MP 608 – Marshall, Michigan Incident
NTSB/PHMSA Information Request No. 24

24.21 Reference: Field request given to T. Picton by NTSB July 28

Preamble:

Request: **Soil sample near site.**

Response: The area of pipe near the failure has been excavated and the original soil removed and backfilled. Enbridge attaches a GeoTechnical Report dated July 31, 2010. Further to confirmation from Matthew Nicholson, no further soil sample is required at this time.

Geotechnical Investigation Findings Minnesota Limited Marshall Michigan July 31 2010.pdf

Golder Associates

Date July 31, 2010

Mr. Michael Hyke
Minnesota Limited, Inc.
18640 200t Street
P.O. Box 410
Big Lake, MN 55309

RE: GEOTECHNICAL EXPLORATION – MARSHALL MICHIGAN

Dear Mr. Hyke,

Golder Associates Inc. (Golder) presents this report containing the results of our geotechnical drilling exploration completed for Minnesota Limited, Inc. (Minnesota Limited) in Marshall, Michigan on July 31, 2010.

1.0 BACKGROUND

Golder received a telephone call on Friday evening July 30, 2010 requesting Golder to mobilize to the Marshall Project site for Minnesota Limited the following morning. A geotechnical investigation providing lateral earth pressure coefficients and approximate unit weights of the subsurface soils in two separate boring locations located near a rupture in a pipeline was requested.

The geotechnical exploration, testing and reporting described herein was performed under a very short time frame and with limited planning, testing and reporting time. This report should be read in the appropriate context.

2.0 GEOTECHNICAL EXPLORATION

The field exploration program for this project consisted of drilling two (2) geotechnical soil borings at the locations selected by Enbridge Inc. and Minnesota Limited. The exploratory borings were advanced using a CME-55 truck-mounted drill rig equipped with 8-inch outside diameter hollow stem augers provided by Stearns Drilling of Dutton, Michigan.

Soil boring number 1 (SB-1) was drilled at a location approximately 8 feet north of the oil pipeline and approximately 100 feet west of the rupture location as was indicated by the Enbridge Inc. representative. Soil boring number 2 (SB-2) was drilled approximately 10 feet north of the high pressure gas line and approximately 100 feet from the rupture as indicated by the Enbridge Inc. representative. The two borings were drilled approximately 30 feet apart.

Both soil borings were drilled to a depth of approximately 35 feet below ground surface. The soils encountered in these borings were visually logged in the field by a Golder representative. The boreholes were backfilled with the excavated soil cuttings upon completion. The field boring logs are presented in Appendix A. The logs describe the earth materials encountered. The logs also show the boring number, drilling date, and the name of the Golder representative that logged the boring. The soils were described in general accordance with ASTM D2488 procedures. The boundaries between different soil types shown on the logs are approximate because the samples are taken at discrete locations and the actual transition between soil layers may be gradual.

Samples were obtained using a standard penetration test (SPT) split spoon sampler. This sampler consists of a 2-inch O.D., 1.4-inch I.D. split barrel shaft that is driven a total of 18 inches into the soil at the bottom of the borehole. The SPT samplers were driven into the soil using a 140-pound hammer free-falling a vertical distance of 30 inches. The total number of hammer blows required to drive the sampler the final 12 inches is termed the "blow count." The blow counts are also recorded on the boring logs. The procedures employed in the field are generally consistent with those described in ASTM D1586. Soil is retained inside the split barrel shaft and is visually classified.

Soils encountered in both boreholes consisted primarily of a SILTY SAND, USCS classification of SM, with traces of gravel. Very little variation in the sub-surface soils was observed except for variation in density and color. Water was encountered approximately 4 feet below ground surface and is presumed to be the water table in this area. Bedrock was deemed to be reached at approximately 35 feet below ground surface where both borings were completed.

Based on the standard penetration tests, the SILTY SAND is very loose to loose in terms of density in the upper 5 feet and typically loose to medium dense below 5-foot in depth. In both borings at depths of approximately 24 feet to 28 feet low blow counts are suspect, and quick conditions at the bottom of the auger is suspected of loosening the soils from the natural state. In SB-1, an atypically high blow count was measured. This blow count is suspect, and could be the result of the driving shoe encountering gravel.

3.0 GEOTECHNICAL RECOMMENDATIONS

Based on the field exploration, and geotechnical analyses conducted for the current study, Golder has estimated the following geotechnical parameters that Minnesota Limited may use in the design of an excavation shoring system at the site. These parameters should be used by an experienced shoring designer with experience in designing excavation support for excavations in SILTY SAND. These parameters are largely estimated from the standard blow counts and visual assessment of the disturbed samples retrieved in the split spoon.

Active Earth Pressures, k_a: 0.33

Passive Earth Pressure, k_p: 3.0

Unit Weight of Soil, γ_{sat} lb/ft^3: 125

Ground Water: 3.5 feet below ground surface.

Further, based on observations made during drilling Golder makes the following additional observations.

- Basal stability should be addressed by active pumping to keep the groundwater level below the base of the excavation. The SILTY SAND should be expected to boil, or become quick, if the water pressure is not lowered and reduced. The material encountered at the site has no cohesion.
- Depending on groundwater control measures implemented and construction practices used, some amount of soil – on the order of 2 feet minimum - in the base of the excavation should be discounted for use in passive pressure calculations.
- Because of the odor in some samples retrieved from depth, adequate ventilation and air monitoring is suggested for the excavation.

Golder is has not be asked to address the issue of anticipated ground movements resulting from the excavation or shoring activities.

Golder recommends that an experienced geotechnical engineer observe the installation, excavation and dewatering, and make observation during construction.

Golder appreciates the opportunity to be of service on this project. If you have any questions regarding this report, please contact either of the undersigned at [redacted].

Sincerely,

GOLDER ASSOCIATES INC.

[redacted]

Anthony R. Moran
Project Engineer

[redacted]

Mark R. Funkhouser, P.E.
Principal

cc: Mr. Dan Heldt – LHB
Mr. Joe Litman - LHB

Attachments:

Appendix 1 – Field Soil Boring Logs

Appendix 2 - Important Information About Your Geotechnical Engineering Report

ARM/MRF:ARM

APPENDIX 1
FILED SOIL BORING LOGS

GENERAL NOTES FOR SOIL CLASSIFICATION

STANDARD PENETRATION TEST: Driving a 2.0" outside diameter, 1-3/8" inside diameter sampler a distance of 1.5 feet into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The sampler is driven three successive 6-inch increments. The number of blows required for the last 12 inches of penetration is termed the Standard Penetration Resistance (N).

GROUNDWATER: Observations are made at the times indicated on logs. Porosity of soil strata, weather conditions and site topography may cause changes in the water levels.

SOIL CLASSIFICATION PROCEDURE: Classification on the logs is generally made by visual inspection. For fine-grained soils (silt, clay and combinations) the classification is based upon plasticity of soils. Minor constituents of sand and gravel are described as trace (1-10%), little (11-20%) and some (21-35%). For coarse-grained soils (sand and gravel), the classification is based upon particle size distribution. Minor constituents of fines (clay and silt) are reported as trace (1-11%) adjective – clayey, silty, etc (12-35%). A double classification (such as silt and sand) is used if coarse-grained constituents consist of 36 to 64 percent of total soil.

PARTICLE SIZE DISTRIBUTION

Boulders		-	Greater than 12 inches average diameter
Cobbles		-	3 inches to 12 inches
Gravel -	Coarse	-	¾ inches to 3 inches
	Fine	-	No. 4 (3/16 inches) to ¾ inches
Sand -	Coarse	-	No. 10 (2.00mm) to No. 4 (4.75mm)
	Medium	-	No. 40 (0.425mm) to No. 10 (2.00mm)
	Fine	-	No. 200 (0.074mm) to No. 40 (0.425mm)
Silt and Clay		-	Less than 0.074mm, Classification based upon plasticity. Generally silt particles size ranges from 0.005mm to 0.074mm and clay particle size is less than 0.005mm.

CONSISTENCY OF FINE GRAINED SOILS IN TERMS OF UNCONFINED COMPRESSIVE STRENGTH AND N-VALUES

Consistency	Unconfined Compressive Strength (Tons per square foot)	Approximate range of N
Very soft	Less than 0.25	0 - 2
Soft	0.25 to 0.5	3 - 4
Medium Stiff	0.5 to 1.0	5 - 8
Stiff	1.0 to 2.0	9 - 15
Very Stiff	2.0 to 4.0	16 - 30
Hard	over 4.0	over 31

RELATIVE DENSITY OF COARSE GRAINED SOILS ACCORDING TO N-VALUES

Density Classification	Relative Density, %	Approximate Range of N
Very Loose	0 – 15	0 – 4
Loose	16 – 35	5 – 10
Medium Compact	36 - 65	11 - 30
Compact	66 - 85	31 – 50
Very Compact	86 – 100	over 50

Relative density of cohesionless soils is based upon an evaluation of the Standard Penetration Resistance (N), modified as required for overburden pressure.

FIELD SOIL BOREHOLE LOG

Client: Minnesota Limited
Location: Marshall, MI
Project No./Task:
Borehole ID: SB-1
Date: 7/31/10 Time: 11:00

Golder Associates

Elevation: Ground Surface
Datum: N of 6B
Depth of Borehole: 35
Depth of Casing: 35
Drilling Contractor: Stearns Drilling
Type of Rig: CME
Drilling Method: HSA
Sampling Method: 2" Split Spoon

Casing Hammer Wt lb Drop inch
Sample Hammer wt 140 lb Drop 30 inch

Water Level				
Time				
Date				
Casing Depth				

Weather: Partly Cloudy
Temperature: 70's
Logged By: ARM
Checked By: MRF

Depth	Method	Casing	SOIL STRATIGRAPHY – Description of Material (Surface Condition:)	Type	No.	Recov.	Depth	Well casing	Well Annulus	Description of Operation and Remarks
0			grass – vegetation							
2			very Loose Brown SILTY SAND (SM) trace gravel, moist	SS	1	12/18				2,2,3 N=5
										ASSUMED WATER @3.5
4			very Loose Dark Brown SILTY SAND, trace gravel wet (SM)	SS	2	8/18				1,1,2 N=3
6			medium Dense Dark Grayish Brown SILTY SAND (SM), trace gravel wet	SS	3	4/18				3,8,7 N=15
8				SS	4	2/18				3,6,7 N=13 odor
10			Loose Dark Gray SILTY SAND (SM) wet	SS	5	12/18				1,4,5 N=9 odor
12										
14				SS	6	18/18				1,2,4 N=6 odor
16			medium Dense Dark Gray SILTY SAND (SM) wet	SS	7	8/18				3,10,10 N=20 odor
18										
19										

FIELD SOIL BOREHOLE LOG

Golder Associates

Client:	Minnesota Limited
Location:	Marshall, MI
Project No./Task:	
Borehole ID:	SB-1
Date:	7/21/10
Time:	11:00

Elevation:	Grade surface	Drilling Contractor:	Stearns Drilling
Datum:	N of GB	Type of Rig:	CME
Depth of Borehole:	35'	Drilling Method:	HSA
Depth of Casing:	35'	Sampling Method:	2" SPLIT SPOON

Casing Hammer Wt ___ lb Drop ___ inch Sample Hammer wt 140 lb Drop 30 inch

Water Level				
Time				
Date				
Casing Depth				

Weather: Partly Cloudy
Temperature: 70's
Logged By: ARM
Checked By: MRF

Depth	Method	Casing	SOIL STRATIGRAPHY – Description of Material (Surface Condition:)	SAMPLES Type	No.	Recov.	Depth	WELL casing	Annulus	Description of Operation and Remarks
20			Dense Dark Gray SILTY SAND (SM) wet	SS	8	12/18				2,9,24 N=33 odor
22										
24			Very Loose Dark Gray SILTY SAND (SM) wet	SS	9	18/18				1,1,1, N=2
26										material very Dense inside spoon
28				SS	10	18/18				1,1,1, 2
30										material very Dense inside spoon
32										
34			medium Dense Dark Gray SILTY SAND (SM) wet trace Gravel (rock related?)	SS	11	8/18				0,7,9, N=16
36			End of Boring at 35' @ 1245							

FIELD SOIL BOREHOLE LOG

Golder Associates

Client:	Minnesota Limited
Location:	Marshall, MI
Project No./Task:	
Borehole ID:	SB-2
Date:	7/31/10
Time:	13:15

Elevation:	Grnd Surface	Drilling Contractor:	STEARNS DRILLING
Datum:	10' N of Vector Line	Type of Rig:	CME
Depth of Borehole:	35'	Drilling Method:	HS
Depth of Casing:	35'	Sampling Method:	2" Split Spoon

Casing Hammer Wt ___ lb Drop ___ inch Sample Hammer wt 140 lb Drop 30 inch

Water Level				
Time				
Date				
Casing Depth				

Weather: Partly Cloudy
Temperature: 70's

Logged By: ARM Checked By: MRF

Depth	Method	Casing	SOIL STRATIGRAPHY – Description of Material (Surface Condition: ✓)	Samples Type	No.	Recov.	Depth	Well casing	Annulus	Description of Operation and Remarks
			grass							
0			Top soil							
2			Loose Brown SILTY SAND (Sm), trace gravel (Sm) moist	SS	1	10/18				2,3,3, N=6
4				SS	2	12/18				2,1,1 N=2
			VERY LOOSE Dark Grayish Brown SILTY SAND (Sm) wet							— ASSUMED WATER TABLE 4.5' DEPTH
6				SS	3	12/18				3,3,3, N=6
8			LOOSE Brownish Grey SILTY SAND (Sm), trace gravel wet							
				SS	4	16/18				4,3,4 N=7
10										
12				SS	5	12/18				3,6,4 N=10
14			very LOOSE Dark Gray SILTY SAND (Sm) wet	SS	6	18/18				2,2,2 N=4
16			medium Dense Dark Gray SILTY SAND (Sm) wet	SS	7	18/18				4,6,6 N=12
18										

FIELD SOIL BOREHOLE LOG

Golder Associates

Client:	Minnesota Limited
Location:	Marshall, MT
Project No./Task:	/
Borehole ID:	SB-2
Date:	7/31/16
Time:	13:15

Elevation:	Grand Surface	Drilling Contractor:	STEARNS DRILLING
Datum:	ASN of Vector Line	Type of Rig:	CME
Depth of Borehole:	35	Drilling Method:	HSA
Depth of Casing:	35	Sampling Method:	2" Split Spoon

Casing Hammer Wt ___ lb Drop ___ inch Sample Hammer wt 140 lb Drop 30 inch

Water Level				
Time				
Date				
Casing Depth				

Weather: Partly Cloudy
Temperature: 70's
Logged By: ARM
Checked By:

Depth	Method	Casing	SOIL STRATIGRAPHY – Description of Material (Surface Condition:)	SAMPLES Type	No.	Recov.	Depth	WELL casing	Annulus	Description of Operation and Remarks
20				SS	8	10/18				3, 5, 7 N=12
22										
23			LOOSE Dark Gray SILTY SAND (SM) wet							
24				SS	9	12/18				6, 5, 2 N=7
26										
28										
29			VERY LOOSE Dark Gray SILTY SAND (SM) wet	S	10	12/18				1, 1, 1, N=2
30										material very Dense inside spoon
32										
34			medium Dense Dark Gray SILTY SAND (SM) wet (Rock reached?)	SS	11					3, 5, 6 N=11
35			End of Boring 35' 14:15							
36										

APPENDIX 2

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.
The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one - not even you* - should apply the report for any purpose or project except the one originally contemplated.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, Project-specific factors when establishing the scope of a study. Typical factors include the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report that was:*

- not prepared for you,
- not prepared for your project.
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes-even minor ones-and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an *opinion* about subsurface conditions throughout the site. Actual sub-surface conditions may differ - sometimes significantly - from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions

A Report's Recommendations Are *Not* Final

Do not over-rely on the construction recommendations included in your report. Those *recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability* for the report's recommendations if that engineer does not perform construction observation.

A Geotechnical Engineering Report Is Subject To Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photo graphic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A brand conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce such risks, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations", many of these provisions indicate where geotechnical engineers responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations: e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures*. If you have not yet obtained your own geoenviromental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Rely on Your Geotechnical Engineer for Additional Assistance

Membership in ASFE exposes geotechnical engineers to a wide army of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE

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