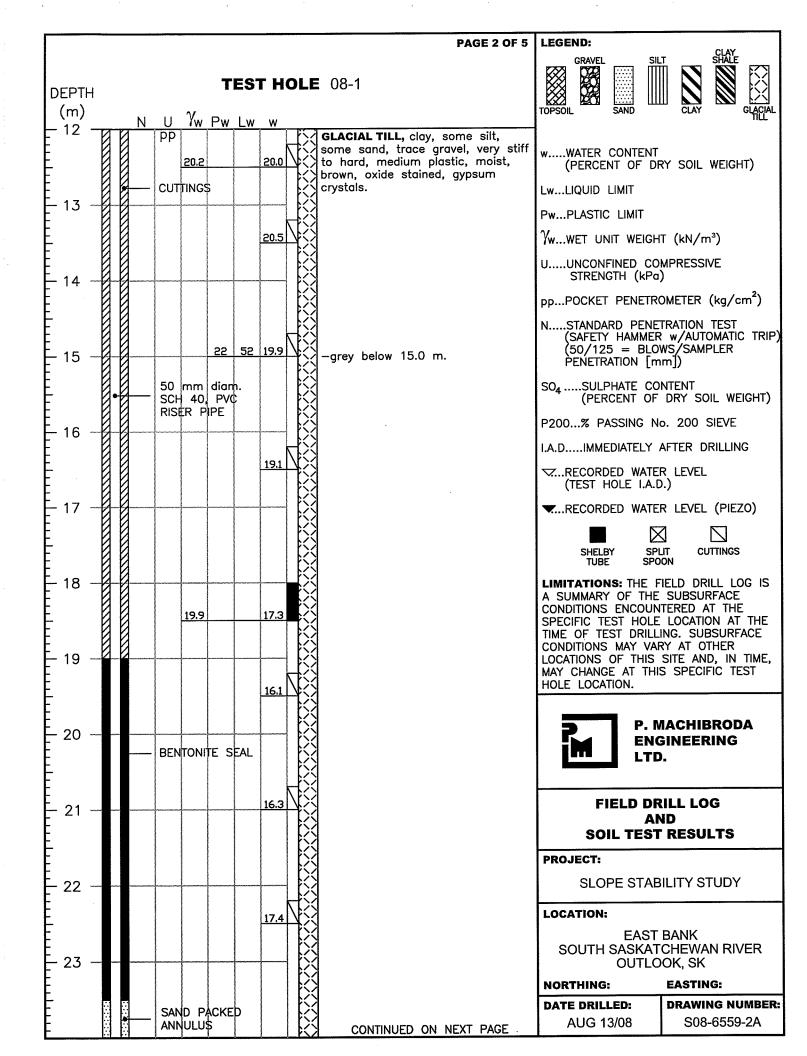


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DRAWINGS



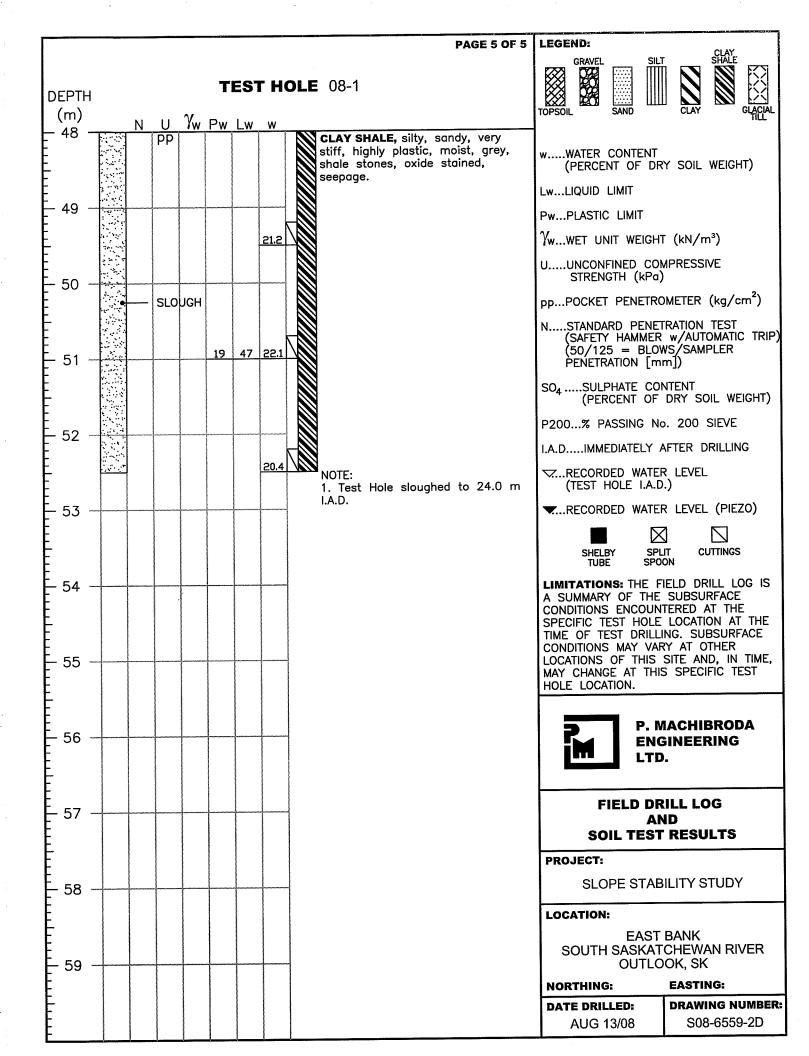
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· · ·	DEPTH (m)		TOPSOIL SIL	
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	3	CUTTINGS 12.9	(50/125 = BLO PENETRATION [m	TRATION TEST w/AUTOMATIC TRIP) WS/SAMPLER m])
	4	• 50 mm diam. SCH 40, PVC RISER PIPE 15 46 14.5	P200% PASSING N I.A.DIMMEDIATELY	DRY SOIL WEIGHT) D. 200 SIEVE AFTER DRILLING R LEVEL
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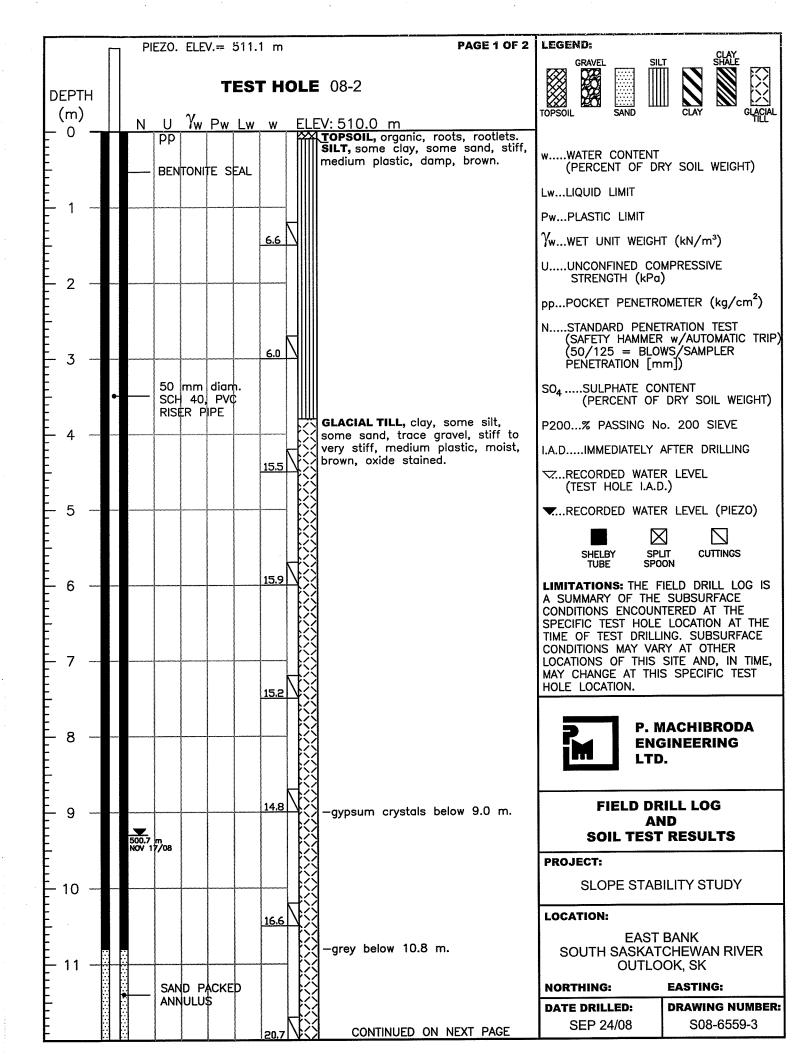


		PAGE 3 OF 5	LEGEND:	
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		<u>g</u> , g, ,	LwLIQUID LIMIT PwPLASTIC LIMIT	
			YwWET UNIT WEIGH UUNCONFINED CO STRENGTH (kPa	MPRESSIVE
50 mm diam. SCH 40, PVC RISER PIPE			ppPOCKET PENETR	OMETER (kg/cm²) TRATION TEST
			(SAFETY HAMMER (50/125 = BLO PENETRATION [m	& w/AUTOMATIC TRIP) WS/SAMPLER Im])
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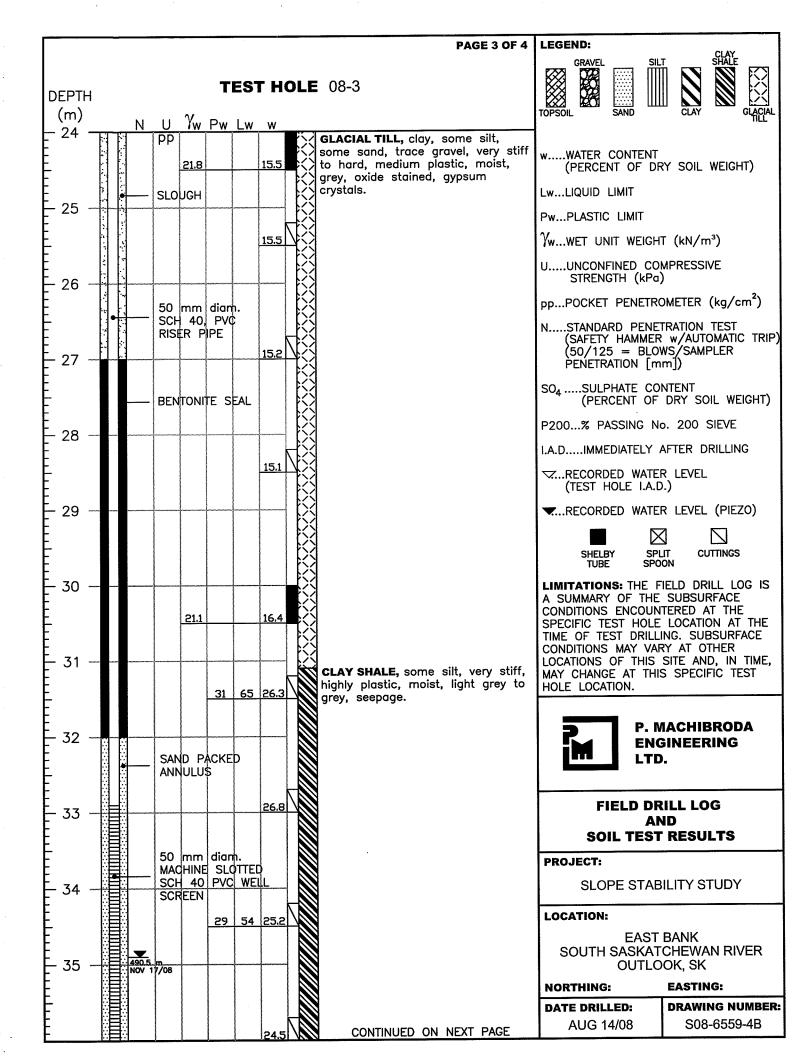




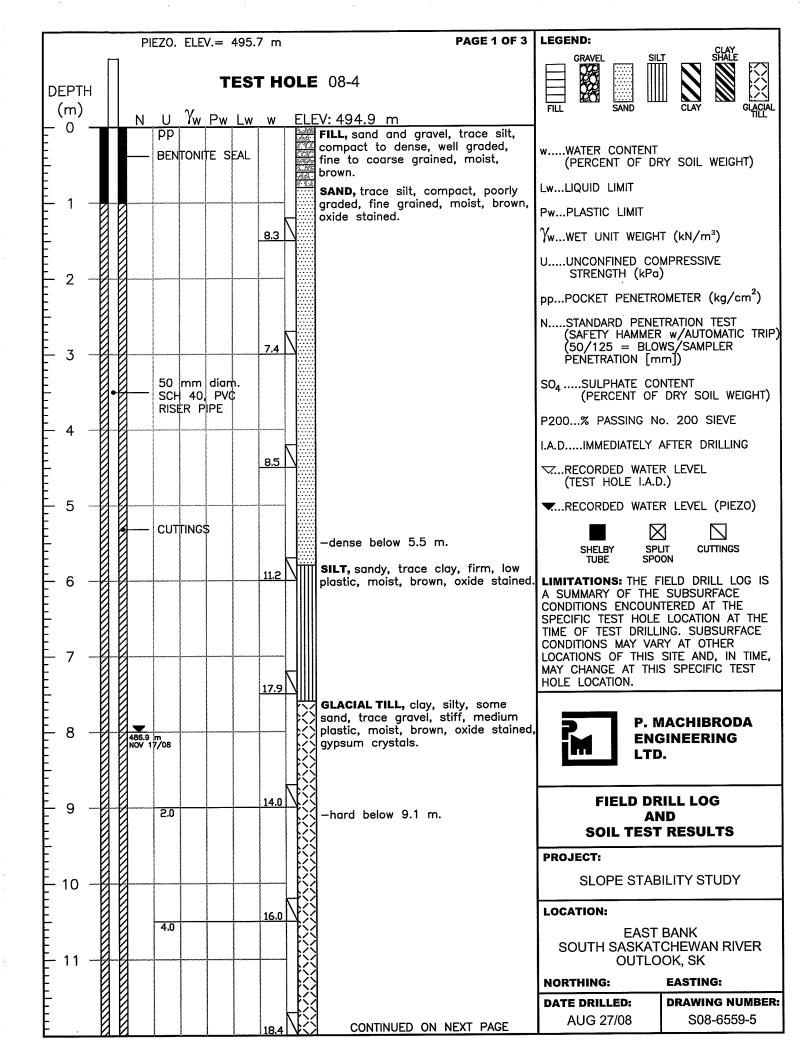
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	11 —							—very stiff to hard, grey below 10.8 m.	SOUTH SASKAT	BANK CHEWAN RIVER OOK, SK
E	Ĕ	18	*****				$ \langle \rangle$		NORTHING:	EASTING:
			******					CONTINUED ON NEXT PAGE	DATE DRILLED: AUG 14/08	DRAWING NUMBER: S08-6559-4
	Ŷ	n V.		, 1		. 1	/			

DEPTH TEST HOLE 08-3 (m) N U/w Pw Lw w 12 PP 10.8 13 13.8 10.8 14 13.2 13.2 15 15.2 15.2 16 12.4 15.2 17 15.2 15.2 18 12.4 12.4 19 12.4 12.4 10 12.4 12.4 10 13.2 13.4 12 14.4 14.4 14 14.4 14.4 15 15.4 15.4 16 12.4 12.4 17 12.4 12.4 18 12.4 12.4 19 16.9 12.4 19 16.9 16.9 12.1 12.4 12.4 19 16.9 16.9 19 16.9 16.9 20 30.00000000000000000000000000000000000		PAGE 2 OF 4	
12 PP CS GLACHATTILL, cloy, some silt, some sord, rowe, suit to hord, medium platic, moist, moi			
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16 124 17 124 17 50 mm diam. 18 50 mm diam. 18 211 19 122 19 163 163 163 163 163 18 211 19 169 19 169 100 163 110 163 111 163 112 163 113 163 114 163 115 163 116 163 117 163 118 163 119 163 119 163 119 163 119 163 119 163 1103 163 1104 163 1105 163 1106 163 1107 163 1108 163 1109 163 1100 163 1103<		<u>16.2</u>	(50/125 = BLOWS/SAMPLER PENETRATION [mm]) SO4SULPHATE CONTENT
17 50 mm diom. SCH 40, PVC RISER PIPE 18 211 17.2 21.1 172 21.1 172 21.1 172 21.1 172 21.1 172 22.1 16.9 23 SLOUCH 23 16.3 23 14.3 24 14.3 25 14.3	16		P200% PASSING No. 200 SIEVE
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21 17.2 19 16.9 20 16.9 21 16.9 20 16.9 21 16.3 21 16.3 22 16.3 23 16.3 24 16.3 25 16.3 26 SLOUGH 27 16.3 28 14.3 29 16.3 20 16.3 21 16.3 22 16.3 23 16.3 24 16.3 25 16.3 26 SLOUGH 27 16.3 28 P. MACHIBRODA ENGINEERING LTD. 29 14.3 20 14.3 21 16.3 22 14.3 23 14.3 24 16.3 25 16.3 26 16.3 27 16.3 28 16.3 29 16.3	SCH 40, PVC RISER PIPE		SHELBY SPLIT CUTTINGS TUBE SPOON
20 Ib3 21 Ib3 21 Ib3 21 Ib3 21 Ib3 22 Ib3 23 Ib3 24 Ib3 25 Ib3 26 Ib3 27 Ib3 28 Ib3 29 Ib3 20 Ib3 21 Ib3 22 Ib3 23 Ib3 24 Ib3 25 Ib3 26 Ib3 27 Ib3 14.3 Ib3 23 Ib3 14.3 Ib3 23 Ib3 24 Ib3 25 Ib3 26 Ib3 27 Ib3 14.3 Ib3 14.3 Ib3 14.3 Ib3 14.3 Ib3 14.3 Ib3 14.3 Ib3 14.4.3 Ib3 <td>21.1</td> <td></td> <td>A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST</td>	21.1		A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST
21 AND 22 PROJECT: 22 SLOPE STABILITY STUDY Location: EAST BANK SOUTH SASKATCHEWAN RIVER OUTLOOK, SK NORTHING: EASTING: DATE DRILLED: DRAWING NUMBER: AUG. 14/08 S08-6559-44			P. MACHIBRODA ENGINEERING
22 22 14.3 SLOPE STABILITY STUDY LOCATION: EAST BANK SOUTH SASKATCHEWAN RIVER OUTLOOK, SK NORTHING: EASTING: DATE DRILLED: DRAWING NUMBER: AUG 14/08 S08-6559-4A		16.3	AND
EAST BANK SOUTH SASKATCHEWAN RIVER OUTLOOK, SK NORTHING: EASTING: DATE DRILLED: DRAWING NUMBER: ALIC: 14/08 S08-6559-4A			
DATE DRILLED: DRAWING NUMBER:			EAST BANK SOUTH SASKATCHEWAN RIVER OUTLOOK, SK
		CONTINUED ON NEXT PAGE	DATE DRILLED: DRAWING NUMBER:

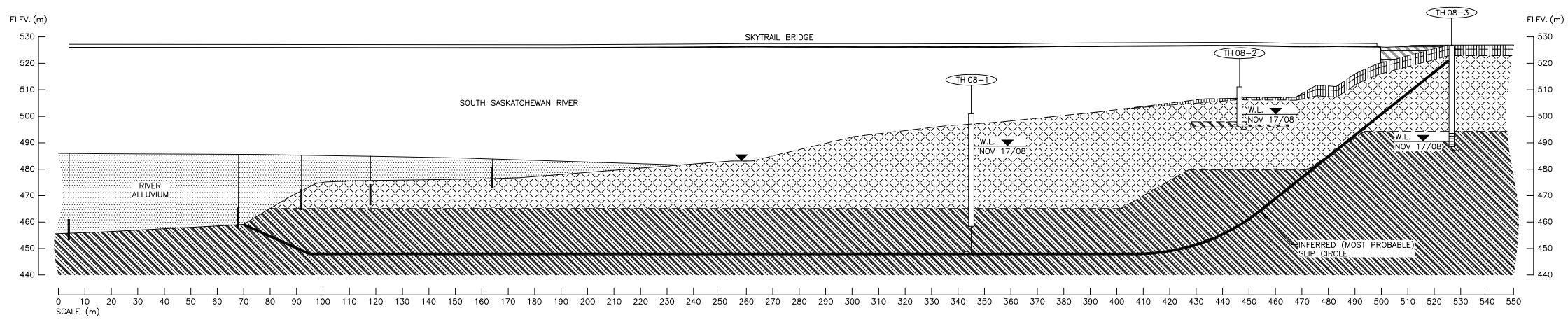


39									PAGE 4 OF 4	LEGEND:	
37 SMD PACKED ANNULUS 37 So min diam. So min di di diam. So min di di di di di di di di di d	(m)	N	υ%				E 08-3				
37 E B) mind dera. SCHEEN B) 47 481 38 Green B) 47 481 I. Test Hole open to 37.5 m and dry I.A.D. 39 Green B) 47 481 39 Green B) 47 481 39 Green B) 47 481 40 Green B) 47 481 41 Green B) 47 481 42 Green B) 47 481 41 Green B) 47 481 42 Green B) 47 481 43 Green B) 47 481 44 Green B) 47 481 44 Green B) 47 481 45 Green B) 47 481 46 Green B) 47 481 47 Green B) 47 481 47 Green B) 47 481 47 Green B) 47 481	- 36 -		SAND	PACKE			highly plastic	, moist,	ilt, very stiff, light grey to		
38 Note: Hole open to 37.5 m and dry LA.D. 39	E - 37		MACHIN	NE SLO	OTTED						
38 dry LAD. 39 ppPOCKET PENETROMETER (kg/cm ²) 39 STRENGTH (kP0) 40 SAFETY HAMMER PAULTONATIC TRIP) (SO/122 = BLOWS/SAMPLER PENETRATION [mm]) 40 Southastic Company (kg/cm ²) 41 Southastic Company (kg/cm ²) 42 Safety Hammer Der Southastic Company (kg/cm ²) 43 Same and the					WEUL	8.1		opon to	375 m and	Ywwet unit weig	
39 STANDARD PENETRATION TEST (SAFETY HAMBER AVAIDMARTC TRIP) (SO/125 = BLOWS/SAMPLER PENETRATION [mm]) 40 STANDARD PENETRATION TEST (SAFETY HAMBER AVAIDMARTC TRIP) (SO/125 = BLOWS/SAMPLER PENETRATION [mm]) 40 STANDARD PENETRATION TEST (SAFETY HAMBER AVAIDMARTC TRIP) (SO/125 = BLOWS/SAMPLER PENETRATION [mm]) 40 STANDARD PENETRATION TEST (SAFETY HAMBER AVAIDMARTC AVAIDMARTC TO FUEL ON THE SOLUTION PENETRATION [mm]) 41	- - 38								57.5 m dhu	STRENGTH (kF	Pa)
40 SQ SQ <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>NSTANDARD PEN (SAFETY HAMME</td><td>IETRATION TEST ER w/AUTOMATIC TRIP)</td></td<>										NSTANDARD PEN (SAFETY HAMME	IETRATION TEST ER w/AUTOMATIC TRIP)
40 (PERCENT OF DRY SOIL WEIGHT) 40	— 39 — -									PENETRATION [mm])
40 I.A.DIMMEDIATELY AFTER DRILLING 41 ✓RECORDED WATER LEVEL (PIEZO) 41 ✓RECORDED WATER LEVEL (PIEZO) 42 ✓RECORDED WATER LEVEL (PIEZO) 43 ✓RECORDED WATER LEVEL LOG IS 43 ✓RECORDED WATER LEVEL LOG IS 44 ✓RECORDED WATER LEVEL LOG IS 44 ✓RECORDED WATER LEVEL LOG IS 45 ✓RECORDED WATER LEVEL LOG IS 46 ✓RECORDED WATER LEVEL LOG IS 47 ✓RECORDED WATER LEVEL (PIEZO)	-									(PERCENT O	F DRY SOIL WEIGHT)
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43 LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION. 44 P. MACHIBRODA ENGINEERING LTD. 45 FIELD DRILL LOG AND SOIL TEST RESULTS 46 SIOPE STABILITY STUDY 47 LOCATION: 47 EAST BANK SOUTH SASKATCHEWAN RIVER OUTLOOK, SK NORTHING: EASTING: DATE DRILLED: DRAWING NUMBER:	- 42 -						×			A SUMMARY OF TH CONDITIONS ENCOU SPECIFIC TEST HOL TIME OF TEST DRIL	E SUBSURFACE INTERED AT THE E LOCATION AT THE LING. SUBSURFACE
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EAST BANK SOUTH SASKATCHEWAN RIVER OUTLOOK, SK NORTHING: EASTING: DATE DRILLED: DRAWING NUMBER:	E - 46				ļ						BILITY STUDY
A7 A7 OUTLOOK, SK NORTHING: EASTING: DATE DRILLED: DRAWING NUMBER:	-										
DATE DRILLED: DRAWING NUMBER:	E - 47				ļ					SOUTH SASKA	TCHEWAN RIVER
	E		****		*******					NORTHING:	EASTING:
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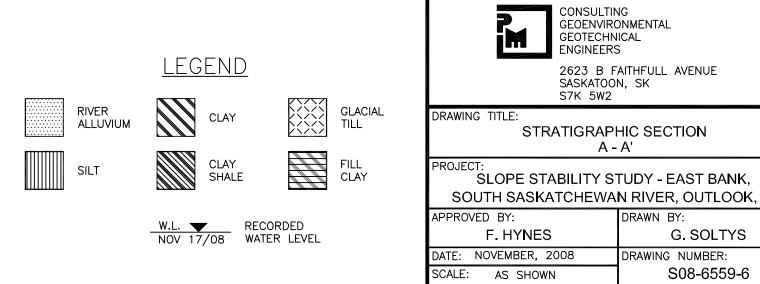


					PAGE 2 OF 3	LEGEND:	
	DEPTH (m)	~		HOLE		GRAVEL SIL	
	- 12	N U M	w Pw Lw	W			1166
			GS		GLACIAL TILL , clay, silty, some sand, trace gravel, hard, medium plastic, moist, brown, oxide stained, gypsum crystals.	wWATER CONTENT (PERCENT OF DF	RY SOIL WEIGHT)
	- - 13				377	LwLIQUID LIMIT	
				{		PwPLASTIC LIMIT	T (1)1 (3)
				<u>21.7</u>		YwWET UNIT WEIGH	
	- 14 -			-		STRENGTH (kPa)
				X		ppPOCKET PENETRO	
	- 15			0.5		NSTANDARD PENE (SAFETY HAMMER (50/125 = BLO' PENETRATION [m	w/AUTOMATIC TRIP) WS/SAMPLER
		• SCH 4	m diam. 10, PVC			SO ₄ SULPHATE CO (PERCENT OF	NTENT DRY SOIL WEIGHT)
	- 16 - 6	RISER	PIPE			P200% PASSING N	o. 200 SIEVE
·			4	8.4		I.A.DIMMEDIATELY	AFTER DRILLING
						TEST HOLE I.A.D	R LEVEL 9.)
	- 17			\neg		RECORDED WATE	R LEVEL (PIEZO)
						SHELBY SPI TUBE SPO	IT CUTTINGS
	18					LIMITATIONS: THE F A SUMMARY OF THE CONDITIONS ENCOUN SPECIFIC TEST HOLE TIME OF TEST DRILL CONDITIONS MAY VAF LOCATIONS OF THIS MAY CHANGE AT THIS HOLE LOCATION.	SUBSURFACE TERED AT THE LOCATION AT THE ING. SUBSURFACE Y AT OTHER SITE AND, IN TIME,
				<u>:6.8</u>			
	20 -						IACHIBRODA GINEERING J.
	- - 21 -			28.8 28.8		FIELD DR	
			*****			AN SOIL TEST	
			· · · · · · · · · · · · · · · · · · ·			PROJECT:	
	- 22 -				CLAY SHALE, silty, trace sand, very stiff, highly plastic, moist, grey.	SLOPE STAB	ILITY STUDY
				25.1	and many problem moles groy.	LOCATION:	
	- 23 -						CHEWAN RIVER OK, SK
	ŧ į					NORTHING:	EASTING:
				26.8	CONTINUED ON NEXT PAGE	DATE DRILLED: AUG 27/08	DRAWING NUMBER: S08-6559-5A
	- r.	7 A 1 3					

											PA	GE 3 OF 3	LEGE	ND:	نىسىلىكى <u>مەرىمىيە مەرمىيە</u>			·····	
DEPTH (m)	ł	N	U	γ_{w}	T Pw			OLE	08-4					GRAVEL	SAND			CLAY SHALE	GLACIAL
- 24 -			PP 50 SC⊦	mm 40,	dian PV(n .			CLAY S stiff,h	HALE, silt ighly plast	ty, trace tic, mois	sand, very t, grey.			CONTENT		OIL V	WEIGH	IT)
- - 25 -			RISE	ER P	IPE								1	quid l					
							25.6								T WEIGH	HT (kl	N/m ⁴	³)	
_ 26 ∽													UU	NCONFI STRENG	INED CO TH (kPo	DMPRE D)	ESSIV	Æ	
			CUT	TING	-(A)														m²)
- 27							<u>25.5</u>						(5	SAFETY 50/125	RD PENE HAMME = BLC TION [r	R w// DWS/S	AUTO	MATIC	; TRIP)
										·			S0 ₄		HATE CO CENT OF			L WE	IGHT)
E - 28 -															SSING N				_
							26.1						\	ECORDE	DIATELY	ER LE		(ILLIN)	G
E - 29 ∽			50	m m	dian										DLE I.A. ED WATE		VEL	(PIEZ	:0)
			MAC SCH	HINE	SLC	TTEC	L							SHELBY TUBE	r SF] דעס		
- 30 -			SLO	UGH			<u>25.4</u>						A SUI CONDI SPECI TIME CONDI	MMARY ITIONS FIC TES OF TES ITIONS	S: THE OF THE ENCOUN ST HOLI ST DRILI MAY VA	E SUE NTERE E LOC LING. NRY A	BSURI D AT CATIO SUB T OT	FACE THE NAT SURF/ HER	THE
- 31 - - -													MAY (of this at th Ion.				
- 													Ē			MAC GINE D.			A
- - 33 - -															ELD DI A L TES	ND			
													PROJ						
- 34 -									-wet, 34.0 m	seepage, 1.	sloughing	, below	1000	SLOP	PE STAI	SILII	r 51	UDY	
- - - 35 -									-sandy	below 3	5.0 m.				EAST SASKA OUTLO	TCHE	WAN:	N RIV	'ER
Ē						-							NORT	THING:			STING	G:	
			****	*****		*****			NOTE: 1. Test I.A.D.	Hole slo	oughed to	29.6 m		UG 27				G NU 6559-	MBER: -5B



<u>STRATIGRAPHIC SECTION A-A'</u>



LIMITATION THIS STRATIGRAPHIC SECTION SUBSURFACE FIELD CONDITION ENCOUNTERED AT SPECIFIC TE TIME OF TEST DRILLING. SUBS VARY AT OTHER LOCATIONS AN AT THE SPECIFIC LOCATION OF	IS A SUMMARY OF S INFERRED FROM DATA ST HOLE LOCATIONS AT THE SURFACE CONDITIONS MAY ND, IN TIME, MAY CHANGE
P. MACHIBRODA EI	NGINEERING LTD.
CONSULTIN GEOENVIRG GEOTECHN ENGINEERS 2623 B F SASKATOOI S7K 5W2	NMENTAL ICAL S AITHFULL AVENUE
DRAWING TITLE: STRATIGRAPI A -	
PROJECT: SLOPE STABILITY S SOUTH SASKATCHEWA	
APPROVED BY:	DRAWN BY:
F. HYNES	G. SOLTYS
DATE: NOVEMBER, 2008	DRAWING NUMBER:
SCALE: AS SHOWN	S08-6559-6

Project: SLOPE STABILITY STUDY

EAST BANK, SOUTH SASKATCHEWAN RIVER, OUTLOOK, SK

Project No.: S08-6559

Date Tested: OCTOBER 7, 2008

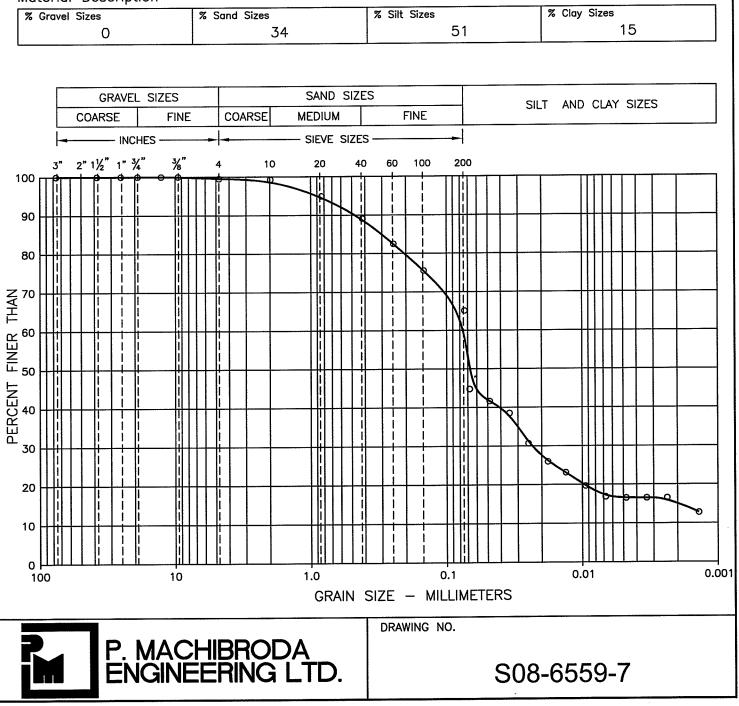
3

Test Hole No.: 08-1

Sample No.:

Depth (m): 4.5

Remarks:



Project: SLOPE STABILITY STUDY

EAST BANK, SOUTH SASKATCHEWAN RIVER, OUTLOOK, SK

Project No.: S08-6559

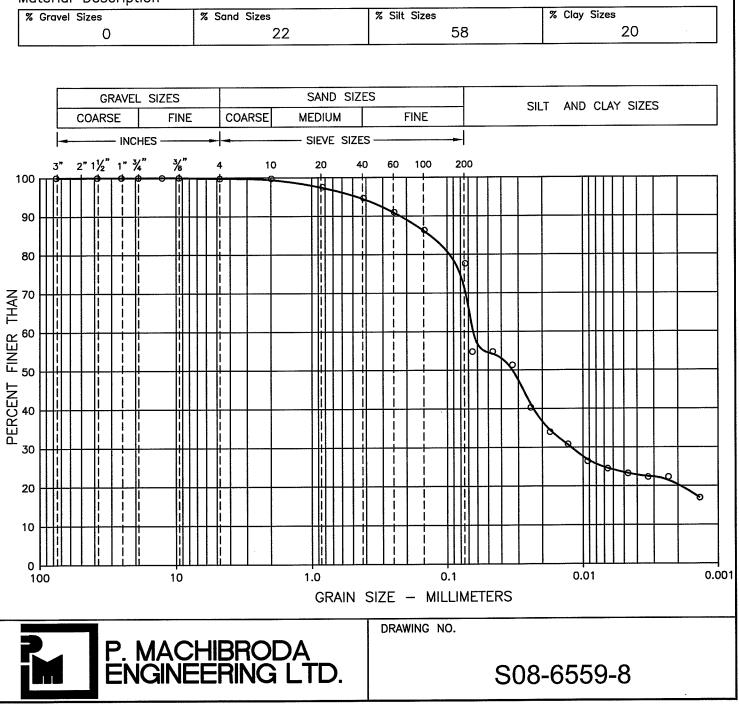
Date Tested: OCTOBER 7, 2008

Test Hole No.: 08-1

Sample No.: 10

Depth (m): 15.0

Remarks:



Project: SLOPE STABILITY STUDY

EAST BANK, SOUTH SASKATCHEWAN RIVER, OUTLOOK, SK

Project No.: S08-6559

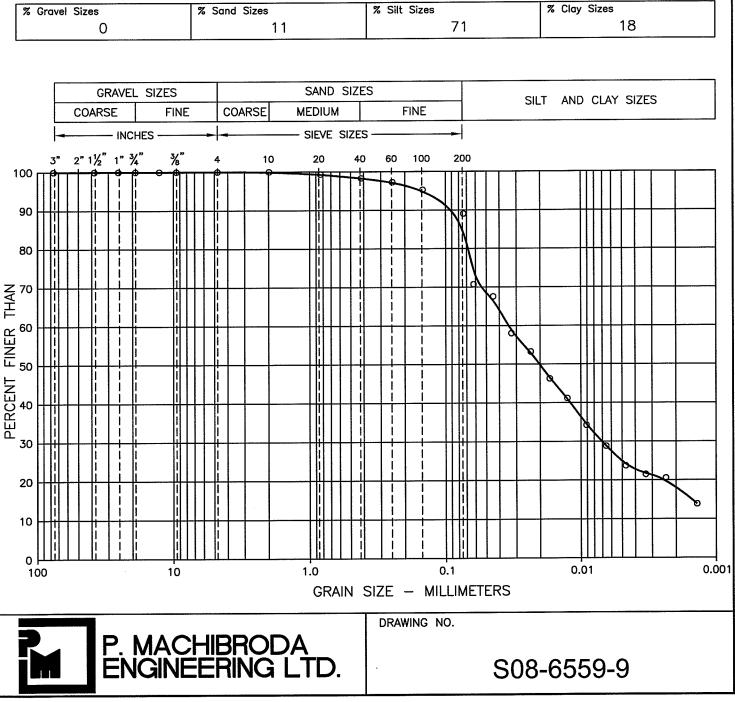
Date Tested: OCTOBER 7, 2008

Test Hole No.: 08-1

Sample No.: 25

Depth (m): 37.5

Remarks:



SLOPE STABILITY STUDY Project:

EAST BANK, SOUTH SASKATCHEWAN RIVER, OUTLOOK, SK

S08-6559 Project No.:

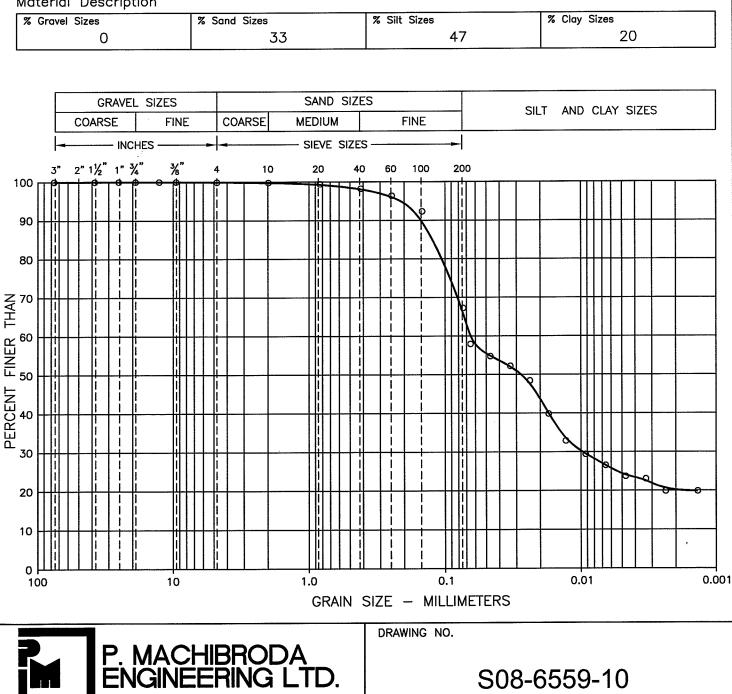
Date Tested: OCTOBER 7, 2008

Test Hole No.: 08-2

208 Sample No.:

Depth (m): 13.5

Remarks:



APPENDIX A

EXPLANATION OF TERMS ON TEST HOLE LOGS

CLASSIFICATION OF SOILS

Coarse-Grained Soils: Soils containing particles that are visible to the naked eye. They include gravels and sands and are generally referred to as cohesionless or non-cohesive soils. Coarse-grained soils are soils having more than 50 percent of the dry weight larger than particle size 0.080 mm.

Fine-Grained Soils: Soils containing particles that are not visible to the naked eye. They include silts and clays. Fine-grained soils are soils having more than 50 percent of the dry weight smaller than particle size 0.080 mm.

Organic Soils: Soils containing a high natural organic content.

Soil Classification By Particle Size

Clay – particles of size	< 0.002 mm
Silt – particles of size	0.002 – 0.060 mm
Sand – particles of size	0.06 – 2.0 mm
Gravel – particles of size	2.0 – 60 mm
Cobbles – particles of size	60 – 200 mm
Boulders – particles of size	>200 mm

TERMS DESCRIBING CONSISTENCY OR CONDITION

Coarse-grained soils: Described in terms of compactness condition and are often interpreted from the results of a Standard Penetration Test (SPT). The standard penetration test is described as the number of blows, N, required to drive a 51 mm outside diameter (O.D.) split barrel sampler into the soil a distance of 0.3 m (from 0.15 m to 0.45 m) with a 63.5 kg weight having a free fall of 0.76 m.

Compactness Condition	SPT N-Index (blows per 0.3 m)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	Over 50

Fine-Grained Soils: Classified in relation to undrained shear strength.

Consistency	Undrained Shear Strength (kPa)	N Value (Approximate)	Field Identification
Very Soft	<12	0-2	Easily penetrated several centimetres by the fist.
Soft	12-25	2-4	Easily penetrated several centimetres by the thumb.
Firm	25-50	4-8	Can be penetrated several centimetres by the thumb with moderate effort.
Stiff	50-100	8-15	Readily indented by the thumb, but penetrated only with great effort.
Very Stiff	100-200	15-30	Readily indented by the thumb nail.
Hard	>200	>30	Indented with difficulty by the thumbnail.

Organic Soils: Readily identified by colour, odour, spongy feel and frequently by fibrous texture.

DESCRIPTIVE TERMS COMMONLY USED TO CHARACTERIZE SOILS

Poorly Graded Well Graded Mottled Nuggety Laminated Slickensided Fissured	 predominance of particles of one grain size. having no excess of particles in any size range with no intermediate sizes lacking. marked with different coloured spots. structure consisting of small prismatic cubes. structure consisting of thin layers of varying colour and texture. having inclined planes of weakness that are slick and glossy in appearance. containing shrinkage cracks.
Fractured	- broken by randomly oriented interconnecting cracks in all 3 dimensions.

MAJOR DIVISION				GROUP SYMBOL	TYPICAL DESCRIPTION				LABORATORY CLASSIFICATION CRITERIA					
ŀ	IIGHLY ORG	ANIC	SOILS	Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS				STRONG COLOUR OR ODOUR AND OFTEN FIBROUS TEXTURE					
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS More than half coarse fraction larger than No. 4 sieve size	CLE	AN GRAVELS	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES <5% FINES				$C_u = \underline{D}_{60} > 4$ $C_c = \underline{(D_{50})^2} = 1 \text{ to } 3$ D_{10} $D_{60} \times D_{10}$					
	GRAVELS I half coarse an No. 4 sie			GP	POORLY-GRADED GRAVELS AND GRAVEL-SAND MIXTURES <5% FINES				NOT MEETING ALL ABOVE REQUIREMENTS FOR GW					
	GR/ GR/ sr than ha	DIRTY GRAVELS		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES >12% FINES				ATTERBERG LIMITS BELOW "A" LINE OR PI < 4					
	More large			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES >12% FINES				ATTERBERG LIMITS ABOVE "A" LINE WITH PI > 7					
	fraction ve size	CLEAN SANDS		sw	WELL-GRADED SANDS, GRAVELLY SANDS MIXTURES <5% FINES				$C_u = \underline{D}_{60} > 6$ $C_c = \underline{(D_{30})}^2 = 1 \text{ to } 3$ D_{10} $D_{60} \times D_{10}$					
	SANDS half coarse an No. 4 sie			SP	POORLY-GRADED SANDS OR GRAVELLY SANDS <5% FINES				NOT MEETING ALL GRADATION REQUIREMENTS FOR SW					
	SANDS More than half coarse fraction smaller than No. 4 sieve size			SM	SILTY SANDS, SAND-SILT MIXTURES >12% FINES				ATTERBERG LIMITS BELOW "A" LINE OR PI < 4					
	More t smalle	DIRTY SANDS		sc	CLAYEY SANDS, SAND-CLAY MIXTURES >12% FINES				ATTERBERG LIMITS ABOVE "A" LINE WITH PI >7					
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSING NO. 200 SIEVE SIZE)	SILTS			ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY				W _L < 50					
	Below "A" line on plasticity chart; negligible organic content			INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS				W _L > 50						
	CLAYS Above 'A" line on plasticity chart; negligible organic content			CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS				W _L < 30					
				сі	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS				W _L >30 < 50					
				СН	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS				W _L > 50					
	ORGANIC SILTS & ORGANIC CLAYS Below "A" line on plasticity chart			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY				W _L < 50					
U)				он	ORGANIC CLAYS OF HIGH PLASTICITY				W _L > 50					
	·····	60 T						•						
	PLASTIC FOR CLA		PLASTICIT FOR CLASS OF FINE GF	SIFICATION										
		40 -	01111201											
								ara ann a mheistrachair a tair an t-an						
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APPENDIX B

PHOTOGRAPHS



PHOTOGRAPH NO. S08-6559-1 T

Tension crack.



PHOTOGRAPH NO. S08-6559-2

Pavement distress south side Skytrail Bridge.



PHOTOGRAPH NO. S08-6559-3

Bridge distress.



PHOTOGRAPH NO. S08-6559-4

Bridge distress.



PHOTOGRAPH NO. S08-6559-5

Swimming Pool and Water Pumphouse.



PHOTOGRAPH NO. S08-6559-6

Landslide topography looking north.



PHOTOGRAPH NO. S08-6559-7

Bridge distress.



PHOTOGRAPH NO. S08-6559-8

Bridge distress.



PHOTOGRAPH NO. S08-6559-9

Bridge distress.



PHOTOGRAPH NO. S08-6559-10 Water Pumphouse.



PHOTOGRAPH NO. S08-6559-11

Asphalt distress – Sewage Pumping Station.



PHOTOGRAPH NO. S08-6559-12

Asphalt distress – Sewage Pumping Station.