

LABEC CENTURY IRON ORE INC.

Joyce Lake and Area DSO Project Geotechnical Feasibility Study – Surrounding Areas

Final Report

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TABLE OF CONTENTS

1	INTRO	ODUCTION	1
	1.1 1.2 1.3	Description of Mandate Objective of the Geotechnical Feasibility Study for the Surrounding Areas Report Organization	1
2	PROJ	ECT DESCRIPTION AND GENERAL GEOLOGICAL CONDITIONS	3
	2.1	Project description	
	2.1.1 2.2	Proposed Development – Surrounding Areas	
3	СОМІ	PONENTS OF STUDY	6
	3.1	Photo interpretation of subsurface material	
	3.2	Geotechnical Fieldwork	
		Location of the boreholes Boreholes	
	3.3	Laboratory Work	
4	NATU	IRE AND PROPERTIES OF MATERIALS	10
	4.1	Surrounding areas	10
	4.1.1	Surface deposits identification	10
		Stratigraphy	
	4.1.3	Organic soils	13
		Granular Soils	
		Cohesive Soils	
		Till Deposit	
		Bedrock	
	4.2	BORROW PITS	
5	GROU	JNDWATER	18
6	PREL	IMINARY DISCUSSIONS AND RECOMMENDATIONS	20
	6.1	Generalities	20
	6.2	Permafrost	
	6.3	Foundation analysis	20
	6.4	Areas of cut	22
	6.4.1	Generalities	22
	6.4.2	Stability of cut	22
	6.5	Areas of fill	22
	6.5.1	Generalities	22
		Stability of fill	23
	6.5.3	Settlement	23



TABLE OF CONTENTS

6.6	Resistivity testing	24
Tables		
Table 1:	Summary of Areas of Significant Fill	4
Table 2:	Summary of Areas of Significant Cut	4
Table 3:	Summary of Significant Structures	4
Table 4:	: Summary of borehole Drilling	7
Table 5:	Summary of Laboratory Tests	8
Table 6	Summary of Soil Conditions – Surrounding Areas	11
Table 7:	Grain Size Analyses Results – Granular Soils	13
Table 8:	Grain Size Analyses Results - Cohesive Soil	14
Table 9	Grain Size Analyses Results – Till Deposit	14
Table 10	0: Summary of Soil Conditions – Borrow pits	16
Table 11	1: Grain Size Analyses Results – Borrows Pits	16
	2: Laboratory tests performed on bedrock samples from boreholes drilled at the	
	of the Open Pit and borehole BH-03-14	17
	3: C.B.R. test performed on bedrock samples from boreholes drilled at the location	
	pen pit – Iron Formation	1/
	4: C.B.R. test performed on bedrock samples from boreholes drilled at the location pen pit – Shale and Siltstone	17
	5: Summary of Groundwater Conditions.	
	6: Summary of the foundation types and preliminary geotechnical resistance at	10
	ability limit state (SLS)	21
	7: Area of Cut	
	8: Areas of Fill	
Figure		
Figure 1	: Project Location	3
Append	lices	
Appendi	ix 1 Scope of Geotechnical Investigation (1 page)	
Appendi	ix 2 Photo Interpretation (3 pages)	
Appendi	ix 3 Explanatory Notes and Survey Log Reports – Surrounding Areas (30 pages)	
Appendi	ix 4 Laboratory Test Results – Surrounding Areas (4 figures)	
Appendi	ix 5 Location of boreholes – Surrounding Areas (1 page)	
Appendi	ix 6 Ground Resistivity testing (11 pages)	



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1 INTRODUCTION

1.1 DESCRIPTION OF MANDATE

In September 2014, Labec century Iron Ore inc. (LCIO) granted the mandate to WESA, a division of BluMetric, (WESA) and LVM inc., a Division of Englobe Corporation inc. (LVM) to respectively perform Hydrogeological and Geotechnical Feasibility Studies for the Joyce Lake and Area Direct Shipping Ore (Joyce Lake DSO) Project.

The mandate included site work consisting of drilling boreholes, logging cores and in situ testing for both the Hydrogeological and Geotechnical aspects. The site investigation work was followed by laboratory testing and a series of three study reports cover the site investigation. WESA is responsible for the Hydrogeology feasibility Study and LVM is responsible for the Geotechnical Feasibility Study. The geotechnical Feasibility Study is two folds: one part concerns the pit slope analysis and design and, the other one concern the mine infrastructures of the surrounding areas. This report presents the results of the mine infrastructures of the surrounding areas.

The three stand-alone reports are:

- Joyce Lake and Area DSO Project Hydrogeological Study;
- Joyce Lake and Area DSO Project Geotechnical Engineering Feasibility Study Open Pit Design (Current Report);
- Joyce Lake and Area DSO Project Geotechnical Feasibility Study Surrounding Areas.

The site investigation work, the study and the reporting have been completed during Fall 2014.

1.2 OBJECTIVE OF THE GEOTECHNICAL FEASIBILITY STUDY FOR THE SURROUNDING AREAS

The objective of the Geotechnical Feasibility Study for the Surrounding Areas is to identify the nature and properties of subsurface materials and groundwater conditions at specific locations where twenty-five (25) boreholes were drilled to provide geotechnical data for the design of roads and the railway loop regarding:

- Nature and geotechnical properties of soil material and rock
- Groundwater conditions
- Recommendations for foundations
- Guidelines for excavations
- Guidelines for embankments
- Evaluation of the settlements due to embankment constructions
- Stability of embankments



- Stability of excavations
- Potential of reusing excavated material for embankments
- Identification of potential borrows pits and characterization subsurface material

1.3 REPORT ORGANIZATION

This report contains a description of the project and general geological conditions, the field investigations work methods, a detailed of the description of the nature and properties of the soils in place and groundwater conditions prevailing at the site. A section is devoted to the discussion of the results as well as geotechnical recommendations relevant to the project.

The comments and recommendations presented in this report are based on the information we have been provided by the designer of the Project (BBA inc.). The road alignment and the profile of haul roads and the railway loop have been sent to LVM in October 2014.

The terms defining the scope of the Geotechnical Feasibility Study are presented in Appendix 1 of the report.



2 PROJECT DESCRIPTION AND GENERAL GEOLOGICAL CONDITIONS

2.1 PROJECT DESCRIPTION

The Joyce Lake and Area DSO Project property is located 20 km northeast of Schefferville, Québec, and is within the provincial boundary of Newfoundland and Labrador, near the Attikamagen Lake.

The Joyce Lake DSO project mainly consists of a Mining Pit, Access roads, Benefication Plant Workers Camp, Haul road leading to a railway loop and loading station. The Ore is extracted from the pit, sent to a dry plant to be processed, loaded on trucks, hauled to the loading railway loop and loaded on train for shipment to the Pointe Noire Harbour facility near Sept-Îles, Québec. The location of the Joyce Lake and DSO Project is shown on figure 1.

ALABRADOR Project Location

TROUGH

LABRADOR

Figure 1: Project Location



2.1.1 **Proposed Development – Surrounding Areas**

The proposed development for the Surrounding Areas include Mine haul roads, Benefication Plant, Camp, Haul road of about 43 km length from the Beneficiation plant to Rail yard and Railway loop. The roads and the railway loop will run over areas of fill and cut and will require the installation of many culverts because of the nature of the surrounding lands. The haul road from the beneficiation plant to rail yard will also cross rivers that will require the construction of bridges. These features are summarized below.

Table 1: Summary of Areas of Significant Fill

CHAINAGE	REMARKS
0+850	Up to 10 m high
3+500	Up to 10 m high
8+875	5 m high
9+400	10 m high
12+575	6,5 m high
12+900	5 m high
16+075	5 m high
16+800	5 m high
33+150	5 m high

Table 2: Summary of Areas of Significant Cut

CHAINAGE	REMARKS
33+425	5 m deep

Table 3: Summary of Significant Structures

REMARKS	CHAINAGE
Gilling River Bridge (Option route 01)	0+875
Bridge Km 3.5	3+500
Lake/ km 17	17+100
Bridge km 27+500	27+500
Causeway/Iron Arm Lake	36+200
Camp	41+000
Benefication Plant	43+000
Low Grade Stockpile	N/A



REMARKS	CHAINAGE
Overburden Stockpile	N/A
Waste rock/ Stockpile	N/A

2.2 REGIONAL GEOLOGY

The Labrador Trough is also called the Labrador-Quebec Fold Belt. It extends North-South for more than 1,000 km along the eastern margin of the Superior craton from Ungava Bay to Lake Pletipi, Quebec. The belt is about 100 km wide in its central part and becomes narrower at the north and south.

The Labrador Trough is a sequence of Proterozoic sedimentary rocks including iron formation, volcanic rocks and mafic intrusions forming the Kaniapiskau Supergroup. The Kaniapiskau Supergroup is comprised of the Knob Lake Group in the western part and the Doublet Group which is primarily volcanic in the eastern part. The Knob Lake Group rocks underlie the Lac Le Fer and Rainy Lake properties. To the west of Schefferville, rocks of the Knob Lake Group lie unconformably on Archean gneisses and, to the east; they pass into the eugeosynclinal facies of the Labrador Trough. The Kaniapiskau Supergroup has been intruded by numerous diabase dikes known as the Montagnais Intrusive Suite. These dikes along with the Nimish volcanic rocks are the only rock types representing igneous activity in the western part of the central Labrador Trough.

The Knob Lake Group includes the Sokoman Formation which is the main exploration target of the Joyce Lake Iron Project.



3 COMPONENTS OF STUDY

3.1 PHOTO INTERPRETATION OF SUBSURFACE MATERIAL

Immediately after project kickoff, a desktop study consisting of Photo interpretation was initiated by Poly-Géo Inc. The Photo interpretation objective is to identify the subsurface material in a corridor of 300 to 500 m wide centered on the horizontal geometry of the planned road. This enables optimization of the road horizontal geometry in relation with identified subsurface material. The Photo interpretation was also performed to identify potential borrow pits.

Photo interpretation is a method of studying terrain by examining aerial photographs, mainly in three dimensions and involving detection and identification of the nature, qualitative and quantitative characteristics of landforms and vegetative covers.

The results of the Photo interpretation prepared by Poly-Geo inc. are presented in Appendix 2.

3.2 GEOTECHNICAL FIELDWORK

3.2.1 Location of the boreholes

The programmed borehole locations were established by LVM and the designer of the Project (BBA inc.) as the Photo Interpretation was performed.

Boreholes were typically located at the location of areas of cut and fill, major water streams and at the location of potential material borrow pit identified by Photo interpretation. Boreholes were also implemented within the projected mine site area (Camp, Benefication Plant and Stockpiles).

All boreholes were located on site by LVM. Surveying (coordinates) of these points was performed by LVM after drilling using a hand held GPS. The location of the boreholes is presented in Appendix 5.

3.2.2 Boreholes

The drilling work was conducted between September 24 and October 15, 2014. The drilling program comprised 25 boreholes advanced to depths between 2.39 m and 20.90 m below existing grades. A summary of the borehole drilling is given in table 4.



Table 4: Summary of borehole Drilling

FEATURE	CHAINAGE	BOREHOLE ID	BOREHOLE DEPTH (m)			
	SURROUNDING	G AREAS				
Approach to Gilling River	1+950 (Original route)	BH-01-14	20.90			
(Original route)	2+040 (Original route)	BH-02-14	16.13			
Rail Loop	Rail Loop - 4+100	BH-03-14	4.04			
Rail Loop	Rail Loop - 1+850	BH-04-14	14.02			
Approach to Gilling River	0+850	BH-05-14	6.53			
Option route 01	0+900	BH-06-14	7.19			
Approach to Lake/km 17	17+010	BH-07-14	12.45			
Approach to Lake/ km 17	17+050	BH-08-14	11.51			
Area of slope/Iron Arm	34+180	BH-09-14	3.05			
Approach to Iron Arm	36+150	BH-10-14	5.64			
Approach to Iron Arm	37+450	BH-11-14	5.84			
Camp		BH-12-14	3.78			
Benefication Plant		BH-13-14	2.41			
Low Grade Stockpile		BH-14-14	2.74			
Overburden Stockpile		BH-15-14	4.45			
Waste rock/ Stockpile		BH-16-14	17.91			
Area of Slope/ km 5+300	5+300	BH-17-14	2.39			
Approach to Lake/ km 27+500	27+550	BH-18-14	3.05			
	BORROWS PITS					
Borrow Pit – 02		BP-02-01-14	7.92			
DOITOW FIL - UZ		BP-02-02-14	6.40			
Borrow Pit – 03		BP-03-01-14	6.40			
Borrow Pit – 04		BP-04-01-14	7.92			
Borrow Pit – 05		BP-05-01-14	6.10			
Borrow Pit – 06		BP-06-01-14	6.40			
DUIIUW FIL - UU		BP-06-02-14	6.71			

The boreholes were carried out by means of a duralite diamond drill. Due to the location of the project, drill rig and staff was transported by a helicopter between each borehole site.

Soil sampling was performed using a 51 mm outside diameter split spoon sampler. During sampling, the Standard Penetration Index (N_{spt}) values were measured according to ASTM D1586 Standard. SPT was carried out at intervals of 1.5 m.



Bedrock was sampled in boreholes BH-02-14 to BH-15-14, BH-17-14 and BH-18-14 using a NQ size (47.6 mm rock core inside diameter) core barrel. The bedrock was cored over lengths of 1.24 m (BH-11-14) to 9.76 m (BH-04-14) in order to confirm that true bedrock was encountered and not boulders.

Following the drilling work, open pipe type piezometers well were installed in all boreholes. They consist of tubes with an interior diameter of 21 mm. Subsequent measurements of the groundwater levels were performed.

3.3 LABORATORY WORK

The soil and bedrock samples recovered from the boreholes were sent to our laboratory for identification, analysis and classification. All were subject to a visual examination by a geotechnical professional.

Representative soil samples were submitted to laboratory testing in order to complete the information obtained during on-site sampling. Table 5 summarizes the different laboratory tests carried out on these samples.

Table 5: Summary of Laboratory Tests

BOREHOLE ID	SAMPLE NO.	DEPTH (m)	GRAIN SIZE ANALYSIS (NQ 2501-025)	HYDROMETER TEST (NQ 2501-025)	ATTERBERG'S LIMITS (ASTM D4318-05)	WATER CONTENT (LC 21-200)
			SURROUNDING	AREAS		
BH-01-14	SS-5	5.79 - 6.40	Χ			
BH-01-14	SS-8	10.37 - 10.98	Χ	Х		
BH-01-14	SS-10	13.42 - 14.03	Х	Х	X	
BH-02-14	SS-3	2.44 - 3.05	Х	Х		
BH-02-14	SS-5	5.49 - 6.10	Х	Х	Х	
BH-04-14	SS-4	2.75 - 3.36	Х			
BH-05-14	SS-2	0.91 - 1.53	Х			
BH-06-14	SS-2	1.07 - 1.68	Х			
BH-07-14	SS-5	4.42 - 5.03	Х			
BH-08-14	SS-2	1.22 - 1.83	Х			
BH-08-14	SS-3	2.74 - 3.35	Х			
BH-11-14	SS-3	2.59 - 3.20	Х			
BH-16-14	SS-2	1.37 - 1.98	Х			
BH-16-14	SS-5	5.08 - 5.69	Х			



Table 5: Summary of Laboratory Tests (suite)

BOREHOLE ID	SAMPLE NO.	DEPTH (m)	GRAIN SIZE ANALYSIS (NQ 2501-025)	HYDROMETER TEST (NQ 2501-025)	ATTERBERG'S LIMITS (ASTM D4318-05)	WATER CONTENT (LC 21-200)
			BORROWS P	ITS		
BP-02-01-14	SS-2	1.22 - 1.83	Χ			Х
BP-02-01-14	SS-5	5.79 - 6.40	Χ			Х
BP-02-02-14	SS-2	1.22 - 1.83	Χ			Х
BP-04-01-14	SS-2	1.22 - 1.83	Х			Х
BP-04-01-14	SS-5	5.79 - 6.40	Х			Х
BP-04-01-14	SS-6	7.32 - 7.93	Х			Х
BP-05-01-14	SS-3	2.75 - 3.36	Х			Х
BP-06-01-14	SS-3	2.75 - 3.36	Х			Х
BP-06-01-14	SS-4	4.27 - 4.88	Х			X

Laboratory test results are presented in the appropriate columns on the borehole reports in Appendix 3 while summary tables of grain size analyses and soil description are presented in Appendix 4. The results are discussed in Sections 4 of the present report.

All samples recovered from the boreholes that were not subjected to laboratory testing will be stored for a period of six (6) months from the end of the site work. After this, they will be disposed off unless a written request from the Client as to their final destination is transmitted to LVM.



4 NATURE AND PROPERTIES OF MATERIALS

4.1 SURROUNDING AREAS

4.1.1 Surface deposits identification

The results of the Photo interpretation prepared by Poly-Geo inc. are presented in Appendix 2. They take the form of maps identifying probable surface deposits types and thicknesses.

4.1.2 **Stratigraphy**

This section presents the stratigraphic conditions observed in the boreholes relative to the surrounding areas. Table 6 presents the various stratigraphic units encountered in the boreholes.



Table 6 Summary of Soil Conditions – Surrounding Areas

BOREHOLE	LOCATI	ON	COORDINATES		DEPTH (m) [ELEVATION (m)]					
ID [ELEV. (m)]	FEATURE	CHAINAGE	East (X)	North (Y)	ORGANIC SOILS	GRANULAR SOILS	COHESIVE SOILS	TILL	BEDROCK	END OF SURVEY
	SURROUNDING AREAS									
BH-01-14 [473.99]	Approach to Gilling River	1+950	651638	6059445		0.00 - 10.36 [473.99 - 463.63]	10.36 - 14.94 [463.63 - 459.05]	14.94 - 20.90 ¹ [459.05 - 453.09]		20.90 [453.09]
BH-02-14 [474.24]	(Original alignment)	2+040	651603	6059525		0.00 - 0.20 [474.24 - 474.04]	0.20 - 8.23 [474.04 - 465.21]	8.23 - 11.20 [465.21 - 463.04]	11.20 [463.04]	16.13 [458.11]
BH-03-14 [508.03]	Rail Loop	4+100	652017	6057771	0.00 - 0.05 [508.03 - 507.98]	0.05 - 0.53 [507.98 - 507.50]			0.53 [507.50]	4.04 [503.99]
BH-04-14 [502.25]	Rail Loop	1+850	651513	6058738	0.00 - 0.05 [502.25 - 502.20]			0.05 - 4.27 [502.20 - 497.98]	4.27 [497.98]	14.02 [488.23]
BH-05-14 [475.55]	Approach to Gilling River	0+850	651781	6059494	0.00 - 0.05 [475.55 - 475.50]	0.05 - 1.22 [475.50 - 474.33]		1.22 - 3.20 [474.33 - 472.35]	3.20 [472.35]	6.53 [469.02]
BH-06-14 [477.17]	(Revised alignment route 01)	0+900	651806	6059525		0.00 - 0.91 [477.17 - 476.26]		0.91 - 2.57 [476.26 - 474.60]	2.57 [474.60]	7.19 [469.98]
BH-07-14 [475.99]	Approach to Lake/	17+010	654849	6070159	0.00 - 0.61 [475.99 - 475.38]	0.61 - 2.44 ² [475.38 - 473.55]		2.44 - 9.07 [473.55 - 466.92]	9.07 [466.92]	12.45 [463.54]
BH-08-14 [476.19]	km 17	17+050	654843	6070194	0.00 - 0.91 [476.19 - 475.28]	0.91 - 2.44 ² [475.28 - 473.75]		2.44 - 8.05 [473.75 -468.14]	8.05 [468.14]	11.51 [464.68]
BH-09-14 [548.17]	Area of slope/Iron Arm	34+180	657067	6081969	0.00 - 0.10 [548.17 - 548.07]			0.10 - 1.37 [548.07 - 546.80]	1.37 [548.80]	3.05 [545.12]
BH-10-14 [475.81]	Approach to Iron Arm	36+150	658815	6081090	0.00 - 0.10 [475.81 - 475.71]			0.10 - 2.29 [475.71 - 473.52]	2.29 [473.52]	5.64 [470.17]
BH-11-14 [470.45]	Approach to Iron Arm	37+450	660073	6081398	0.00 - 0.20 [470.45 - 470.25]			0.20 - 4.60 [470.25 - 465.85]	4.60 [465.85]	5.84 [464.61]
BH-12-14 [506.90]	Camp		658408	6083663				0.00 - 0.76 [506.90 - 506.14]	0.76 [506.14]	3.78 [503.12]
BH-13-14 [489.75]	Processing Plant		656731	6084916				0.00 - 0.15 [489.75 - 489.60]	0.15 [489.60]	2.41 [484.34]



BOREHOLE	LOCATION		COORDINATES		DEPTH (m) [ELEVATION (m)]					
ID [ELEV. (m)]	FEATURE	CHAINAGE	East (X)	North (Y)	ORGANIC SOILS	GRANULAR SOILS	COHESIVE SOILS	TILL	BEDROCK	END OF SURVEY
BH-14-14 [533.86]	Low Grade Stockpile		657965	6085653				0.00 - 0.46 [533.86 - 533.40]	0.46 [533.40]	2.74 [531.12]
BH-15-14 [542.02]	Overburden Stockpile		658634	6086784				0.00 - 0.89 [542.02 - 541.13]	0.89 [541.13]	4.45 [537.57]
BH-16-14 [531.57]	Waste rock/ Stockpile		657773	6087536				0.00 - 17.91 ¹ [531.57 - 513.66]		17.91 [513.66]
BH-17-14 [516.45]	Area of Slope/ km 5+300	5+300	651740	6062586	0.00 - 0.15 [516.45 - 516.30]				0.15 [516.30]	2.39 [514.06]
BH-18-14 [472.00]	Approach to Lake/ km 27+500	27+550	656770	6077624	0.00 - 0.15 [472.00 - 471.85]			0.15 - 1.52 [471.85 - 470.48]	1.52 [470.48]	3.05 [468.95]

Note:

¹End of the penetration test. ² Presence of organics matters.



A brief description of the stratigraphy along with the laboratory test results is given bellow.

4.1.3 **Organic soils**

Layers of organic soil were encountered at surface of boreholes BH-03-14 to BH-05-14, BH-07-14 to BH-11-14, BH-17-14 and BH-18-14. These layers varied in thickness from 0.05 m to 0.91 m (BH-08-14).

4.1.4 **Granular Soils**

Layers of granular soil were encountered in boreholes BH-01-14 to BH-03-14 and BH-05-14 to BH-08-14. At the location of the boreholes, these layers varied in thickness from 0.48 m (BH-03-14) to 10.36 m (BH-01-14).

The granular soils layer consists generally of a sand with some silt to a silt with some sand with traces of clay and gravel.

Grain size analyses were performed on samples collected in the granular soils layer. Table 7 presents the results of these tests.

Table 7: Grain Size Analyses Resu	ults – Granular Soils
-----------------------------------	-----------------------

			% PASSING AND PARTICLES DIMENSIONS			
BOREHOLE ID.	SAMPLE NO.	DEPTH (m)	GRAVEL > 5 mm	SAND > 80 µm and < 5 mm	SILT and CLAY < 80 µm	
BH-01-14	SS-5	5.79 - 6.40	0	55	45	
BH-05-14	SS-2	0.91 - 1.53	1	15	84	
BH-08-14	SS-2	1.22 - 1.83	1	23	76	

The standard penetration index "N" was measured in the granular soils layer in the boreholes. The measured values were used to determine the compactness of the granular soils layer. They were found to be generally very loose to loose.

4.1.5 Cohesive Soils

A layer of cohesive soils was encountered in boreholes BH-01-14 and BH-02-14 on both banks of the Gilling river. The thickness of this cohesive deposit is 4.58 m at borehole BH-01-14 and 8.03 m at the borehole BH-02-14.

The cohesive deposit consists, generally, of clayey silt to silt with some sand and clay.

Grain size analyses and hydrometer tests were performed on samples collected in the cohesive deposit. Table 8 presents the results of these tests respectively.

025-B-0010504-1-GE-R-0001-00



Table 8: Grain Size Analyses Results - Cohesive Soil

			% PASSING AND PARTICLES DIMENSIONS				
BOREHOLE ID.	SAMPLE NO.	DEPTH (m)	GRAVEL > 5 mm	SAND > 80 µm and < 5 mm	SILT > 20 μm and < 80 μm	CLAY < 20 µm	
BH-01-14	SS-8	10.37 - 10.98	0	2	77	21	
BH-01-14	SS-10	13.42 - 14.03	0	14	76	10	
BH-02-14	SS-3	2.44 - 3.05	0	0	77	23	
BH-02-14	SS-5	5.49 - 6.10	0	11	76	13	

4.1.6 Till Deposit

Till deposits were encountered at the location of all boreholes, except at the location of boreholes BH-03-14 and BH-17-14.

The till deposit, generally, composed of a sandy gravelly silt. Cobbles and boulders were also encountered at the location of some boreholes.

Grain size analyses were performed on samples collected in the till deposit. Table 9 presents the results of these tests respectively.

Table 9 Grain Size Analyses Results - Till Deposit

			% PASS	SING AND PARTICLES D	IMENSIONS
BOREHOLE ID.	SAMPLE NO.	DEPIH (m)	GRAVEL > 5 mm	SAND > 80 µm and < 5 mm	SILT and CLAY < 80 µm
BH-04-14	SS-4	2.75 - 3.36	28	46	26
BH-06-14	SS-2	1.07 - 1.68	36	38	26
BH-07-14	SS-5	4.42 - 5.03	21	32	47
BH-08-14	SS-3	2.74 - 3.35	38	37	25
BH-11-14	SS-3	2.59 - 3.20	44	44	12
BH-16-14	SS-2	1.37 - 1.98	21	33	46
BH-16-14	SS-5	5.08 - 5.69	26	30	43

The standard penetration index "N" was measured in the till deposit layer. The measured values showed that the compactness of the till is generally compact to very dense. At the location of the borehole BH-02-14, the standard penetration index "N" obtained were 7 and 16 which shows that the till like material of the till is loose to compact. Therefore, it might have been affected or transported by



an ancien river. Refusals were also obtained in boreholes on possible cobbles and boulders. Given the nature of the deposit, the proportion and size of cobbles and boulders can vary.

4.1.7 **Bedrock**

Bedrock was encountered in all boreholes, except at the location of boreholes BH-01-14 and BH-16-14, at depths of 0.15 m (BH-13-14 and BH-17-14) to 11.20 m (BH-02-14). The bedrock was cored over lengths of 1.24 m (BH-11-14) to 9.76 m (BH-04-14) in order to confirm that true bedrock was encountered and not boulders.

At the location of boreholes BH-03-14, BH-05-14, BH-06-14, BH-08-14, BH-09-14, BH-12-14, BH-14-14, BH-15-14 and BH-17-14, the rock consists of a grey siltstone fine grained of very poor to poor quality with associated RQD (Rock Quality Designation) values that range between 0 and 46 %.

At the location of boreholes BH-07-14, BH-10-14, BH-11-14 and BH-18-14, the rock consists of a black shale of very poor to fair quality with associated RQD values that range between 24 and 63 %.

At the location of the borehole BH-02-14, BH-04-14 and BH-13-14, the bedrock recovery was nul suggesting it is very altered at surface.

4.2 BORROW PITS

The photo interpretation study performed by Poly-Geo Inc. identified, amongst other features, potential material borrow pits.

A total of 23 potential borrow pits were identify and their locations are presented in Appendix 2.

A total of five (5) potential borrow pits were chosen by LVM in agreement with BBA for geotechnical investigation. Borrow pits were selected based on the nature of soil anticipated, their proximity to the haul road and the size of the borrow pit.

Table 10 presents the stratigraphic units encountered at the location of borrow pits investigated. Table 11 presents the results of grain size analyses were performed on samples collected in borrow pits.

Representative bedrock samples from boreholes drilled at the location of the Open Pit and borehole BH-03-14 were submitted to laboratory testing to evaluate the potential of reusing excavated material for the construction of haul roads. Table 12, 13 and 14 present the result of the laboratory tests performed.



Table 10: Summary of Soil Conditions – Borrow pits

LOCATION	BOREHOLE ID	COORI	DINATES	DEPTH (m) [ELEVATION (m)]		
LOCATION	[ELEV. (m)]	East (X)	North (Y)	GRANULAR SOILS	COHESIVE SOILS	END OF SURVEY
			ВС	DRROW PITS		
Borrow Pit	BP-02-01-14 [483.99]	651887	6059033	0.00 - ≥ 7.92 [483.99 - ≤ 476.07]		 7.92 [476.07]
02	BP-02-02-14 [482.70]	651526	6059023	$0.00 - 2.29$ $[482.70 - 480.41]$ $5.80 - \ge 6.40$ $[476.90 - \le 476.30]$	2.29 - 5.80 [480.41 - 476.90]	6.40 [476.30]
Borrow Pit 03	BP-03-01-14 [482.04]	651510	6059631	0.00 - 2.29 [482.04 - 479.75]	2.29 - ≥ 6.40 [479.75 - ≤ 475.64]	6.40 [475.64]
Borrow Pit 04	BP-04-01-14 [489.14]	651060	6062425	0.00 - ≥ 7.92 [489.14 - ≤ 481.22]		7.92 [481.22]
Borrow Pit 05	BP-05-01-14 [490.22]	651232	6062737	0.00 - ≥ 6,10 [490.22 - ≤ 484.12]		6.10 [484.12]
Borrow Pit	BP-06-01-14 [492.43]	655150	6068990	0.00 - ≥ 6.40 [492.43 - ≤ 486.03]		6.40 [486.03]
06	BP-06-02-14 [486.07]	655059	6069386	0.00 - ≥ 6.71 [486.07 - ≤ 479.36]		6.71 [479.36]

Table 11: Grain Size Analyses Results – Borrows Pits

			% PASSING AND PARTI			G AND PARTICLES DI	MENSIONS
BOREHOLE ID.	DREHOLE ID. SAMPLE NO.	DEPTH (m)	GRAVEL > 5 mm	SAND > 80 µm and < 5 mm	SILT and CLAY < 80 µm		
BP-02-01-14	SS-2	1.22 - 1.83	0	75	25		
BP-02-01-14	SS-5	5.80 - 6.41	0	26	74		
BP-02-02-14	SS-2	1.22 - 1.83	0	49	51		
BP-04-01-14	SS-2	1.22 - 1.83	33	57	10		
BP-04-01-14	SS-5	5.80 - 6.41	8	64	28		
BP-04-01-14	SS-6	7.32 - 7.93	20	61	19		
BP-05-01-14	SS-3	2.75 - 3.36	14	29	57		
BP-06-01-14	SS-3	2.75 - 3.36	63	32	5		
BP-06-01-14	SS-4	4.27 - 4.88	45	45	10		



Table 12: Laboratory tests performed on bedrock samples from boreholes drilled at the location of the Open Pit and borehole BH-03-14

		SAMPLE			
LABORATORY TESTS	REFERENCE	From the Open pit Iron Formation	From the Open pit Shale and Siltstone	From the borehole BH-03-14	
Micro-Deval	LC 21-070	18.3 %	19.5 %	5.4%	
Los Angeles	LC 21-400	19.3 %	19.0 %		
Bulk relative density	LC 21-067	3.359	2.688	2.718	
Bulk relative density (Saturated surface dry-basis	LC 21-067-	3.468	2.773	2.729	
Apparent relative density	LC 21-067	3.770	2.936	2.749	
Absorption	LC 21-067	3,25 %	3,13 %	0,42 %	

Table 13: C.B.R. test performed on bedrock samples from boreholes drilled at the location of the Open pit – Iron Formation

	UNIT	10 blows	25 blows	56 blows
Bearing ration at 0.1-inch penetration	%	23.7	50.7	99.3
Bearing ration at 0.2-inch penetration	%	35.9	70.1	139.3
Swelling	%	0	0	0
Dry density after soaking	kg/m³	2394	2542	2724
Water content as compacted	%	8.4	8.6	8.3
Water content after soaking	%	7.1	7.0	7.4
Duration of soaking	days	96	96	96
Surcharge Amount	kg	5.80	5.62	5.63

Table 14: C.B.R. test performed on bedrock samples from boreholes drilled at the location of the Open pit – Shale and Siltstone

	UNIT	10 blows	25 blows	56 blows
Bearing ration at 0.1-inch penetration	%	16.7	40.2	81.7
Bearing ration at 0.2-inch penetration	%	23.4	51.4	103.9
Swelling	%	0	0	0
Dry density after soaking	kg/m³	1833	1947	2124
Water content as compacted	%	7.2	7.4	7.2
Water content after soaking	%	7.8	7.2	7.0
Duration of soaking	days	96	96	96
Surcharge Amount	kg	5.77	5.63	5.38



5 GROUNDWATER

The groundwater level was measured in each open pipe piezometer at the end of the geotechnical investigation work. The water level was observed at the depths and elevations shown in Table 15 below.

Table 15: Summary of Groundwater Conditions

BOREHOLE ID	LOCAT	ION	DEDTU (m)	[ELEVATION (m)]	
BUREHULE ID	FEATURE	CHAINAGE	DEPTH (m)		
	S	URROUNDING AREAS			
BH-01-14 [473.99]	Approach to Gilling River	1+950	0.47	473.52	
BH-02-14 [474.24]	(Original route)	2+040	0.00	474.24	
BH-03-14 [508.03]	Rail Loop	4+100			
BH-04-14 [502.25]	Rail Loop	1+850	7.80	494.45	
BH-05-14 [475.55]	Approach to Gilling River	0+850	1.00	474.55	
BH-06-14 [477.17]	(Option route 01)	0+900	5.03	472.14	
BH-07-14 [475.99]	Approach to Lake/km 17	17+010	0.25	475.74	
BH-08-14 [476.19]	Approach to Lake/ km 17	17+050	0.00	476.19	
BH-09-14 [548.17]	Area of slope/Iron Arm	34+180	0.25	547.92	
BH-10-14 [475.81]	Approach to Iron Arm	36+150	0.70	475.11	
BH-11-14 [470.45]	Approach to Iron Arm	37+450	0.40	470.05	
BH-12-14 [506.90]	Camp		0.00	506.90	
BH-13-14 [489.75]	Processing Plant		≥ 1.28	≤ 488.47	
BH-14-14 [533.86]	Low Grade Stockpile		1.25	532.61	
BH-15-14 [542.02]	Overburden Stockpile		4.23	537.79	



PODELIOLE ID	LOCAT	TON	DEDTH (m)	IELEVATION (**)	
BOREHOLE ID	FEATURE	CHAINAGE	DEPTH (m)	[ELEVATION (m)]	
BH-16-14 [531.57]	Waste rock/ Stockpile		0.27	531.30	
BH-17-14 [516.45]	Area of Slope/ km 5+300	5+300	1.68	514.77	
BH-18-14 [472.00]	Approach to Lake/ km 27+500	27+550	0.50	471.50	
		BORROW PITS			
BP-02-01-14 [483.99]			≥ 4.90	≤ 479.09	
BP-02-02-14 [482.70]	Borrow Pit - 02		3.22	479.48	
BP-03-01-14 [482.04]	Borrow Pit - 03		2.53	479.51	
BP-04-01-14 [489.14]	Borrow Pit - 04		≥ 4.70	≤ 484.44	
BP-05-01-14 [490.22]	Borrow Pit - 05		2.44	487.78	
BP-06-01-14 [492.43]	D D'I 00		≥ 2.82	≤ 489.61	
BP-06-02-14 [486.07]	Borrow Pit - 06		4.98	481.09	

It is important to note that the water level in soils is likely to rise or fall depending on changes to the physical environment, seasons and/or climatic conditions, and can be found at different depths at other times of the year. To clarify the exact depth of the groundwater, other readings would be required at different times.



6 PRELIMINARY DISCUSSIONS AND RECOMMENDATIONS

6.1 GENERALITIES

The preliminary comments and recommendations presented in the following paragraphs are based on the results of the photo interpretation, fieldwork and laboratory tests, as well as the information LVM have been provided with by the designer of the Project (BBA).

6.2 PERMAFROST

Permafrost in the area of Shefferville is described as Sporadic. Usually, permafrost is found in high grounds where snow cover is minimized by winds and is not generally present under and in immediate proximity of wetlands and lakes.

According to the geotechnical investigations conducted, no evidence of permafrost was observed within the boreholes drilled.

6.3 FOUNDATION ANALYSIS

The longitudinal profile of haul roads sent by BBA to LVM in October 2014 reveals that there are three (3) bridges proposed. At time of the present report issue date, the foundation level of the bridges was not set.

This section presents the technical information collected during the geotechnical investigation at each bridge site and preliminary geotechnical recommendations for the foundation of the three (3) bridges proposed.

The present section also covers the preliminary foundation recommendations for the structures at the Camp and the Beneficiation Plant.

At time of the present report issue date, the location of culverts was not set. This report does not provide preliminary recommendations for the foundations of culverts. Also, this report does not provide geotechnical recommendations for the design of the Causeway proposed at the location of Iron Arm Lake.

Table 16 summarises the location of the three (3) bridges, the Camp and the Benefication Plant and results of the geotechnical investigation carried out at each site. Table 13 presents also the foundation types that were evaluated for the proposed structures and the preliminary geotechnical resistance at the associated Serviceability Limit State (SLS).



Table 16: Summary of the foundation types and preliminary geotechnical resistance at serviceability limit state (SLS)

STRUCTURE	LOCATION	TOPOGRAPHY	INVESTIGATION	STRATIGRAPHY	TYPE OF FOUNDATION	PRELIMINARY GEOTECHNICAL RESISTANCE (SLS)
Gilling River Bridge (Revised alignment route 01)	0+875	Valley, with shores about 12 m above the riverbed on the south side and 18 m above the riverbed on the north side.	Photo Interpretation One borehole on each shore of the river (BH-05-14 and BH-06-14)	Granular soils 2 m compact Till deposit Bedrock	Shallow foundation	350 kPa (within the till deposit)
Bridge Km 3.5	3+500	Valley, with shores about 15 m above the riverbed on the south side and 6 m above the riverbed on the north side	Photo Interpretation	Granular soils Till deposit Bedrock (anticipated by the photo interpretation, no borehole was done)	Shallow foundation	Not determined
Lake/ km 17	17+100	Flat, shores about 3 m above the riverbed	Photo Interpretation One borehole on each shore of the lake (BH-07-14 and BH-08-14)	0.6 to 0.9 m Organic soils 1.5 to 1.8 m very loose to loose Granular soils 5.6 to 6.6 very dense Till deposit Bedrock	Shallow foundation	100 kPa (within the granular soils) 350 kPa (within the till deposit)
Bridge km 27+500	27+500	Flat, shores about 2 m above the riverbed	Photo Interpretation One borenole on the East shore of the lake (BH-18-14)	1.5 m compact to dense Till deposit Bedrock	Shallow foundation	350 kPa (within the till deposit
Camp	41+000	Relatively Flat	Photo Interpretation One borehole (BH- 12-14)	0.8 m loose Till deposit Bedrock	Shallow foundation	500 kPa (within the Bedrock
Benefication Plant	43+000	Relatively Flat	Photo Interpretation One borehole (BH-13-14)	0.2 m Till deposit Bedrock (completely altered)	Shallow foundation	350 kPa (within the Bedrock

The preliminary geotechnical resistance value at serviceability limit state is defined for a total settlement less than 25 mm.

In addition, the preliminary geotechnical resistance value at serviceability limit state is defined as the pressure that can be transmitted to the ground by a square or rectangular footing in addition to earth pressure. Accordingly, the weight of the soil overlying the footings should not be included in the calculation of the pressure supplied to the footing.



6.4 AREAS OF CUT

6.4.1 **Generalities**

At time of report issue date, there is only one area of major cut have been set. Table 17 presents the location of this major area of cut and the anticipated stratigraphy.

Table 17: Area of Cut

CHAINAGE	HEIGHT OF CUT (m)	INVESTIGATION	STRATIGRAPHY
33+425	5 m high	Photo Interpretation (no borehole)	Till Deposit Bedrock

6.4.2 **Stability of cut**

Slopes excavated through the till deposit are likely to be stable at a preliminary slope of 1 V in 2 H.

To protect the slopes against surface erosion, gullies formation and local instabilities, a surface protection should be installed upon the till surface.

6.5 AREAS OF FILL

6.5.1 **Generalities**

Table 18 presents the major areas of fill and the anticipated stratigraphy.

Table 18: Areas of Fill

CHAINAGE	HEIGHT OF FILL (m)	INVESTIGATION	STRATIGRAPHY
0+850	Up to 10 m high	Photo Interpretation Two boreholes (BH-05-14 and BH-06-14)	Granular soils Till Deposit Bedrock
3+500	Up to 10 m high	Photo Interpretation No borehole	Granular soils Till Deposit Bedrock
8+875	5 m high	Photo Interpretation No borehole	Till Deposit Bedrock
9+400	10 m high	Photo Interpretation No borehole	Till Deposit Bedrock
12+575	6,5 m high	Photo Interpretation No borehole	Till Deposit Bedrock
12+900	5 m high	Photo Interpretation No borehole	Till Deposit Bedrock



CHAINAGE	HEIGHT OF FILL (m)	INVESTIGATION	STRATIGRAPHY
16+075	5 m high	Photo Interpretation BP-06-01-14	Granular soils Till Deposit Bedrock
16+800	5 m high	Photo Interpretation No borehole	Organic soils Granular soils Till Deposit Bedrock
33+150	5 m high	Photo Interpretation No borehole	Till Deposit Bedrock

6.5.2 **Stability of fill**

The road design process entails the generation of significant cuts and fills. To avoid substantial wastage of cuts materials, which are essentially till deposit, it would be desirable to reuse such materials in embankments.

The remaining material may be reuse as an engineering fill. It is important to note that till deposits have high silt contents (range 12% to 47 % at the location of boreholes drilled) therefore till embankment are susceptible to deterioration under adverse weather conditions. Slopes surface protection should be installed.

Slopes of compacted till embankments are likely to be stable at inclinations of 1 V to 2 H with proper surface protection.

6.5.3 **Settlement**

Construction of embankments will result in settlement of the underlying soil.

Considering that the underlying soil is mostly granular, only elastic deformations are expected. These types of deformation are usually rapid and limited to the duration of construction.

At the location where organic soil was encountered, compression and consolidation settlements are expected if the organic layer is not removed prior to construction of the embankment.

Settlements in the underling soil are not numerically evaluated within the scope of the present study.

On the other hand settlement can be qualitatively described for the haul road and rail loop. Their alignments generally cross either till deposits or rock outcrops where no noticeable settlement should be expected. Where the alignments cross wetlands and organic peat units, preloading and/or increased maintenance of these sections should be foreseen.



6.6 RESISTIVITY TESTING

On-site soil resistivity testing was conducted according to IEEE STD 81-1983 (IEEE Guide for Measuring Earth Resistivity), IEEE STD 80-2000 (IEEE Guide For safety in AC substation grounding) and Hydro-Québec GT-T-12.01.03.B. Results of testing are presented in Appendix 6.

Appendix 1

Scope of Geotechnical Investigation (1 page)





SCOPE OF THE GEOTECHNICAL STUDY

1.0 Characteristics of soil and rock

The soil and rock characteristics described in this report originate from geotechnical investigations conducted within a given period and correspond to the nature of the terrain only at the specific locations where these investigations were carried out.

Soil and rock formations have natural variations. The limits between the different formations presented in the sounding logs must therefore be considered as transitions between the formations rather than set boundaries. The precision of these limits depends on the type and number of soundings, the sounding methods used, as well as sampling frequency and methods.

The descriptions of the samples taken are based on recognized identification and classification methods used in geotechnics. They can call into play the judgement and interpretation of the personnel who carried out the examination of materials and can be presumed to be accurate and correct in keeping with current best practices in the field of geotechnics. Finally, if tests were carried out, the results of these tests apply solely to the samples tested, as described in this report.

The properties of the soil and rock can undergo significant modifications in the wake of construction activities such as excavation, blasting, pile driving or drainage activities, carried out on the site under study or an adjacent site. They can also be indirectly modified by the exposure of the soil or rock to freezing or weather stresses.

2.0 Groundwater

The groundwater conditions presented in this report apply only to the site under study. The accuracy and representation of these conditions must be interpreted based on the type of instrumentation used, as well as the period, duration, and number of observations carried out. These conditions can vary depending on precipitation, the seasons and, ultimately, the tides. They can also vary as a result of construction activities or the modification of physical elements on the site under study or in its vicinity. The problematic of ferrous ochre and its effects is not covered in this report.

3.0 Use of the report

The comments and recommendations contained in this report are intended primarily for the project's design team. The number of soundings required to identify all of the underground conditions that could impact construction costs, techniques, the choice of equipment and planning of operations could be greater than the number required for design purposes. All contractors bidding on or carrying out the work on the site under study must undertake their own interpretation of the results of the soundings and, if need be, carry out their own investigations to determine how site conditions could influence their operations or work methods.

Any modifications to the design, position and elevation of the works must be quickly communicated to LVM, allowing the validity of the recommendations presented to be verified. Complementary site or laboratory work could ultimately be required.

This report cannot be reproduced, in whole or in part, without the authorization of LVM.

4.0 Project tracking

The interpretation of the on-site and laboratory results obtained, as well as the recommendations presented in this report, apply solely to the site under study and to the information available about the project at the time this report was drafted.

Information available concerning the site and groundwater conditions increases as construction work progresses. As site conditions were interpreted and correlated between sounding points, LVM should be allowed to verify these conditions, during site visits conducted as work progresses, in order to confirm the information provided by the drillings soundings. If it is not possible for us to conduct these verifications, LVM shall assume no responsibility for geotechnical interpretations by third parties concerning recommendations contained in this report, particularly if the design has been modified or if site conditions different from those described in this report are encountered. The identification of such changes requires experience and must be carried out by an experienced geotechnical engineer.

5.0 Environment

The information contained in this report does not cover the environmental aspects of the site conditions, as these aspects were not included in the study mandate.

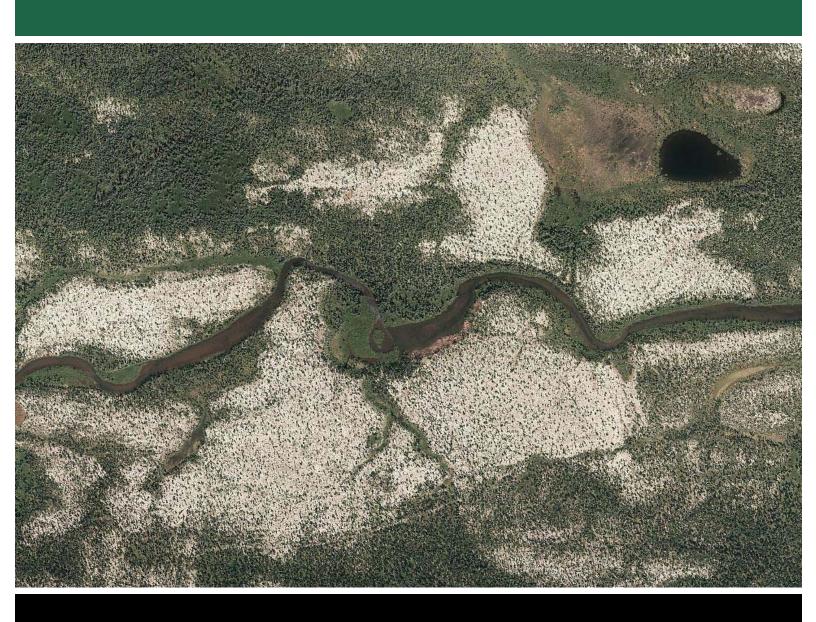
Appendix 2

Photo Interpretation (3 pages)



JOYCE LAKE DIRECT SHIPPING IRON ORE PROJECT, LABRADOR

PROJECTED ACCESS ROAD





Mapping of surficial materials in corridor study and identification of potential borrow sources by air photo-interpretation

Final report presented to LVM

December 2014



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Saint-Lambert, December 16, 2014

Mrs. Marianne Aquin, Eng. Geotechnical Project Manager LVM 1200 Blvd. Saint-Martin West, Suite 300 Laval, Québec H7S 2E4

Re: JOYCE LAKE DIRECT SHIPPING IRON ORE PROJECT, LABRADOR

PROPOSED ACCESS ROAD

Mapping of surficial materials in the study corridor and identification of potential borrow sources by air photo-interpretation

FINAL REPORT

Ref. number Poly-Géo Inc.: 14971

Dear Mrs. Aguin,

Please find below the results of our photo-interpretation study in connection with the proposed construction of the road about 45 km long linking the QNS&L railway to the Joyce Lake mine site in Labrador. As agreed, we are providing a map showing the nature and distribution of surficial materials in a corridor approximately 500 m wide, centered on the proposed route for the road (Map 1 in Appendix 1), a map showing the location of the main potential borrow sources for road construction materials (sand and gravel, till and rock) (Map 2 in Appendix 2), and finally, a table containing more detailed information on the type of material, site areas and estimated volumes of usable material.

Literature Review and Analysis

The study area is covered by several geological maps (Wardle, 1982; Wardle et al., 1997) and medium- and small-scale maps of the surficial deposits (Liverman et al. 2007 and 2010). Liverman and Vatcher (1993) briefly describe the geomorphology and surface geology in the area covered by maps 23J/10 and 23J/15. Although relatively small scale and not very detailed, these documents provide valuable information regarding the nature of the rock and the general distribution of surficial materials.

Geology and Geomorphology

The area is relatively flat and the rock structure trends generally NNW-SSE. Elevations range from a minimum of about 470 m to a maximum of about 580 m, with an average of about 500 m. The rocks of the study area are part of the Labrador Trough. These sedimentary and volcanic rocks have been metamorphosed and strongly deformed/folded by tectonic movements during their history. As a result, the rocks vary widely in type and quality over short distances, making it difficult to identify suitable potential quarry sites for the production of the aggregates required for access road construction.

According to the North America deglaciation map produced by Dyke *et al.* in 2003, the Laurentide ice sheet slowly retreated to the north and completely disappeared from the study area between 7.5 and 7.0 cal ka BP. During its retreat, various-sized bodies of meltwater were trapped between the retreating ice front to the north and the higher elevations to the south. The Attikamagen and Petitsikapau glacial lakes formed as a result of this. Based to the shorelines observed in the sand and gravel deposits in the vicinity of km 30 on the proposed road, Petitsikapau glacial lake would have reached an elevation of at least 488 m, approximately 18 m above its current level. The lowlands in the area would therefore have been covered by a layer of water thick enough to allow the deposition of fine sediments (silts and clays) under certain conditions, which would explain the presence of silt and clay layers under the sandy deposits found in some of the LVM boreholes, particularly those drilled on either side of the Gilling River (km 1).

In general, the layer of surficial material is relatively thin and discontinuous in the area along the proposed route of the road. Till is by far the most abundant deposit. It is generally thin (< 2 m), but thicknesses of over 4 m are observed locally, as evidenced by the channels cut into it by meltwater. Glaciofluvial and ice-contact deposits are very rare. The only deposits of interest are located in the vicinity of km 4-5 and 16-17 of the proposed road.

The rock in the region is generally friable and altered on surface. Weathering processes seem to be very active. There are large areas covered by cobbles and boulders, mostly from weathering of the bedrock surface. These large boulder fields are especially abundant in the lowlands between km 23 and 30 of the proposed road.

Alluvial sand covers the till and fine sediments locally. Finally, small, shallow bogs (< 2 m) occupy the low-lying, poorly-drained areas.

Photo-interpretation and Mapping

The surficial materials and potential borrow sources were identified and mapped using digital aerial photographs with a resolution of 20 cm, taken by XEOS in 2012. Our team did not undertake any field investigations, but we did have access to the results for 20 boreholes drilled by LVM in October 2014.

1) Map of the surficial materials in the study corridor (Map 1, Sheets 1 and 2)

The legend used for the analysis of aerial photographs distinguishes the nature, thickness and overlap of the various layers of surficial material. Landforms that could hamper road construction were also mapped.

The good resolution of the aerial photographs allowed for detailed photo-interpretation, but the presence of gently rolling rock over a large part of the territory and its rather friable nature sometimes made determination of the thickness of the surficial materials difficult. This was especially true between km 18 and 22 of the proposed road, where the rock is not visible, but appears to control the morphology of the till. The large cobble and boulder fields between km 24 and 30 are probably thin (< 1-2 m), because here and there, numerous small rocky ridges can be seen sticking out a few tens of centimetres.

In some cases, the rock may be sufficiently friable and altered to cut into with a bulldozer, without resorting to blasting.

2) Map of potential borrow sources (Map 2)

Potential borrow sources were identified taking into account the likely nature of the materials, potential volumes available and operating constraints. The nature of the surficial material was determined by photo-interpretation, while the probable type of rock in the proposed quarry sites was obtained from the 1:100,000-scale geological maps produced by Wardle in 1982. This data is imprecise and drilling will be required to determine the best site(s).

Table 1 provides key data relating to the potential borrow sources. The estimated volumes were calculated taking into account the site area and the potentially exploitable thickness. The most promising quarry sites are Q-03 and Q-04, where the geological map indicates the presence of dolomite and chert beds. The other sites are mainly composed of shale, slate and siltstone.

Deposits with the highest potential for providing sand and gravel with a significant proportion of cobbles are located in the area of km 16-17 of the proposed road (D-06 to D-11). They could allow the production of the aggregates required for the road surface. The deposits near the Gilling River (D-02 and D-03) are essentially sandy and overlie fine-grained sediments. Deposits D-04 and D-05 appear to be composed of a mixture of till and sand and gravel. Detailed exploration using an excavator would be required to determine their potential. Deposits D-12 to D-16 are composed of cobbles and boulders with no matrix. They appear to be very thin, with the water table close to the surface. Recovery of significant volumes would be costly and would entail the disturbance of large areas. Deposit D-17 has good potential. It is probably composed of well-drained sand and gravel. Finally, there is a till ridge about 1.5 km long, 100 m wide and at least 4-5 m thick near km 33 of the proposed road. This deposit contains volumes of in excess of 200,000 m³ and is probably well drained. However, the many scars, associated with small slides, visible on its southwest slope suggest a fairly high proportion of fine particles.

We trust that everything is to your satisfaction. Please do not hesitate to contact us should you require more information.

Sincerely,

Richard Lévesque, M.Sc. Senior Geomorphologist Poly-Géo Inc.

REFERENCES

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TABLE 1: POTENTIAL BORROW SOURCES FOR ROAD CONSTRUCTION

Cita	Coord	inates	Access road	Type of material	Area	Estimated volumes	Domonto
Site	UTM, Zone	19, Nad83	(km)	interpreted from small-scale geological maps and air photos)	(ha)	(m³)	Remarks
Quarries							
Q-01	651 408	6 058 143	0+000	Shales and/or siltstones.	6.3	≥ 300,000	Probably poor rock quality for road construction.
Q-02	651 841	6 057 802	0+000	Shales and/or siltstones.	4.1	≥ 150,000	Probably poor rock quality for road construction.
Q-03*	651 372	6 060 247	1 + 800	Interbedded dolomite and chert breccia.	4.3	≥ 200,000	* Best potential for good quality rock.
Q-04*	650 793	6 063 092	4+400	Interbedded dolomite and chert breccia.	35.9	≥ 1,000,000	* Best potential for good quality rock. Site probably already claimed.
Q-05	651 293	6 063 374	5+000	Shales and/or siltstones.	5.0	≥ 500,000	Probably poor rock quality for road construction.
Q-06	653 813	6 063 104	9+100	Interbedded shales,quartzites and/or siltstones.	10.5	≥ 1,000,000	Probably poor rock quality for road construction.
Q-07	656 692	6 081 866	32+300	Iron formation or/and shales, slates, dolomite, etc.	4.3	≥ 500,000	Probably poor rock quality for road construction. Site probably already claimed.
Deposits							
D-01	651 571	6 058 211	0+000	Till	2.0	10,000	Water table near surface.
D-02	651 718	6 059 064	0+500	Sand, becoming sandy silt under 2 to 3 metres.	13.8	≥ 100,000	Water table could be reached at a depth of 2 to 4 m.
D-03	651 511	6 059 628	0+900	Sand, becoming sandy silt under 2 to 3 metres.	3.1	25,000	Water table could be reached at a depth of 2 to 4 m.
D-04	651 067	6 062 422	4+100	Approximately 2 m of sand and gravel overlying silty sand or till.	3.5	30,000	Water table could be reached at a depth of 2 to 4 m
D-05	651 233	6 062 735	4+600	Till with some sand and gravel.	5.5	> 50,000	Water table could be reached at a depth of 2 to 4 m.
D-06	655 162	6 069 059	16+000	Sand and gravel.	38.0	≥ 500,000	Appears to be the best deposit in the region.
D-07	654 757	6 069 464	16+100	Sand and gravel overlying till.	8.6	≥ 75,000	
D-08	654 281	6 070 091	16+300	Probably a thin layer of sand and gravel overlying till.	24.8	≥ 100,000	
D-09	654 609	6 069 953	16+600	Sand and gravel, maybe till.	2.5	50,000	
D-10	654 506	6 070 249	16+800	Sand and gravel.	1.8	25,000	About 20% of the deposit is less than 75 m from a creek.

JOYCE LAKE PROJECTED ACCESS ROAD



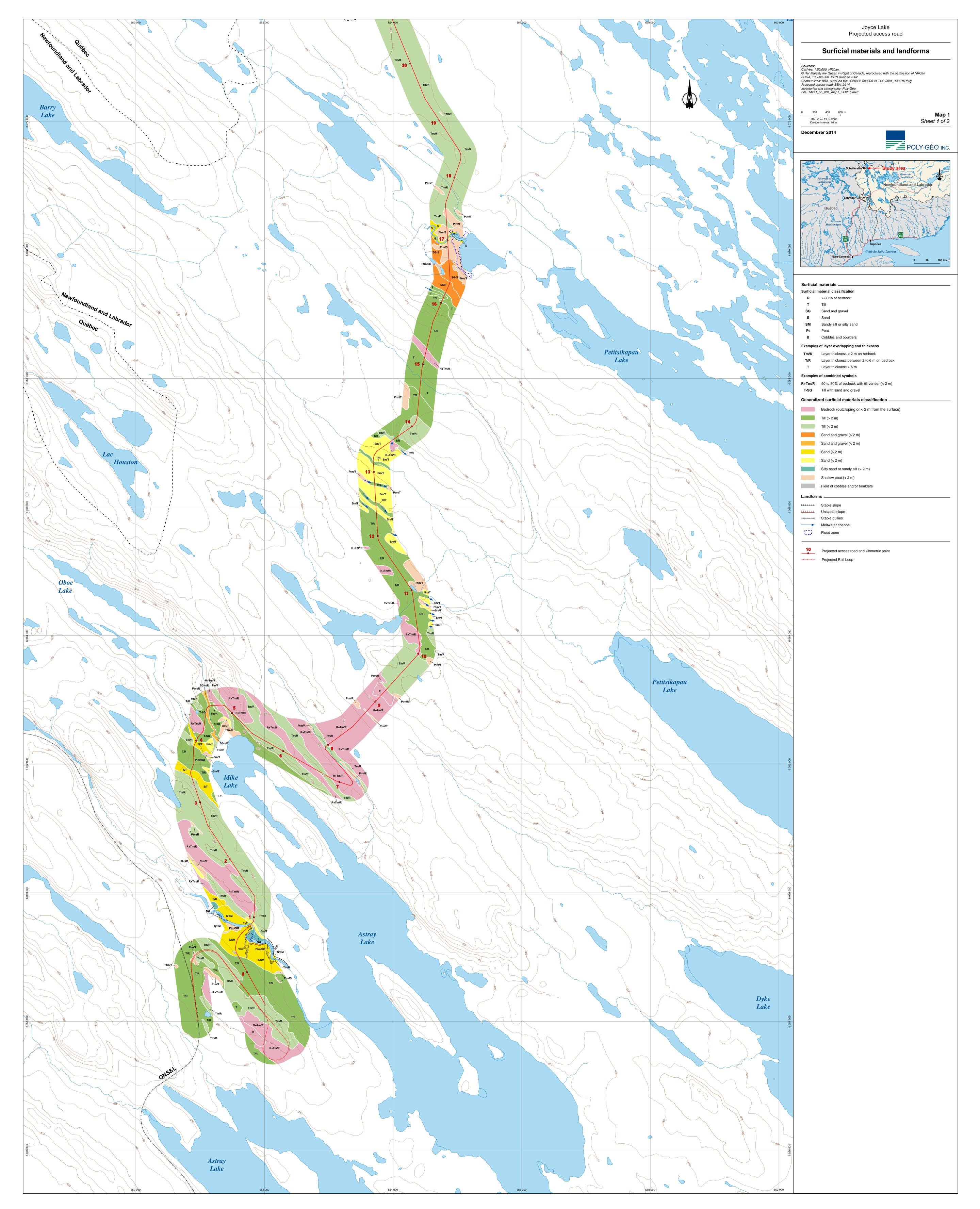
TABLE 1: POTENTIAL BORROW SOURCES FOR ROAD CONSTRUCTION

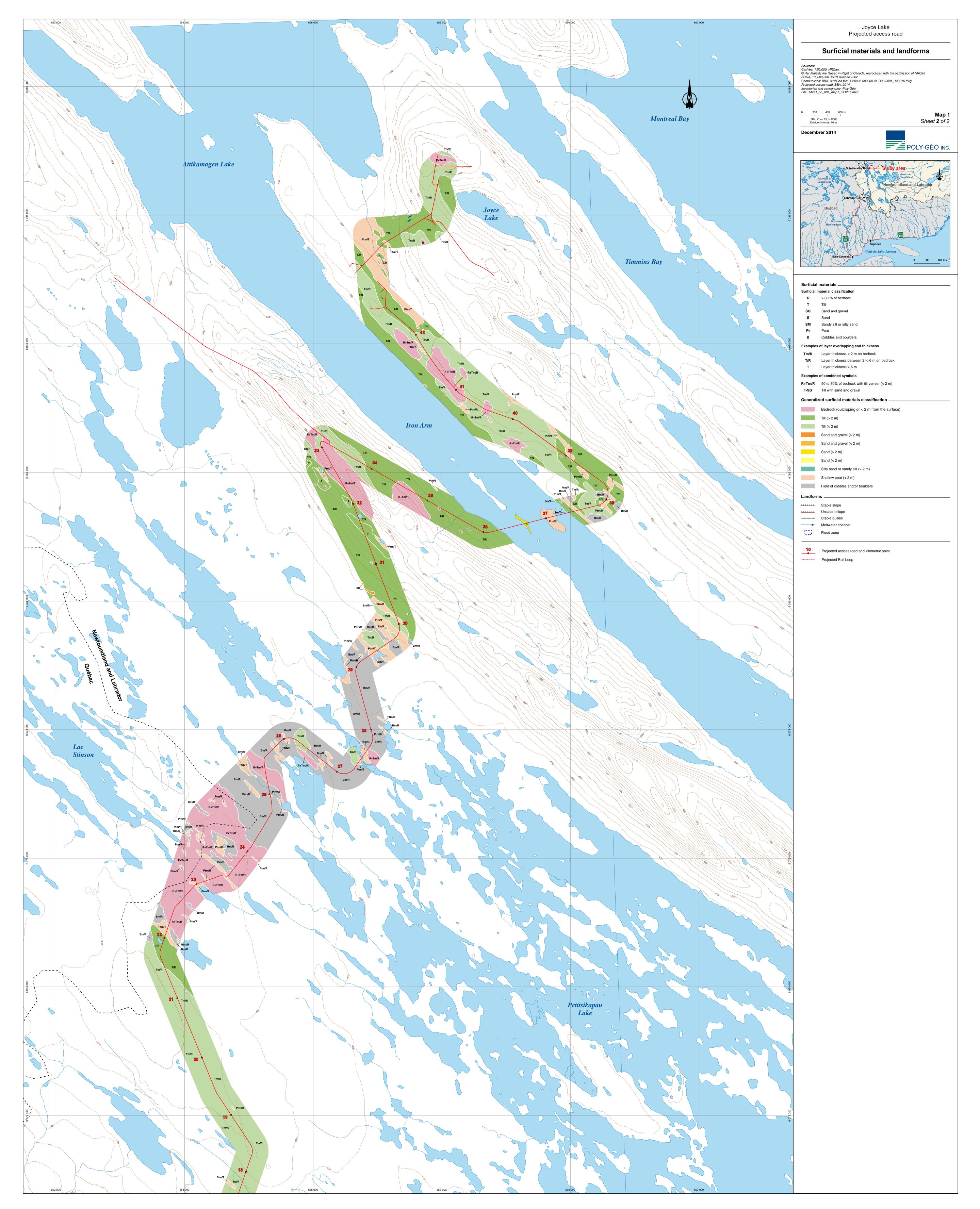
Site	Coord	inates	Access road	Type of material (interpreted from small-scale geological maps and air	Area	Estimated volumes	Remarks
Ollo	UTM, Zone	19, Nad83	(km)	photos)	(ha)	(m³)	nomar ko
D-11	654 360	6 070 413	16+900	Sand and gravel.	1.3	≤ 5,000	Almost all of the deposit is less than 75 m from a creek.
D-12	655 789	6 075 926	24 + 500	Probably a thin layer (< 1 m) of clean cobbles and boulders overlying bedrock.	9.5	≤ 25,000	Cobbles and boulders are probably from bedrock weathering. Solid rock and water table appear to be near the surface. Costly, difficult operation.
D-13	655 144	6 078 294	26+000	Probably a thin layer (< 1 m) of clean cobbles and boulders overlying bedrock.	8.2	≤ 25,000	Cobbles and boulders are probably from bedrock weathering. Solid rock and water table appear to be near the surface. Costly, difficult operation.
D-14	656 589	6 077 388	27 + 100	Probably a thin layer (< 1 m) of clean cobbles and boulders overlying bedrock.	9.4	40,000	Cobbles and boulders are probably from bedrock weathering. Solid rock and water table appear to be near the surface. Costly, difficult operation.
D-15	656 635	6 078 519	28 + 500	Probably a thin layer (< 1 m) of clean cobbles and boulders overlying bedrock.	4.5	20,000	Cobbles and boulders are probably from bedrock weathering. Solid rock and water table appear to be near the surface. Costly, difficult operation.
D-16	656 616	6 079 127	29+000	Probably a thin layer (< 1 m) of clean cobbles and boulders overlying bedrock.	3.2	15,000	Cobbles and boulders are probably from bedrock weathering. Solid rock and water table appear to be near the surface. Costly, difficult operation.
D-17	656 688	6 080 215	30 + 700	Sand and gravel.	5.7	100,000	Former lacustrine beaches are visible on the south side of the deposit.
D-18	655 365	6 082 659	33+000	Till (> 5 m thick)	20.2	≥ 200,000	Relatively well-drained till.

APPENDIX 1

MAP 1 (SHEETS 1 AND 2):

SURFICIAL MATERIALS AND LANDFORMS

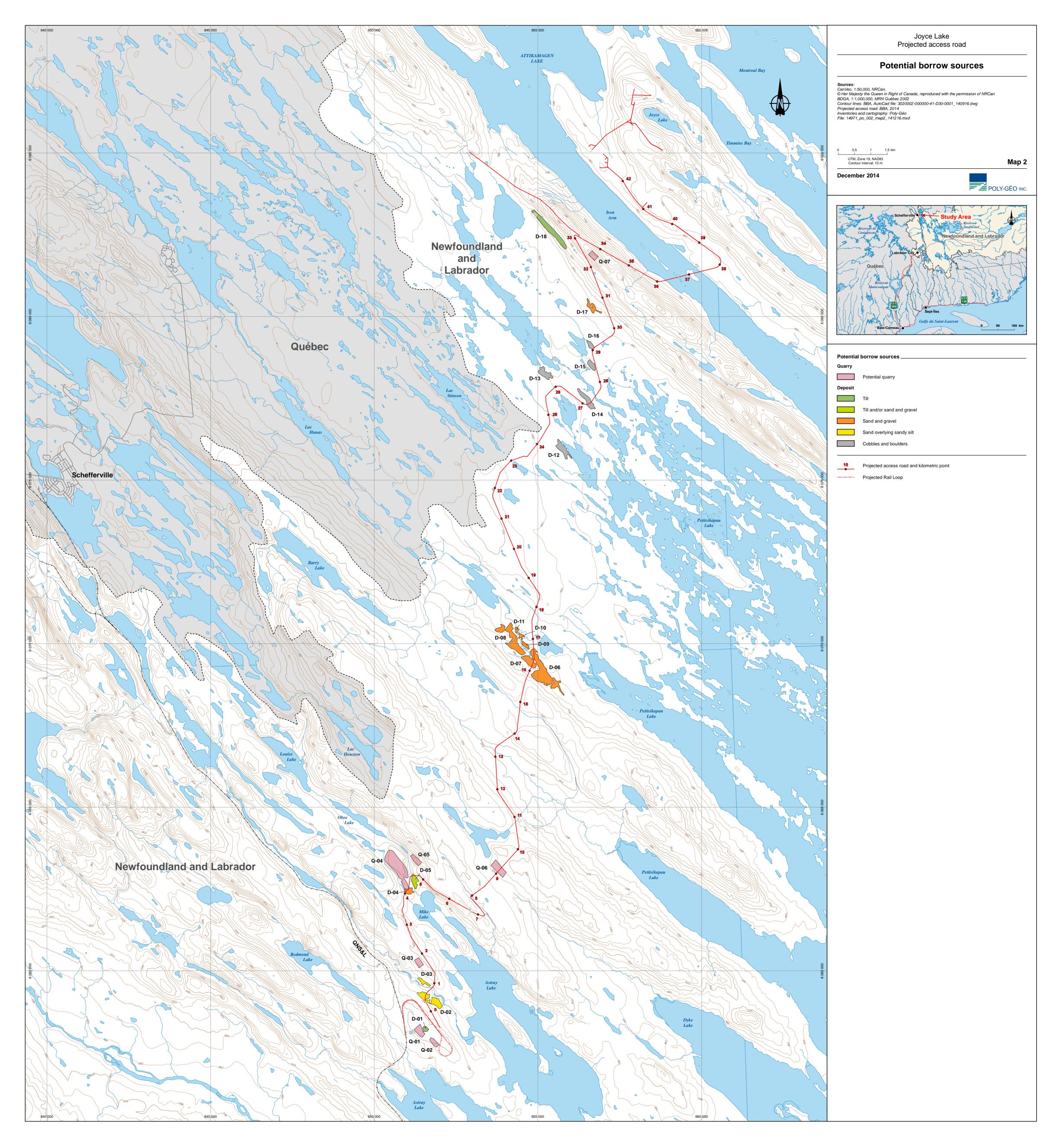




APPENDIX 2

MAP 2 :

POTENTIAL BORROW SOURCES



Appendix 3

Explanatory Notes and Survey Log Reports – Surrounding Areas (30 pages)





EXPLANATION NOTE ON SOUNDING LOGS

The following sounding logs summarize soils and rock geotechnical properties as well as ground water conditions, as collected during field work and/or obtained from laboratory tests. This note explains the different symbols and abbreviations used in these logs.

S	TRATIGRAPHIC UNITS		SYI	MBOLS	
Elevation/Depth:	Reference to the geodesic elevation of the or to a bench mark of arbitrary elevation, location of the sounding. Depth of the digeological boundaries as measured from gurface. On the left, the scale is in meters	at the TOP SOIL ferent ground BACKELL	SAND	СОВ	BLE SO
Description of the	on the right, it is in feet. Every geological formation is detailed.	GRAVEL	CLAY	ROC	C.i. K 폴
stratigraphic units:	The proportion of the different elements soil, defined according to the size of the pais given following the classification hereafte relative compactness of cohesionless s defined by the "N" index of the Sta Penetration Test. The consistency of cosoils is defined by their shear resistance.	rticles, r. The oils is This column andard during the ge	shows the ground wa eotechnical investigation re also illustrated in thi	on. The details of the	
<u>Classification</u> Clay	< 0.002	Type and nu	ımber: Each sample	is labelled in acco	
Clay and silt (undiffere Sand Gravel Cobble Boulder	vertificated) < 0.08	Sub-sample:	: When a sam stratigraphic un it and create si identification of	ple contains two o its, it is sometimes nec ub-samples. This colu the latter and the asso surements to these sub	essary to separate umn allows for the ociation to <i>in situ</i> or
"Traces" (tr.) "Some" (s.) Adjective (ex.: sandy	1 to 10 10 to 20 , silty) 20 to 35	Condition:	shown in this	ength and condition of column. The synthesis cample, following the eg.	mbol shows the
"And" (ex.: sand and o	gravel) 35 to 50	Size:	This column in	dicates the split spoor	n sampler size.
Compactness of cohes soils Very loose Loose Compact Dense Very dense	Standard Penetration Test is ("N" value), ASTM D-1586		expressed with with the Standa the number of the split spoor freely from a health of the spoon adding the number 2 nd and 3 rd	enetration index show the letter "N". This ard Penetration Test. blows required to drive a, using a 622 Newto eight of 762mm (ASTI olit spoon, the "N" independence of blows required 150mm of the split space of blows greater to the letter of blows greater to the letter "N".	index is obtained It corresponds to the last 300mm of on hammer falling M D-1586). For a lex is obtained by d for the driving of ooon. Refusal (R)
Consistency of cohesi Very soft Soft Firm Stiff	ve soils Undrained shear strength (< 12 12 to 25 25 to 50 50 to 100	(kPa)	numbers such number of blo 150mm of the Moreover, it inc	as 28-30-50/60mm was required to drive split spoon are respective to the split spoon are respective to the spoon of 60mm, whereup	indicates that the the the 1 st and 2 nd ctively 28 and 30. were necessary to
Very stiff Hard Plasticity of cohesive Low Medium	100 to 200 > 200 e soils Liquid limit (%) < 30 30 to 50	RQD index:	as the ratio be of 100mm and the core run measurement	designation index: This tween the total length more in length over the The RQD index of the number of "nature of the alteration in a ro	n of all rock cores the total length of x is an indirect ural" fractures and
High	> 50			ESTS	
Sensitivity of cohesiv Low Medium High Extra-sensitive Quick (sensitive) c	$S_t < 2$ $2 < S_t < 4$ $4 < S_t < 8$ $8 < S_t < 16$	Results:	results of test laboratory (sh Atterberg limit information, pl part of the so	nows, for the corresponding carried out in the lear strength, dyna is with the cone, elease refer to the legunding log. However, pe of analysis performested.	e field or in the mic penetration, etc.). For more tend in the upper r, an abbreviation
Classification of r Very poor quality Poor quality Fair quality Good quality Excellent quality	y 25 25 to 50 50 to 75 75 to 90	Graph:	resistance of co laboratory (NQ Dynamic Cone Moreover, this	hows the undrained hesive soils, as measu 2501-200). It is also u Penetration Test (NQ 2 graph is used for the ent and Atterberg limits	ared in situ or in the used to present the 2501-145) results.

BOREHOLE REPORT

File n°: B-0010504-1 Borehole nº: BH-01-14

Date: From 2014-09-25 to 2014-09-25

Coordinates (m): North 6059445.0 (Y) 651638.0 (X) Nad83 UTM 19 East

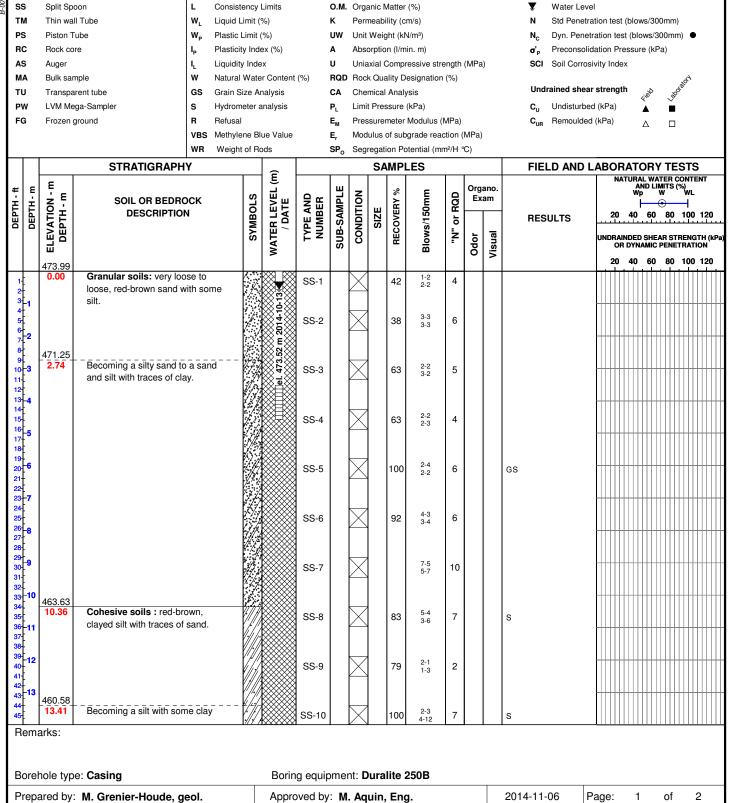
Arbitrary Elevation Bedrock: m End depth:

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)

Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Organoleptic soil examination:

473.99 (Z) 20.90 m



BOREHOLE REPORT

File n°: B-0010504-1 BH-01-14 Borehole n°:

Date: From 2014-09-25 to 2014-09-25

Coordinates (m): North 6059445.0 (Y) East Nad83 UTM 19

Arbitrary Elevation Bedrock: m End depth:

651638.0 (X) 473.99 (Z) 20.90 m

t				STRATIGRAPHY						SA	MPI	ES.				FIELD AND L	ABO	RA	TO	R۱	ΥT	ES	TS	;	
B-0010504-1	DEPTH - II	DEPTH - m	ELEVATION - m DEPTH - m	SOIL OR BEDROCK	OLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	TION	ш	RECOVERY %	Blows/150mm	RQD	Org:	ano. am			IATU	\vdash	_	⊙		1		
B-001	DE	DEP	VATI	DESCRIPTION	SYMBOLS	ER L	YPE,	B-SA	CONDITION	SIZE	COVE	vs/15	"N" or RQD		_	RESULTS) 4							
١			EE		S	WAT		SU	ၓ		#	Blo	<u>.</u>	Odor	Visual			DR D	/NAI	MIC	PEN	NETR	RATIO	ON	
ŀ	1			and sand.	///	*****										L	20) 4	0	60	80	0 1	00 	120)
1	47 48		459.05	and sand.																					
1	50 51	15	14.94	Till: compact, black silt some sand with traces of gravel.	, //		SS-11		X		4	5-7 19-10	26							П	П	Ш	Ш		
1	52 53	16		•	/ ? ?														-	Н	\mathbb{H}	+	₩	H	
1	54 55	17	456.92		(./ <u>.</u> 9/)		SS-12	A	X		38	10-9 11-12	20									Ш	Ш	Ш	
	49 50 51 52 53 54 55 56 57 58 60 61	"	17.07	End of sampling at a depth of 17.07m. Boring was pursued by a				٦								N _c = 15 N _c = 23 N _c = 44 N _c = 24 N _c = 17 N _c = 21 N _c = 21									
1	59 60	18		dynamic cone penetration test.												N _C = 24 N _C = 17	•		$\frac{1}{1}$	Н	+	\parallel	₩	#	
1	61 62	19														N _c = 21 N _c = 28					Ш	Щ	Щ	Щ	
1	64 65															N _c = 50 N ₋ = 52			•						
١	62- 63- 64- 65- 66- 67- 68- 69- 70- 71- 72- 73- 74- 75- 76- 77- 78- 79- 80-	20														N _c = 34 N _c = 38 N _c = 58		•	1	•	П	Ш	Ш	П	
١	68- 69-	21	453.09 20.90	End of the penetration test at a		*****										N _c = 79 N _c = 100				Н	•	,	\blacksquare	H	
١	71 - 72	,,,		deph of 20.90m.																		Ш	Ш	Ш	
١	73 74	_																							
١	75 - 76 -	23																	\parallel	Н	\forall	#	#	#	
١	78- 79	24																			Щ	Щ	Щ	\mathbb{H}	Щ
- 1	81-																								
١	82 83 84	25																			П	Ш	Ш	П	
١	85 86	26																	#	Н	\mathbb{H}	#	₩	#	\prod
١	87 88	27																	\parallel	Ш	Щ	Щ	Ш	\parallel	Ш
١	82 83 84 85 86 87 88 90 91 92 93																								
١	92 93	28																	\parallel		Ш	\parallel	$\parallel \parallel$	#	
١	94 95 -	29																		Н	\mathbb{H}	+	₩	H	
١	97 98	30																		Ш	Ш	Ш	Ш	Ш	
1	99 00 01	•																							
1	95- 96- 97- 98- 99- 00- 01- 02- 03- 04- 05- 06- 07- 08- 09- 10-	31																		Н	+	\parallel	$\parallel \parallel$	#	
1	04 <u> </u>	32																	\parallel	Ш	Щ	Щ	Щ	\mathbb{H}	-
1	06- 07- 08-																								
1	09	33																				Ш	\prod		
1	11 12	34																	+		\mathbb{H}	+	₩	Н	
	13- Re	ma	arks:		<u> </u>				l					I		<u> </u>		Ш		Ш		Ш	Ш		Ш
	Во	reh	nole typ	e: Casing			ıg equip									T									
L	Pr	epa	ared by:	M. Grenier-Houde, geol.		Appro	oved by	: М	. Aq	uin,	Enç	J.				2014-11-06 F	age:		2		of	f	2	2	

BOREHOLE REPORT File n°:

B-0010504-1 Borehole n°: BH-02-14

Date: From 2014-09-29 to 2014-09-29

m End depth:

16.13 m

6059525.0 (Y) Coordinates (m): North Nad83 UTM 19 East 651603.0 (X) **Arbitrary** Elevation 474.24 (Z)

Bedrock: Organoleptic soil examination:

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S) Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

•	type	Test

ts Consistency Limits W_L Liquid Limit (%) Plastic Limit (%) W_P

Lost

Client:

Κ Plasticity Index (%) Liquidity Index U

 \mathbf{I}_{L} w Natural Water Content (%) GS Grain Size Analysis s Hydrometer analysis R

Refusal VBS Methylene Blue Value Weight of Rods WR

O.M. Organic Matter (%) Permeability (cm/s) UW Unit Weight (kN/m³) Absorption (I/min. m)

Uniaxial Compressive strength (MPa) RQD Rock Quality Designation (%) Chemical Analysis CA Limit Pressure (kPa) $\mathbf{P}_{\!\mathsf{L}}$

 $\mathbf{E}_{\mathbf{M}}$ Pressuremeter Modulus (MPa) E, Modulus of subgrade reaction (MPa) Segregation Potential (mm²/H °C) SP.

Water Level

Std Penetration test (blows/300mm)

 N_c Dyn. Penetration test (blows/300mm)

Preconsolidation Pressure (kPa) σ'_P

Soil Corrosivity Index SCI

Undrained shear strength

Undisturbed (kPa)

Remoulded (kPa) Δ

L			WR Weigh	t of Ro	ods		SPo	Segi	regati	on Po	tential (mr	n²/H°	C)											
l			STRATIGRAPHY		_				SA	MPI	_ES				FIELD AND L	.AB								
DEPTH - ft	DEPTH - m	ELEVATION - m DEPTH - m	SOIL OR BEDROCK	SYMBOLS	R LEVEL (m) DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION		RECOVERY %	mmo	"N" or RQD	Orga					٧	AND Vp	LIM	ER C ITS (* /	%) ₩L —	_	
ם	EP	ĔĔ	DESCRIPTION	ĕ	PA I	MB	SAI		SIZE	OVE	15	or			RESULTS		20	4(6	0	80	100) 12	٩
ľ		ELEV/ DEF		SY	WATER LEVEL / DATE	₹ B	SUB-	CON	0,	REC	Blows/150mm	Z	Odor	Visual		UNE	ORAI OF	NDE	D SH NAM	IEA IC P	R STI	RENG TRAT	GTH FION	(kPa)
l		- 474.24			^						_		١	^			20	40	6	0	80	100) 12	:0
1 2		0.00 474.04 0.20	Granular soils : brown sand with some silt.	(2014-10-13	SS-1	A B	X		71	1-1 1-2	2	Ι	Ι										
3 4 5	1 2	0.20	Cohesive soils: red-brown clayed silt with traces of sand.	/// ///	m 2014-	SS-2		X		67	2-3 4-6	7	I	I							Ш			
6 7 8	-2				474.24 n												₩			Н	Н	Н		++
9 10 11	3				6	SS-3		X		88	1-1 1-1	2	I	I	S						Ш	Н		
12	4			1//	\boxtimes																			
14 15	ŧ	469.24				SS-4		\times		100	1-0 1-0	1	1	1										
18		5.00	Becoming a silt with some clay and sand.			SS-5		X		100	0-2 2-2	4	1	1	S									
21 22	ŧ														L									
24 25						SS-6		X		100	1-1 2-1	3	I	I										
27	† I	466.01 8.23	Till: loose to compact, gravel with	• //./ 4	$\otimes \otimes$												Ш	Ш	$\parallel \parallel$	Ш	Ш	Ш	Ш	
28 29 30	9	020	some sand.			SS-7				0	8-4 3-3	7	I	I										++
31 32 33	F 1																				Ш	Ш		
34 35		463.04		•	$\otimes \otimes$	SS-8		\times		21	4-8 8-34	16	I	1									Ш	
37 38	ŧ	11.20	Bedrock : Iron oxyde with red chert, fractured rock.	17/1/2/		RC-9				39		0												
41	ŀ		Iron oxyde with red chert, fractured rock.	シジン		no-s				งฮ		U												
43 44 45	-13			之以																				$\parallel \parallel$
R	ema	arks:		1-,	IXXI DXXI												ш	ш	ш	Ш	ш	ш		

EQ-09-Ge-66A R.1 04.03.2009

Borehole type: Casing

Boring equipment: Duralite 250B

Prepared by: M. Grenier-Houde, geol.

Approved by: M. Aquin, Eng.

2014-11-06

Page:

1

of

2

Borehole type: Casing

Remarks:

Boring equipment: Duralite 250B

2

B-0010504-1

6059525.0 (Y) 651603.0 (X)

474.24 (Z)

16.13 m

BH-02-14

B-0010504-1

6057771.0 (Y)

60 80 100 120

Δ

40

652017.0 (X)

508.03 (Z)

4.04 m

BH-03-14

EQ-09-Ge-66A R.1 04.03.2009

Borehole type: Casing

Boring equipment: Duralite 250B

2014-11-06

Page:

1

of

1

Prepared by: M. Grenier-Houde, geol. Approved by: M. Aquin, Eng.

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BH-04-14

Date: From 2014-10-13 to 2014-10-13

Coordinates (m): North 6058738.0 (Y) Nad83 UTM 19 East

Arbitrary Elevation Bedrock: m End depth:

651513.0 (X) 502.25 (Z)

14.02 m

Organoleptic soil examination:

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S) Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

O.M. Organic Matter (%)

Unit Weight (kN/m³) Absorption (I/min. m)

Uniaxial Compressive strength (MPa) RQD Rock Quality Designation (%)

Pressuremeter Modulus (MPa) Modulus of subgrade reaction (MPa) Water Level

Std Penetration test (blows/300mm)

 N_c Dyn. Penetration test (blows/300mm)

Preconsolidation Pressure (kPa) σ'_P

Soil Corrosivity Index SCI

Undrained shear strength

Undisturbed (kPa)

Remoulded (kPa)



			STRATIGRAPHY)				SA	MPI	_ES				FIELD AND L								
DEPTH - ft	DEPTH - m	ON - m 1 - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	E	ERY %	Blows/150mm	"N" or RQD	Orga Exa					H	(TER C MITS (W	\dashv		
DEF	DEP	EVATIO DEPTH	DESCRIPTION	MB	B L	PE	-SA	Ī	SIZE	RECOVERY	s/15	o			RESULTS	2	<u>.</u>	40	60	80	100) 12	ᅫ
		ELEVATION DEPTH - n		S	WATE	ŽΞ	SUB	S		HE HE	Blow	N.	Odor	Visual		UNDF							
		502.25														2	:0 -	40	60	80	100) 12	<u> </u>
1- 2- 3-	-	0.00 502.20 0.05	Organic soils Till: compact to dense, brown gravelly silty sand.			SS-1		X		88	1-2 5-5	7	I	I									
4- 5-	-1		gravery sitty sand.	//		SS-2		X		29	5-8 8-9	16	ı	I					П	Ш	П		
2- 3- 4- 5- 6- 7- 8- 9- 10- 11-	2			< % 7 %		RC-3													-		#		
10- 11-	3					SS-4				67	25-23 27-16	50	I	I	GS		Ш		#		#		++
13-	4	497.98		4.7	\boxtimes	RC-5											Ш	Ш	Щ	Ш	Ш	Ш	Щ
14- 15- 16-		4.27	Probable bedrock : completly altered.	1/2/	⊗ ₽⊗	SS-6		X		71	9-7 9-9	16	1	I									
17- 18- 19-				12	014-10	RC-7																	
20- 21- 22-	- 6			13/	494.45 m 2014-10-13	SS-8		$\overline{m{\parallel}}$		67	6-13 15-8	28	1	I									
23-	7			137	$\otimes_{2} \otimes$	RC-9											₩	\mathbb{H}	₩	₩	₩	Ш	+
25- 26-	8			1/2/	ĕ	SS-10		X		100	4-5 8-8	13	1	I									Ш
12- 13- 14- 15- 16- 17- 18- 19- 20- 21- 22- 23- 24- 25- 26- 27- 28- 29- 30- 31-						SS-11		\bigvee		92	6-8 10-20	18	ı	ı									
30- 31- 32-				13/				/_\															
32- 33- 34- 35- 36-	-10			12/1		SS-12		X		88	5-11 12-14	23	ı	ı									
35- 36- 37- 38- 39- 40-																							
40 41 42	-12 -13			シジ		SS-13		\times		88	10-16 21-22	37	1	I									
45		orke:		ンジン		SS-14		\times		92	6-5 9-10	14	ı	ı									

Remarks:

EQ-09-Ge-66A R.1 04.03.2009

Borehole type: Casing

Boring equipment: Duralite 250B

Prepared by: M. Grenier-Houde, geol.

Approved by: M. Aquin, Eng.

2014-11-06

Page:

of

1

2

Labec Century Iron Ore inc.

			VM	Client	:		Labe	ec	Ce	ntu	iry					BORE File n°: Borehole n°:	H) O	LE			-0	01	05	04		
ľ							Iro	n C	re	inc).					Date: From 2	014	l-1	0- ⁻	13	to						
	roje oca	Aı	oyce Lake and Area DSO Pro reas ail Loop - Chainage 1+850	oject - (Geo	techni	cal fea	sibi	lity	Stuc	ly -	Surrour	nding		Nac Arb	ordinates (m): 183 UTM 19 itrary lrock:	Elev	/at	ast on			65	515 50	13 2.2	.0 (25 ((Y) (X) (Z))
H			STRATIGRAPHY							SA	MPI	LES			Бео	FIELD AND	m D L A										_
₌	Ε	E _				iL (m)		щ	7		%	E		Orga					NA	TUR	AL \ AND	VAT LIM W	ER (ITS /	CON (%) W	TEN L	П	
DEPTH - ft	DEPTH - m	ELEVATION - DEPTH - m	SOIL OR BEDROCK DESCRIPTION		SYMBOLS	WATER LEVEL / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	or RQD	Exa	am	RESULTS			20		\vdash	•		-1		120	
ä	ᆸ	EVAT DEPT			SYMI	TER / D	TYPE NUM	NB-S	ONE	S	(ECO)ws/1	N.	'n	lal	RESULTS		UNE	RAI	NDE		1			•••	H (ki	
		ᆸ _				W		S)		_	ä		Odor	Visual								ENE 80				
47	 	14.02	End of borehole at a depth of															T	Ì	Ħ		Ì	İ	T		Ť	Ť
48 49 50 51	15		14.02m.														,										1
52 53 54 55	16																٠										ł
56 57 58	-17 -																٠									Ħ	t
60 61 62	19																										I
63 64 65 66	† -																,										+
67 68 69 70	21																,										
71 72 73 74	22																										1
74 75 76 77	-23																٠										
78 79 80 81	24																3										
82 83 84	25																,										
85 86 87 88	-																										
90 91 92	t																										
93 94 95 96	- -29																,										+
97 98 99	30																,										1
100 101 102 103	31																,										1
104 105 106 107	32																ò		#								
108 109 110 111	33																										1
112 113 R	<u> </u>	arks:																								Ш	
В	ore	hole typ	ne: Casing			Borin	g equip	mei	nt: D	ural	lite :	250B															_
Р	rep	ared by	: M. Grenier-Houde, geol.			Appro	ved by	: М	Aq	uin,	Enç	g.				2014-11-06	Pa	ige	:	-	2		of		2		

EQ-09-Ge-66A

Prepared by: M. Grenier-Houde, geol.

Borehole type: Casing

Boring equipment: Duralite 250B Approved by: M. Aquin, Eng.

2014-11-06

Page: 1 of

1

BH-05-14

6059494.0 (Y) 651781.0 (X)

П

60 80 100 120

475.55 (Z)

6.53 m

Boring equipment: Duralite 250B

2014-11-06

Page:

1

1

of

Approved by: M. Aquin, Eng.

BH-06-14

6059525.0 (Y)

60 80 100 120

651806.0 (X)

477.17 (Z)

7.19 m

EQ-09-Ge-66A

Borehole type: Casing

Prepared by: M. Grenier-Houde, geol.

Borehole type: Casing

Prepared by: M. Grenier-Houde, geol.

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BH-07-14

Date: From 2014-10-04 to 2014-10-05

6070159.0 (Y) Coordinates (m): North

East 654849.0 (X) 475.99 (Z) Elevation 9.07 m End depth: 12.45 m

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)

Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Water Level

Dyn. Penetration test (blows/300mm)

Std Penetration test (blows/300mm)

Preconsolidation Pressure (kPa)

Soil Corrosivity Index

Undrained shear strength

Undisturbed (kPa)

2015-01-05

Page:

1

1

of

Remoulded (kPa)

П Δ

			STRATIGRAPHY		=				SA	MP	LES				FIELD AND L	.At										
DEPTH - ft	DEPTH - m	.EVATION - m DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	Έ	RECOVERY %	Blows/150mm	"N" or RQD	Orga Exa						M _I	ND I	LIM	ER (ITS)	(%) V	WL		n
冒		TA'.	2200	NE.	J. J.	2 E	S-	Ð	SIZE	ò	s/1	ō			RESULTS	-	تَ		<u>ı</u>	ٽــ	<u>.</u>	ப்	<u></u>	ŭ	ئنـ	<u>. </u>
		ELEVATION DEPTH - n		S	VATE	ŽΞ	SUB	8		REC	Blow	Ÿ	Odor	Visual		UN	IDR/	AINI OR [DED) SH AMI	IEAI IC P	R ST	TRE ETR	NG ATI	TH (ON	(kPa)
		475.99			>									>			20)	40	6	0	80	1/	00	12	0
1-		0.00 475.38	Organic soils			SS-1				0	1-1 1-1	2				Т	П	T	П	П	П		П	П	T	П
2 3 4	ŧ. I	0.61	Granular soils : very loose, brown	9.	⊗ն⊗														Ш		Ш		Ш			
4	F'		sandy silt with traces of gravel.	///	2014-10-14	00.0					1-1	_					П	П	П	П	П	Ш	П	П	П	П
6	<u> </u>		Presence of organics matters	1///	⊗⊵⊗	SS-2		\triangle		4	2-3	3	ı	1					Ш		Ш		Ш			
7- 8	[473.55		///	××× ×××												П	П	П	П	П	П	П	П	П	П
5- 6- 7- 8- 9- 10- 11-		2.44	Till: Very dense, brown sandy and gravelly silt.	1,36	el. 475.74 m	SS-3		$\overline{}$		20	16-37	R							Ш		Ш		Ш			
10 11	3		gravelly silt.	18	i ⊗ĕ⊗	00-0		$\widehat{\mathbf{T}}$		20	50 /8cm	11	'	'		П	П	П	П	П	П	П	П	П	П	П
				1/4	\boxtimes	RC-4							I	1					Ш		Ш		Ш			
14	-4			,	\boxtimes												П	П	П	Ш	Т	Ш	П	Ш	Т	П
15 16	<u> </u>				$\bowtie \bowtie$	SS-5		\times	1	67	28-29 26-21	55	1	1	GS				Ш		Ш		Ш			
17	5			//×	$\bowtie \bowtie$												П	П	П	Ш	П	Ш	П	Ш	Т	П
18 19	<u> </u>			/s/	\boxtimes	RC-6													Ш		Ш		Ш			
12- 13- 14- 15- 16- 17- 18- 19- 20- 21- 22- 23- 24- 25- 26- 27- 28- 29- 30- 31-	6			/9/	$\bowtie \bowtie$	SS-7		$\stackrel{\blacksquare}{\checkmark}$		47	28-47	R	ı	ı		Т	П	П	Ш	Ш	Ш	Ш	Ш	Ш	Т	Ш
22	<u> </u>			///	$\bowtie \bowtie$						50 /8cm								Ш		Ш		Ш			
23 24	7			///	$\bowtie \bowtie$	RC-8										Ħ	П	т	Ш	Ш	Т	Ш	П	Ш	Т	Ш
25				//•	$\bowtie \bowtie$	SS-9			7	96	23-30 43-40	73	1						Ш		Ш		Ш			
27	8				\boxtimes	33-9		\triangle		90	43-40	13	'	'		Ħ	П	т	Ш	Ш	Т	Ш	П	Ш	Т	Ш
28 29	<u> </u>	466.92		/0/	\boxtimes														Ш		Ш		Ш			
30-	9	9.07	Bedrock : black shale, very poor	7.7.	$\bowtie \bowtie$	RC-10				100		30					П	Ħ	Ш	Ш	Ш	Ш	П	Ш	Т	Ш
32	<u> </u>		to poor quality.		\boxtimes														Ш		Ш		Ш			
33 34	-10 -11			137	\boxtimes											Т	П	П	Ш	Ш	Ш	Ш	Ш	Ш	Ш	Ш
35	ŧ l			<u>~</u>	$\otimes \otimes$														Ш		Ш		Ш			
36- 37-	-11			137		RC-11				95		24				Т	Ш	Ħ	Ш	Ш	Ш	$\dagger \dagger$	Ш	Ш	#	\parallel
38-	[-\															Ш		Ш		Ш			
40	-12	463.54														Ħ	Ш	Ħ	Ш	Ħ	Ħ	#	Ш	Ħ	Ħ	Ш
41 42	[12.45	End of borehole at a depth of		AXI IXX				1												Ш		Ш			
43	-13		12.45m.													H	$\parallel \parallel$	Ħ	Ш	$\dagger \dagger$	#	##	$\parallel \parallel$	$\dagger \dagger$	#	#
44 45	[Ш			
R	ema	arks:		-	1		ш		1		L						ш	ш		ш		ш		ш		ш

Boring equipment: Duralite 250B

Approved by: M. Aquin, Eng.

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BH-08-14

Date: From 2014-10-03 to 2014-10-04

6070194.0 (Y) Coordinates (m): North

Joyce Lake and Area DSO Project - Geotechnical feasibility Study - Surrounding Nad83 UTM 19 East 654843.0 (X) 476.19 (Z) Location: Mine Haul Road - Chainage 17+050 Arbitrary Elevation Bedrock: 8.05 m End depth: 11.51 m Organoleptic soil examination: Visual aspect: Non-existent(N); Disseminated(D); Soaked(S) Lost Odor: Non-existent(N); Light(L); Medium(M); Persistent(P) O.M. Organic Matter (%) Water Level Consistency Limits Liquid Limit (%) Permeability (cm/s) Std Penetration test (blows/300mm) Plastic Limit (%) Unit Weight (kN/m³) UW N_c Dyn. Penetration test (blows/300mm) Preconsolidation Pressure (kPa) Plasticity Index (%) Absorption (I/min. m) σ'_P Soil Corrosivity Index Liquidity Index U Uniaxial Compressive strength (MPa) SCI Natural Water Content (%) RQD Rock Quality Designation (%) Undrained shear strength Grain Size Analysis Chemical Analysis CA Hydrometer analysis Limit Pressure (kPa) Undisturbed (kPa) $\mathbf{P}_{\!\mathsf{L}}$ Refusal \mathbf{E}_{M} Pressuremeter Modulus (MPa) Remoulded (kPa) Methylene Blue Value E, Modulus of subgrade reaction (MPa) Weight of Rods SPo Segregation Potential (mm²/H ℃) SAMPLES FIELD AND LABORATORY TESTS

			STRATIGRAPHY		_				SA	MP	LES				FIELD AND L	Αŀ										ı
DEPTH - ft	DEPTH - m	ON - m	SOIL OR BEDROCK	OLS	EVEL (m) .TE	AND SER	MPLE	TION	ш	ERY %	шшо	or RQD	Org:						W _E	ND L	-IMI W		%) ₩L	-		
DEP	DEP	ELEVATION - m DEPTH - m	DESCRIPTION	SYMBOLS	WATER LEVEL / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY	Blows/150mm	"N" or	Odor	Visual	RESULTS	UP	NDR.	AINI OR D	DED	SHE	EAR C PE	80 STF ENET	RENG	GTH	(kP	_ a)
	_	476.19 0.00	Organic soils		XXI <u>¥</u> IXX						1-1	_		_		╁	ΗÌ		+	Щ		ĴΠ	.		Ш	\mathbf{H}
1-			Organic sons	4	476.19 m 2014-10-14	SS-1		imes		17	1-1 1-1	2														
3	-1	475.28 0.91	Granular soils : loose, sandy silt	17/	\otimes $\overline{4}\otimes$											\parallel	Щ	Щ	4	Щ	Ш	Ш	Щ	#	Ш	\perp
4· 5·	:	5.5.	with traces of gravel. Presence of	1/1/	⊗≅⊗	SS-2		\bigvee		46	1-2	5	$ \cdot $	l i	GS											
6	,		traces of organics matters.	1././2	XEX	00 2		\triangle		.0	3-4		'	'	30	Ц	Ш	Ш	Ш	Ш	Ш	Ш	Ш	Ш	Ш	
7- 8-	:	473.75		[///	⊗ 5⁄																					
9-	:	2.44	Till: very dense, brown sandy and	6//	\otimes 4 \otimes						10.00															
10-	3		silty gravel.	·	▧▫▧	SS-3		\angle		46	13-33 48-47	81			GS	Ħ	Ш	Ш	T	Ш	Ш	.111	$\forall \forall$	Т	П	1
12	.			6//	$\bowtie \bowtie$																					
13	4			7/7	$\bowtie \bowtie$	RC-4										H	Н	₩	+	₩	Н	#	+	Ж	Н	Н
15-	.			1/1	\boxtimes	SS-5		∇		46	25-21 29-48	50	ı	ı												
16	-5			1/4/	$\bowtie \bowtie$			\bigoplus			29-40					\perp	Щ	Щ	4	Ш	Ш	Ш	Щ	Ж	Щ	4
17- 18-				7	$\bowtie \bowtie$	RC-6																				
19				///	$\bowtie \bowtie$	SS-7		*		80	50 /13cm	R	1	1		Ц	Ш		Ш	Ш			Ш	Ш	Ш	
20-	.			o7./o/	$\bowtie \bowtie$												П		П					П		
22	:			1/1/	$\bowtie \bowtie$	RC-8																				
23	7				\boxtimes	00.0		↲			30-37					\parallel	Ш	\forall	+	Ħ	Ш	#	$\forall \forall$	т	Ш	Ħ
25	:			6/ 0	$\bowtie \bowtie$	SS-9		$\widehat{\ }$		100	30-37 50 /13cm	R														
26	8	468.14 8.05	Bedrock: grey, siltsone with thin	1.5%	$\bowtie \bowtie$											+	₩	₩	+	₩	Н		₩	Ж	₩	\mathbb{H}
28	:	0.00	beds of black shale, very poor	131	$\bowtie \bowtie$																					
29	9		quality.	 <	$\bowtie \bowtie$											\downarrow	Щ	Щ	4	Ш	Ш	Ш	Щ	Ш'	Щ	\bot
31	.			13.	$\bowtie \bowtie$	RC-10				70		8														
32	10				$\bowtie \!\!\! \perp \!\!\! \bowtie$	110-10				10							Ш	Ш	Ш	Ш	Ш	Ш	Ш	Ш	Ш	
33	: ''			157	\bowtie																					
35	: .			-/	$\bowtie \bowtie$																					
36	-11	464.68		だ	$\bowtie \bowtie$											Ħ	Ш	Ш	#	Ш	Ш	.111	$\forall \forall$	Т	Ш	1
38		11.51	End of borehole at a depth of	<u> </u>	XXIIIXX												Ш									
39 40	12		11.51m.													+	Н	$^{++}$	+	₩	Н	+++	₩	Ж	H	Н
41-	:																									
† ৫ ৫ 4 5 6 7 8 9 9 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	13															4	#	#	#	#	Ш	#	#	#	#	\perp
44-	-																Ш									
45-																Ш	Ш	Ш	\perp	Ш	Ш	Ш		Ш	Ш	\perp
R	ema	arks:																								

Boring equipment: Duralite 250B Borehole type: Casing

Prepared by: M. Grenier-Houde, geol. Approved by: M. Aquin, Eng.

2015-01-05

Page: 1 of

1

EQ-09-Ge-66A R.1 04.03.2009

Boring equipment: Duralite 250B Borehole type: Casing

Prepared by: M. Grenier-Houde, geol. Approved by: M. Aquin, Eng. 2014-11-20

Page: 1 of 1

B-0010504-1 BH-09-14

548.17 (Z)

North 6081969.0 (Y) East 657067.0 (X)

Elevation

m End depth:

3.05 m Visual aspect: Non-existent(N); Disseminated(D); Soaked(S) Odor: Non-existent(N); Light(L); Medium(M); Persistent(P) Std Penetration test (blows/300mm) Dvn. Penetration test (blows/300mm) Preconsolidation Pressure (kPa) Soil Corrosivity Index Undrained shear strength Undisturbed (kPa) Δ

FIELD AND LABORATORY TESTS 60 80 100 120 40 INDRAINDED SHEAR STRENGTH (kPa OR DYNAMIC PENETRATION 20 40 60 80 100 120 Remarks:

EQ-09-Ge-66A

Borehole type: Casing

Boring equipment: Duralite 250B Prepared by: M. Grenier-Houde, geol.

Approved by: M. Aquin, Eng.

2014-11-20

Page: 1 of

1

475.81 (Z)

5.64 m

R.1 04.03.2009

EQ-09-Ge-66A

Borehole type: Casing Prepared by: M. Grenier-Houde, geol. Boring equipment: Duralite 250B

Approved by: M. Aquin, Eng.

2015-01-05

Page: 1 of

1

B-0010504-1

6081398.0 (Y) 660073.0 (X)

60 80 100 120

Δ

470.45 (Z)

5.84 m

Client:

BOREHOLE REPORT

File n°: B-0010504-1 BH-12-14 Borehole n°:

Date: From 2014-10-06 to 2014-10-06

North 6083663.0 (Y)

s [amı amı s M	_	dition ct Remoulded e oon Il Tube fube	Tests L Consist W _L Liquid L W _P Plastic I I _P Plasticit I _L Liquidity	ency .imit (Limit ty Ind	Limits (%) (%) (ex (%)	Co.	re	Orga Perm Unit Abso Unia	Org	Janc Matter lity (c lity (k lity (k l/m Comp	oleptic s V (%) (%)	oil e isual Ddor:	exan aspe Non	Nad Arbi Bed nina ct: No -exist	rock: 0.76 m Ition: on-existent(N); Dissemina ent(N); Light(L); Medium Water Level N Std Penetra N _C Dyn. Penetr	East vation End depth ted(D); Soaked M); Persistente tion test (blows/ ation test (blows/ ation Pressure (300mm) √300mm) • kPa)	
TI P			arent tube ega-Sampler	GS Grain S S Hydrom		nalysis analysis		CA P _L		mical t Pres		/sis (kPa)				Undrained shear Cu Undisturbed	į.	\$ Jagdagd ⁴	
F	à	Frozen		R Refusal	ne B	lue Value		E _M E _r SP _o	Pres Mod	surer ulus d	meter of sub	Modulus (Mograde reacotential (mm	tion (C _{UR} Remoulded	_	_	
			STRATIGRAPH		. 01 11			0.0	Ocg		MP		1711	0)		FIELD AND L	ABORATO	RY TESTS	┨
DEPTH - ft	DEPTH - m	ELEVATION - m DEPTH - m	SOIL OR BEDRO		SYMBOLS	R LEVEL (m) DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	'ERY %	50mm	or RQD	Org Ex	ano. am	DECULTO.	AND Wp	WATER CONTENT LIMITS (%) W WL 0 80 100 120	
BE	DE	ELEVATION - DEPTH - m			SYME	WATER LEVEL / DATE	TYPE AND NUMBER	SUB-S/	COND	IS	RECOVERY	Blows/150mm	ION	Odor	Visual	RESULTS	UNDRAINDED SI OR DYNAM	HEAR STRENGTH (kP	<u>-</u> a)
1		506.90 0.00	Till: loose, brown, sand	y and	/ *		SS-1		\times		38	1-2 5-6	7	1	1		20 40 6	60 80 100 120	\blacksquare
3-	-1	506.14 0.76	gravelly silt. Bedrock: grey, siltstone			2014-10-13													\parallel
5· 6·			beds of black shale, poo	r quality.		90 80 80 80 80 80 80 80 80 80 80 80 80 80	SS-2		$\stackrel{\times}{-}$		50	5-22 24-39	46	'	I				
5 6 7 8 9 10	3				12/	el. 506	RC-3				98		30						
11- 12- 13- 14-		503.12 3.78	End of borehole at a dep	oth of	15/	9													
15	4	3.70	3.78m.	on or															
18	1																		
19 20 21 22																			
24- 25- 26-																			
27 28 29																			
30 31 32	9																		
33 34 35	-10 -																		
37- 38- 39-	-12																		
222 233 244 255 266 277 288 299 30- 31- 32- 33- 34- 35- 36- 37- 38- 39- 40- 41- 42- 43-	13																		

Remarks:

Boring equipment: Duralite 250B Borehole type: Casing

Prepared by: M. Grenier-Houde, geol. Approved by: M. Aquin, Eng. 2014-11-06

1

1 of

Borehole type: Casing Boring equipment: Duralite 250B

Prepared by: M. Grenier-Houde, geol. Approved by: M. Aquin, Eng.

2014-11-06

Page: 1 of

1

B-0010504-1

6084916.0 (Y)

60 80 100 120

Δ

656731.0 (X)

489.75 (Z)

2.41 m

BH-13-14

BH-14-14

6085653.0 (Y) 657965.0 (X)

60 80 100 120

533.86 (Z)

2.74 m

EQ-09-Ge-66A R.1 04.03.2009

Borehole type: Casing

Prepared by: M. Grenier-Houde, geol.

Boring equipment: Duralite 250B Approved by: M. Aquin, Eng.

2014-11-06

Page:

1

1

of

Prepared by: M. Grenier-Houde, geol.

Borehole type: Casing

Boring equipment: Duralite 250B Approved by: M. Aquin, Eng.

2014-11-06

Page: 1

of

1

B-0010504-1 BH-15-14

542.02 (Z)

4.45 m

6086784.0 (Y) 658634.0 (X)

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)

Std Penetration test (blows/300mm)

Dyn. Penetration test (blows/300mm)

Δ

DEPTH - fl	DEPTH - n	NO -	SOIL OR BEDROCK	STC	=VEL TE	ND ER	MPLE	NOL		RY %	Omm	3QD	Exa	am					Vp ├	w •)—	₩L		
DEP	DEP	ELEVATION - DEPTH - m	DESCRIPTION	SYMBOLS	WATER LEVEL / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	or	ıal	RESULTS	UN		40 UNDE		<u> </u>			120 3TH (т
		ᆿ _			W	•	S			"	В	•	Odor	Visual									ION	- 1
		542.02															20	40	6	0	80	100	120	<u>'</u>
1- 2-		0.00 541.13	Till: brown, silt with some sand and gravel.	//, 		SS-1		X		44	1-2 50 /10cm	R	I	I										
3- 4- 5-	-1	0.89	Probable bedrock	(V) (V)		RC-2				26		0												
2- 3- 4- 5- 6- 7- 8- 9- 10- 11- 12- 13-	-2 -3	539.96 2.06	Grey, sandstone, fine to medium, grained, poor quality.			RC-3				100		33												
13- 14- 15- 16- 17-	٠ ا	537.57 4.45	End of borehole at a depth of 4.45m.	\$\langle \text{\$\int \te					-															
17- 18- 19- 20-	6																							
21- 22- 23-	7																							
24 25 26	-8																							
25- 26- 27- 28- 29- 30-																								
30- 31- 32- 33-	.																							
33- 34- 35- 36- 37-	.																							
36- 37- 38-	-11															Ħ	Ш				Ш			П

R.1 04.03.2009

EQ-09-Ge-66A

Borehole type: Casing

Prepared by: M. Grenier-Houde, geol.

Boring equipment: Duralite 250B

Approved by: M. Aquin, Eng. 2014-11-06 Page:

1

2 of

B-0010504-1

6087536.0 (Y)

60 80 100 120

Δ

657773.0 (X)

531.57 (Z)

17.91 m

BH-16-14

Labec Century Iron Ore inc.

Client:

BOREHOLE REPORT

File n°: B-0010504-1 BH-16-14 Borehole n°:

Date: From 2014-10-07 to 2014-10-09

North 6087536.0 (Y) Coordinates (m): East 657773.0 (X) Nad83 UTM 19

Arbitrary Bedrock:

Elevation m End depth:

531.57 (Z) 17.91 m

ŀ				STRATIGRAPHY		<u>-</u>				SA	MPL	.ES				FIELD AND L	.AI	ВС)R	ΑT	OF	RY	TE	ST	3		ı
B-0010504-1	DEPTH - ft	DEPTH - m	ELEVATION - m DEPTH - m	SOIL OR BEDROCK DESCRIPTION	30LS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	2E	RECOVERY %	Blows/150mm	"N" or RQD	Org Ex	ano. am	DECI II TO					\vdash	•)	ONT (%) WL			
_B-00	DE	B	EVAT DEPT		SYMBOLS	TER / D,	TYPE	UB-S/	OND	SIZE	ECOV	ws/1	N. o		lal	RESULTS	UI		1	-1-1-1						•••	l
			ᆿ _		"	W	•	เร	0		-	Bic	=	Odor	Visual									RENG TRAT			l
. i e	616-62-63-63-64-65-66-66-67-66-69-67-71-73-73-74-75-6-77-73-73-74-75-6-77-73-73-74-75-6-77-73-73-73-73-73-73-73-73-73-73-73-73-	-16 -17 -18 -19 -20 -21 -22 -23 -24 -25 -26	513.66 17.91	End of borehole at a depth of 17.91m.		WA WA	RC-16 SS-17 RC-18 SS-19 RC-20 SS-21				58 100 67	20-15 11-29 28-50 /10cm 50 /8cm	26 R R)pO	Visu									100			
	112 113		rke.																								
	В	oreh		pe: Casing : M. Grenier-Houde, geol.			g equip								T	2014-11-06 P	'an	ge:					of		2		
L	۲۱	epa	area by	. w. Grenier-Houae, geol.		Appro	vea by	. 101	. Aq	uın,	⊏ng	J.				2014-11-06 P	ag	je:		4	=		Uľ		2		ı

6062586.0 (Y)

60 80 100 120

651740.0 (X)

516.45 (Z)

2.39 m

EQ-09-Ge-66A R.1 04.03.2009

Borehole type: Casing

Prepared by: M. Grenier-Houde, geol.

Boring equipment: Duralite 250B Approved by: M. Aquin, Eng.

2014-11-06

Page:

1

1

of

Borehole type: Casing Prepared by: M. Grenier-Houde, geol. Boring equipment: Duralite 250B

Approved by: M. Aquin, Eng.

2014-11-06

Page: 1 of

1

B-0010504-1

6077624.0 (Y)

60 80 100 120

Δ

656770.0 (X)

472.00 (Z)

3.05 m

Client:

BOREHOLE REPORT

File n°: B-0010504-1 BP-02-01-14 Borehole n°:

Date: From 2014-09-27 to 2014-09-27

6059033.0 (Y) Coordinates (m): North East 651887.0 (X) Nad83 UTM 19

Arbitrary Bedrock:

Elevation m End depth:

483.99 (Z) 7.92 m

on: -existent(N); Disseminated(D); Soaked(S) tt(N); Light(L); Medium(M); Persistent(P)
▼ Water Level
N Std Penetration test (blows/300mm)
N _c Dyn. Penetration test (blows/300mm) ●
σ' _P Preconsolidation Pressure (kPa)
SCI Soil Corrosivity Index
_{ster}
Undrained shear strength
C _U Undisturbed (kPa)
C _{UR} Remoulded (kPa) △ □
FIELD AND LABORATORY TESTS

L			WR Weigh	t of R	ods		SPo	Seg	regati	on Po	tential (mn	n²/H °	C)						_	_						_
ı			STRATIGRAPHY		_				SA	MPL	.ES				FIELD AND L	.AI	BC	R	Αī	ГО	RY	Τ	ES	TS	;	- 1
DEPTH - ft	DEPTH - m	ELEVATION - m DEPTH - m	SOIL OR BEDROCK	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	ш	RECOVERY %	mm0	"N" or RQD	Org:							\vdash	-	•	(%)	1		
빌	핅	ΨĘ	DESCRIPTION	Ä	L A	ÄE,	ŞA	Ē	SIZE	8	15	o			RESULTS	L	2	0	40) —	60	80	0 1	00	120	
ľ		ELEV, DEF		NS.	WATE!	¥ N	SUB-	S		REC	Blows/150mm	.N	Odor	Visual		UI	NDF	RAII	IDE DY	ED S	HEA	AR S PEN	STRE	:NGT	TH (I ON	(Pa)
ı		483.99												_			2	0	40) _.	60	80	0 1	00	120	'. I
1-2-	-	0.00	Granular soils: very loose to compact, red-brown silty sand.	/ /		SS-1		X		56	1-1 3-2	4														
4- 5-	-1			, /. /		SS-2		X		50	4-6 6-4	12			GS				Ī	T				Ш		
7- 8- 9-	-2																		#	T				Ш		
1- 2- 3- 3- 4- 5- 6- 6- 7- 7- 8- 9- 9- 10- 11- 12- 13- 14- 15- 16- 17- 18- 19- 20- 21- 22- 23- 23- 24- 24- 24- 24- 24- 24- 24- 24- 24- 24	3	480.64 3.35	Becoming a sandy silt.	/ ///		SS-3		X		50	1-2 3-3	5					\parallel		\parallel	+			\parallel	\parallel	\parallel	\parallel
13- 14- 15-	4					SS-4		\times		58	1-2 3-3	5							#	H				\prod	\parallel	\parallel
16 17 18	5																		#	H			+		\parallel	\parallel
20 21	6			(SS-5		X		79	1-3 3-3	6			GS		\parallel		#	H			\prod		\parallel	
				(:// _/ ///:		SS-6		\vee		100	1-1 1-1	2				+			\parallel	H				\prod	\mathbb{H}	
24 25 26 27 28 29 30 31	8	476.07 7.92	End of borehole at a depth of 7.92m.	1/77	XXI-XX						1-1								+	H			\prod			
30 31	9																			-						
32 33 34 35	-10																		#	H				\prod		
	-11																+		\parallel	\parallel			\parallel	\parallel	H	#
39 40 41	- 12															+	\parallel		+	\parallel			\parallel	\prod	\parallel	#
42- 43- 44-	- 1															\parallel	\parallel	H	+	\parallel			H	\prod		#
45																			Ш	Ш			Ш	Ш		Щ
R	ema	arks:	- No water 2014-10-13																							1

Boring equipment: Duralite 250B Borehole type: Casing

Prepared by: M. Grenier-Houde, geol. Approved by: M. Aquin, Eng.

2014-11-06

Page: 1 of

1

EQ-09-Ge-66A R.1 04.03.2009

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BP-02-02-14

Date: From 2014-09-28 to 2014-09-28

Coordinates (m): North 6059023.0 (Y) Nad83 UTM 19 East 651526.0 (X) 482.70 (Z) **Arbitrary** Elevation

Bedrock: m End depth: Organoleptic soil examination:

 $Visual\ aspect:\ Non-existent(N);\ Disseminated(D);\ Soaked(S)$ Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Tests

Consistency Limits W_L Liquid Limit (%) Plastic Limit (%) W_P

Plasticity Index (%) Liquidity Index \mathbf{I}_{L} w Natural Water Content (%) GS Grain Size Analysis

Lost

s Hydrometer analysis R Refusal VBS Methylene Blue Value

Client:

O.M. Organic Matter (%) Κ Permeability (cm/s)

UW Unit Weight (kN/m³) Absorption (I/min. m) U Uniaxial Compressive strength (MPa)

CA Chemical Analysis Limit Pressure (kPa) $\mathbf{P}_{\!\mathsf{L}}$

RQD Rock Quality Designation (%)

 \mathbf{E}_{M} Pressuremeter Modulus (MPa) E, Modulus of subgrade reaction (MPa) Water Level

Std Penetration test (blows/300mm)

 N_c Dyn. Penetration test (blows/300mm)

Preconsolidation Pressure (kPa) σ'_P

Soil Corrosivity Index SCI

Undrained shear strength

Undisturbed (kPa)

Remoulded (kPa)

>	abrator4	
	_	

Δ

6.40 m

ı			WR Weigh	nt of R	ods		SP _o	Seg	regati	ion Po	tential (mn	n²/H 9	C)										
Г			STRATIGRAPHY						SA	MPL	.ES				FIELD AND L								
DEPTH - ft	DEPTH - m	ELEVATION - m DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Orga Exa		RESULTS	20 UNDRA	O 4	IO (60 SHEA	80 AR ST PENE	10 TREN		20 (kPa)
L		482.70												_		20) 4	0	60	80	10	0 12	:0
1 2 3 4 5	-1 -2 -3	0.00	Granular soils : very loose, red brown silt and sand.		479.48 m 2014-10-13	SS-1 SS-2		X		54 46	1-1 2-3 3-5 3-5	3 8			GS								
7	2	480.41		//.*	X¥⊗												₩	Щ	Щ	Ш	₩	Щ	+++
8	<u> </u>	2.29	Cohesive soils : red-brown silt																				
10 11 12	3		and clay with traces of sand.		je ¥	SS-3		\times		100	1-1 1-1	2											
13 14 15 16	5 6 7 8					SS-4		X		96	2-2 5-6	7											
17 18 19	6	476.90 5.80 476.30	Granular soilsl : compact, black,			SS-5				54	3-13	23									Щ		
21 22 23	- 7	476.30 6.40	sandy and gravelly silt. End of borehole at a depth of 6.40m.	<i>)</i> ?}/;		00-0				34	10-8	20											
24 25 26	8																	Ш					
28 29 30	9																						
31 32 33	10																						
35 36	<u> </u>																						Щ
37 38 39	Ł₁ ₀																	Ш			Щ		
41	-13																				Щ		
44 45	-																						
lR	lema	arks:																					

Boring equipment: Duralite 250B

Prepared by: M. Grenier-Houde, geol. Approved by: M. Aquin, Eng. 2014-11-06

Page:

1

of

1

SPo

Client:

Weight of Rods

WR

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BP-03-01-14

Date: From 2014-09-02 to 2014-09-02

Coordinates (m): North 6059631.0 (Y) Nad83 UTM 19 East 651510.0 (X)

482.04 (Z) **Arbitrary** Elevation Bedrock: m End depth: 6.40 m Organoleptic soil examination: $Visual\ aspect:\ Non-existent(N);\ Disseminated(D);\ Soaked(S)$ Remoulded Lost Odor: Non-existent(N); Light(L); Medium(M); Persistent(P) Tests Consistency Limits O.M. Organic Matter (%) Water Level W_L Liquid Limit (%) Κ Permeability (cm/s) Std Penetration test (blows/300mm) Plastic Limit (%) W_P UW Unit Weight (kN/m³) N_c Dyn. Penetration test (blows/300mm) Preconsolidation Pressure (kPa) Plasticity Index (%) Absorption (I/min. m) σ'_P Liquidity Index Soil Corrosivity Index \mathbf{I}_{L} U Uniaxial Compressive strength (MPa) SCI w Natural Water Content (%) RQD Rock Quality Designation (%) GS Undrained shear strength Grain Size Analysis CA Chemical Analysis s Hydrometer analysis Limit Pressure (kPa) Undisturbed (kPa) $\mathbf{P}_{\!\mathsf{L}}$ R Refusal \mathbf{E}_{M} Pressuremeter Modulus (MPa) Remoulded (kPa) Δ VBS Methylene Blue Value E, Modulus of subgrade reaction (MPa)

Segregation Potential (mm²/H °C)

\vdash	_		OTDATIONADUM	OI FIC	ius .		3P ₀	Jegi	_		TO THE	17/17	<u> </u>	FIELD AND			_		200			_	\dashv
ı			STRATIGRAPHY		(n				SA	MPL	.ES			FIELD AND L	ΑŁ								
4 1111111	DEPTH - M	ELEVATION - m DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Orga Exa	RESULTS	UN	2(IDR	AIN OR I	40 DED	60 SHE	AR S		00 1 NGTI ATIO	120 H (kPa) N
L		482.04			~~										Ļ	2() 	40	60	8	0 10)0 1	20
	1. 2 3 4 5 6 7 7 8 9 9 3 111. 122 4 4 155 5 166 5 5 167 7 8 199 6 6 177 8 199 6 177 8 178 178 178 178 178 178 178 178 1	0.00	Granular soils : loose, brown sand, traces of silt.			SS-1 SS-2		\times		58 42	2-3 5-8	10		GS									
ı	6-2			/:	$\otimes \otimes$	33-2		\triangle		42	5-6	10		GS		Ш	Щ	Ш	Ш	Ш	Ш	Ш	
	7 - 8- 9- 10- 3	479.75 2.29	Cohesive soils: red-brown, silt with some clay with traces of sand.		F13€	SS-3		\vee		42	2-4 3-2	7											
	11- 12- 13-4			\ <i>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</i>	479.51 m 2014-10-13						3-2												
ľ	14- <u>-</u> 15-	477.34		///	Ж г .	SS-4	A B	\times		100	1-1 2-2	3											
	16- 5 17- 18-	4.70	Becoming silt and clay, traces of sand.		el. 479		⁰																
	20 6 21	475.64 6.40	End of borehole at a depth of		$\boxtimes = \boxtimes$	SS-5		\boxtimes		100	1-1 2-2	3			П	П		П			\prod		
	22- 23- 7	0.40	6.40m.												\parallel	Щ		Ш	Щ	Ш	Щ	Ш	
	24 25 26 -8 27																						
	27- 28- 29- 30-																						
1	30 31 32 33 10																						
	34 35 36 –11																						
	37-[38- ³⁹ -12																						
	41- 42-																						
Ŀ	44- 45-																						
ı	Rem	arks:																					

Boring equipment: Duralite 250B

2014-11-06

Page:

1

1

of

Approved by: M. Aquin, Eng.

Borehole type: Casing

Prepared by: M. Grenier-Houde, geol.

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BP-04-01-14

Date: From 2014-09-30 to 2014-09-30

Joyce Lake and Area DSO Project - Geotechnical feasibility Study - Surrounding

Coordinates (m): Nad83 UTM 19 **Arbitrary**

Bedrock:

North East

m End depth:

Elevation

6062425.0 (Y) 651060.0 (X) 489.18 (Z)

7.92 m

Organoleptic soil examination:

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S) Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Water Level

Std Penetration test (blows/300mm)

 N_c Dyn. Penetration test (blows/300mm)

Preconsolidation Pressure (kPa) σ'_P

Soil Corrosivity Index

Undrained shear strength

Undisturbed (kPa)

Remoulded (kPa)

Δ

			STRATIGRAPHY)				SA	MPL	_ES				FIELD AND L	ΑE	30	R/	\T(OR'	ΥT	ES	TS		
DEPTH - ft	DEPTH - m	ON - m - m	SOIL OR BEDROCK	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	=	:RY %	0mm	"N" or RQD	Orga Exa				N		Wr Wr	ND L	MIT: W	R CON S (%) V	wL		
EP.	핅	EVATIO DEPTH	DESCRIPTION	MBC	R LE	Æ/	SAI		SIZE	OVE	3/15	or			RESULTS		20		40	60	8	0 1	<u>00</u>	120	_
_		ELEVATION DEPTH - n		SY	WATE	ξ¥	SUB	00		RECOVERY	Blows/150mm	 Z	Odor	Visual		UN						STRE NETR			
		489.18			*** ***											L	20	4	40	60	8	0 1	00	120	,
1 2 3	-1	0.00	Granular soils: loose to compact, red-brown gravelly sand with some silt.			SS-1	,	X		8	3-11 15-15	26	I	I								Ш			
		400.00		(°)		SS-2		X		46	8-6 3-2	9	I	I	GS							Ш			
5- 6- 7- 8- 9- 10- 11-	-3	486.89 2.29	Silty sand with traces of gravel.	77		SS-3		\bigvee		33	2-2		ı									Ш			
11 12 13	4					000							•	·								Ш			
14- 15- 16-	-5			4/,		SS-4		X		33	2-3 3-3	6	ı	I								Ш			
17 18 19	6					SS-5				46	2-2	_										Ш			
21 22 23	7			///		55-5				46	3	5	ı	I	GS							Ш			
24- 25- 26-	8	481.86 7.32 481.26 7.92	and sitt.	/ • /		SS-6		X		42	4-9 6-4	15	ı	ı	GS							Ш			
27 28 29	9	7.92	End of borehole at a depth of 7.92m.																			Ш			
30 31 32	10																					Ш			
34 35 36	-11																					Ш			
37 38 39	-12																					Ш			
40 41 42	-10 -11 -12																					Ш			
43 44 45																									
R	ema	arks:	- No water 2014-10-13																						1

EQ-09-Ge-66A R.1 04.03.2009

Borehole type: Casing

Boring equipment: Duralite 250B

Prepared by: M. Grenier-Houde, geol.

Approved by: M. Aquin, Eng.

2014-11-06

Page:

1

of

1

Labec Century Iron Ore inc.

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BP-05-01-14

Date: From 2014-10-01 to 2014-10-01

6.10 m

Coordinates (m): North 6062737.0 (Y) Nad83 UTM 19 East 651232.0 (X) **Arbitrary** Elevation 490.22 (Z)

Bedrock: m End depth: Organoleptic soil examination: $Visual\ aspect:\ Non-existent(N);\ Disseminated(D);\ Soaked(S)$

Tests

 \mathbf{I}_{L}

w

GS

s

R

Client:

Lost

Plasticity Index (%)

Grain Size Analysis

Hydrometer analysis

Liquidity Index

VBS Methylene Blue Value

Refusal

Consistency Limits O.M. Organic Matter (%) W_L Liquid Limit (%) Κ Permeability (cm/s) Plastic Limit (%) W_P

UW Unit Weight (kN/m³) Absorption (I/min. m) U Uniaxial Compressive strength (MPa)

Natural Water Content (%) RQD Rock Quality Designation (%) CA Chemical Analysis Limit Pressure (kPa) $\mathbf{P}_{\!\mathsf{L}}$ \mathbf{E}_{M} Pressuremeter Modulus (MPa)

> E, Modulus of subgrade reaction (MPa)

Water Level

Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Std Penetration test (blows/300mm)

 N_c Dyn. Penetration test (blows/300mm) Preconsolidation Pressure (kPa)

σ'_P

Soil Corrosivity Index SCI

Undrained shear strength

Undisturbed (kPa)

Remoulded (kPa) Δ

l				WR Weight				E, SP _o				grade read tential (mn											
l			STRATIGRAPH	Υ						SA	MPL	.ES				FIELD AND L							
	DEPTH - #	ELEVATION - m DEPTH - m	SOIL OR BEDRO DESCRIPTION	оск	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Orga		RESULTS	20 UNDR/	AINDE	D SHI		TRE	00 12 NGTH ATION	20 (kPa)
ŀ		490.22	Granular soils : very loo	se to	/- p 7	XXI XX					\dashv	2.2					20	40	60	80) 10)0 12	20
	1- 2- 3-1 5- 6-2 8- 9- 10-3	0.00	compact, brown sandy s some gravel. Presence of and boulders.	ilt with	[SS-1 SS-2		X		46	2-2 2-4 10-9 7-6	16	1	1								
l	7 ² 8-					×₩													Ш		П		
ı	9 10 3				, 6. ⁷ .) , 7. 7. 2	⊗ 13 ⊗13	SS-3		X		42	2-3 2-6	5	ı	ı	GS		#	Ш	Ш	Ш		
ı	11-					% 2%	SS-4					17-20	00										
l	12 13 -4 14 15 -16 -5 17 -					el. 487.78 m 2014-10-1	55-4				8	16-18	36	ı	I								
	17- 18- 19- 20- 6	484.12				el.	SS-5				0	4-6 8-8	14										
l	18- 19- 20-6 21- 22- 23-7 24- 25- 26-8 27-	6.10	End of borehole at a dep 6.10m.	ith of																			
	24 25 26 8 27																				\prod		
	28																					Ш	
	29 30 31 32 33 10 34																						
ı	34- 35- 36- 11 37-																					Ш	
l	38- 39- ₁₂																						
l	40 41 42 43 -13																						
L	44 45						_																
	Rem	narks:																					

Boring equipment: Duralite 250B Borehole type: Casing

Prepared by: M. Grenier-Houde, geol. Approved by: M. Aquin, Eng. 2014-11-06

Page: 1 of

1

EQ-09-Ge-66A R.1 04.03.2009

Labec Century Iron Ore inc.

Client:

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BP-06-01-14

Date: From 2014-10-02 to 2014-10-02

6.40 m

Coordinates (m): North 6068990.0 (Y) Nad83 UTM 19 East 655150.0 (X) 492.43 (Z)

Arbitrary Elevation Bedrock: m End depth: Organoleptic soil examination:

 $Visual\ aspect:\ Non-existent(N);\ Disseminated(D);\ Soaked(S)$

Lost Odor: Non-existent(N); Light(L); Medium(M); Persistent(P) Tests Consistency Limits O.M. Organic Matter (%) Water Level W_L Liquid Limit (%) Κ Permeability (cm/s) Std Penetration test (blows/300mm) Plastic Limit (%) W_P UW Unit Weight (kN/m³) N_c Dyn. Penetration test (blows/300mm) Preconsolidation Pressure (kPa) Plasticity Index (%) Absorption (I/min. m) σ'_P Liquidity Index Soil Corrosivity Index \mathbf{I}_{L} U Uniaxial Compressive strength (MPa) SCI w Natural Water Content (%) RQD Rock Quality Designation (%) GS Undrained shear strength Grain Size Analysis CA Chemical Analysis s Hydrometer analysis Limit Pressure (kPa) Undisturbed (kPa) $\mathbf{P}_{\!\mathsf{L}}$ R Refusal \mathbf{E}_{M} Pressuremeter Modulus (MPa) Remoulded (kPa) Δ VBS Methylene Blue Value E, Modulus of subgrade reaction (MPa) Weight of Rods WR SPo Segregation Potential (mm²/H °C)

H	1		OTDATIONADIN	OI NO	ius	SAMPLES							FIELD AND I	FIELD AND LABORATORY TESTS											
ı			STRATIGRAPHY		п				SA	MPL	.ES		_		FIELD AND L	AE									4
# DEGE	DEPTH - m	ELEVATION - m DEPTH - m	SOIL OR BEDROCK DESCRIPTION	SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	Ξ.	RECOVERY %	Blows/150mm	"N" or RQD	Orga Exa						ŀ		\odot	R CON S (%) V	ł		
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l		ELE		Ś	WATI	ĹΖ	SUE	ၓ		Ä	Blow	Z	Odor	Visual		UN								H (kP	2)
L		492.43														L	20	<u></u>	40	60	8	0 10	00 1	120	
l	1-2-3-4	0.00	Granular soils: compact to very dense, brown sandy gravel to sand and gravel with traces of silt.	/ 5/		SS-1		\times		13	4-5 9-11	14	I	I											
	5-6-6-		Presence of cobbles and boulders.	ø: { v/::y		SS-2		X		17	8-14 20-10	34	ı	ı											
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	17- 18- 19-										10.0														
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	33-10 34- 35- 36-11																								
	37- 38- 39-12																								
	10-12 11- 12-																								
1	13 - 13 14 - 15 -																								
Г	Rem	arks:	- No water 2014-10-13																						1

EQ-09-Ge-66A R.1 04.03.2009

Borehole type: Casing

Prepared by: M. Grenier-Houde, geol.

Boring equipment: Duralite 250B

Approved by: M. Aquin, Eng.

2014-11-06

Page: 1 of

1

Labec Century Iron Ore inc.

BOREHOLE REPORT

File n°: B-0010504-1 Borehole n°: BP-06-02-14

Date: From 2014-10-03 to 2014-10-03

m End depth:

6.71 m

Coordinates (m): North 6069386.0 (Y) Nad83 UTM 19 East 655059.0 (X) 486.07 (Z)

Elevation

Bedrock: Organoleptic soil examination:

 $Visual\ aspect:\ Non-existent(N);\ Disseminated(D);\ Soaked(S)$ Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

Arbitrary

Tests

Consistency Limits W_L Liquid Limit (%) Plastic Limit (%) W_P

Plasticity Index (%) \mathbf{I}_{L} Liquidity Index U w Natural Water Content (%) GS

Grain Size Analysis s Hydrometer analysis R Refusal VBS Methylene Blue Value

Lost

Client:

O.M. Organic Matter (%) Κ Permeability (cm/s) UW Unit Weight (kN/m³) Absorption (I/min. m)

Uniaxial Compressive strength (MPa) RQD Rock Quality Designation (%) CA Chemical Analysis Limit Pressure (kPa) $\mathbf{P}_{\!\mathsf{L}}$

 \mathbf{E}_{M} Pressuremeter Modulus (MPa) E, Modulus of subgrade reaction (MPa) Water Level

Std Penetration test (blows/300mm)

 N_c Dyn. Penetration test (blows/300mm)

Preconsolidation Pressure (kPa) σ'_P

Soil Corrosivity Index SCI

Undrained shear strength

Undisturbed (kPa) Remoulded (kPa)

Δ

				WR Weight		ods		SP _o				tential (mn	,	,								
			STRATIGRAPH	Υ						SA	MPL	.ES				FIELD AND L	ABOF	RATO	DRY	RY TESTS		
DEPTH - ft		ELEVATION - m DEPTH - m	SOIL OR BEDRO DESCRIPTION		SYMBOLS	WATER LEVEL (m) / DATE	TYPE AND NUMBER	SUB-SAMPLE	CONDITION	SIZE	RECOVERY %	Blows/150mm	"N" or RQD	Orga Exa		RESULTS	20 UNDRA OI	40 INDED	60 SHEAI	80 AR STR PENET	ONTEN 6) WL 100 1 RENGTI RATIO 100 1	120 H (kPa) N
1-		486.07 0.00	Granular soils: compact dense, brown sandy grav		/ /		SS-1		X		17	4-6 8-11	14	_	I							
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9- 10-3 11- 12- 13-4	3					el. 481.09 m 2014-10-1	SS-3		X		8	14-13 10-8	23	I	ı							
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12- 13- 14- 15- 16- 17- 18- 20- 21- 22- 23- 24- 25- 26- 27- 28- 29- 30-	7	6.71	End of borehole at a dep 6.71m.	th of	\$\delta \times \delta \delta \times \delta \times \delta \delta \times \delta \delta \times \delta \	× - × ×																
30 - 31 - 32 - 33 - 34 -																						
34- 35- 36	- 1																					
37- 38- 39- 40-	12																					
41- 42- 43	13																					
44- 45-																						
l Ke	ma	rks:																				

Borehole type: Casing

Boring equipment: Duralite 250B

Prepared by: M. Grenier-Houde, geol.

Approved by: M. Aquin, Eng.

2014-11-06

Page:

of

1

1

Appendix 4

Laboratory Test Results – Surrounding Areas (4 figures)

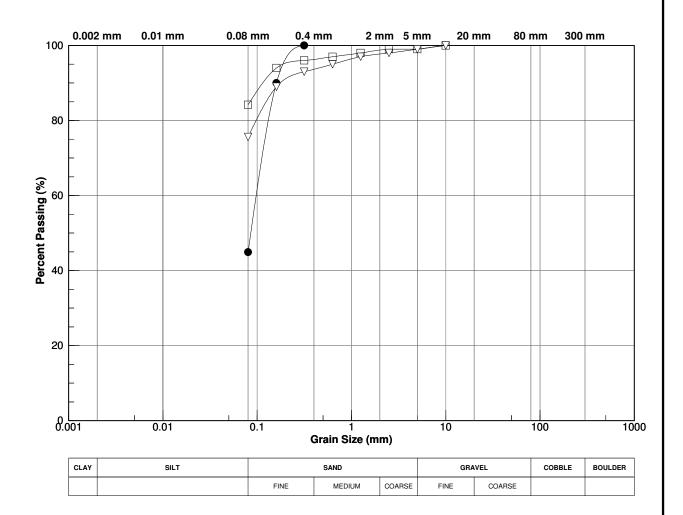




GRAIN-SIZE ANALYSIS

Project: Joyce Lake and Area DSO Project - Geotechnical feasibility Study - Surrounding Areas Figure n°: 1

Location:Surrounding Areas File n°: B-0010504-1



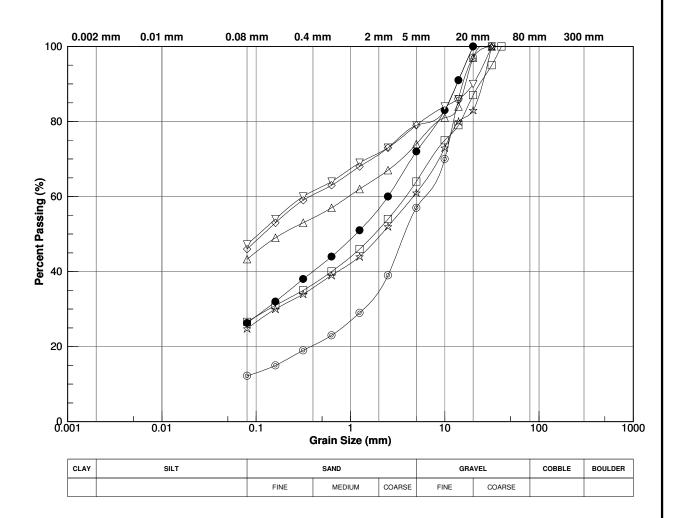
Col. symboles	Borehole n°	Sample n°	Depth (m)	Description	USCS class. (ASTM D-2487)
	BH-01-14	SS-5	5.79 - 6.40	Sand and silt.	-
	BH-05-14	SS-2	0.91 - 1.52	Silt with some sand.	-
$-\nabla$	BH-08-14	SS-2	1.22 - 1.83	Sandy silt with traces of gravel.	-



GRAIN-SIZE ANALYSIS

Project: Joyce Lake and Area DSO Project - Geotechnical feasibility Study - Surrounding Areas Figure n°: 2

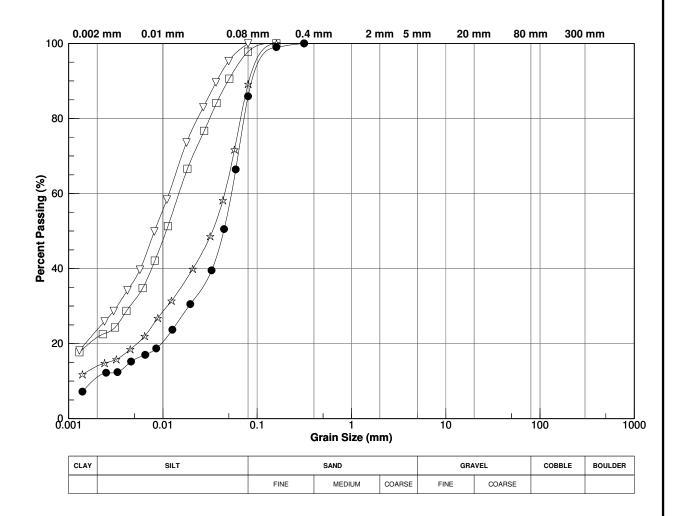
Location: Surrounding Areas File n°: B-0010504-1



Col. symboles	Borehole n°	Sample n°	Depth (m)	Description	USCS class. (ASTM D-2487)
	BH-04-14	SS-4	2.74 - 3.35	Gravelly silty sand.	-
	BH-06-14	SS-2	1.07 - 1.68	Silty sand and gravel.	-
$-\nabla$	BH-07-14	SS-5	4.42 - 5.03	Sandy and gravelly silt.	-
	BH-08-14	SS-3	2.74 - 3.35	Sandy and silty gravel.	-
—⊚—	BH-11-14	SS-3	2.59 - 3.20	Sand and gravel with some silt.	-
\longrightarrow	BH-16-14	SS-2	1.37 - 1.98	Sandy and gravelly silt.	-
	BH-16-14	SS-5	5.08 - 5.69	Sandy and gravelly silt.	-

GRAIN-SIZE ANALYSIS

Project: Joyce Lake and Area DSO Project - Geotechnical feasibility Study - Surrounding Areas Figure n°: Location: Surrounding Areas File n°:_____ B-0010504-1



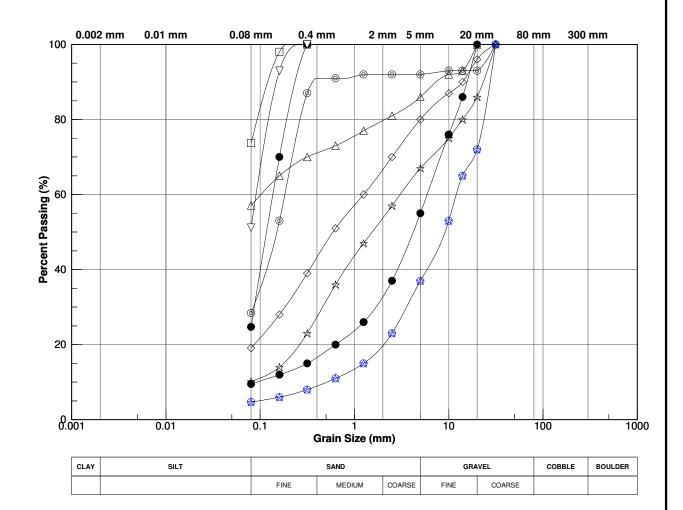
Col. symboles	Borehole n°	Sample n°	Depth (m)	Description	USCS class. (ASTM D-2487)
	BH-01-14	SS-10	13.41 - 14.02	Silt with some clay and sand.	-
	BH-01-14	SS-8	10.36 - 10.97	Clayed silt with traces of sand.	-
$\overline{}$	BH-02-14	SS-3	2.44 - 3.05	Clayed silt.	-
	BH-02-14	SS-5	5.49 - 6.10	Silt with some clay and sand.	-

LVM

GRAIN-SIZE ANALYSIS

Project: Joyce Lake and Area DSO Project - Geotechnical feasibility Study - Surrounding Areas Figure n°: 4

Location: Borrows Pits File n°: B-0010504-1

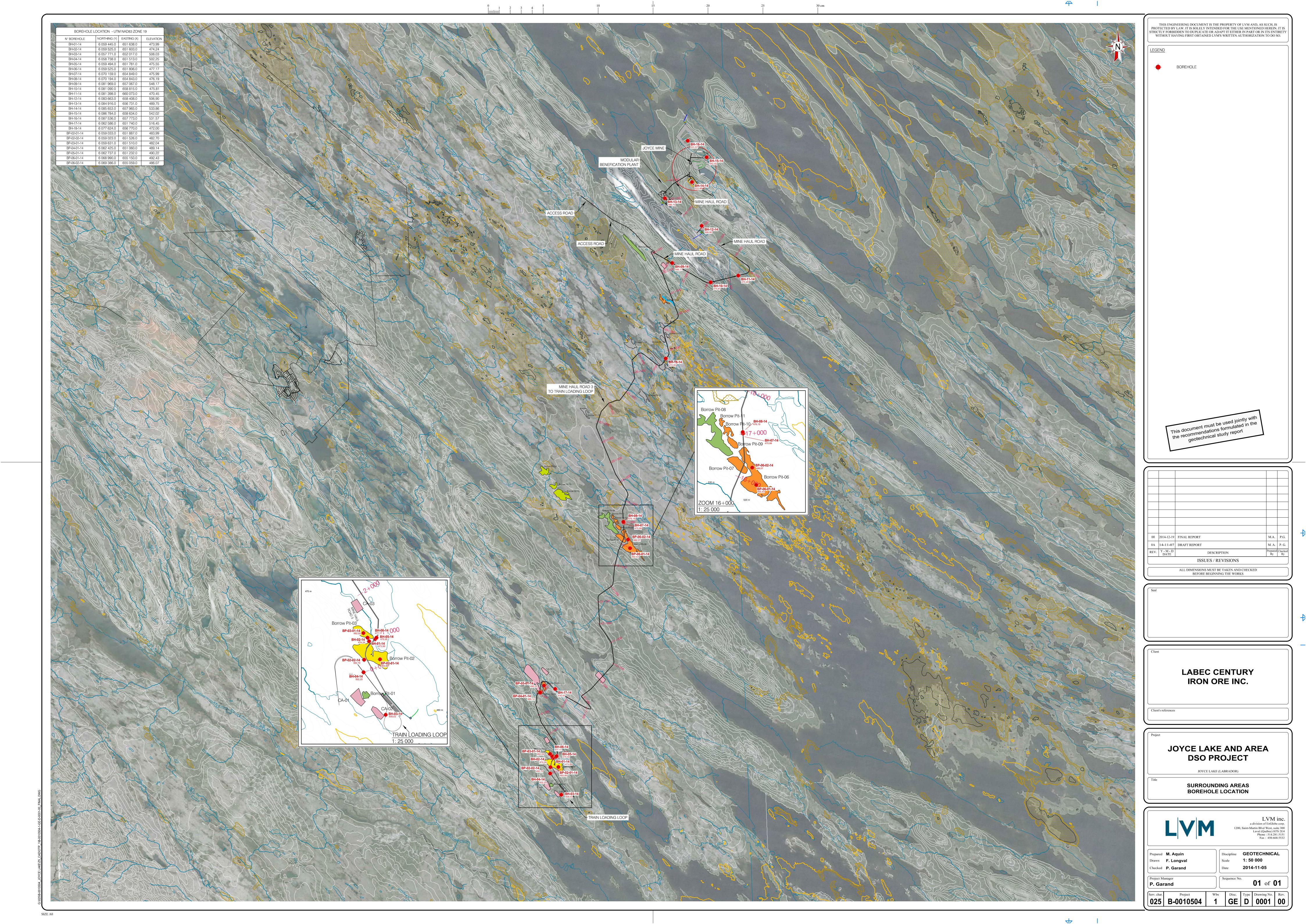


Col. symboles	Borehole n°	Sample n°	Depth (m)	Description	USCS class. (ASTM D-2487)
-	BP-02-01-14	SS-2	1.22 - 1.83	Silty sand.	-
	BP-02-01-14	SS-5	5.79 - 6.40	Sandy silt.	-
$-\nabla$	BP-02-02-14	SS-2	1.22 - 1.83	Silt and and.	-
	BP-04-01-14	SS-2	1.22 - 1.83	Gravelly sand with some silt.	-
—⊚—	BP-04-01-14	SS-5	5.79 - 6.40	Silty sand with traces of gravel.	-
	BP-04-01-14	SS-6	7.31 - 7.92	Sand with some gravel and silt.	-
<u> </u>	BP-05-01-14	SS-3	2.74 - 3.35	Sandy silt with some gravel.	-
	BP-06-01-14	SS-3	2.74 - 3.35	Sandy gravel with traces of silt.	-
-	BP-06-01-14	SS-4	4.27 - 4.88	Sand and gravel with traces of silt.	-

Appendix 5

Location of boreholes – Surrounding Areas (1 page)





Appendix 6

Ground Resistivity testing (11 pages)





JOYCE LAKE PROJECT GROUND RESISTIVITY TESTING

Presented to

LVM INC.

1200, boul. Saint-Martin Ouest, bureau 300 Laval (Québec) H7S 2E4

NOVEMBER 2014

C14147

SIGMA GEOPHYSICS INC.

1400 Marie-Victorin, suite 200 ST-BRUNO QC J3V 6B9

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Email: info@geosigma.com www.Geosigma.com



TABLE OF CONTENT

1	INTRODUCTION		
2	GENERAL REMARKS	1	
2.1	SURVEY LOCATION AND POSITIONING	1	
2.2	WORK SCHEDULE, CREW AND EQUIPMENT	1	
3	METHODOLOGY	3	
3.1	RESISTIVITY SURVEY	3	
4	RESULTS	4	
4.1	SOIL RESISTIVITY	4	
4.2	Water resistivity	5	
5	CONCLUSION	6	

APPENDIX

APPENDIX 1 RESISTIVITY MEASUREMENT



1 INTRODUCTION

In October 2014, **SIGMA GEOPHYSICS INC**. has been mandated by **LVM Inc.** for the execution of a resistivity survey on the future site of the power plant of the **Joyce Lake** project of **Labec Century Iron Ore**. The present report deals mainly with the results obtained as well as their analysis. Other topics such as field methods, site characteristics, equipment and personnel are also briefly discussed herein.

2 GENERAL REMARKS

2.1 Survey location and positioning

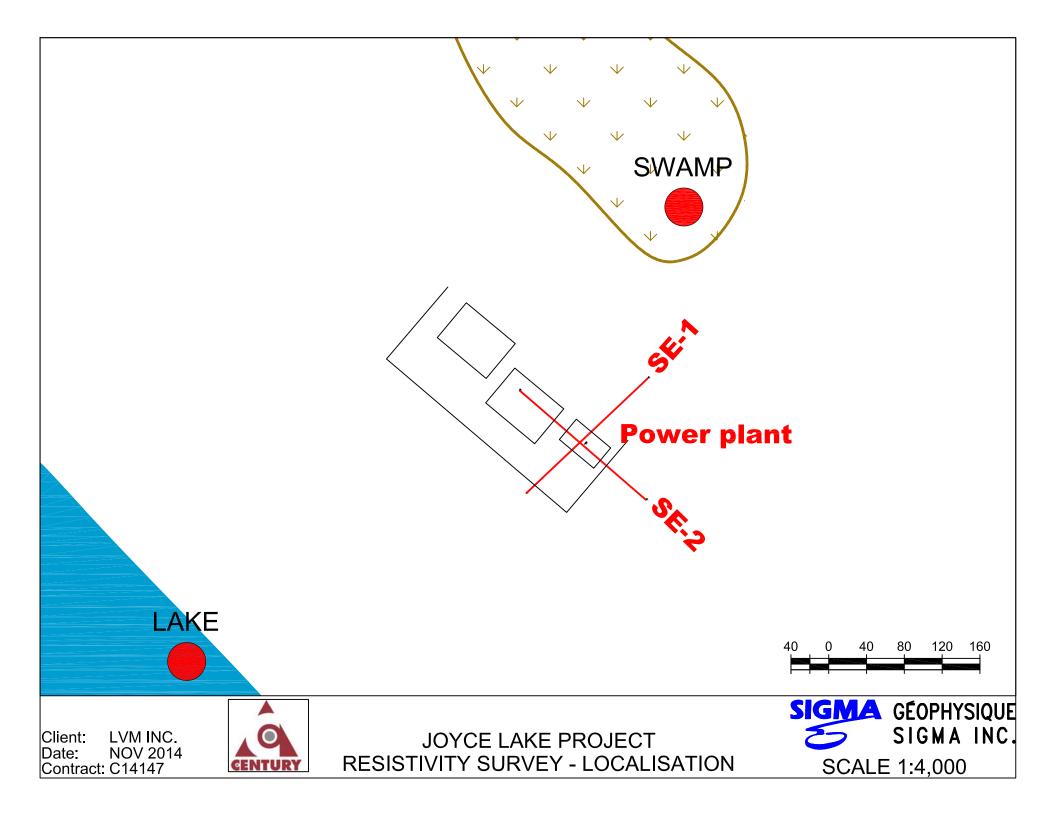
The survey was located on the site of the future power plant. The localization map on the next page shows the position of the resistivity soundings. The positions were determined on site using a differential GPS with a precision of around 2 metres.

2.2 Work schedule, crew and equipment

The field work was executed on October 22 and 23 2014. Table 1 and table 2 describe the crew and equipment associated with the data acquisition, the administration and the report.

TABLE 1 – 1	TABLE 1 – LIST OF PERSONNEL									
NAME	TASK									
Claude Provost, Engineer	Report, interpretation									
Jean-Philippe Demers, Sr. Tech.	Data acquisition									

	TABLE 2 – LIST OF EQUIPMENT												
QTY	DESCRIPTION MODEL MAKER												
1	Resistivity meter Syscal R1+ Iris Instrument												
28	Stainless steel electrode												
1	Water conductivity meter 9835 Hannah												
1	Differential GPS (Garmin 60 in WAAS 3D mode)												





3 METHODOLOGY

3.1 Resistivity survey

As recommended by the standards **IEEE STD 81-1983** (*IEEE Guide For Measuring Earth Resistivity*) and **IEEE STD-80-2000** (*IEEE Guide for safety in AC Substation Grounding*), soundings with multiple spacing have been carried out, to obtain the resistivity values of every layers that form the overburden (and the rock, if it is the case).

The electrodes array used was a *Schlumberger array with multiple partitions*, including **Wenner** configuration. The advantage of this array is the possibility to measure the lateral variations in resistivity, giving of a more accurate value of the true resistivity.

The spacing between the 2 current injection electrodes starts at 1 metre, with a logarithmic increment of 4 steps per decade (1 m, 1.8 m, 3.2 m, 5.6 m, 10 m, etc...) with a maximum of 100 metres on this site. The current was injected on the form of continuous current with a polarity inversion, using a 2 sec cycle (pos. 1 sec and neg. 1 sec). From the measurements, a modelisation of the data has been carried out to obtain the true resistivity value of each layer forming the soil. The results of the modelisation for the 7 soundings are presented on the "Interpretation and modelisation" graphs located in appendix. The modelisation has been executed with the assumption that the layers are parallel. In this case, we can obtain by mathematic inversion a geoelectric representation of each site. As more than one resistivity-thickness combination can theoretically give the same result, the use of geotechnical data, such as nature and thickness of the soil, allows for a better estimation of the true thickness and resistivity of each layer. However, no geotechnical data were available at the power plant site.

Water conductivity have also been measured in the Petitsikapau lake and on a swamp close of the site.



4 RESULTS

4.1 Soil resistivity

The following table summarizes the results of the modelization for each sounding, consisting in the **thickness** (**T**) in m, the **resistivity** (ρ) in ohm-m and, using the geotechnical data, the <u>probable</u> **stratigraphic interpretation** (**Stra**) for each layer with the following code:

SD Superficial deposit DS Dry sand probable

R Rock

	JOYCE LAKE POWER PLANT - SUMMARY OF RESULTS													
LAYER 1					LAYER 2]	LAYER 3		LAYER 4				
No	Tm	ρ ohm-m	Stra	Tm	ρ ohm-m	Stra	Tm	ρ ohm-m	Stra	T m	ρ ohm-m	Stra		
1	0.2	5,208	SD	0.3	65,780	DS	∞	5,698	R	-	-	-		
2	0.2	5,336	SD	0.6	63,266	DS	∞	6,109	R	-	-	-		

^{?=}unknown depth, ∞=infinite depth

The soil on the site of the future power plant is made of a thin layer of dry sand over the rock.

As the soil will be probably removed for the power plant construction, we can suppose an uniform earth resistivity model for this site, with an average resistivity of **5,903 ohm-m**.

This model does not take into account the resistivity of the surface granular material that will be added during the construction of the power plant.

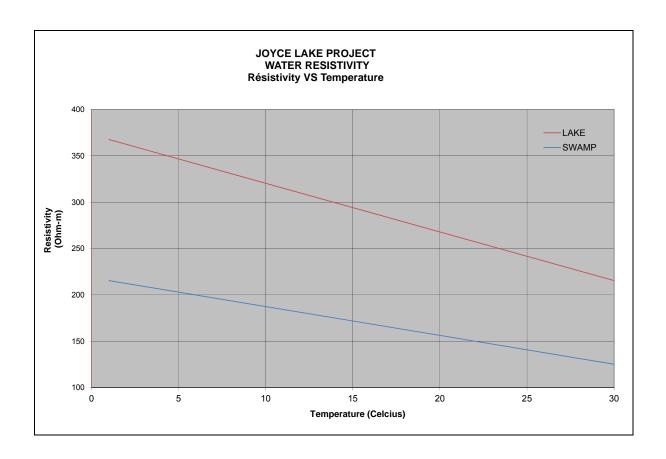


4.2 Water resistivity

The water conductivity has been measured in the Petitsikapau lake and on a swamp close of the site, with the following results:

WATER CONDUCTIVITY										
LOCATION	TEMP. (C °)	CONDUCTIVITY (µs-cm)	RESISTIVITY (Ohm-m)							
Petitsikapau lake	10.2	31.2	320							
Swamp	12.0	55.2	181							

As water resistivity varies with temperature, the following graph presents an estimate of the water resistivity for various temperatures (formula from Sorensen and Glass, 1987).



The position of the water resistivity measurements are indicated on the localization map.



5 CONCLUSION

The resistivity survey executed over the site of the future power plant has allowed for the measurement of the soil and rock resistivity. The water resistivity has also been measured on two locations near the plant.

The interpretation and the report have been executed by Mr Claude Provost, Eng.

Claude Provost, Eng.

Geophysicist

5

APPENDIX RESISTIVITY MEASUREMENTS

Survey Date: Oct 23 2014

Temp: 8 C, rainy

Sounding direction:NW-SE Sounding location: see map

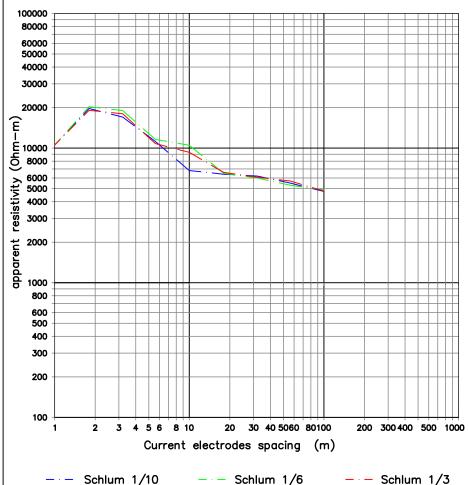
Equipment used: IRIS SYSCAL SWITCH

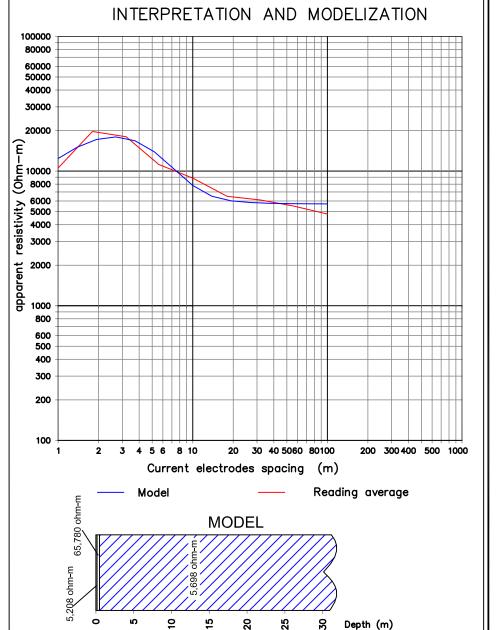


Labec Century Iron Ore

POWER STATION SOUNDING SE- 1









Sigma Geophysics inc. Survey Date: Oct 23 2014

Temp: 8 C, rainy

Sounding direction:NE-SW Sounding location: see map

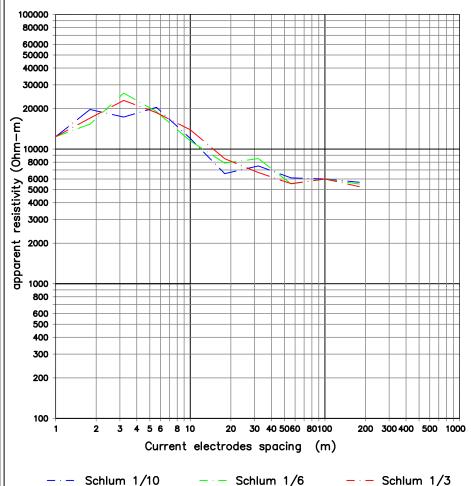
Equipment used: IRIS SYSCAL SWITCH

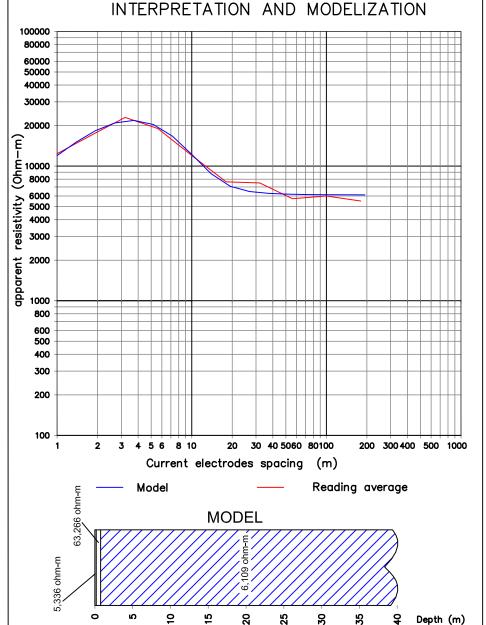


Labec Century Iron Ore

POWER STATION SOUNDING SE- 2









Sigma Geophysics inc.