APPENDIX S

Baseline Hydrogeology Scoping Study

DRAFT FOR CLIENT REVIEW

Joyce Lake Direct Shipping Iron Ore Project: Baseline Hydrogeology Scoping Study

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1.0 INTRODUCTION

1.1 BACKGROUND

Labec Century Iron Ore (Labec Century; the Proponent), a subsidiary of Century Iron Mines Corporation (TSX: FER), is proposing to develop an iron mine in western Labrador, approximately 20 kilometres (km) to the northeast of the town of Schefferville, Québec. The Joyce Lake Direct Shipping Iron Ore (DSO) Project (the Project) lies on a peninsula within Attikamagen Lake and all physical elements of the Project are located within Labrador (Figure 1.1, Appendix A).

The mine will produce up to four million tonnes (MT) of product per year. The ore will be transported to the existing railway owned by Tshiuetin Rail Transportation Inc., and further onto the Québec North Shore and Labrador Railway (QSN&L) for transportation to the Port of Sept-Îles.

The Project will require approval from the Government of Newfoundland and Labrador and is subject to an environmental assessment (EA) under the *Newfoundland and Labrador Environmental Protection Act* (NL EPA) and associated *Environmental Assessment Regulations*. Under the *Canadian Environmental Assessment Act* (CEAA 2012*)* the Project is a Designated Project pursuant to Section 15(a) *Regulations Designating Physical Activities* and will require federal EA.

This report documents baseline the hydrogeological assessment required in support of the federal EA.

1.2 SITE LOCATION

The Proposed Joyce Lake Direct Shipping Iron Ore Project (the Project) is situated in western Labrador, approximately 20 kilometers (km) to the northeast of the Town of Schefferville, Québec. The Joyce Lake property is part of the larger Attikamagan Iron Project straddling the boundary of Quebec and Newfoundland / Labrador (total area of 345 km^2, SRK, 2011). The mine area lies within two map-staked licenses (020238M and 020231M, 309 claims) covering 12,665 hectares (ha), and is situated in an undeveloped area adjacent to the small Joyce Lake water body which lies on a peninsula within Attikamagan Lake, in an area with numerous northwest to southeast trending interconnected large lakes. All physical elements of the Project that will be subject to assessment lie within Labrador (Figures A.1 and A.2, Appendix A).

The prospect is accessed from the mainland by crossing a relatively narrow stretch of water, called Iron Arm. Currently, the prospect is accessed from Schefferville either direct by helicopter or first by ground on an existing road to Iron Arm, and then by helicopter from there to Joyce Lake.

1.3 PROJECT OVERVIEW

The Project consists of mining a high grade deposit of hematite iron in western Labrador, approximately 20 km to the northeast of Schefferville, as shown in Figure 1.1 (Appendix A). The physical works for the Project that are subject to assessment are located wholly in Labrador. The mine area lies within two map-staked licences (309 claims) covering 12,665 hectares (ha) in an undeveloped area adjacent to Joyce Lake on a peninsula within Attikamagen Lake, in an area with a number of interconnecting large lakes. The prospect can be reached from the mainland by crossing a relatively narrow stretch of water, called Iron Arm. Currently, the prospect is accessed from Schefferville either directly by helicopter or first by ground on an existing road to Iron Arm and then by helicopter from there to Joyce Lake.

Extraction of the resource will be by open pit and construction of this pit will require dewatering of Joyce Lake. The mining operation will consist of removing ore from the single open pit using drilling and blasting, a hydraulic excavator and haul trucks. In Phase I, mining equipment and supplies will be brought to the mine site by barge over Attikamagen Lake during the ice free season and over an ice bridge in the winter. The pre-stripping of overburden at the open pit will start during the summer, with waste rock and low grade ore being stockpiled outside the pit limits.

The estimated production of iron ore for the Project by year, based on current exploration information, is described in Table 1.1. The current target production estimate is 4 (MT/yr) of ore. The first three years of operation will focus on production of DSO which has a high iron content (~60% iron), with stockpiling of lower grade ore (< 60% iron) that will be beneficiated in Phase II to bring it up to the desired commercial grade.

Table 1.1 Estimated Production (by year) of Iron Ore in Phase I and Phase II for the Joyce Lake Project

Product	Unit	Estimated Production by Year							
		2014	2015	2016	2017	2018	2019	2020	2021
Phase I Ore (DSO; 62% Fe)	tonne		1,000,000	2,500,000	2,500,000				
Phase II Ore (55% Fe)	tonne					3,000,000	4,000,000	TBD	TBD
Waste Rock	tonne	200,000	10,800,000	11,900,000	1,100,000	12,800,000	19,200,000		
Overburden	tonne	500,000	1,000,000		1,000,000	1,000,000			

Notes:
TBD - To be determined.

The physical elements of the Project include the Joyce Lake mining area, options for conveyance across Iron Arm (ice bridge, barge and/or conveyor), a beneficiation plant on the mainland, a new haul road to connect to a new rail loop by Astray Lake, access roads, and an accommodation camp.

Phase I construction will begin upon release from EA and with receipt of the relevant permits. For Phase I, mining activities will occur throughout the year. From April to November standard mining activities will occur and ore will be stockpiled. During the winter season, the mining activities will include moving the stockpiled ore by truck from the mine site to the beneficiation plant using the ice bridge to cross Iron Arm. After beneficiation, the ore products will be hauled by truck over the new road to the new rail yard.

At the present time, it is anticipated that Phase I will include three years of production (2015 to 2017), followed by three years of Phase II production. Construction of additional infrastructure for Phase II will begin during the last half of Phase I production. The total life-of-mine is anticipated to be up to seven years, but this timeframe may be adjusted as exploration proceeds.

Beneficiation in Phase I of the Project will consist of a dry circuit with two crushing and two screening steps necessitating no water addition, allowing operation in cold weather. In Phase I, the beneficiation plant will be operated year round. Only high grade ore will be processed during Phase I generating two different products: lump ore and sinter feed. During Phase I, the plant will not produce any tailings.

For Phase II, a wet circuit will be added which will require the use of fresh water and may include an iron content upgrading process. For Phase II, the beneficiation plant will be operated approximately 250 days per year (during the warmer months). Processing details for Phase II have not yet been determined and are being studied in parallel with information obtained during exploration activities.

A conveyor may be used as an alternative to the use of ice bridges to convey iron ore across Iron Arm and then overland directly to the beneficiation plant. A conveyor would allow for the year-round transport of iron ore from the mining operation to the beneficiation plant, thus extending the transportation period to include summer months and shoulder seasons when the ice bridges are not in operation. There are two conveyor options: Option 1 would span Iron Arm using the islands as support in the channel; Option 2 would be constructed to “float” on the surface of the water/ice of Iron Arm alongside the southern ice bridge. The conveyor option would reduce the haulage distance of mining trucks. This option requires that the iron ore is crushed on the peninsula near the ROM stockpile prior to loading onto the conveyor.

For both phases, the final product will be hauled by truck from the beneficiation plant to the rail yard, a distance of approximately 28 km along a new haul road.. At the rail yard, the product will be loaded onto rail cars on a new 6 km rail loop that will connect to the existing Tshiuetin Rail. The product will be taken south to Sept-Îles, Québec, where it will be stockpiled on Port Authority land prior to shipping to market.

Power for the Project will be provided by diesel generators using fuel stored mainly at the beneficiation plant, with smaller tanks at other locations where power is required. Other physical elements of the Project include stockpiles for overburden, waste rock and ore (pre- and post-processing), water supply systems, settling ponds with water treatment, domestic waste water treatment, drainage ditches, explosives storage, a hazardous materials storage and management area, access roads, an accommodation camp, and ancillary buildings (*e.g.,* offices, workshops, warehouse/storage areas, worker facilities and mobile equipment storage).

All structures will be constructed so that they can be removed from the site and re-used elsewhere when no longer required for this Project.

1.4 OBJECTIVE

The objective of this baseline hydrogeology assessment is to provide an initial description of groundwater flow and quality conditions expected in the vicinity of the Project. The assessment is based on review of existing hydrogeological information relevant to the Project area and an initial field program in October 2012 to collect preliminary hydrogeological data within the mine area utilizing existing mineral exploration boreholes. It is intended that this preliminary overview will be used to guide future hydrogeological investigation that may be required as part of regulatory project registration as the project advances through the permitting and development process.

This overview is also intended to identify gaps in the available data set, the importance of the data to meet the Project's EA requirements, and to provide recommendations for future work to further investigate hydrogeological conditions within the Project area.

1.5 SCOPE OF WORK

This baseline hydrogeological assessment was based on a review of available Project information provided by Labec Century, consultation with the client, consultation with federal and provincial regulators, and consideration of anticipated Project requirements. The scope of work included:

- ***Information Review***: including review of previous reports relevant to the site, climate records, overburden and bedrock geological maps and identification of any geological structural features (faults/fracture zones) that may influence groundwater flow patterns in the area;
- ***Site Investigations*:** including inspection of existing mineral exploration boreholes, measurement of static water levels in accessible boreholes, hydraulic testing of a limited number of suitable boreholes, collection of water groundwater chemistry samples and installation of automated groundwater level data loggers for future evaluation; and
- ***Interpretation and Reporting***: including hydrogeological data and groundwater quality analysis, and reporting. The interpretation included:
  - Consultation with the Project team to review the locations of the proposed mine components, and define the boundaries of the area of study;
  - Characterization of groundwater depth, flow patterns, identify recharge and discharge areas, and probable directions of groundwater flow within the Project area;
  - Characterization of likely groundwater chemistry;
  - Provide a preliminary opinion on bedrock or overburden hydraulic conductivity, and,
  - Develop an initial field program to address the information gaps.

1.6 ASSESSMENT LIMITATIONS

This assessment is being done prior to detailed geotechnical and environmental site investigation, and is limited to information derived from the 2010, 2011 and 2012 mineral exploration drilling by Labec Century, and a short field reconnaissance of the site conducted by Stassinu Stantec in October 2012. The above scope of work was for an initial field program and characterization of the site hydrogeology; supplemental field programs will be required to collect additional hydrogeological information in support of the Project's EA and engineering.

The information presented in this assessment is based entirely on previous project submissions and information provided by Labec Century and its agents and review of the exploration borehole data. This is supplemented with limited additional site specific field data derived from one field program conducted in October 2012.

This assessment is intended to provide a baseline overview of expected hydrogeological conditions on the site. Recommendations are provided to guide additional more detailed assessment to be undertaken in combination with proposed geotechnical investigations of the various mine components over the ensuing years of site development.

1.7 REPORT STRUCTURE

This report is laid out in 5 sections. Section 1 describes the Project and study objectives. Section 2 describes the methods and procedures utilized in the collection and interpretation of relevant information. Section 3 provides a baseline interpretation of the hydrogeological conditions in the vicinity of the Joyce Lake site. Section 4 summarizes relevant conclusions, and section 5 provides some general recommendations for the collection of site-specific hydrogeological information going forward.

2.0 METHODOLOGY

2.1 APPROACH AND RATIONALE

The aim of this groundwater characterization study is to develop a site-wide characterization of both the quality and quantity of the groundwater in the vicinity of the mine area. An initial interpretation of water levels, flow directions and patterns, and the hydraulic properties of overburden and bedrock are considered to help develop an understanding of how groundwater might interact with the Project, and how the Project might in turn interact with the natural hydrogeological-hydrologic cycle. Seasonal water level fluctuations will be further evaluated from water level data loggers deployed by Stassinu Stantec in October 2012.

Investigation into specific groundwater characteristics focused on accessible boreholes in the vicinity of Joyce Lake. The locations of the boreholes are provided in Figure A.3 (Appendix A), including those used in the water level assessment.

An initial understanding of the groundwater characteristics of the Joyce Lake Property was obtained through the collection and analysis of physical data (water levels, hydraulic conductivity, and water quality) from selected boreholes, and through the review of available information on the local hydrogeological environment.

2.2 INFORMATION REVIEW

The main objective of this work was to compile and review all existing, relevant information for the mine area, and to develop a conceptual understanding of groundwater conditions in the Project area. As part of this component of work, an inspection of the site was carried out by Stassinu Stantec in October 2012.

2.2.1 On-site Sources

On-site activities began with a Stassinu Stantec site visit in August 2012 to get an overview of the Joyce Lake Property and to discuss the current state of the project. Available mapping, exploration drilling and conceptual stratigraphy and ore body information was provided by Labec Century personnel. During this visit, a preliminary understanding of the site's spatial characteristics, geology and topography was gained to help develop the next steps of the project. A second site visit in October 2012 resulted in the collection of limited water level, water quality and hydraulic testing information from accessible boreholes on the site.

2.2.2 Off-Site Sources

Information gathered from off-site sources was primarily composed of a review of relevant reports and documents provided to Stassinu Stantec by Labec Century. The most relevant information was gained from annual assessment reports provided by SRK Consulting Inc., (2011) and Labec Century. Baseline information on the regional bedrock and surficial geology was obtained from Province of Newfoundland and Labrador Department of Natural Resources mapping. The information review, along with communication with Labec century, helped to develop a conceptual hydrogeological model and to guide the development of the hydrogeological field investigation programs carried out in October 2012.

2.2.3 Identified Knowledge Gaps

Due to the climate in the mine area, with temperatures below 0^oC for much of October through to May, some substantial gaps exist in the information collected to date from the field investigation program. Because there are no groundwater monitoring wells installed to date, only a general opinion on water levels, water quality and hydraulic conductivity can be gained from the data derived from un-cased and potentially unstable exploration boreholes. Only one round of water levels has been collected to date; no opinion on seasonal water level variance can be made until automated water level loggers are down-loaded over the next year.

In developments such as this, the groundwater investigations are usually combined with geotechnical drilling for open pit and site infrastructure requirements. More site specific detail respecting stratigraphy, overburden thickness variance, hydraulic properties of overburden and bedrock, vertical and horizontal hydraulic gradients, and water quality variation will be available after the site development work is completed.

One of the recommendations going forward will be to install properly screened and sealed monitoring wells in selected or new boreholes to better evaluate site hydrogeological conditions.

2.3 FIELD PROGRAM

The field data collected as part of this assessment is relevant to the northern end of Joyce Lake. Other mine infrastructure located outside of this ore area (i.e., in the vicinity of the proposed low-grade stockpile, beneficiation plant, roadway to the train loading area, and the train loading area) will need to be addressed in future phases of the development.

2.3.1 Site Inspections

Two site visits were conducted to date. An initial site visit was completed from August 20 to 22, 2012 by Ms. Carolyn Anstey-Moore, M.Sc., M.A.Sc., P.Geo. of Stassinu Stantec and included a fly-over of the Project area via helicopter. This site visit provided an overview of the Project area terrain, general geological conditions and the proposed Project development. In addition, a tour of the on-site core shack was provided by the Labec Century Project team with a presentation of the limited bedrock core material available for the Joyce Lake Prospect.

The Joyce Lake site was visited by a Stassinu Stantec hydrogeological field crew between October 4 through 8, 2012. The weather was intermittently cold, sunny to cloudy, with drizzle or snow. The primary purpose of the field work was to gain an insight into the site topography and drainage conditions, to inspect exploration boreholes and measure depth to water table if accessible, and to install automated water level and climate monitoring devices throughout the site. Additional work included preliminary hydraulic response testing and water quality sampling at three accessible wells.

2.3.2 Borehole Inspections

The field program focused on the north end of Joyce Lake mine area, where approximately 119 existing exploration boreholes were present at the time of the field work. The existing exploration boreholes were inspected for down-hole access, since the majority of existing boreholes in the area do not have surface casing and are thus susceptible to caving of the overburden materials resulting in blockage. Of the estimated 119 existing boreholes in the area that were completed during various exploration programs from 2010 to 2012, 106 boreholes are located on land portions of the site, and 42 were found to be open and accessible for water level measurement and hydrogeological testing (Table B.3, Appendix B). The borehole locations were accessed via helicopter and site visits were coordinated so that multiple tasks could be completed per visit (i.e., hydraulic testing or water quality sampling).

2.3.3 Water Level Monitoring

A groundwater level survey was completed using the existing exploration boreholes in the Joyce Lake mine area as part of the October 2012 program. Based on results of the borehole inspection, all accessible boreholes were measured for open depth and depth to water level, which would represent the static water level averaged over the length of the open borehole.

Water level monitoring was carried out using a water level meter at 42 accessible boreholes. HOBO$^{@}$ water level data loggers were deployed during the water level survey. A total of 14 data loggers were installed in selected open uncased boreholes strategically distributed across the site to be used for long term groundwater level monitoring, including:

- Joy-11-05, 09, 17, 19, 30, 37, 41, 59

- Joy-12-57, 78, 98, 103, 112, 116
- A barologger was placed near Joy-11-30 to monitor atmospheric pressure

Since the existing boreholes are open, those selected for data logger installation were stabilized with a 4” diameter casing with aluminum well cover, which was manually driven into the ground surrounding the open borehole to prevent direct recharge from precipitation, as well as to provide a connection point to secure the data logger at ground surface. The data loggers were connected to the top of the well with either high gauge fishing line or 1/16” aircraft cable. The loggers were set at a depth that was anticipated to keep them submersed year round and allow for continuous data collection, at six hour intervals. The data loggers are of two types, depending on the anticipated submerged depth of installation: those that could be submersed to a depth of 30.4 m (100 ft) and those that could be submersed to a depth of 9.14 m (30 ft). In addition, a precision data logger (barologger) was installed in a “dry” well above the water table to monitor barometric pressure during the monitoring program. The barometric pressure data will be used to correct the water levels for barometric influences after the data-loggers are retrieved in the Spring of 2013, and on a quarterly basis thereafter.

Groundwater elevations were determined by subtracting the depth to water measured in meters below grade (mbg) from the borehole collar elevation or the local topography. Using the assumption of similar conditions throughout the site for specific elevations, a potentiometric surface groundwater contour map (Figure A.4, Appendix A) was developed for the Joyce Lake site. This initial conceptual groundwater map is used to assess depth to groundwater, horizontal hydraulic gradient, groundwater recharge and discharge areas and directions of groundwater flow throughout the site.

2.3.4 Hydraulic Response Testing

Hydraulic response testing during the October 2012 field program consisted of short term drawdown and recovery pumping tests at three boreholes chosen for deployment of water level data loggers. Because the boreholes are not equipped with properly constructed monitoring wells, these results should be considered as very preliminary.

Three (3) wells selected for hydraulic response testing included:

- Joy-12-102
- Joy-12-103
- Joy-12-87 (pump failure)

The testing was carried out using a small diameter (approximately 42 mm) Grundfos Redi-Flo electric submersible pump, which was lowered into and set near the apparent bottom of the open borehole. Hydraulic response (i.e., water level) data was recorded at pre-determined time intervals during the pumping period (drawdown) and subsequent recovery, and was analyzed using AquiferTest Version 3.5 (Waterloo Hydrologic, 2003) to determine hydraulic conductivity estimates for the underlying overburden and bedrock in the Joyce Lake mine area. Pumping proceeded for one to two hours, followed by a period of recovery measurements (usually 20 minutes).

2.3.5 Baseline Groundwater Quality Sampling

Groundwater sampling was carried out during late fall to early winter of October 2012, to characterize the chemistry of water in overburden and bedrock throughout the Joyce Lake mine area. An understanding of groundwater chemistry is required in order to assess the potential effects of mine-related seepages, and the potential for the on-site development of water supply wells.

Groundwater samples were collected from three of the boreholes selected for hydraulic response. Depending on measured borehole depth, these would be interpreted to represent overburden, bedrock or a combination of both, and are intended to provide a preliminary interpretation of likely groundwater quality in the area.

Samples were collected as grab samples from the discharge line at the end of the hydraulic response test. Samples were collected in clean water sample bottles provided by the laboratory, and were analyzed by Maxxam Analytics Laboratory in Halifax, Nova Scotia for general chemistry, dissolved metals including mercury, fluoride and sulfide, total suspended solids, and total and dissolved organic carbon. In addition, it is proposed that a subsequent groundwater quality sampling event be completed for the same boreholes during the proposed Spring 2013 water level data logger download site visit. The samples submitted for dissolved metals analysis were field-filtered and preserved using 15 drops of nitric acid solution (1%). A summary of the sampling results is presented in Table B.1 (General Chemistry) and Table B.2 (Metals) in Appendix B. The baseline groundwater quality will be compared against the Federal Interim Groundwater Quality Guidelines.

3.0 HYDROGEOLOGICAL CHARACTERIZATION

The following sections describe the physiological and hydrogeological conditions within the overall Joyce Lake Project area.

3.1 CLIMATE

The Schefferville area experiences subarctic climate with long, severe winters and cool to mild summers. Based on the Schefferville AES Station climate normals summarized in Stassinu Stantec, 2012 (Table B.5, Appendix B), the daily mean temperatures during the coldest months of January and February are -24 ˚C and -22 ˚C respectively, and the average snowfall is 57 cm and 43 cm respectively. During the warmest months of July and August, the daily mean temperatures are 12 ˚C and 11 ˚C, respectively. The annual average temperature is -5.3 ºC. A summary of the daily average, daily maximum and daily minimum temperatures on a monthly basis over the period 1971 to 2000 is presented in Table B.5, Appendix B.

Annual precipitation averages 823 mm/year, of which 48.1% occurs as rain and 51.9 % occurs as snow. Monthly precipitation is well distributed over the year. July is typically the wettest month and averages 107.2 mm of rainfall, and February is typically the driest month (42.6 cm snow (38.5 mm precipitation equivalent). Freeze up typically occurs between mid-October and early November, and major snow melt typically occurs between late-April and mid-June.

The Project is located in an area of 'isolated patches of permafrost' according to Natural Resources Canada, 1993. No permafrost has been reported to date.

3.2 TOPOGRAPHY AND DRAINAGE

Surface water hydrology is important to mining as a source of mine water supply, discharge dilution and assimilative capacity and, as mine site drainage works, can affect the quantity and quality of local surface water and groundwater. Changes to the hydrological regime can affect fish, fish habitat, as well as other aquatic and terrestrial resources and ecosystems. Minimizing hydrological effects is a key criterion in obtaining environmental permits to mine.

On a regional scale, the Study Area is situated within the Attikamagan lake system, a series of lakes and fjord-like waterways that cover an estimated 1000 km^2 in northwestern Labrador. This region is relatively pristine, there being no other mining activities in the immediate area. The Project is located within a relatively rugged physiography with rolling hills and valleys reflecting the northwest trending structure of the underlying bedrock. Elevation in the Project Area can vary from 472 m on the shores of Iron Arm up to 564 m at the high point about 350 m north of Joyce Lake.

In the area of the open pit mine, drainage is dominated by Joyce Lake, an elongate upland lake that drains to the south via an un-named brook to Hollister Lake. The Joyce Lake sub-watershed forms a bowl-shaped feature between bedrock ridges located to the east, west and northwest. Two smaller un-named similarly bedrock-controlled elongate lakes are identified to the east of Joyce Lake. Outside of this hydrologic feature lies Iron Arm to the west, Attikamagan Lake to the north and Timmins Bay on the east (Figures A.2, Appendix A).

The beneficiation plant appears to be situated on a bedrock ridge between Iron Arm on the east and a series of un-named lakes and wetlands on the west (Figures A.2, Appendix A). Drainage from the Plant site could be directed towards Iron Arm, or westerly towards a major wetland area.

Based on Google Earth and available air photos (Stassinu Stantec, 2012), the area is sparsely vegetated with numerous areas of apparent exposed bedrock or bog lands.

3.3 OVERBURDEN GEOLOGY

3.3.1 Stratigraphy

Figure A.5, Appendix A illustrates the surficial geology in the Joyce Lake Development Area (Liverman et al, 2010). The natural overburden material in the immediate vicinity of Joyce Lake and the proposed mine area is mapped as predominantly undifferentiated glacial till with frequent areas of exposed bedrock. The waste rock pile and settling ponds located north of the proposed mine area is underlain by thicker deposits of glacial till, with some esker structures identified radially from the height of land. Eskers are typically developed by glacial outwash, and can include relatively thick deposits of sand and gravel.

The beneficiation plant, ore stockpile and tailings management facility (TMF) west of Iron Arm are underlain by variable thicknesses of hummocky glacial till associated with glacial melting (e.g., kame deposits). A major northwest trending area of exposed bedrock is located between the Plant and Iron Arm. The proposed Accommodation Camp is underlain by glacial till veneer, and a series of east-trending esker structures are identified along the shores of Iron Arm in this vicinity. An area of possible wetland developed on glacial till is inferred between the beneficiation plant and an unnamed lake to the northwest.

3.3.2 Overburden Thickness

Intrusive geotechnical investigations to determine subsurface conditions in the vicinity of the proposed open pit and mine site infrastructure developments have not yet occurred. No detailed borehole logs are available with information on overburden stratigraphy. A review of 36 on-land borehole logs completed in 2011 in the vicinity of the OPM infers that the overburden thickness across the site ranges from nil to 13.7 m, with an average of 4.5 m and a median of 3.0 m.

Based on the field visit and range of overburden thicknesses reported in the exploration borehole logs, it is likely that the glacial till overburden is thinnest (e.g., a thin veneer to exposed rock) along the bedrock ridges, and thicker in intervening valleys. The thickest overburden is noted both northwest (6 to 12 m at JOY-11-40 and 07 respectively) and southeast (6 to 16 m at Joy-11-31, 19A and 24A) of Joyce Lake. It is suspected that this may be related to a northwest trending bedrock depression beneath Joyce Lake.

3.3.3 Hydrogeological Properties

No hydraulic testing data is yet available to assess the hydraulic properties of the overburden materials. In general, sandy to silty glacial till can typically be expected to have a low to moderate hydraulic conductivity in the range of 1E-5 to 1E-7 m/s. Glacial outwash deposits (kame, esker structures) dominated by sand and gravel can have higher K values in the order of 1E-3 to 1E-4 m/s. In consideration of its relatively thin thickness (mean 4.5 m), groundwater supply development in overburden deposits from dug or screened wells is considered to be poor in the mine area; the presence of possible kame deposits and eskers west of Iron Arm, and esker structures to the north of the mine site and in the vicinity of the accommodation facilities may offer limited groundwater development potential.

Further assessment of overburden lithology, thickness and hydraulic properties is planned with the detailed geotechnical and hydrogeological studies.

3.4 BEDROCK GEOLOGY

Figure A.6, Appendix A illustrates the bedrock geology in the Joyce Lake Development Area (Wardle, R.J. 1982).

3.4.1 Regional Geology and Structure

The regional geology of the Attikamagan Iron Project was summarized by SRK (2011, 2012) and Stassinu Stantec (2012). The Attikamagan Iron Project is located on the western margin of the Labrador Trough, a Proterozoic volcano-sedimentary sequence wedged between Archean basement gneisses. The Labrador Trough, otherwise known as the Labrador-Québec Fold Belt, extends for more than 1,000 kilometers along the eastern margin of the Superior craton from the Ungava Bay in the north to Lake Pletipi, Québec. The belt is about 100 kilometers wide in its central part and narrows considerably to the north and south.

The Labrador Trough is a sequence of Proterozoic sedimentary rocks including iron formation, volcanic rocks and mafic intrusions, which together form 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. To the west of Schefferville, rocks of the Knob Lake Group lie unconformably on Archean gneiss basement rock 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.

Metamorphic grade increases from sub-greenschist assemblages in the west, to upper amphibolite to granulite assemblages in the eastern part of the Labrador Trough (Dimroth and Dressler 1978; Hoffman 1988). Thrusting and metamorphism occurred between 1,840 and 1,829 million years (Hoffman 1988).

The Joyce Lake Development Area is situated on a northwesterly trending series of tight anticlines and synclines, with the Joyce Lake deposit (Sokomon Formation) being located within a local southeasterly plunging synclinal structure where Joyce Lake is situated. Bedrock outcrops are noted in the immediate area. A southeast trending fault is noted along the east side of Joyce Lake (Wardle, 1982).

3.4.2 Stratigraphy

Figure A.6, Appendix A illustrates the relative stratigraphy of the Knob Lake bedrock units present in the Joyce Lake Development Area. In the vicinity of the mine area, the Knob Lake Group is subdivided into eight formal geological units. The lowermost unit (Sawyer Lake) rests unconformably over Archean-aged gneiss of the Ashuanipi Complex, and is not present at the Project site.

The Knob Lake Group is comprised of two sedimentary cycles: The older Cycle 1 or Lower Knob Lake Group (the Attikamagan Subgroup) is a shallow marine shelf depositional sequence comprised, in order of decreasing age, gray shale, siltstone, wacke, tuff and basalt of the Le Fer formation; massive dolomite and minor conglomerate of the Denault formation, and gray and black shale and siltstone of the Dolly Formation. Cycle 2 or the Upper knob Lake Group (the Ferriman Subgroup) was deposited in a deeper water slope-rise environment beginning with a transgressive quartz arenite (Wishart Formation) followed by basal black shale and cherty iron-formation of the Sokoman Formation, and conformably overlain by clastic shale, slate and siltstone of the Menihek Formation.

3.4.3 Ore Occurrence

The Upper Knob Lake Group includes the Sokoman Formation which is the main exploration target of the Attikamagan Iron Project. The Sokoman Formation forms a continuous stratigraphic unit varying in thickness as a result of folding and fault repetition. The iron formations of the Sokoman Formation are classified as Lake Superior type. They consist of a banded sedimentary unit composed principally of bands of magnetite and hematite within chert-rich rock and variable amounts of silicate-carbonate-sulphide. Such iron formations have been the principal sources of iron throughout the world.

Superior-type iron formations with low iron tenor can be locally brought to "ore grade" through the process of enrichment ("enriched ore") by leaching and deep weathering processes (Direct Shipping Ore, "DSO" type) via circulation of meteoric and syn-orogenic fluids. Hydrothermal and meteoritic fluids circulating through the banded iron formation during the Hudsonian orogenesis recrystallized iron minerals to hematite, and leached silica and carbonate gangue. The result is a residually enriched iron formation that may be further enriched, whereby iron oxides (goethite. limonite), hematite and manganese are redistributed into the openings left by the primary leaching phase, and/or deposited along fracture/cleavage surfaces and in veinlets.

Almost all of the iron deposits near surface in the Labrador Trough are enriched to some degree by these processes. The minimum iron content required to be considered as economic at a given market price is generally greater than 30 % iron. Iron oxides must also be amenable to concentration (beneficiation) and the concentrates produced must be low in manganese, aluminum, phosphorus, sulphur and alkalis. Beneficiation involves segregating the silicate and carbonate gangue and other rock types interbedded within the iron formation from the iron-rich oxides.

The iron formation occurring on the Attikamagan Iron Project consists mostly of subunits of the Sokoman Formation characterized by recrystallized chert and jasper with bands and disseminations of magnetite, hematite and martite; a type of hematite pseudomorph after magnetite and specularite. Other gangue minerals are a series of iron silicates comprised of minnesotaite, pyrolusite and stilpnomelane and, iron carbonate (mainly siderite).

3.4.4 Local Geology and Structure

Figure A.6, Appendix A illustrates the interpreted geology of the Joyce Lake Project area (after Wardle, 1982). The Project is located in the south eastern part of the Attikamagan property on a sequence of property-scale synclinal and anticlinal folds, which was offset by a west to northwest striking fault. These hinges are historically reported to be the most enriched iron formation found in the area.

The proposed mine site near Joyce Lake is developed in a synclinal basin, consisting of Sokomon formation (cherty iron formation) underlain in turn by progressively older beds of the Wishart formation (quartzite, siltstone and minor chert) and Dolly formation (gray shale and siltstone). A sub-crop of younger Menihek formation (gray and black shale and siltstone) is noted immediately west of Joyce Lake, and may underlie portions of Joyce Lake.

Two fault lineaments (Ferrum River Fault and an un-named fault) lie about 1100 m and 300 m respectively to the east of the proposed OPM (Wardle, 1982).

The beneficiation plant, ore stockpiles and TMF are underlain predominantly by gray, black and red shale of the Menihek Formation (Figure A.6, Appendix A). Structurally, this area is situated on a major northwest striking synclinorium, which implies that the older rocks of the Sokomon, Wishart and Dolly formations may occur at depth.

The accommodation area lies on the contact between the Wishart formation quartzite on the west, and the Menihek formation shale to the east.

3.4.5 Hydrogeological Properties

Information respecting the hydraulic properties of the bedrock underlying the Joyce Lake and beneficiation plant sites is very limited to date, and is derived from three short hydraulic response tests performed at Joy-12-102, Joy-12-103 and Joy-12-87 in October 2012. Based on the static water levels, these wells are assumed to be completed in bedrock. Table 3.1, summarizes available hydraulic conductivity results for bedrock on this site. Appendix C contains the hydraulic testing data and illustrations of the time-drawdown responses.

Table 3.1 Summary of In-Situ Hydraulic Conductivity Testing - Joyce Lake Property

Well	Depth (m)	Material	Q (m^3/d)	T (m^2/d)	K (m/s)	Method
JOY-12-87	46.0	Bedrock	21.81	2.1 -	2.0E-06 -	Cooper-Jacob Drawdown No recovery, pump failure
JOY-12-102 (Test 2)	45.5	Bedrock	14.42	31.4 17.5	1.4E-05 7.5E-06	Cooper-Jacob Drawdown Theis Recovery
JOY-12-102 (Test 3)	45.5	Bedrock	16.42	11.5 27.5	5.0E-06 1.2E-05	Cooper-Jacob Drawdown Theis Recovery
JOY-12-103	32.5[1]	Bedrock	25.43	125 173	4.4E-05 5.8E-05	Cooper-Jacob Drawdown Theis Recovery
Arithmetic Mean				**54.0**	**2.0E-05**	
Geometric Mean				**25.7**	**1.2E-05**	

Note 1: BH Depth 153 m; open depth recorded as 32.5 m

Only three wells could be tested before the pump became clogged with silt at JOY-12-87. In general, the results imply a fairly consistent hydraulic conductivity in the order of 1.2E-05 m/s, with a small range from 2E-06 to 5.8E-05 m/sec. The higher values implied for JOY-12-103 may be related to the apparent collapse of this well measured at 32.5 m below grade; the well is actually 153 m in depth, and likely partially open based on the chemistry results. Pending further hydraulic testing of properly completed monitoring wells, a baseline hydraulic conductivity value of 1E-05 m/sec is suggested for the bedrock in the vicinity of the mine area. In consideration that the boreholes were not cased, and partially collapsed, these values should be taken as approximate

3.4.6 Groundwater Flow Conditions

3.4.7 Groundwater Depth

Groundwater depths vary across the site and generally reflect the topographic relief of the Joyce Lake sub-watershed, with higher groundwater elevations expected to occur in wells located at higher topographic elevations. A total of 106 un-cased boreholes were inspected. Of these, 49 holes were found to be blocked at various depths above water table (grade to 20.5 m), 41 holes could be measured for apparent water table depth, and one hole (Joy-12-115) was dry to 150.5m depth.

Groundwater levels from 42 open boreholes varied from possible artesian flow (<0.1 m in five open boreholes) to 36.4 metres below ground (mbg), and averaged 17.37 mbg across the site. Table B.3 in Appendix B summarizes available groundwater level information including; borehole location, borehole depth, borehole inclination, borehole diameter, grade elevation, water level depth in metres below grade (mbg), and groundwater elevation in metres above sea level (masl). Figure A.4, Appendix A illustrates the relative groundwater levels across the Joyce Lake site based on 42 measurements.

Static groundwater elevations varied 42.2 m in elevation across the study area, from 482.7 m to 524.85 m, averaging 510.27 m. In general, water levels are highest near the lake at Joy-11-0.6, 10, 32, 39 and deepest along watershed divides such as Joy-12-86, 87, 88, 90.

Further assessment on water table depth and seasonal fluctuation will be provided as data from the data loggers is retrieved over the next two years.

3.4.8 Groundwater Flow Directions

A preliminary groundwater surface map was generated from the 42 water level elevations, and the local topography mapping, assuming that similar water levels would be present at similar elevations (Figure A.4, Appendix A).

The Joyce Lake watershed is an upland sub-watershed situated on a bedrock peninsula within Attikamagan Lake (Figure A.2, Appendix A). Groundwater flow directions are expected to closely follow topography, flowing from local recharge areas at topographic highs towards local topographic lows around Joyce Lake. Conceptually, the local groundwater flow directions can be expected to relatively short (1 or 2 km) from the local bedrock ridge dominated upland areas (average elevation 550-560 m) located north, east and west of Joyce Lake, flowing inwards towards Joyce Lake (est. elevation 503 m) and associated local lowlands that host lakes, streams and wetlands. Outside of these local topographic highs forming the Joyce Lake sub-watershed, groundwater flow would be expected to be towards Attikamagan Lake on the north, Iron Arm on the west, Timmins Bay on the east and Hollinger Lake on the south. The interpreted groundwater flow directions are shown as arrows on Figure A.4, Appendix A.

3.4.9 Horizontal Hydraulic Gradient

Horizontal gradients (dh/dl) were calculated by dividing the difference in elevation between two monitoring wells or a monitoring well and Joyce Lake (assumed elevation 505 m) by the distance separating them. Inferred horizontal groundwater gradients range from 1.2 % (0.012 m/m) to 4.4% throughout the site, averaging 3% towards the lake shores, and averaging 1.6% southward in the area of the proposed open pit mine immediately north of the lake.

3.4.10 Vertical Hydraulic Gradient

There is insufficient data to calculate the vertical hydraulic gradients at this site. Properly constructed multi-level monitoring wells will need to be installed for further assessment of vertical gradients. Furthermore, it is unknown whether the numerous small lakes in the area are influent to groundwater or effluent from groundwater. For example, the small un-name lake located 250 m southeast of Joyce Lake has a water level 25 to 30 m higher than Joyce Lake, and Joyce Lake water level appears to be higher than the adjacent Iron Arm and Attikamagan Lake.

A comparison of depth to water table with grade elevation for the most reliable water levels used on Figure A.4 indicates a general increase in water table depth with increasing grade elevation (r = 0.61).

A comparison of water level depth below grade with total borehole depth for the most reliable water levels used on Figure A.4 suggests a gradual decline in water levels with depth to borehole depths of about 70 m, followed by a gradual increase in water level with depth below 70 m depth. This is interpreted to represent downward vertical hydraulic gradient in the upper bedrock zone (possibly above the base level of Attikamagan Lake and Iron Arm), and net upward vertical hydraulic gradient from a more regional groundwater flow system below 70 m depth. As it is unknown the degree to which the various uncased boreholes have collapsed below the measured water table, these observations may be biased.

3.4.11 Groundwater Velocity Estimates

An estimate of potential groundwater velocity can be made for the various types of overburden, shallow weathered bedrock and deep bedrock can be made using the Darcy approach:

$$Q = K(dh/dl)/\mu$$

where:

Q = average linear groundwater velocity in m/d,

K = hydraulic conductivity in m/d ($m^3/m^2/d$),

dh/dl = horizontal hydraulic gradient (m/m) and

μ = effective porosity (e.g., total porosity – specific retention)

Using the results of the three hydraulic response tests, and local hydraulic gradients inferred from Figure A.4, Appendix A and Table B.6, Appendix B, Table 3.2 summarizes estimated groundwater velocities for the predominantly bedrock aquifer found on the Joyce Lake Property in the proposed pit area north of Joyce Lake, and in the watershed surrounding Joyce Lake.

Table 3.2 Estimated Range of Groundwater Velocity – Joyce Lake Property

Material	K (m/s)	Eff. Porosity	Gradient (m/m)	V (m/d)
	(mean)	Min-max (mean)	Min-max (mean)	Min-max (mean)
North of Joyce Lake	2E-06 – 5.8E-05 (1.2E-05)	0.001 – 0.01 (0.0055)	0.012 – 0.022 (0.016)	0.2 – 110 (3.0)
Towards Joyce Lake	2E-06 – 5.8E-05 (1.2E-05)	0.001 – 0.01 (0.0055)	0.021 – 0.044 (0.03)	0.4 – 220 (5.6)

Average velocity in the bedrock is difficult to characterize, and is proportional to the degree of secondary fracturing and preferential flow pathways (e.g., joints, faults) within the rock mass. Using a range of hydraulic conductivity of 2E-06 – 5.8E-05, mean 1.2E-05 m/s derived from limited hydraulic response tests (Table 3.1), a range of calculated horizontal hydraulic gradients, and an effective bulk bedrock porosity of 0.001 to 0.01 (0.1 to 1%) for fractured bedrock, average linear groundwater velocities of 0.2 to 110 m/day, (mean 3 m/day) are suggested in the mine area north of Joyce Lake, and potential velocity in the order of 0.4 to 220 m/day, (mean 5.6 m/day) is suggested in the watershed near the shore of Joyce Lake.

It should be noted that local velocities through permeable joints, faults or fracture pathways could be considerably higher, and velocities through deep dense bedrock would be considerably slower. Furthermore, these estimates are for illustrative purposes only, and would be updated with site-specific hydraulic conductivity data. These velocity estimates are likely conservative due to the limited shallow hydraulic testing, which is expected to be dominated by the upper more permeable bedrock and overburden zone.

3.5 GROUNDWATER RECHARGE POTENTIAL

Based on its upland location on a bedrock peninsula in Attikamagan Lake, groundwater recharge is likely due entirely from precipitation, and would be locally variable based on topography, overburden thickness and permeability, bedrock permeability and seasonal thaw periods. Based on experience elsewhere in Labrador, groundwater recharge and evapotranspiration would be expected to occur during the summer months of June through September; groundwater outflow to streams could continue to occur during the remaining periods of the year. In consideration of the terrain, limited vegetation cover, bedrock type (fractured metacrystalline quartzite and slate), a long freeze period (October through April) and studies completed elsewhere, a preliminary estimate of annual groundwater recharge could be in the order of 7 % of annual precipitation (dry year) to 12 % (wet year).

3.6 GROUNDWATER CHEMISTRY

The groundwater chemistry across the site was characterized with samples collected from three (3) vertical boreholes (Joy-12-87, 102 and 102) ranging in depth from 48 to 153 mbg.

Tables B.1 and B.2, Appendix B summarize the available major ion chemistry and metals chemistry respectively. Based on a limited sampling of three wells, the pre-construction groundwater chemistry of the Joyce Lake site is generally characterized as a clear, very soft (hardness 11 to 58 mg/L, mean 27 mg/L), naturally acidic (pH 6.7 to 7.1, mean 6.96; alkalinity 9.3 to 48 mg/L, mean 26.4 mg/L; calcite saturation index -3.5 to -2.0, mean -2.9), calcium bicarbonate water type of low total dissolved solids (TDS 21 to 116 mg/L, mean 56 mg/L).

All analyzed parameters typically meet Guidelines for Canadian Drinking Water Quality (GCDWQ), Health Canada, 2012, with the exceptions of manganese (42 to 16,400, mean 6,903 µg/L) and turbidity (1.7 to >1000, mean 386 NTU (attributed to method of sampling – bailing). Iron (4,510 µg/L) was elevated in the deep well Joy-12-103, and absent in shallow wells.

Because the three boreholes are uncased, there is a possibility that the observed chemistry is mixed with surface water. A comparison of two "shallow" wells Joy-12-87 and Joy-12-102 averaging 49 m with the 153 m deep well Joy-12-103 suggests that hardness, alkalinity, TDS, iron, manganese, and other ions increase in concentration with depth. The shallow groundwater at Joyce Lake is characterized by very low concentrations of major ions, nutrients, metals and dissolved solids consistent with other areas in Labrador.

3.7 GROUNDWATER RESOURCES

3.7.1 Local (Nearest) Groundwater Users

Within the immediate vicinity of the Joyce Lake Project there are no known permanent dwellings that rely on groundwater as a drinking water source. The nearest municipal area is the Town of Schefferville, located 20 km to the southwest of the site. The nearest Aboriginal communities (Kawawachikamach, Lac John and Matimekosh) are located 13 to 21 km to the west in Quebec (Stassinu Stantec, 2012). Because of distance and the numerous intervening lakes, interaction between the proposed mine project and groundwater supply wells possibly located at these communities is considered to be highly unlikely.

There may be cabins or hunting camps in the area that may have drinking water wells; however, it would be necessary to conduct a visual inspection of these locations to confirm presence or absence of a supply. From experience, seasonal camps generally rely on surface water, springs or bottled water for potable use.

3.7.2 On-Site Water Well Development Potential

There will be three types of water supply requirements for the Project (Stassinu-Stantec 2012):

Toilet Water Supply – this water will be extracted from groundwater wells that are constructed locally and installed where required, such as near the mine, at the beneficiation plant, the accommodation camp, and the rail yard.

Potable Water Supply – water treatment units will be installed at the accommodation camp to treat groundwater from wells for the potable water supply, shower and toilet; potable water and hot water tanks will be appropriately sized for peak requirements; additional potable water treatment units will be installed at the mine site, beneficiation yard, and rail yard for workers to access during the work day.

Process and Fire Suppression Water Supply (Surface) – mine and process plant water supply will be extracted from Attikamagan Lake and stored in water reservoirs prior to use. Water will be reclaimed and recycled where possible from the TMF. Water will be kept pressurized at the pumping station for the beneficiation plant for fire suppression.

Water supply wells are proposed to be developed in the Main Plant, mine site and accommodation areas to use for both potable and non-potable purposes.

Ancient metasedimentary and crystalline bedrock is typically considered to be a poor aquifer, with a generally low bulk hydraulic conductivity in the order of 1E-5 m/s or lower, and poor municipal or industrial-scale well development potential (typically less than 100 liters per minute). However, this bedrock can locally provide sufficient yield for small commercial and individual domestic users.

Based on this, it is our opinion that low to moderate yield groundwater supply drilled wells could be developed on this site. Pending confirmation by future on-site groundwater exploration and testing, and based on yields from other mines in similar bedrock terrain, these wells are likely to exhibit low to moderate yields in the order of 45 to 55 m^3/day (11 to 12 igpm) assuming well depths of 90 to 120 m. With on-site storage, these yields could meet specific potable demands.

Groundwater exploration of a specific location would involve the drilling of a test well and an observation well, followed by hydraulic testing (step drawdown test and constant rate pumping test), and water chemistry analysis. The test data would be analyzed by a hydrogeologist to determine the sustainable yield of the well, well interference parameters, and recommended pump setting and pumping rates. Assessment of water chemistry samples taken during the testing would be done to design water treatment measures, if needed.

3.8 OPEN PIT SEEPAGE AND GROUNDWATER MANAGEMENT

Collected precipitation and groundwater seepage water will be pumped out of the operational pit to an engineered settling pond for treatment of suspended solids and residual chemistry sufficient to meet regulated limits prior to release to Attikamagan Lake.

At this stage of the development, there is insufficient information for a reliable estimate of seepage potential into the open pit mine. Further investigation of overburden and bedrock hydraulic conductivity with monitoring wells, drilled water wells, packer testing and hydraulic response testing will be needed to provide an estimate of water management needs (e.g., quantity and quality of groundwater) at the open pit mine.

4.0 CONCLUSIONS

This section summarizes the overall hydrogeology of the Study Area, and identifies information gaps that will need to be addressed as the project progresses.

4.1 OVERBURDEN GEOLOGY

The mineral exploration drilling to date and review of regional geologic mapping indicates a lithological profile characterized by thin deposits (nil to 16.0 m, mean 4.5 m, median 3.0 m) of predominantly sandy to silty glacial till and areas of exposed bedrock in the vicinity of the open pit mine. Deeper than average glacial deposits are inferred north and south of Joyce Lake along a possible bedrock depression.

4.2 BEDROCK GEOLOGY

The proposed open pit mine (OPM) site near Joyce Lake is developed in a synclinal basin, consisting of Sokomon formation (cherty iron formation) underlain in turn by progressively older beds of the Wishart formation (quartzite, siltstone and minor chert) and Dolly formation (gray shale and siltstone). A sub-crop of younger Menihek formation (gray and black shale and siltstone) is noted immediately west of Joyce Lake, and may underlie Joyce Lake. Two fault lineaments (Ferrum River Fault and an un–named fault) lie about 1100 m and 300 m respectively to the east of the proposed OPM (Wardle, 1982). Based on three short term pumping tests in uncased boreholes, the shallow bedrock has a moderate bulk hydraulic conductivity in the order of 1×10^{-5} m/s.

The beneficiation plant, ore stockpile and TMF are situated on a major northwest striking synclinorium underlain predominantly by gray, black and red shale of the Menihek Formation. The accommodation area lies on the contact between the Wishart formation quartzite on the west, and the Menihek formation shale to the east.

4.3 GROUNDWATER FLOW DIRECTIONS AND THEORETICAL TRAVEL TIMES

The observed depth to groundwater and groundwater flow directions and gradients generally reflect the local topography. In general, groundwater flow paths in this area are expected to be short (< one kilometer) from areas of high elevation towards areas of low elevation hosting streams, lakes and wetlands, where it will exit to the surface water regime. The geology and topography of the mine area indicates pre-development groundwater flow pattern that is inward towards Joyce Lake, with average horizontal hydraulic gradients of 1.6 % in the vicinity of the mine north of Joyce Lake, and about 3% in the areas surrounding Joyce Lake. Preliminary theoretical linear groundwater velocities were estimated for bedrock ranging from 0.2 to 220 m/day, (mean 3 to 5.6 m/day) based on very preliminary hydraulic testing data.

4.4 IMPACTS TO GROUNDWATER USERS

No impacts to local groundwater users are anticipated from the development of this mine. The nearest potential water well users (first Nations communities) are expected to be greater than 13 km from the open pit mine excavation. In addition, local groundwater flow systems are expected to be limited by the proximity of major water bodies such as Attikamagan Lake and Iron Arm which should limit the extent of drawdown effects.

4.5 GROUNDWATER BASELINE CHEMISTRY

Based on a limited sampling of three wells, the pre-construction groundwater chemistry from bedrock underlying the Joyce Lake site is generally characterized as a clear, very soft (hardness mean 27 mg/L), naturally acidic (mean pH 7.0; mean alkalinity 26.4 mg/L), calcium bicarbonate water type of low total dissolved solids (mean TDS 56 mg/L). All analyzed parameters typically meet Guidelines for Canadian Drinking Water Quality, Health Canada, 2012, with the occasional exceptions of manganese (mean 6,903 µg/L). Iron (4,510 µg/L) is elevated in the deep well Joy-12-103, and absent in the shallow wells.

4.6 GROUNDWATER SUPPLY POTENTIAL

There are opportunities for the development of small scale water supply wells for various site uses such as the beneficiation plant, mine site, accommodation area and associated buildings where showers, kitchen and other potable uses may be required. The inferred K of the overburden and bedrock suggests well yields in the order of 45 L/min (10 igpm) or more from drilled wells (bedrock). With on-site storage, these yields could meet specific potable demands.

5.0 RECOMMENDATIONS

5.1 INFORMATION GAPS

This assessment provides a general overview of expected hydrogeological conditions on the Joyce Lake site, and is limited by very sparse site-specific data. As in all mining related developments in remote areas, the availability of relevant information and confidence in the results will grow as the project progresses.

The following information gaps are identified. It is anticipated that these will be addressed through future joint geotechnical/hydrogeological studies on this site in support of engineering design and mine development.

- Hydraulic conductivity of overburden (from slug test and pumping tests);
- Hydraulic conductivity of bedrock (from slug test, pumping tests and packer injection tests);
- Seasonal water table variation (from installed data loggers);
- Lithology of overburden deposits (from grain size analysis, detailed geotechnical drilling);
- Vertical hydraulic gradients (multi-level monitoring wells);

- Interactions between groundwater and surface water in the vicinity of the open pit mine (integrated hydrology/hydrogeology investigations); and,
- Open Pit mine seepage potential (packer injection testing of deep boreholes and pump testing of large diameter water well boreholes in the pit area, groundwater model);

The usual method of determining baseline hydrogeology is to install a series of monitoring wells at strategic locations within the Project area. The groundwater monitoring wells would be installed concurrent with any geotechnical investigations at the various Project components, and used for baseline and compliance monitoring of groundwater conditions at the TMF, ore areas, fuel handling facilities, and other waste management facilities. These monitoring wells will be located and designed to provide site-specific information on:

- Overburden and bedrock stratigraphy;
- Water table elevations and seasonal variations;
- Hydraulic properties of overburden and bedrock;
- Water chemistry of overburden and bedrock aquifers;
- Horizontal and vertical hydraulic gradients;
- Groundwater flow directions and velocity;
- Potable and process supply potential; and,
- Compliance monitoring of waste management facilities;

The monitoring well locations would focus on the TMF, waste rock storage piles, ore stockpiles, fuel storage facilities for baseline characterization and long term operational monitoring uses; and on the open pit mine areas predominantly for water level monitoring.

5.2 HYDROGEOLOGICAL PROGRAM

As work continues in 2013, additional data will be compiled and added to the baseline database to provide a more comprehensive understanding of the hydrogeology of various proposed mine components.

Further assessment of the potential water level drawdowns induced by the proposed open pit mine is warranted, in consideration of the proximity to large watercourses within 1 km distance. This would include the on-going packer testing of the deep bedrock (RBR-series boreholes), hydraulic response testing of additional boreholes, hydraulic testing using 152 mm diameter water wells in the vicinity of specified site facilities, and groundwater flow modeling.

It is proposed to combine the groundwater investigations with routine geotechnical investigations of the various mine components. This combination of work should provide significant cost and logistical benefit. The following preliminary recommendations are provided based on our current understanding of the site design and groundwater flow pathways:

5.2.1 Key Monitoring Well Locations

Additional fully-penetrating and depth-specific groundwater monitoring wells will be installed in the 2013 overburden and bedrock geotechnical boreholes. These will be used to further evaluate the site hydrogeology. Depending on their location, a sub-set of these exploratory wells will be incorporated into the site-wide groundwater monitoring network. In addition, the following general locations are recommended for the establishment of permanent groundwater monitoring wells with data loggers:

Open Pit Mine (OPM)

- Install and maintain perimeter monitoring wells to monitor the effects of mine dewatering on overburden and bedrock, and inversely, to monitor head levels outside the excavation areas;
- Install groundwater monitoring nests between the open pit mine and any remnants of Joyce Lake or the southern outflow of Joyce Lake;
- Install monitor wells on the watershed divides between the Joyce Lake pit and Attikamagan Lake on the east, and northwest;
- Each monitoring well station would include a shallow (overburden or shallow bedrock) well and a deep (bedrock well). The objective is to monitor vertical hydraulic gradients between the developing pit and the major water bodies; and,
- Additional monitor wells may be installed at distance from the OPM to monitor regional groundwater responses to excavation dewatering.

Waste Rock Areas (WRA)

- Install a minimum of three monitor well nests: (one up gradient, and two between the Low Grade Rock storage area and Iron Arm;
- Install three monitor well nests: (one up-gradient on the south, two down-gradient on the northwest between the waste rock and Attikamagan Lake; and,
- Install two monitor wells, one up-gradient on the south and one downgradient on the east between the overburden stockpile and Attikamagan Lake;

Tailings Management Facility (TMF)

Because it appears to be situated on a watershed divide, the TMF will need to be surrounded by monitoring wells to confirm absence of seepage into nearby streams and lakes. The following initial locations are suggested;

- Install two back-ground monitor well nests on highlands to the southeast and southwest corners of the TMF;
- Install one nest on the southwest boundary between the TMF and the stream;
- Install two nests on the east side between the TMF and streams leading to Iron Arm; and,
- Install one nest on the north boundary between the TMF and the beneficiation plant;

The final locations will depend on the final TMF locations, and monitoring well nests would be placed in preferential seepage release pathways such as bedrock depressions, topographical low areas, and areas with identified higher than average hydraulic conductivity.

Main Site Facilities

It is anticipated that the geotechnical boreholes proposed for the various site facilities could be equipped with groundwater monitoring wells. Monitoring well location and strategy would depend on the specific activities and hazards of concern at each facility (e.g., fuel oil, process chemicals, wastewater management, etc.). In addition, any water supply wells drilled for specific facilities would also become part of the overall environmental monitoring program. Suggested examples include:

- Shallow groundwater monitoring wells around major fuel oil storage facilities;
- Shallow groundwater monitoring wells around major rail loading facilities; and,
- Shallow groundwater and deep monitoring wells down-gradient of any solid waste of septage disposal areas.

5.2.2 Monitor Well Design

The specific monitoring well designs would vary with the intent and location. The majority of wells will likely consist of 51 mm diameter, schedule 40, flush-threaded PVC pipe and No. 20 slotted PVC screen set in clean silica sand packs within 100 mm diameter (HQ) boreholes, and isolated from the surface and overlying monitored zones with bentonite grout.

Monitoring well nests would typically consist of a shallow (upper few meters of saturated overburden and/or shallow bedrock), and a deep (deeper overburden, bedrock-till interface or bedrock, depending on overburden thickness) monitoring well. The two sand-packed zones would be separated by at least 5 m to permit vertical gradient determination.

Each new monitoring well will be completed with a lockable steel protector, and clearly labeled. The top of the PVC casings would be sealed with a vented cap (typically a PVC end cap with small holes drilled, to prevent air lock and to allow water level equilibrium with the atmosphere (data loggers). Upon completion of any new monitoring wells, each should be thoroughly developed by surging or flushing to remove drill debris and to render the sand packed screen as hydraulically efficient as possible. Each new well would be surveyed into the mine grid (grade and top of PVC casing).

Hydraulic response tests (e.g., slug tests) should be performed on as many wells as possible to provide further insight into site hydraulic properties.

5.2.3 Monitoring Frequency

Groundwater monitoring will include both water levels and water quality. It is recommended that the wells selected for baseline and/or long term monitoring be subjected to quarterly sampling for a period of two years, after which a lesser frequency may be determined, depending on the location, mine development progress and significance of seepages. Monitoring should begin as soon as possible to establish a pre-construction background condition.

Water levels should be measured each time a well is sampled for groundwater chemistry. In addition, a representative number of strategically located monitor wells would be instrumented with automated water level data loggers to establish seasonal water level distribution around the OPM and other mine components. Installed data loggers should be down-loaded to a central database on a quarterly basis. The static water level and logger setting should be recorded at each down-load date.

The groundwater monitoring frequency can be aligned with surface water monitoring events.

5.2.4 Sampling Parameters

At a minimum, the baseline sampling should include field parameters (pH, conductance, temperature and dissolved oxygen), general chemistry and field filtered and acid-preserved metals. Petroleum hydrocarbon should be included for wells established around proposed major fuel storage or handling areas.

5.2.5 Monitoring Network Maintenance

During each sampling round, the condition of each well (casing protector, depth, site conditions if in active construction area) would be reported. Minor repairs such as cover, lock and sample tube replacement would be implemented during that sampling event.

5.2.6 Database Management

In order to reliably interpret and assess long term hydrochemical and water level trends at an industrial site, it is important to maintain a consistent means of data collection, storage and quality control. As part of the environmental monitoring plan for this development, Stantec will prepare a detailed monitoring protocol that includes consistent methods for the collection, analysis and reporting of monitoring results, a database framework for the storage, review and graphical imaging of long term water level, water quality and mine water discharge data, and a recommended data review frequency.

5.3 GROUNDWATER SUPPLY WELLS

5.3.1 Well Locations

At this point, there is no direction as to where water supply wells might be located. It is anticipated that most of the wells would be located at specific plant facilities such as the guard house, gate house, employees dry, concentrator, mine services building, Main Plant east, Main Plant west, crusher building, and others.

For each application, the well heads should be located in a manner that allows easy access for maintenance, reasonable proximity to limit length of buried pipelines and outside of any major activities that could impact the well (i.e., vehicular collision or fuel spills). Available geological and structural information would also be used in the siting of water supply wells.

5.3.2 Well Design and Construction Criteria

At a minimum, any water supply well must be constructed in a manner pursuant to the Newfoundland and Labrador Well Construction Regulations. All wells must be constructed by a licensed well drilling contractor. Ideally, all wells should be constructed under the direction of a hydrogeologist.

Each water supply well should have a minimum of 15 m (if overburden is less than 10 m) of 152 mm diameter steel well casing with drive shoe. The casing should be securely grouted into a 203 mm or larger pilot hole to limit the entry of potential surface-source contaminants along the borehole-casing annulus. The well depth should be a minimum of 61 m or as needed to achieve a reasonable flow of groundwater (e.g., 22 to 45 L/min) with efficient storage. Each completed well should be developed with air for a period of two hours to remove drill debris from fractures, and to render the borehole as hydraulically efficient as possible. Upon completion, each well should be completed with a pit-less adapter (all well heads above grade, even in a well house for ease of maintenance and inspection) and with a vermin-proof, vented well seal.

5.3.3 Hydraulic Testing

The pump installations would be done after the sustainable yield of the well has been determined (air lift yield tests, step drawdown tests, constant rate pumping tests). All wells will be subjected to an air-lift yield test at the completion of drilling. This provides an initial estimation of probable flow rate and quality. For major facilities, it is recommended that hydraulic testing (step tests, and 24 to 72 hour constant rate pumping test) be performed to confirm water quality and sustainable yield. At least two of the test locations should also have fully-penetrating monitoring wells to determine the aquifer hydraulic properties for optimum spacing of additional supply wells. This information would be used by the design engineers to select appropriate pumping and treatment (if needed) appurtenances.

5.3.4 Water Quality Treatment Options

The most likely water quality issues expected in this hydrogeological setting include aesthetic issues such as elevated iron and manganese concentration, especially in iron-rich bedrock aquifers. Commercially-available treatment options are available for the cost-effective treatment of these issues (e.g., water softener for low pH waters and permanganate green-sand filters for high pH waters). The best treatment option would be determined from the water chemistry data obtained from sustained pumping tests.

All public water supply wells (e.g., potable supply for accommodation area and offices) should also be provided with disinfection (dirt filter, chlorination, ultraviolet or a combination of these).

5.3.5 Monitoring and Maintenance Plan

A supply well monitoring and maintenance strategy should be established for the long term maintenance and security of the wells. This plan would include such elements as:

- Annual inspection of well head, seals, power use efficiency, pumping equipment and on-site water storage tanks and treatment devices;
- Monitoring of specific capacity (flow rate divided by pumping level) every 2 years;
- Monthly monitoring of total and fecal coliform bacteria in raw and treated water;
- Annual water quality monitoring (general chemistry, metals, coliform bacteria);
- Monthly water usage (cumulative flow meter on discharge line);
- Static and pumping levels (quarterly); and,
- Pump efficiency (current draw), etc.

5.3.6 Monitoring Reporting

It is likely that the regulator will require an annual report of groundwater monitoring at the Joyce Lake site as part of the permit process. Annual reporting should include:

- A summary of groundwater monitoring completed;
- Monitoring methods;
- Description of water levels, horizontal and vertical hydraulic gradients;
- Cumulative water level hydrographs for wells with data loggers;
- Assessment of water chemistry results, including identification of anomalies and concentration trends that could indicate seepage;
- Total groundwater usage from all installed supply wells (flow meters); and,
- History of maintenance and repairs.

6.0 CLOSURE

This report has been prepared for the sole benefit of Labec Century. The report may not be used by any other person or entity without the express written consent of Stassinu Stantec Limited Partnership and Labec Century Iron Ore Inc.

Any uses that a third party makes of this report, or any reliance on decisions made based on it, are the responsibility of such third parties. Stassinu Stantec Limited Partnership accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made, or actions taken, based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Conclusions and recommendations presented in this report should not be construed as legal advice.

The conclusions presented in this report represent the best technical judgement of Stassinu Stantec Limited Partnership based on the data obtained from the work. If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

Respectfully submitted,

STANTEC CONSULTING LTD.

DRAFT

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Appendix A

Figures and Drawings

FIGURE TITLE:			
Project Location Overview			
CLIENT: **LABEC CENTURY IRON ORE INC.**			
CHECKED BY: **C. Shupe**	FIGURE ID: **FIGURE A.1**	PROJECT NUMBER: **121810649**	FIGURE SOURCES: Basemap information from NRCan CanVec database and Newfoundland and Labrador Department of Natural Resources.

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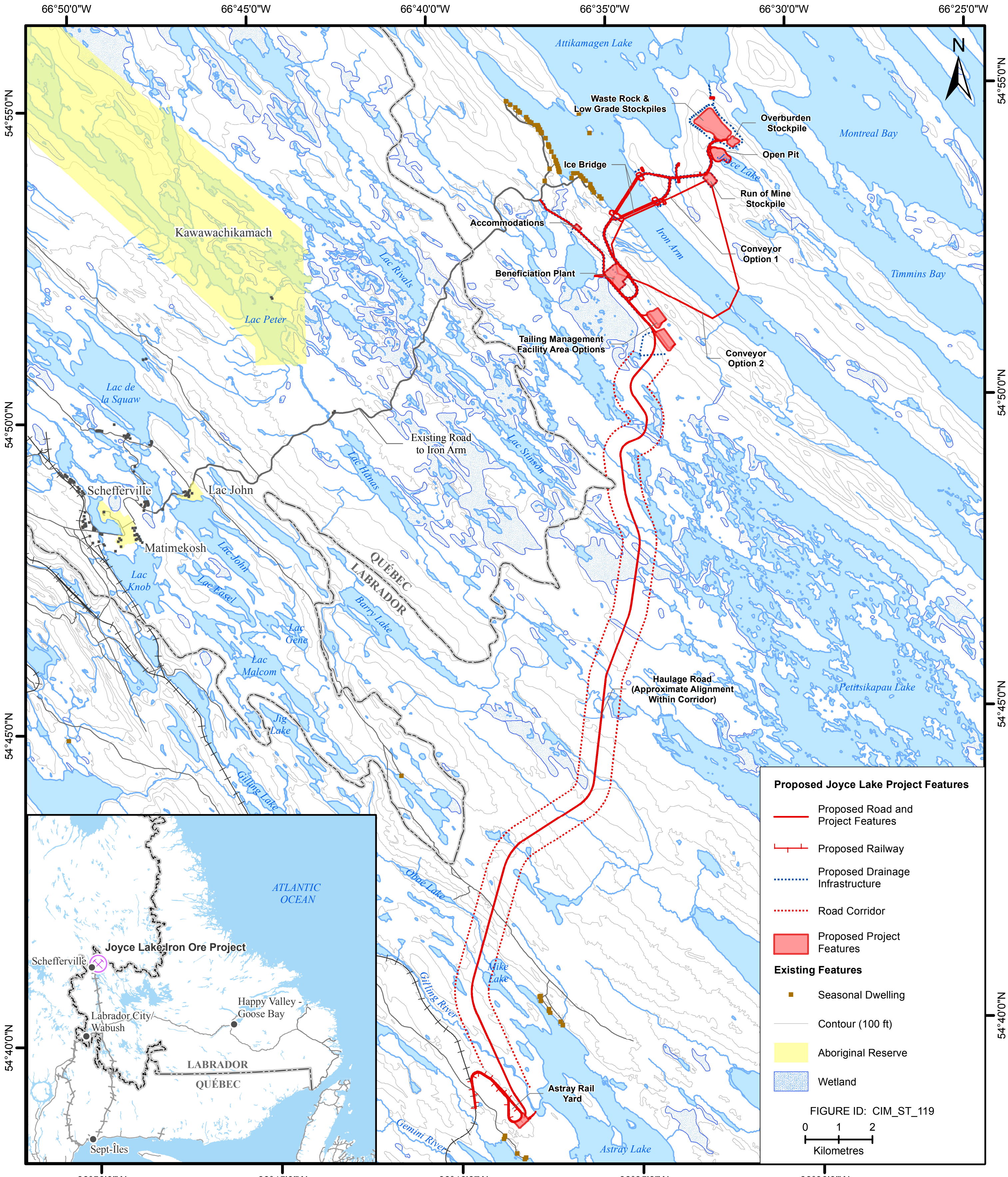


FIGURE TITLE:

Mine Site and Associated Infrastructure

CLIENT:

LABEC CENTURY IRON ORE INC.

CHECKED BY:	FIGURE ID:	PROJECT NUMBER:	FIGURE SOURCES:
A. Frickleton	**FIGURE A.2**	**121810649**	Project features provided by CIMA+ version 9 recieved 2013/02/11. Basemap information from NRCan CanVec database and Newfoundland and Labrador Department of Natural Resources.

CENTURY IRON MINES CORP.

Stassinu Stantec Limited Partnership

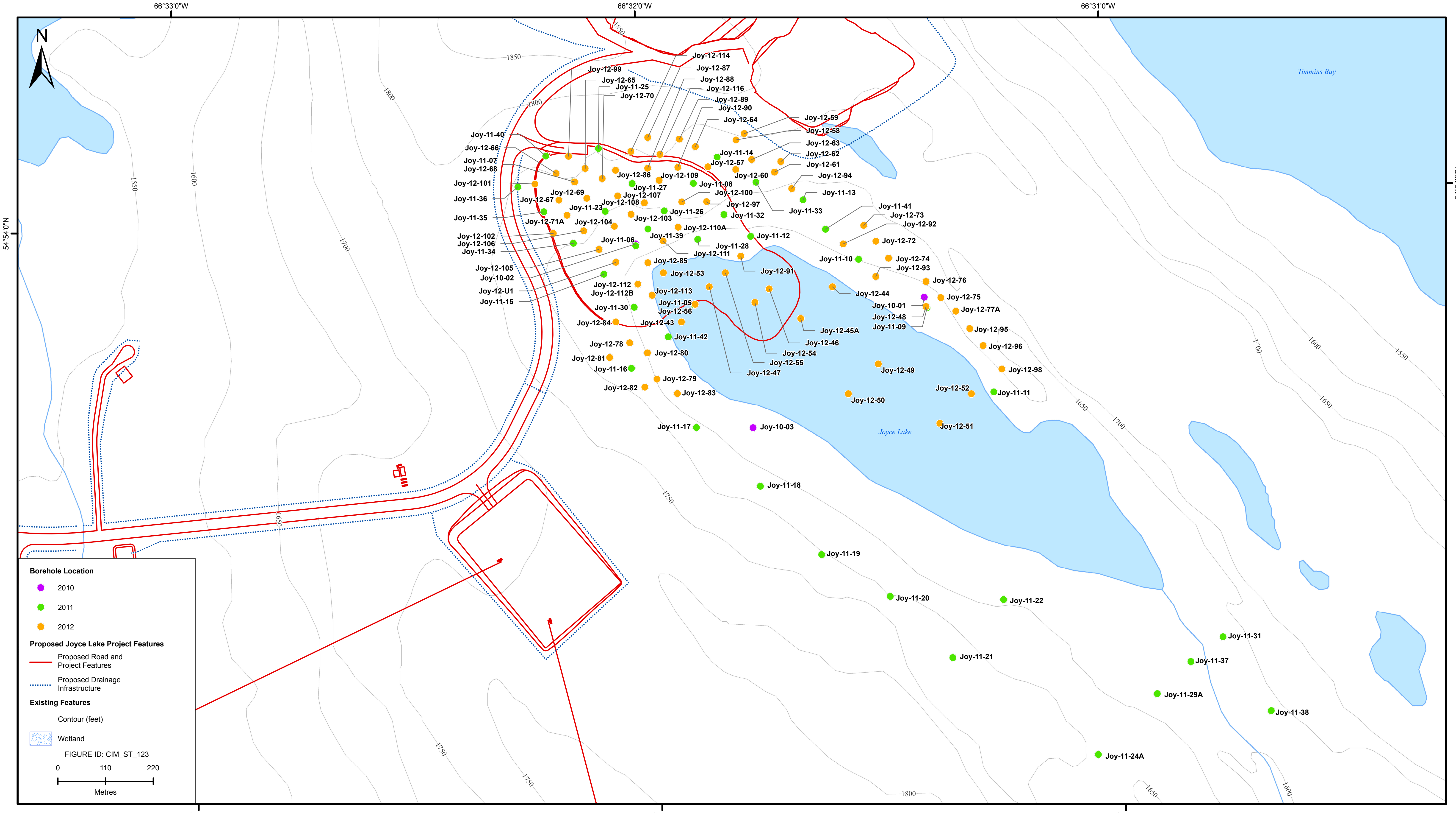


FIGURE TITLE:

Existing Exploration Borehole Location Plan

CLIENT:

LABEC CENTURY IRON ORE INC.

CHECKED BY:	FIGURE ID:	PROJECT NUMBER	FIGURE SOURCES:
A. Frickleton	**FIGURE A.3**	**121810649**	Project features provided by CIMA+ version 09 recieved 2013/02/11. Basemap information from NRCan CanVec database and Newfoundland and Labrador Department of Natural Resources.

CENTURY IRON MINES CORP.

Stassinu Stantec Limited Partnership

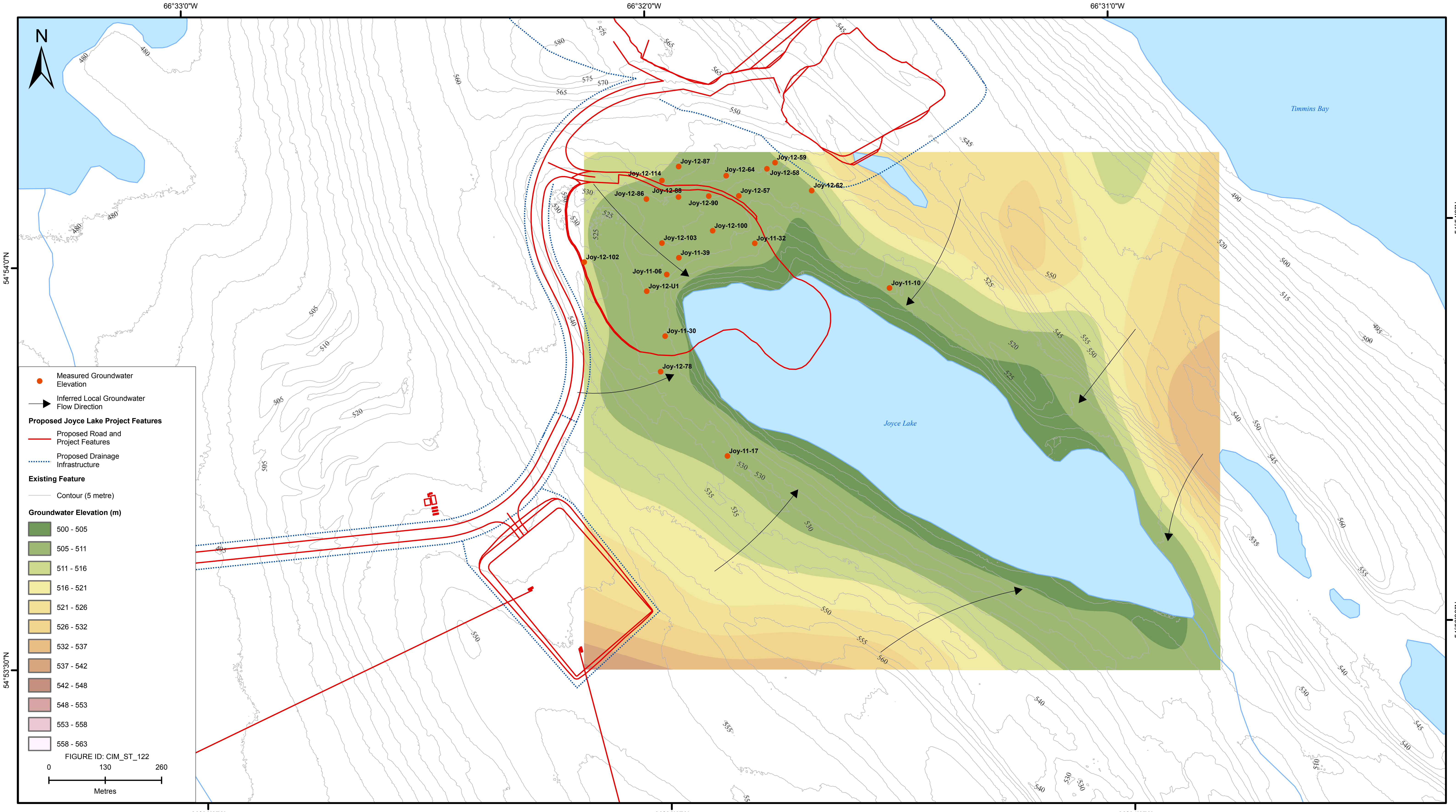


FIGURE TITLE:

Groundwater Elevation and Flow Directions - Joyce Lake Area

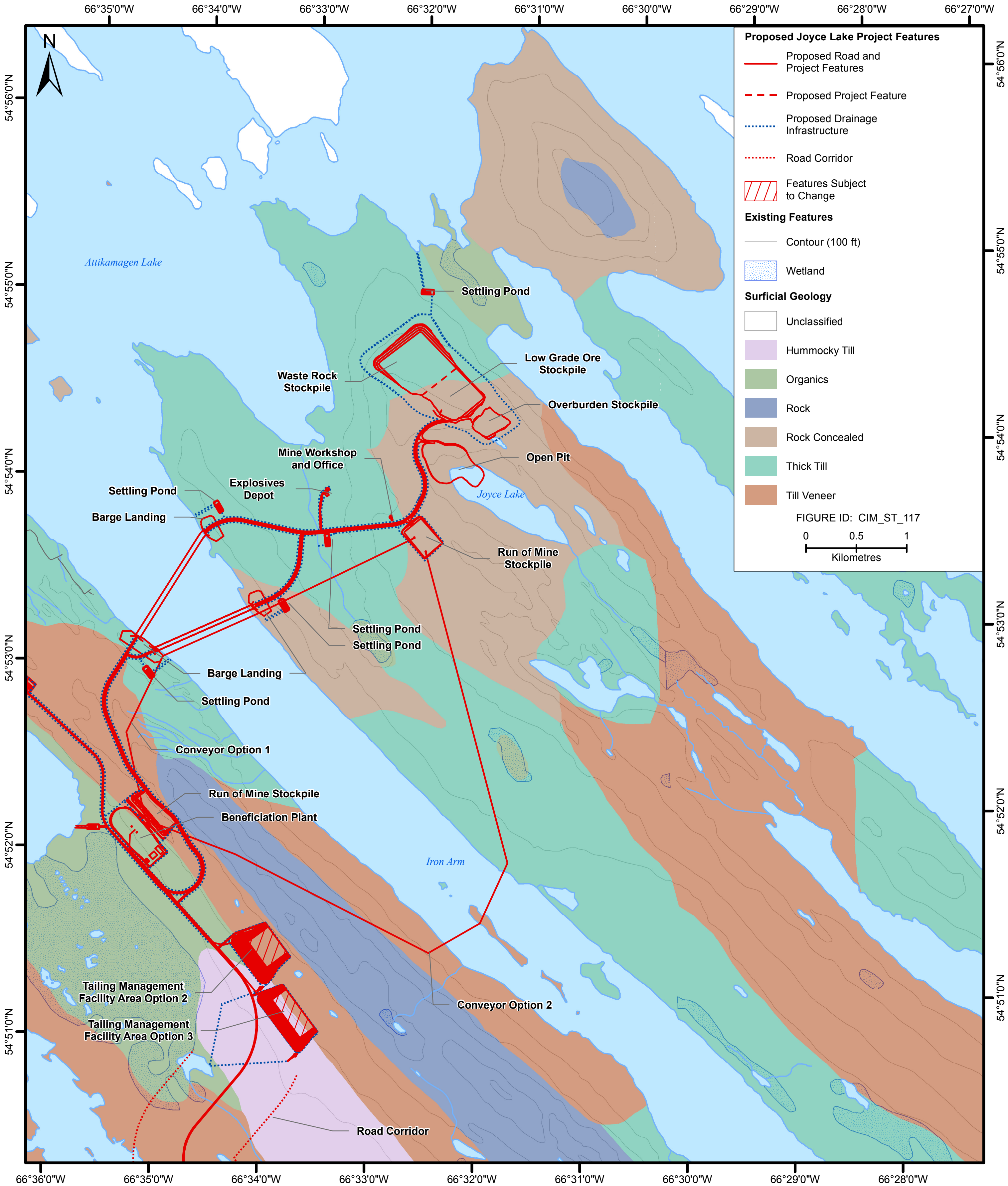
CLIENT:

LABEC CENTURY IRON ORE INC.

CHECKED BY:	FIGURE ID:	PROJECT NUMBER	FIGURE SOURCES:
A. Frickleton	**FIGURE A.4**	**121810649**	Project features provided by CIMA+ version 09 received 2013/02/11. Basemap information from NRCan CanVec database and Newfoundland and Labrador Department of Natural Resources. Contours extracted from LiDAR data provided by XEOS Imaging.

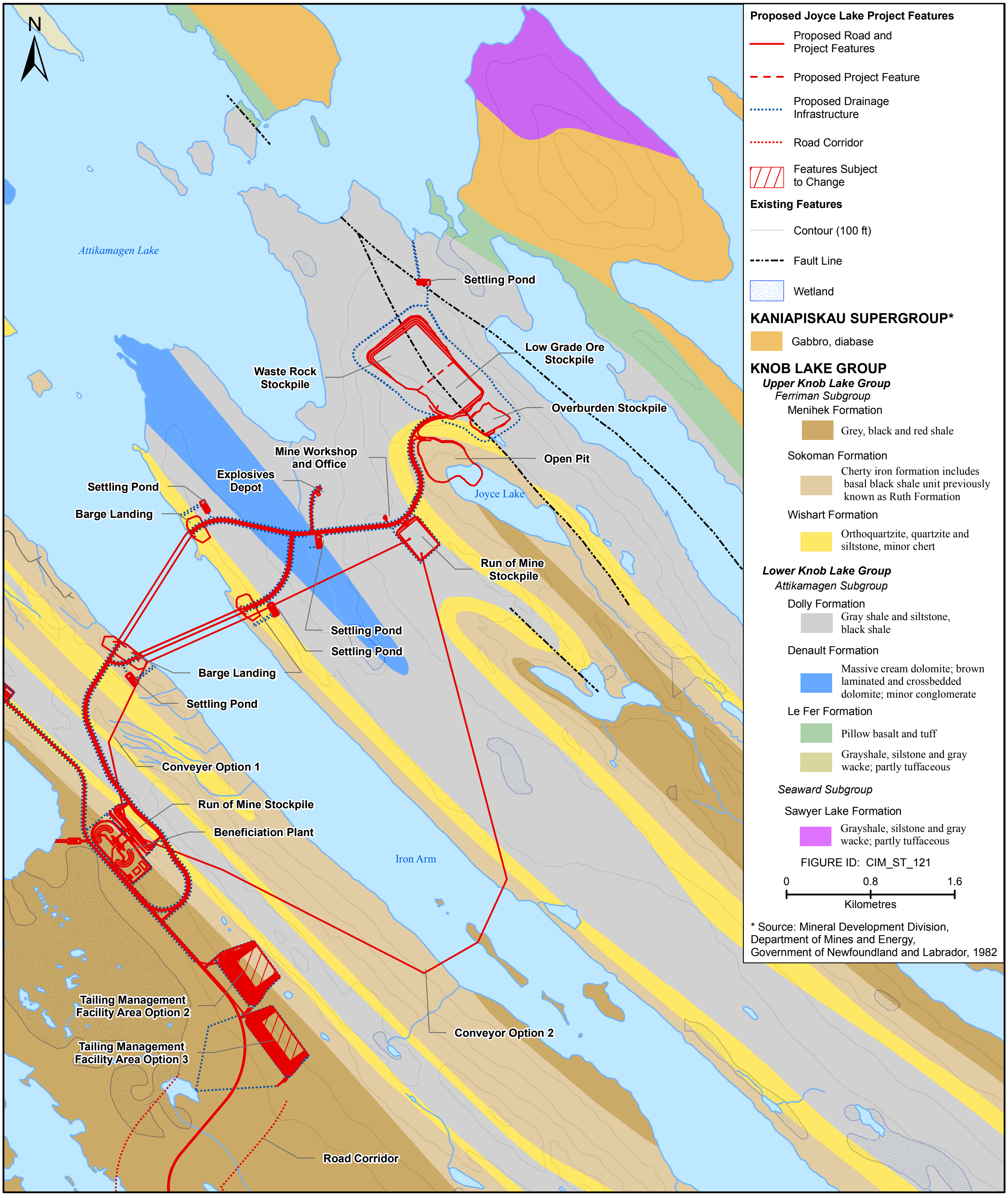
CENTURY IRON MINES CORP.

Stassinu Stantec Limited Partnership



CENTURY IRON MINES CORP.	FIGURE TITLE: **Surficial Geology**			
	CLIENT: **LABEC CENTURY IRON ORE INC.**			
	CHECKED BY: **A. Frickleton**	FIGURE ID: **FIGURE A.5**	PROJECT NUMBER: **121810649**	FIGURE SOURCES: Project features provided by CIMA+ version 9 recieved 2013/02/11. Basemap information from NRCan CanVec database and Newfoundland and Labrador Department of Natural Resources.

Stassinu Stantec Limited Partnership



CENTURY IRON MINES CORP.

FIGURE TITLE:

Bedrock Geology

CLIENT:

LABEC CENTURY IRON ORE INC.

CHECKED BY:	FIGURE ID:	PROJECT NUMBER:	FIGURE SOURCES:
A. Frickleton	FIGURE A.6	121810649	Project features provided by CIMA+ version 9 recieved 2013/02/11. Basemap information from NRCan CanVec database and Newfoundland and Labrador Department of Natural Resources.

Stassinu Stantec Limited Partnership

Appendix B

Summary Tables

Table B.1 General Chemistry - Joyce Lake Mine

Well				JOY-12-87	JOY-12-87	JOY-12-102	JOY-12-103	Statistics		
Well Depth (m)				48 m	Lab-Dup	49.5 m	153.0 m			
Maxxam ID				PE2452	PE2452	PE2453	PE2454			
COC Number				ES613412	ES613412	ES613412	ES613412			
Sample Date	Units[2]	RDL	GCDWQ[1]	6-Oct-12	6-Oct-12	5-Oct-12	6-Oct-12	Min	Max	Mean
Sodium	mg/L	0.1	200	0.7	0.4	0.7	0.7	0.4	0.7	0.6
Potassium	mg/L	0.1	-	0.2	0.2	0.3	0.7	0.2	0.7	0.4
Calcium	mg/L	0.1	-	1.5	1.5	2.0	6.9	1.5	6.9	3.0
Magnesium	mg/L	0.1	-	2.0	2.0	1.5	9.9	1.5	9.9	3.8
Alkalinity	mg/L	5.0	-	22.0	-	9.3	48.0	9.3	48.0	26.4
Sulfate	mg/L	2.0	500	2.5	-	2.3	40.0	2.3	40.0	14.9
Chloride	mg/L	1.0	250	ND	-	ND	ND	ND	ND	ND
Fluoride	mg/L	0.1	1.5	ND	-	ND	ND	ND	ND	ND
Silicate	mg/L	0.5	-	4.4	-	7.5	6.8	4.4	7.5	6.2
Ortho Phosphorus	mg/L	0.01	-	ND	-	ND	ND	ND	ND	ND
Total Phosphorus	mg/L	0.02	-	0.60	-	ND	0.20	<0.02	0.60	0.20
Dissolved Phosphorus (P)	mg/L	0.10	-	ND	ND	ND	ND	ND	ND	ND
Nitrate + Nitrite	mg/L	0.05	10.00	0.20	-	0.21	0.45	0.20	0.45	0.29
Nitrate	mg/L	0.05	45.00	0.2	-	0.21	0.45	0.20	0.45	0.29
Nitrite	mg/L	0.01	1.00	ND	-	ND	ND	ND	ND	ND
Ammonia	mg/L	0.05	-	0.14	-	ND	ND	ND	0.14	0.06
Total Kjeldahl Nitrogen (TKN)	mg/L	0.10	-	0.87	-	0.18	ND	ND	0.87	0.06
Dissolved Organic Carbon (C)	mg/L	0.50	-	ND	-	ND	ND	ND	ND	ND
Total Organic Carbon (C)	mg/L	50		ND (1)	-	ND	0.53	ND	0.53	<0.5
Color	TCU	5.0	15.0	ND	-	ND	ND	ND	ND	ND
Turbidity	NTU	10	5.0	**<u>>1000</u>**	-	1.7	**<u>56.0</u>**	1.7	>1000	386.0
Conductance	uS/cm	1.0	-	50	49	24	180	24.00	180.00	75.75
pH	units	N/A	6.5-8.5	6.9	7.0	6.7	7.1	6.74	7.13	6.96
TDS	mg/L	1	500	31	-	21	116	21.00	116.00	56.00
TSS	mg/L	100	-	6,500	6,600	4.8	96	4.8	6,600.0	3,300.2
Sum Anions	meq/L	-	-	0.51	-	0.25	1.82	0.25	1.82	0.86
Sum Cations	meq/L	-		0.27	-	0.26	1.37	0.26	1.37	0.63
% Difference	-	-		30.80	-	1.96	14.10	2.0	30.8	15.6
Bicarbonate	mg/L	1		22.0	-	9.3	48.0	9.3	48.0	26.4
Carbonate	mg/L	1		ND	-	ND	ND	ND	ND	ND
Hardness		1		12	-	11	58	11.0	58.0	27.0
Langelier Index (@ 4C)		-		-3.11	-	-3.53	-1.95	-3.53	-1.95	-2.86
Langelier Index (@ 20C)		-		-2.86	-	-3.27	-1.70	-3.27	-1.70	-2.61
Saturation pH (@ 4C)		-		10.00	-	10.30	9.08	9.08	10.30	9.79
Saturation pH (@ 20C)		-		9.78	-	10.00	8.83	8.83	10.00	9.54

Notes:
1. GCDWQ - Guideline for Canadian Drinking Water Quality - August 2012 (**<u>bold underlined</u>** exceeds)
2. RDL - Reportable Detection Limited; TCU - True Colour Unit; NTU - Nephelometric Turbidility Unit; mg/L - milligrams per liter; meq/L - milliequivalents/liter; 8uS/Cm - microseimens/centimeter
"-" = no criteria; na - not analysed; "<" - not detected above RDL
3. Samples analyzed by maxxxam Analytical Services Laboratory, Halifax, NS

Table B.2 Metals Chemistry - Joyce Lake Mine

Well				JOY-12-87	JOY-12-87	JOY-12-102	JOY-12-103	Statistics		
Well depth				48 m	Lab-Dup	49.5 m	153.0 m			
Maxxam ID				PE2452	PE2452	PE2453	PE2454			
COC Number				ES613412	ES613412	ES613412	ES613412			
Sample Date	Units[2]	RDL	GCDWQ[1]	6-Oct-12	6-Oct-12	5-Oct-12	6-Oct-12	Min	Max	Mean
Aluminum	µg/L	5	100	ND	ND	5.6	ND	ND	5.6	3.3
Antimony	µg/L	1	6	ND	ND	ND	ND	ND	ND	ND
Arsenic	µg/L	1	10	ND	ND	ND	ND	ND	ND	ND
Barium	µg/L	1	1000	ND	ND	1.9	3.3	ND	3.3	1.3
Beryllium	µg/L	1	-	ND	ND	ND	ND	ND	ND	ND
Bismith	µg/L	2	-	ND	ND	ND	ND	ND	ND	ND
Boron	µg/L	50	5000	ND	ND	ND	ND	ND	ND	ND
Cadmium	µg/L	0.017	10	0.046	0.044	ND	ND	ND	0.046	0.027
Chromium	µg/L	1	50	ND	ND	ND	ND	ND	ND	ND
Cobalt	µg/L	0.4	-	6.8	6.6	0.7	7.4	0.7	7.4	5.4
Copper	µg/L	2	1000	2.7	2.6	4.5	ND	ND	4.5	2.7
Iron	µg/L	50	300	ND	ND	ND	**4510**	ND	**4,510**	**1,146**
Lead	µg/L	0.5	10	ND	ND	ND	ND	ND	ND	ND
Manganese	µg/L	2	50	**5610**	**5560**	41.8	**16400**	42	**16,400**	**6,903**
Mercury	µg/L	0.013	1	0.037	-	ND	0.013	ND	0.037	0.019
Molybdenum	µg/L	2	-	ND	ND	ND	ND	ND	ND	ND
Nickel	µg/L	2	-	39	37.8	ND	5.5	ND	39.0	20.8
Selenium	µg/L	1	10	4.5	4.7	11.2	ND	ND	11.2	5.1
Silver	µg/L	0.1	-	ND	ND	ND	ND	ND	ND	ND
Strontium	µg/L	2	-	4.5	4.6	6.4	9.6	4.5	9.6	6.3
Thallium	µg/L	0.1	-	ND	ND	ND	ND	ND	ND	ND
Tin	µg/L	2	-	ND	ND	ND	ND	ND	ND	ND
Titanium	µg/L	2	-	ND	ND	ND	ND	ND	ND	ND
Uranium	µg/L	0.1	20	ND	ND	ND	ND	ND	ND	ND
Vanadium	µg/L	2	-	ND	ND	ND	ND	ND	ND	ND
Zinc	µg/L	5	5000	ND	ND	ND	ND	ND	ND	ND

Notes:

1. Guidelines for Canadian Drinking Water Quality - Health Canada, August 2012; (**Bold-underlined** exceeds)
2. µg/L - micrograms per liter
   nd or < - not detected above standard RDL
   nd ( ) - not detected at elevated RDL indicated in brackets
3. Samples analyzed by MAXXAM Analytical Services Laboratory, Halifax, NS

Table B.3 Summary of Groundwater Level Monitoring Data - Joyce Lake Mine

DDH	Borehole Depth (m)	Borehole Diameter (mm)	Easting	Northing	Ground Elevation (m)	Water Level (mbg)	Water Elevation (m)	Till Thickness (m)	WL Used	K Test Done	Chemistry Sample Taken	Data Logger		Comments
												Logger ID	Setting (m)	
Joy-11-06	143.0	75	658193.3	6086384	526.7	18.92	507.8	3	Y			10210001	26	
Joy-11-09	140.0	75	658865.3	6086240	514.6	8.21	506.4	9				10209999	15.5	
Joy-11-10	123.0	75	658707.6	6086352	517.1	10.42	506.7	3	Y					
Joy-11-15	147.0	75	658119.6	6086318	521.5	0.55	521.0	3						
Joy-11-17	99.0	75	658333.3	6085964	530.5	21.10	509.4	3	Y			10210013	23.5	
Joy-11-19	146.0	75	658622.3	6085671	541.5	36.40	505.1	3				10210003	45	
Joy-11-30	174.0	75	658189.6	6086242	520.0	12.20	507.8	1	Y			10210007	20	Barologger 10196994
Joy-11-32	174.0	75	658396.6	6086456	521.5	14.15	507.4	3	Y			10210005	20	
Joy-11-39	168.0	75	658221.4	6086422	527.6	19.50	508.1	3	Y					
Joy-11-41	171.0	75	658631.1	6086422	524.1	7.03	517.1	3				10210012	28.5	
Joy-12-57	128.0	90	658359.7	6086565	526.8	17.00	509.8		Y			10210004	24	
Joy-12-58	60.0	90	658424.6	6086628	535.4	24.87	510.6		Y					
Joy-12-59	66.0	90	658443.4	6086642	536.7	25.75	510.9		Y			10210009	30	
Joy-12-62	69.0	90	658528.0	6086578	532.1	21.50	510.6		Y					
Joy-12-63	91.5	90	658460.6	6086582	532.2	22.00	510.2							
Joy-12-64	69.0	90	658330.7	6086612	536.4	27.10	509.3		Y					
Joy-12-67	90.0	90	658016.0	6086489	525.0	0.20	524.8							
Joy-12-69	118.5	90	658080.2	6086493	524.8	2.55	522.3							
Joy-12-71A	90.0	90	658034.4	6086454	524.7	0.10	524.6							
Joy-12-72	84.0	90	658747.4	6086394	519.1	10.17	508.9							
Joy-12-74	90.0	90	658776.6	6086355	516.4	8.40	508.0							
Joy-12-78	30.0	90	658179.2	6086160	524.1	16.55	507.5		Y			10210010	23	
Joy-12-82	42.0	90	658214.1	6086058	533.0	29.85	503.1							
Joy-12-86	79.5	90	658146.5	6086558	533.2	24.20	509.00		Y					
Joy-12-87	48.0	90	658220.9	6086633	544.1	33.75	510.34		Y	Y	Y			
Joy-12-88	69.0	90	658220.6	6086563	534.1	25.55	508.51		Y					
Joy-12-90	78.0	90	658290.4	6086565	530.2	21.55	508.6		Y					
Joy-12-92	42.0	90	658672.0	6086388	521.4	16.50	504.9							
Joy-12-93	76.5	90	658747.2	6086312	512.2	29.50	482.7							
Joy-12-95	129.0	90	658964.2	6086192	527.7	21.53	506.2							
Joy-12-96	103.5	90	658994.7	6086153	527.9	22.10	505.8							
Joy-12-98	45.0	90	659037.9	6086099	525.9	20.48	505.4					10210008	27.5	
Joy-12-100	141.0	75	658299.5	6086485	528.6	20.10	508.5		Y					
Joy-12-102	49.5	90	658002.8	6086412	530.7	18.80	511.87		Y	Y	Y			
Joy-12-103	153.0	75	658182.3	6086456	530.0	21.70	508.34		Y	Y	Y	10210006	28	blocked at 32.5 m ?
Joy-12-105	135.0	75	658108.4	6086375	523.6	0.05	523.5							
Joy-12-106	117.0	75	658073.1	6086418	524.4	0.25	524.2							
Joy-12-110A	171.0	75	658291.0	6086426	524.8	17.10	507.7							
Joy-12-112A	98.0	75	658198.2	6086295	519.8	-						10210011	25	noted as blocked ?
Joy-12-114	117.0	90	658182.2	6086601	541.5	31.00	510.5		Y					
Joy-12-116	100.5	90	658249.0	6086594	536.0	16.70	519.3							
Joy-12-U1	159.0	86	658147.3	6086345	525.2	16.85	508.4		Y					drill rig still over this hole
							Total		**21**	**3**	**3**	**13**		

Table B.4 Summary of Boreholes without Groundwater Level Data - Joyce Lake Mine

DDH	Borehole Depth (m)	Borehole Diameter (in)	Borehole Diameter (mm)	Easting	Northing	Ground Elevation (m)	Borehole Dip (Degrees)	Water Level (mbg)	Till Thickness (m)	Comments
Joy-10-01	110.0	2.36	60	658859.0	6086265	517.0	-90.0	-	0	Blocked @ 1.0
Joy-10-02	129.0	2.36	60	658193.0	6086388	537.0	-90.0	-	0	Blocked @ 0.1
Joy-10-03	84.0	2.36	60	658464.0	6085964	515.0	-90.0	-	0	Blocked @ 0.75
Joy-10-04	39.0	2.36	60	658713.0	6084605	534.0	-90.0	-	0	not found
Joy-11-05	48.0	2.94	75	658329.0	6086247	503.0	-90.0	-	no data	under lake
Joy-11-07	102.0	2.94	75	658051.1	6086532	524.9	-90.0	-	12	not found
Joy-11-08	104.0	2.94	75	658326.0	6086528	528.8	-90.0	-	3	Blocked @1.2
Joy-11-11	105.0	2.94	75	659019.5	6086046	507.4	-90.0	-	3	Blocked @ 2.0
Joy-11-12	156.0	2.94	75	658458.4	6086405	514.2	-90.0	-		Blocked @ 7.10
Joy-11-13	105.0	2.94	75	658579.3	6086489	528.2	-90.0	-	3	Blocked @ 5.25
Joy-11-14	69.0	2.94	75	658381.0	6086588	527.8	-90.0	-	3	Blocked @v0.6
Joy-11-16	123.0	2.94	75	658183.4	6086101	529.8	-90.0	-	2	Blocked @ 10.35
Joy-11-18	111.0	2.94	75	658480.8	6085829	530.3	-90.0	-	1	Blocked @ 2.77
Joy-11-20	142.0	2.94	75	658780.6	6085575	540.2	-90.0	-	6	Blocked @ 0.75
Joy-11-21	117.0	2.94	75	658925.0	6085434	542.0	-90.0	-	3	Blocked @ 1.4
Joy-11-22	144.0	2.98	76	659042.0	6085568	521.4	-90.0	-	6	Blocked @ 16
Joy-11-23	138.0	2.94	75	658122.7	6086463	531.1	-90.0	-	2	Blocked @ 0.30
Joy-11-24A	248.0	2.94	75	659260.8	6085211	533.5	-75.0	-	13.7	Blocked @ 0.01
Joy-11-25	60.0	2.94	75	658107.1	6086608	535.9	-90.0	-	3	not found
Joy-11-26	153.0	2.94	75	658259.1	6086464	528.8	-90.0	-	0	Blocked @ 2.20
Joy-11-27	120.0	2.94	75	658184.8	6086527	533.8	-90.0	-	3	Blocked @ 1.65
Joy-11-28	162.0	2.94	75	658336.1	6086398	518.1	-90.0	-	3	Blocked @ 0.4
Joy-11-29A	175.0	2.98	76	659396.8	6085350	517.5	-65.0	-	16	Blocked @ 20.5
Joy-11-31	134.0	2.98	76	659548.6	6085482	514.5	-65.0	-	6	Blocked @ 0.01
Joy-11-33	138.0	2.94	75	658470.5	6086530	528.7	-90.0	-	3	Blocked @ 1.0
Joy-11-34	130.0	2.94	75	658049.2	6086389	529.4	-90.0	-	3	Blocked @ Surface
Joy-11-35	90.0	2.94	75	657981.1	6086462	530.8	-90.0	-	3	not found
Joy-11-36	51.0	2.94	75	657921.2	6086519	530.7	-90.0	-	3	not found
Joy-11-37	197.1	2.98	76	659474.4	6085425	507.4	-65.0	-	11	Blocked @ 0.8
Joy-11-38	155.0	2.98	76	659659.7	6085311	511.4	-65.0	-	6.6	Blocked @ 3.1
Joy-11-40	45.0	2.94	75	657985.5	6086590	530.3	-90.0	-	6	not found
Joy-11-42	160.0	2.94	75	658268.5	6086173	512.5	-90.0	-	3	Blocked @ 1.25
Joy-12-43	176.0	3.375	86	658298.6	6086208	503.0	-90.0	-		under lake
Joy-12-44	102.0	3.54	90	658647.0	6086289	503.0	-90.0	-		under lake
Joy-12-45A	58.5	3.54	90	658574.0	6086216	503.0	-90.0	-		under lake
Joy-12-46	109.5	3.54	90	658501.0	6086284	503.0	-90.0	-		under lake
Joy-12-47	102.0	3.375	86	658363.0	6086289	503.0	-90.0	-		under lake
Joy-12-48	126.5	3.54	90	658863.0	6086243	515.0	-90.0	-		under lake
Joy-12-49	118.5	3.54	90	658753.0	6086111	503.0	-90.0	-		under lake
Joy-12-50	92.5	3.54	90	658684.0	6086042	503.0	-90.0	-		under lake
Joy-12-51	69.0	3.54	90	658895.0	6085974	503.0	-90.0	-		under lake
Joy-12-52	116.0	3.54	90	658968.0	6086042	503.0	-90.0	-		under lake
Joy-12-53	82.5	3.375	86	658257.0	6086321	503.0	-90.0	-		under lake
Joy-12-54	141.0	3.54	90	658468.0	6086253	503.0	-90.0	-		under lake
Joy-12-55	126.0	3.54	90	658400.0	6086321	503.0	-90.0	-		under lake
Joy-12-56	97.5	3.54	90	658330.1	6086249	503.0	-90.0	-		under lake
Joy-12-60	95.5	3.54	90	658424.1	6086559	526.7	-90.0	-		Blocked @ 18.9
Joy-12-61	99.0	3.54	90	658513.4	6086554	531.3	-90.0	-		Blocked @ 6.77
Joy-12-65	81.0	3.54	90	658076.5	6086562	529.3	-90.0	-		not found
Joy-12-66	82.5	3.54	90	658009.4	6086551	529.3	-90.0	-		not found
Joy-12-68	88.5	3.54	90	658052.0	6086531	524.9	-90.0	-		not found
Joy-12-70	93.0	3.54	90	658115.8	6086539	528.9	-90.0	-		not found
Joy-12-73	33.0	3.54	90	658719.2	6086431	521.6	-90.0	-		Blocked @ 2.70
Joy-12-75	93.0	3.54	90	658897.2	6086264	521.7	-90.0	-		Blocked @ Surface
Joy-12-76	99.0	3.54	90	658863.0	6086301	522.7	-90.0	-		Blocked @ 7.10

Table B.4 Summary of Boreholes without Groundwater Level Data - Joyce Lake Mine

DDH	Borehole Depth (m)	Borehole Diameter (in)	Borehole Diameter (mm)	Easting	Northing	Ground Elevation (m)	Borehole Dip (Degrees)	Water Level (mbg)	Till Thickness (m)	Comments
Joy-12-77A	81.0	3.54	90	658931.7	6086232	524.5	-90.0	-		Blocked @ 6.45
Joy-12-79	82.5	3.54	90	658242.3	6086076	527.4	-90.0	-		Blocked @ 0.75
Joy-12-80	85.5	3.54	90	658220.2	6086136	526.3	-90.0	-		Blocked @ 2.3
Joy-12-81	63.0	3.54	90	658133.0	6086126	530.4	-90.0	-		Blocked @ 2.05
Joy-12-83	90.0	3.54	90	658289.3	6086043	529.7	-90.0	-		Blocked @ 2.4
Joy-12-84	43.5	3.54	90	658147.3	6086208	521.6	-90.0	-		Blocked @ 1.0
Joy-12-85	177.0	2.94	75	658221.3	6086345	509.8	-90.0	-		Blocked @ 1.0
Joy-12-89	45.0	3.54	90	658293.9	6086629	538.1	-90.0	-		Blocked @1.4
Joy-12-91	171.0	2.94	75	658435.6	6086360	507.1	-90.0	-		Blocked @1.0
Joy-12-94	73.5	3.54	90	658553.0	6086515	529.7	-90.0	-		Blocked @ 8.51
Joy-12-97	150.0	2.94	75	658356.7	6086485	525.4	-90.0	-		Blocked @ 0.75
Joy-12-99	57.0	3.54	90	658038.0	6086590	531.4	-90.0	-		not found
Joy-12-101	54.0	3.54	90	657960.5	6086526	529.6	-90.0	-		not found
Joy-12-104	153.0	2.94	75	658143.7	6086428	530.0	-90.0	-		Blocked @ 1.8
Joy-12-107	123.0	2.94	75	658151.5	6086498	530.9	-90.0	-		Blocked @ 1.2
Joy-12-108	147.0	2.94	75	658213.2	6086483	531.4	-90.0	-		Blocked @ 0.85
Joy-12-109	102.0	2.94	75	658247.2	6086534	531.1	-90.0	-		Blocked @3.3
Joy-12-111	171.0	2.94	75	658256.2	6086394	521.0	-90.0	-		Blocked @7.90
Joy-12-112B	162.0	2.94	75	658198.0	6086295	520.0	-90.0	-		Blocked @ 1.65
Joy-12-113	117.0	2.94	75	658231.2	6086153	515.1	-90.0	-		Blocked @ 1
Joy-12-115	109.5	3.54	90	658182.0	6086673	547.0	-90.0	-		Dry at 150.5
Joy-12-117	177.0	2.94	75	658433.0	6086494	520.0	-90.0	-		

Table B.5 Climate Normals for Schefferville Area (1971-2000)

	Jan	Feb	Mar	Apr	may	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	0.2	0.2	1.6	8.4	27.7	65.4	106.8	82.8	85.3	24.4	4.5	0.9	408.2
Snowfall (cm)	57.4	42.6	56.6	54.8	22.9	8	0.5	1.7	12.7	57.2	70.7	55.4	440.5
Total Preciptiation (mm)	53.2	38.7	53.3	61.4	52.1	73.7	107.2	84.5	98.4	80.5	69.4	50.7	822.9
Ave. Snow Depth (cm)	62	70	71	69	18	0	0	0	0	7	26	49	31

Table B.6 Estimated Horizontal Groundwater Gradients

Well 1	Well 2	Elev 1 (m)	Elev 2 (m)	Distance (m)	Gradient (%)	Flow Direction
JOY-11-17	lake	509.38	505	100.0	4.4%	east
Joy-12-78	lake	507.53	505	102.9	2.5%	east
Joy-11-10	lake	506.70	505	54.3	3.1%	west
Joy-11-32	lake	507.38	505	114.3	2.1%	south
Joy-12-82	lake	510.55	505	182.9	3.0%	southwest
Joy-12-57	Joy-11-32	509.78	507.38	157.1	1.5%	south
Joy-12-87	Joy-12-90	510.34	508.61	77.1	2.2%	south
Joy-12-87	Joy-11-32	510.34	507.38	247.1	1.2%	south
Joy-12-102	Joy-12-103	511.87	508.34	182.9	1.9%	east
Joy-12-114	Joy-12-100	510.46	508.47	162.9	1.2%	southeast
				Mean (all)	**2.3%**	
				Mean (Towards Lake)	**3.0%**	
				Mean (north pit area)	**1.6%**	

Appendix C

Hydraulic Testing Data

Stantec Consulting Ltd. 40 Highfield Park Drive Dartmouth, NS. B3A 0A3 Phone: 902 468 7777	**Pumping Test Data Report** Project: Joyce Lake Number: 121810649. Client: Labec Century		Page 1

Data observed at:	**Joy-12-87**	**Pumping Test:**	**Joy-12-87**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-87
Depth to Static WL:	33.85 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	46 [m]
Date:	06/10/2012	Aquifer Thickness:	12.15 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	0	33.85	0.00
2	0.25	33.97	0.12
3	0.5	33.96	0.11
4	2	35.09	1.24
5	2.5	35.25	1.40
6	3	35.39	1.54
7	4.5	35.76	1.91
8	5	35.85	2.00
9	6	35.99	2.14
10	7	36.06	2.21
11	8	36.04	2.19
12	9	35.86	2.01
13	10	35.68	1.83
14	11	35.57	1.72
15	12	35.43	1.58

Stantec

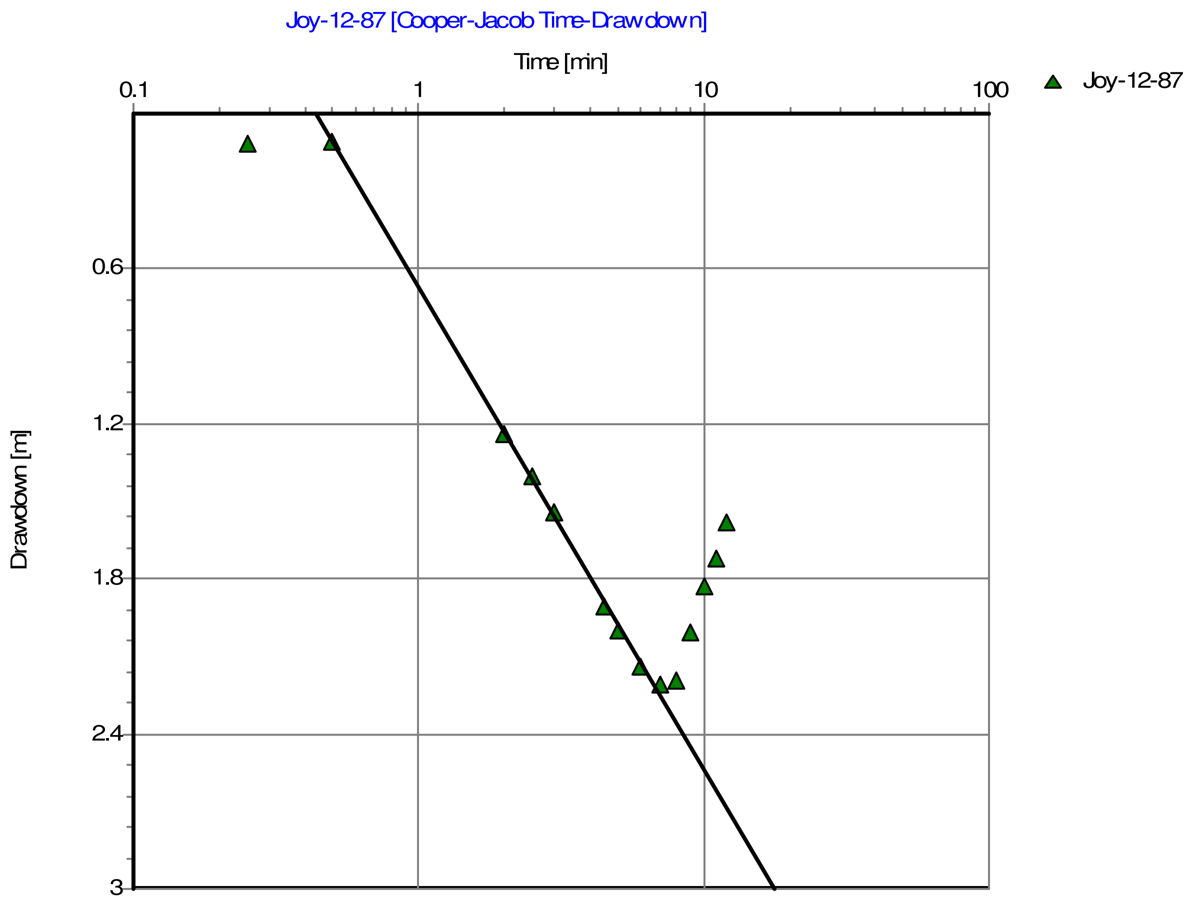
Stantec Consulting Ltd.
40 Highfield Park Drive
Dartmouth, NS. B3A 0A3
Phone: 902 468 7777

Pumping Test Analysis Report

Project: Joyce Lake

Number: 121810649.

Client: Labec Century



Pumping Test: **Joy-12-87**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	2.14E+0 [m²/d]	Conductivity:	1.76E-1 [m/d]

Test parameters:	Pumping Well:	Joy-12-87	Aquifer Thickness:	12.15 [m]
	Casing radius:	0.0475 [m]	Confined Aquifer	
	Screen length:	46 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	21.80858 [m³/d]		

Comments: Test Terminated at 12 minutes after pump became plugged with silt.

Evaluated by: Stantec

Evaluation Date: 18/12/2012

Stantec Consulting Ltd.
40 Highfield Park Drive
Dartmouth, NS. B3A 0A3
Phone: 902 468 7777

Pumping Test Data Report
Project: Joyce Lake
Number: 121810649.
Client: Labec Century

Data observed at:	**Joy-12-102**	**Pumping Test:**	**JOY-12-102-2**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-102
Depth to Static WL:	18.64 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	45.5 [m]
Date:	05/10/2012	Aquifer Thickness:	26.865 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	0	18.64	0.00
2	0.25	18.71	0.07
3	0.5	18.78	0.14
4	0.75	18.85	0.21
5	1	18.93	0.29
6	1.25	18.94	0.30
7	1.5	18.95	0.31
8	1.75	18.96	0.32
9	2	18.97	0.33
10	2.5	18.95	0.31
11	3	18.94	0.30
12	3.5	18.97	0.33
13	4	18.99	0.35
14	4.5	19.00	0.36
15	5	19.00	0.36
16	6	19.01	0.37
17	7	19.02	0.38
18	8	19.02	0.38
19	9	19.02	0.38
20	10	19.02	0.38
21	11	19.02	0.38
22	12	19.02	0.38
23	13	19.02	0.38
24	14	19.02	0.38
25	15	19.04	0.40
26	16	19.04	0.40
27	17	19.04	0.40
28	18	19.04	0.40
29	19	19.04	0.40
30	20	19.04	0.40
31	22	19.05	0.41

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Pumping Test Data Report
Project: Joyce Lake
Number: 121810649.
Client: Labec Century

Data observed at:	**Joy-12-102**	**Pumping Test:**	**JOY-12-102-2**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-102
Depth to Static WL:	18.64 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	45.5 [m]
Date:	05/10/2012	Aquifer Thickness:	26.865 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
32	24	19.07	0.43
33	26	19.07	0.43
34	28	19.08	0.44
35	30	19.08	0.44
36	35	19.08	0.44
37	40	19.08	0.44
38	45	19.08	0.44
39	50	19.08	0.44
40	55	19.08	0.44
41	60	19.08	0.44
42	70	19.08	0.44
43	80	19.08	0.44
44	90	19.08	0.44
45	100	19.08	0.44
46	110	19.08	0.44
47	120	19.09	0.45
48	130	19.15	0.51
49	130.3	18.81	0.17
50	130.5	18.79	0.14
51	130.8	18.79	0.14
52	131	18.77	0.13
53	131.3	18.76	0.12
54	131.5	18.75	0.11
55	131.8	18.74	0.10
56	132	18.73	0.09
57	132.3	18.72	0.08
58	132.5	18.71	0.07
59	132.8	18.71	0.07
60	133.3	18.70	0.06
61	133.5	18.70	0.05
62	133.8	18.69	0.05

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Pumping Test Data Report

Project: Joyce Lake

Number: 121810649.

Client: Labec Century

Data observed at:	**Joy-12-102**	**Pumping Test:**	**JOY-12-102-2**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-102
Depth to Static WL:	18.64 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	45.5 [m]
Date:	05/10/2012	Aquifer Thickness:	26.865 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
63	134	18.68	0.04

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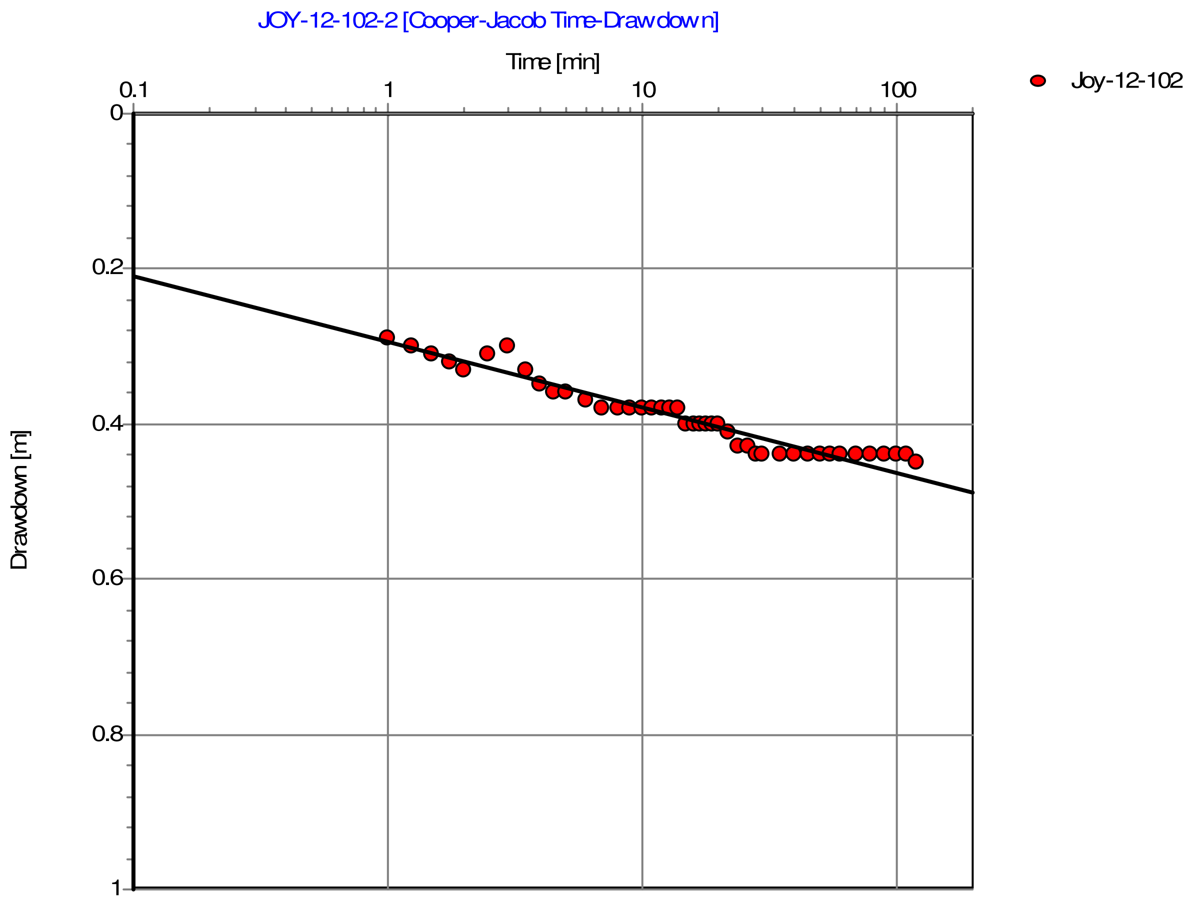
Pumping Test Analysis Report

Project: Joyce Lake

Number: 121810649.

Client: Labec Century



Pumping Test: **JOY-12-102-2**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	3.14E+1 [m²/d]	Conductivity:	1.17E+0 [m/d]

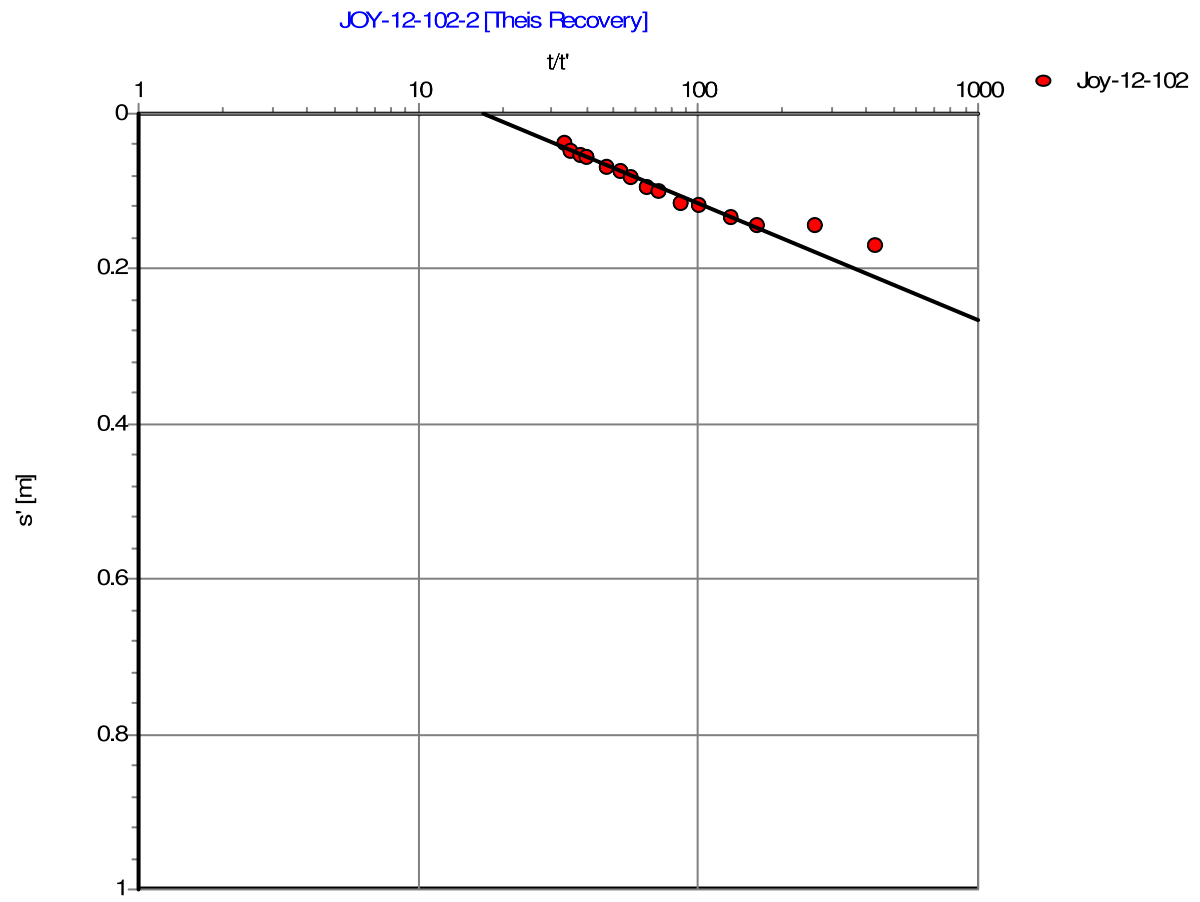
Test parameters:	Pumping Well:	Joy-12-102	Aquifer Thickness:	26.865 [m]
	Casing radius:	0.0475 [m]	Confined Aquifer	
	Screen length:	45.5 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	14.41515 [m³/d]		

Comments:

Evaluated by: Stantec

Evaluation Date: 18/12/2012

	Stantec Consulting Ltd.	Pumping Test Analysis Report
	40 Highfield Park Drive	Project: Joyce Lake
	Dartmouth, NS. B3A 0A3	Number: 121810649.
Stantec	Phone: 902 468 7777	Client: Labec Century



Pumping Test: **JOY-12-102-2**

Analysis Method: **Theis Recovery**

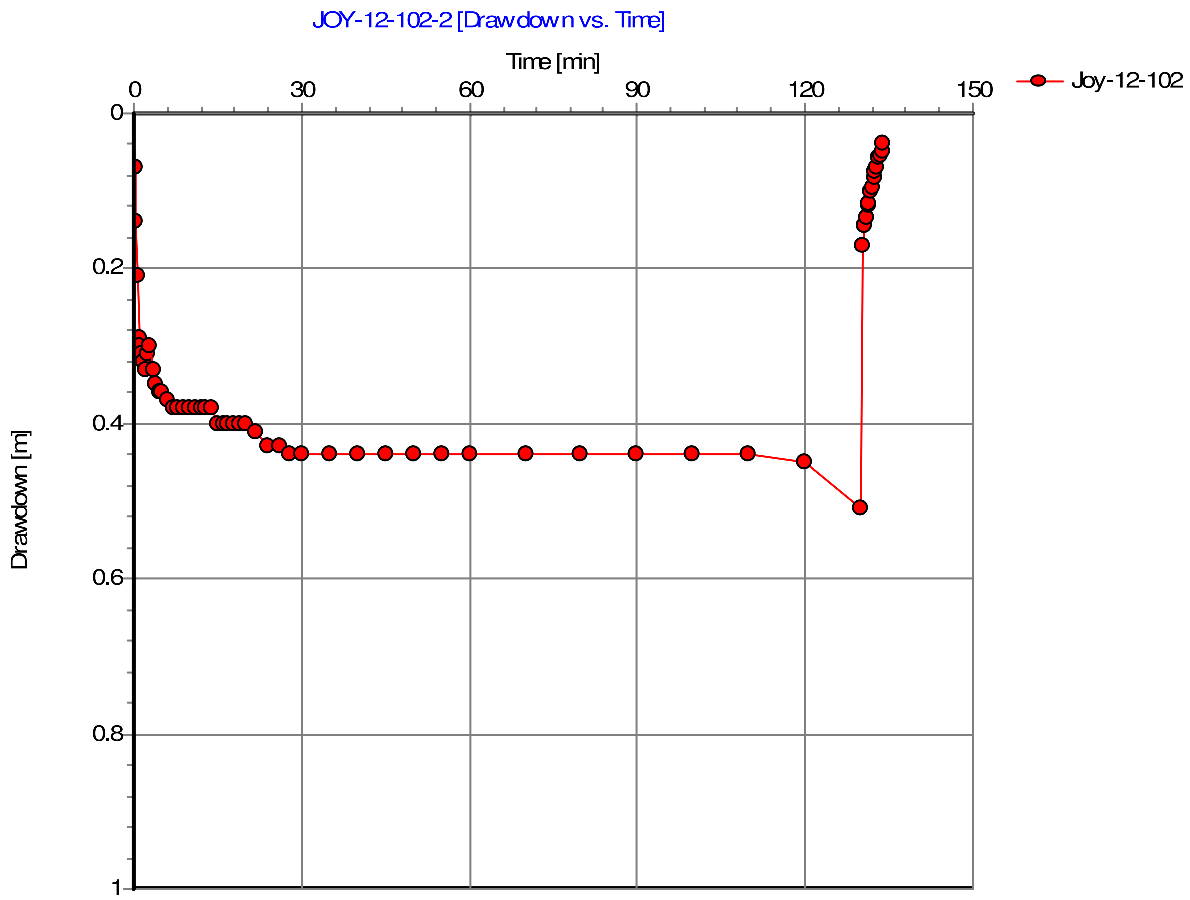
Analysis Results:	Transmissivity:	1.75E+1 [m²/d]	Conductivity:	6.53E-1 [m/d]
Test parameters:	Pumping Well:	Joy-12-102	Aquifer Thickness:	26.865 [m]
	Casing radius:	0.0475 [m]	Confined Aquifer	
	Screen length:	45.5 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	14.41515 [m³/d]		
	Pumping Time	130 [min]		

Comments:

Evaluated by: Stantec

Evaluation Date: 18/12/2012

Stantec Consulting Ltd.	Pumping Test Analysis Report
40 Highfield Park Drive	Project: Joyce Lake
Dartmouth, NS. B3A 0A3	Number: 121810649.
Phone: 902 468 7777	Client: Labec Century



Pumping Test: **JOY-12-102-2**

Analysis Method: **Drawdown vs. Time**

Analysis Results:

Test parameters:				
	Pumping Well:	Joy-12-102	Aquifer Thickness:	26.865 [m]
	Casing radius:	0.0475 [m]		
	Screen length:	45.5 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	14.41515 [m³/d]		

Comments:

Evaluated by: Stantec

Evaluation Date: 18/12/2012

Stantec Consulting Ltd. 40 Highfield Park Drive Dartmouth, NS. B3A 0A3 Phone: 902 468 7777	**Pumping Test Data Report** Project: Joyce Lake Number: 121810649. Client: Labec Century — Page 1

Data observed at:	**Joy-12-102**	**Pumping Test:**	**Joy-12-102-3**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-102
Depth to Static WL:	18.66 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	45.5 [m]
Date:	05/10/2012	Aquifer Thickness:	26.685 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	0	18.66	0.00
2	0.25	18.78	0.12
3	0.75	19.02	0.36
4	1	19.07	0.41
5	1.25	19.13	0.47
6	1.5	19.16	0.50
7	1.75	19.18	0.52
8	2	19.20	0.54
9	2.5	19.22	0.56
10	3	19.24	0.58
11	3.5	19.25	0.59
12	4	19.27	0.61
13	4.5	19.27	0.61
14	5	19.30	0.64
15	5	19.32	0.66
16	6	19.34	0.68
17	7	19.34	0.68
18	8	19.34	0.68
19	10	19.35	0.69
20	11	19.36	0.70
21	12	19.36	0.70
22	13	19.36	0.70
23	14	19.36	0.70
24	15	19.36	0.70
25	16	19.36	0.70
26	17	19.36	0.70
27	18	19.36	0.70
28	19	19.36	0.70
29	20	19.36	0.70
30	22	19.36	0.70
31	24	19.36	0.70

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Pumping Test Data Report

Project: Joyce Lake

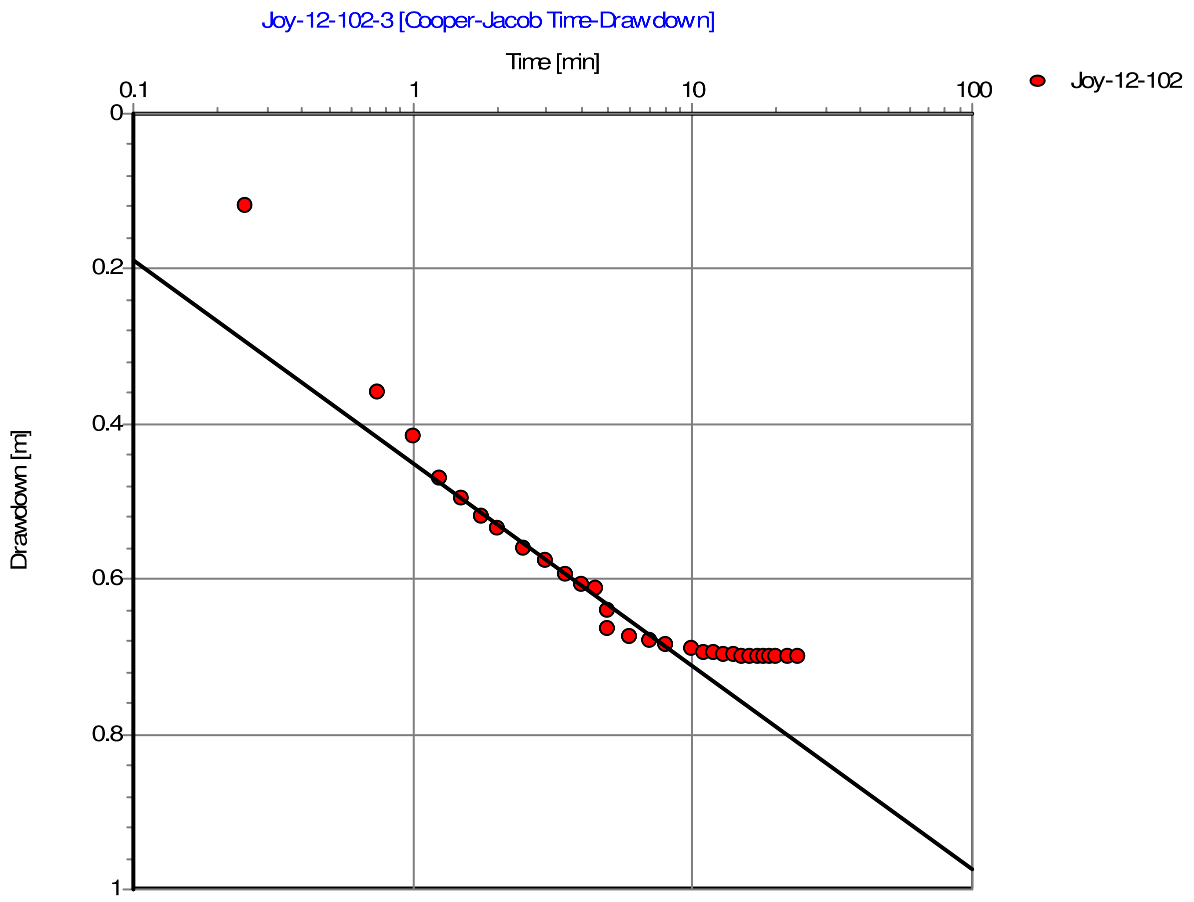
Number: 121810649.

Client: Labec Century

Data observed at:	**Joy-12-102**	**Pumping Test:**	**Joy-12-102-3**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-102
Depth to Static WL:	18.66 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	45.5 [m]
Date:	05/10/2012	Aquifer Thickness:	26.685 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
32	24.25	18.89	0.23
33	24.5	18.73	0.07
34	24.75	18.77	0.11
35	25	18.79	0.13
36	25.25	18.79	0.13
37	25.5	18.78	0.12
38	25.75	18.77	0.11
39	26	18.77	0.11
40	26.5	18.76	0.10
41	27	18.75	0.09
42	27.5	18.75	0.09
43	28	18.74	0.08
44	28.5	18.73	0.07
45	29	18.73	0.07
46	29	18.72	0.06
47	30	18.71	0.05
48	31	18.71	0.05
49	32	18.71	0.05
50	34	18.70	0.04
51	35	18.70	0.04
52	36	18.70	0.04

Stantec Consulting Ltd.	Pumping Test Analysis Report
40 Highfield Park Drive	Project: Joyce Lake
Dartmouth, NS. B3A 0A3	Number: 121810649.
Phone: 902 468 7777	Client: Labec Century



Pumping Test: **Joy-12-102-3**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	1.15E+1 [m²/d]	Conductivity:	4.30E-1 [m/d]

Test parameters:	Pumping Well:	Joy-12-102	Aquifer Thickness:	26.685 [m]
	Casing radius:	0.0475 [m]	Confined Aquifer	
	Screen length:	45.5 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	16.416 [m³/d]		

Comments:

Evaluated by: Stantec

Evaluation Date: 18/12/2012

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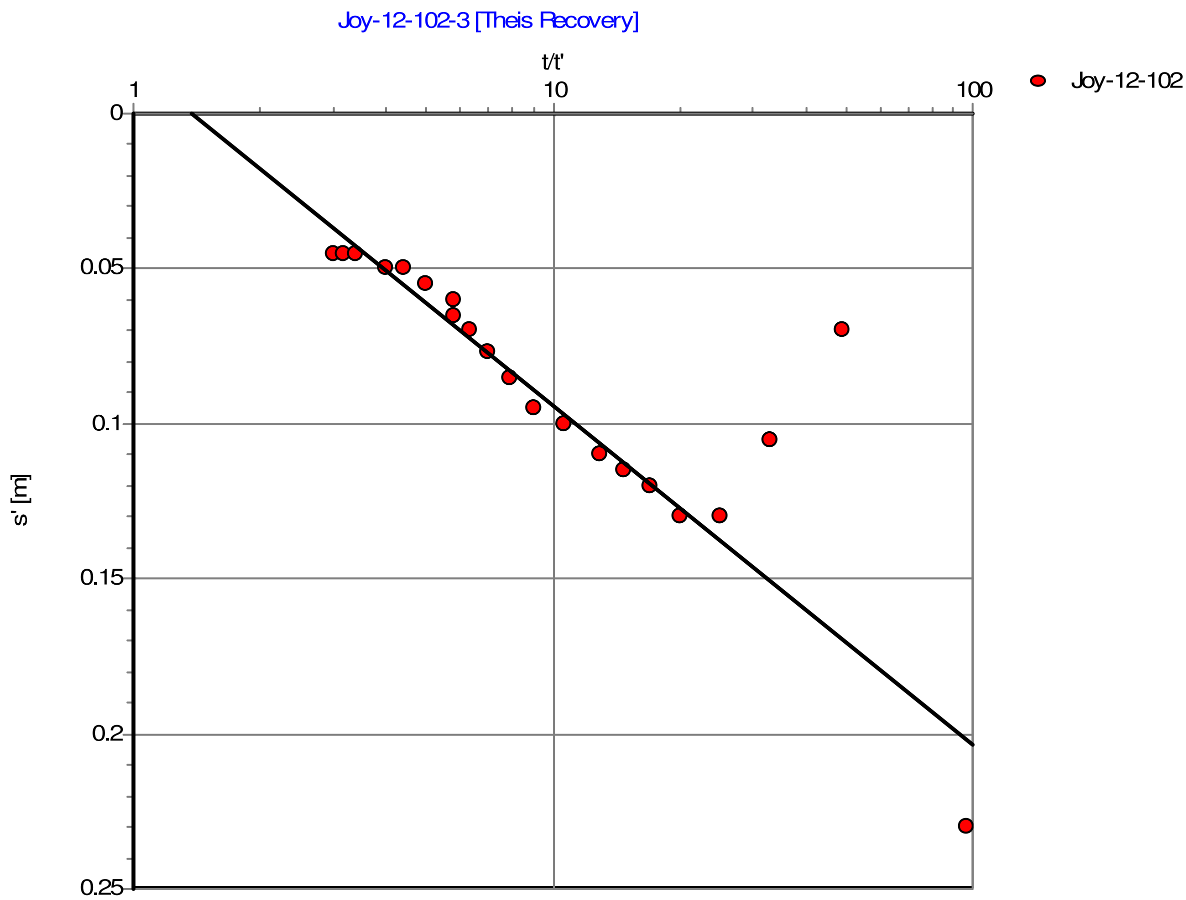
Pumping Test Analysis Report
Project: Joyce Lake
Number: 121810649.
Client: Labec Century



Pumping Test: **Joy-12-102-3**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	2.75E+1 [m²/d]	Conductivity:	1.03E+0 [m/d]

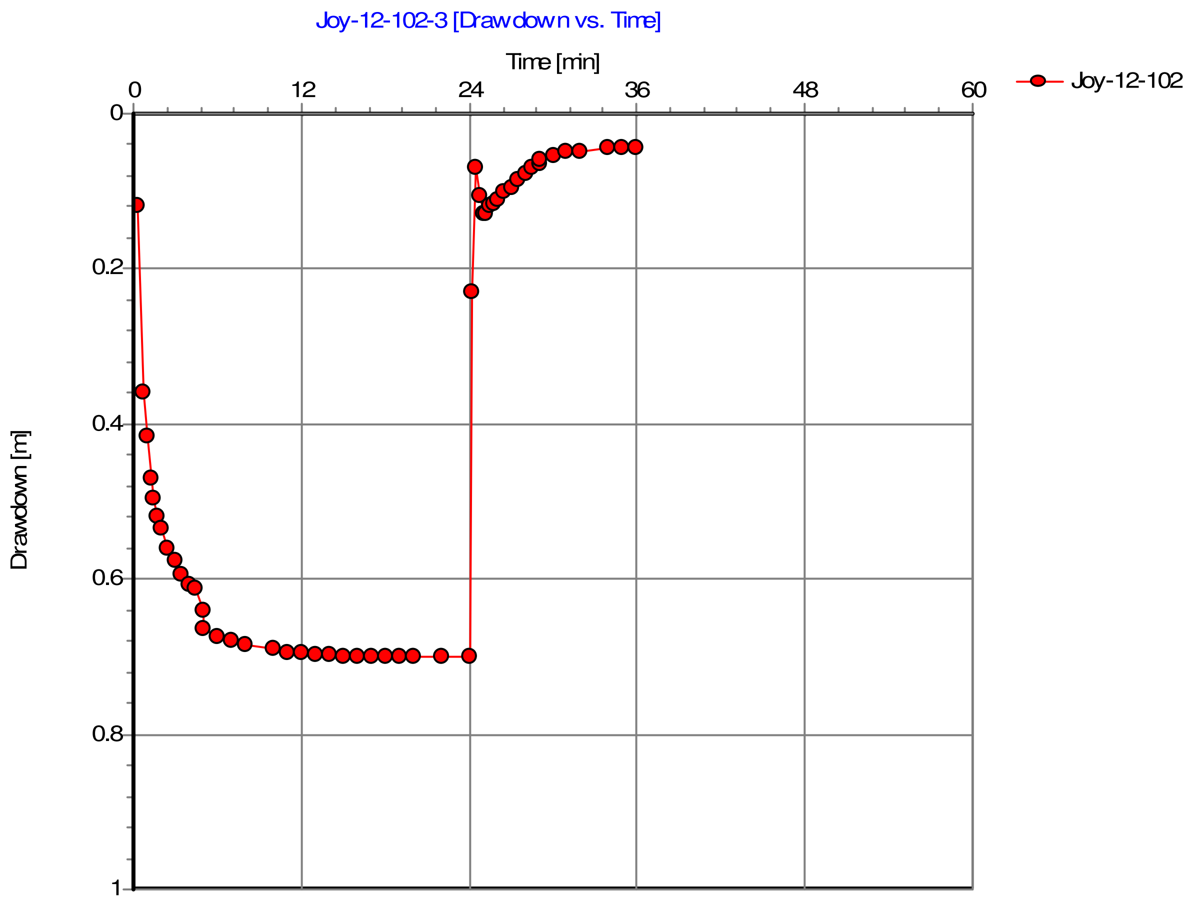
Test parameters:	Pumping Well:	Joy-12-102	Aquifer Thickness:	26.685 [m]
	Casing radius:	0.0475 [m]	Confined Aquifer	
	Screen length:	45.5 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	16.416 [m³/d]		
	Pumping Time	24 [min]		

Comments:

Evaluated by: Stantec

Evaluation Date: 18/12/2012

Stantec Consulting Ltd.	**Pumping Test Analysis Report**	
40 Highfield Park Drive	Project:	Joyce Lake
Dartmouth, NS. B3A 0A3	Number:	121810649.
Phone: 902 468 7777	Client:	Labec Century



<u>Pumping Test:</u> **Joy-12-102-3**

<u>Analysis Method:</u> **Drawdown vs. Time**

<u>Analysis Results:</u>

<u>Test parameters:</u>

Pumping Well:	Joy-12-102	Aquifer Thickness:	26.685 [m]
Casing radius:	0.0475 [m]		
Screen length:	45.5 [m]		
Boring radius:	0.0475 [m]		
Discharge Rate:	16.416 [m³/d]		

<u>Comments:</u>

Evaluated by:

Evaluation Date: 18/12/2012

Stantec Consulting Ltd. 40 Highfield Park Drive Dartmouth, NS. B3A 0A3 Phone: 902 468 7777	**Pumping Test Data Report** Project: Joyce Lake Number: 121810649. Client: Labec Century	Page 1

Data observed at:	**Joy-12-103**	**Pumping Test:**	**Joy-12-103**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-102
Depth to Static WL:	21.94 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	45.5 [m]
Date:	18/12/2012	Aquifer Thickness:	153 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	0	21.94	0.00
2	0.25	21.98	0.04
3	0.5	22.02	0.08
4	0.75	22.07	0.13
5	1	22.11	0.17
6	1.25	22.12	0.18
7	1.5	22.16	0.22
8	1.75	22.17	0.23
9	2	22.18	0.23
10	2.5	22.20	0.25
11	3	22.20	0.26
12	3.5	22.20	0.26
13	4	22.20	0.26
14	4.5	22.20	0.26
15	5	22.20	0.26
16	6	22.21	0.27
17	7	22.21	0.27
18	8	22.21	0.27
19	9	22.21	0.27
20	10	22.22	0.28
21	11	22.22	0.28
22	12	22.22	0.28
23	13	22.21	0.27
24	14	22.21	0.27
25	15	22.22	0.28
26	16	22.21	0.27
27	17	22.21	0.27
28	18	22.21	0.27
29	19	22.21	0.27
30	20	22.21	0.27
31	22	22.21	0.27

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Pumping Test Data Report
Project: Joyce Lake
Number: 121810649.
Client: Labec Century

Data observed at:	**Joy-12-103**	**Pumping Test:**	**Joy-12-103**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-102
Depth to Static WL:	21.94 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	45.5 [m]
Date:	18/12/2012	Aquifer Thickness:	153 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
32	24	22.21	0.27
33	26	22.21	0.27
34	28	22.21	0.27
35	30	22.21	0.27
36	35	22.20	0.26
37	40	22.20	0.26
38	45	22.20	0.26
39	50	22.20	0.26
40	55	22.20	0.26
41	60	22.20	0.26
42	60.3	21.99	0.05
43	60.5	22.00	0.06
44	60.8	22.00	0.06
45	61	22.00	0.05
46	61.3	22.00	0.05
47	61.5	21.99	0.05
48	61.8	21.99	0.05
49	62	21.99	0.05
50	62.5	21.98	0.04
51	63	21.98	0.04
52	63.5	21.98	0.04
53	64	21.98	0.04
54	64.5	21.98	0.04
55	65	21.98	0.04
56	66	21.98	0.04
57	67	21.97	0.03
58	68	21.97	0.03
59	69	21.97	0.03
60	70	21.97	0.03
61	71	21.97	0.03
62	72	21.96	0.02

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Phone: 902 468 7777

Pumping Test Data Report

Project: Joyce Lake

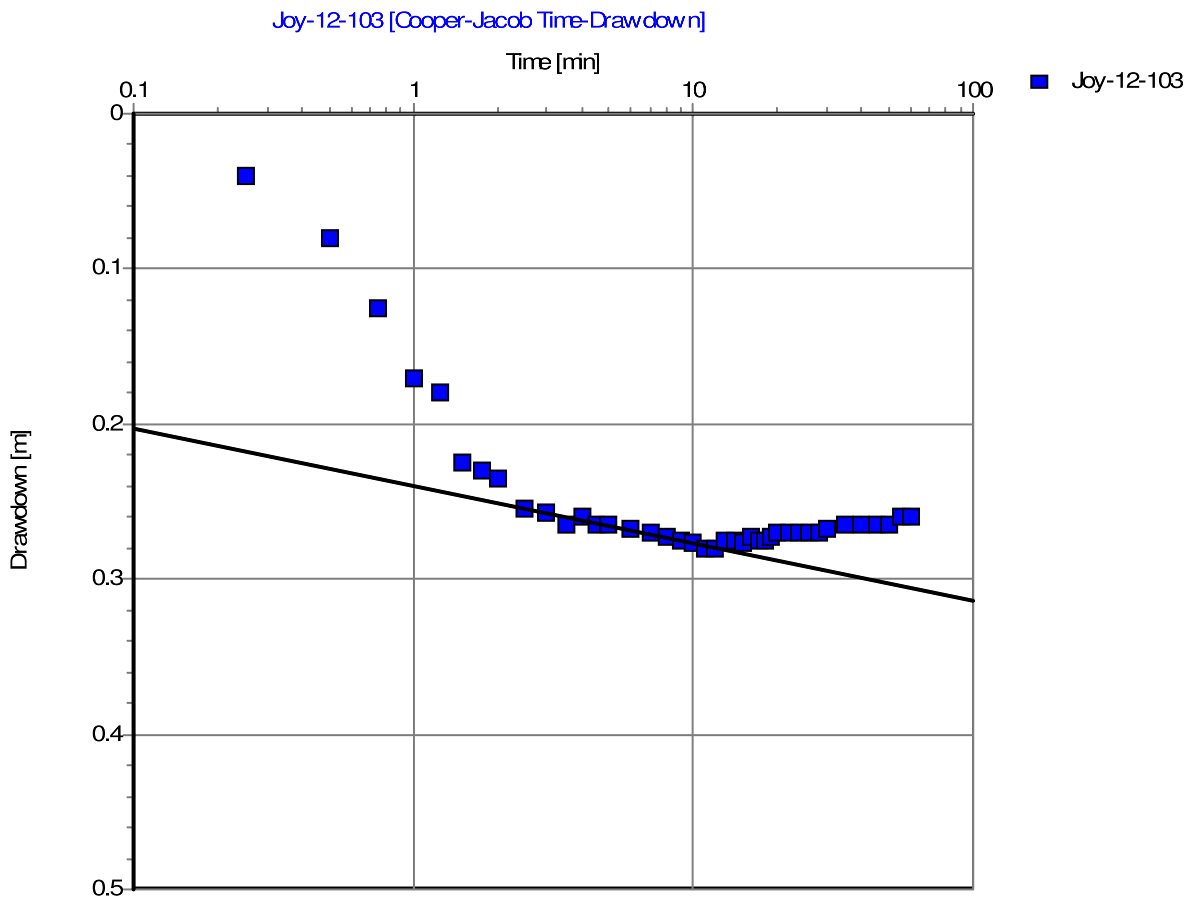
Number: 121810649.

Client: Labec Century

Data observed at:	**Joy-12-103**	**Pumping Test:**	**Joy-12-103**
Distance from PW:	0 [m]	Pumping Well:	Joy-12-102
Depth to Static WL:	21.94 [m]	Casing radius:	0.0475 [m]
Location:	Labrador, NF	Boring radius:	0.0475 [m]
Recorded by:	Stantec	Screen length:	45.5 [m]
Date:	18/12/2012	Aquifer Thickness:	153 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
63	73	21.96	0.02

Stantec Consulting Ltd.	Pumping Test Analysis Report
40 Highfield Park Drive	Project: Joyce Lake
Dartmouth, NS. B3A 0A3	Number: 121810649.
Phone: 902 468 7777	Client: Labec Century



Pumping Test: **Joy-12-103**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	1.25E+2 [m²/d]	Conductivity:	8.18E-1 [m/d]

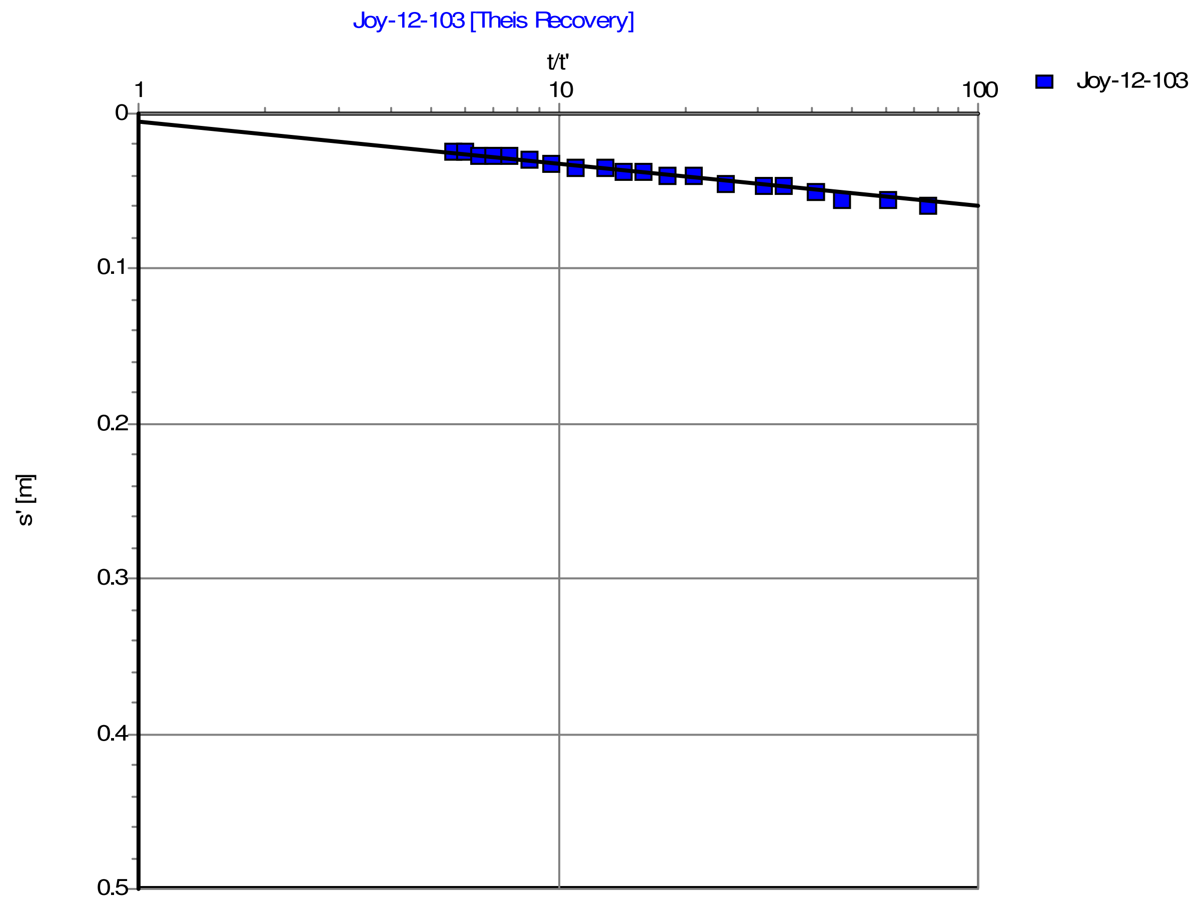
Test parameters:	Pumping Well:	Joy-12-102	Aquifer Thickness:	153 [m]
	Casing radius:	0.0475 [m]	Confined Aquifer	
	Screen length:	45.5 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	25.42962 [m³/d]		

Comments:

Evaluated by: Stantec

Evaluation Date: 18/12/2012

Stantec Consulting Ltd.	Pumping Test Analysis Report
40 Highfield Park Drive	Project: Joyce Lake
Dartmouth, NS. B3A 0A3	Number: 121810649.
Phone: 902 468 7777	Client: Labec Century



Pumping Test: **Joy-12-103**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	1.73E+2 [m²/d]	Conductivity:	1.13E+0 [m/d]

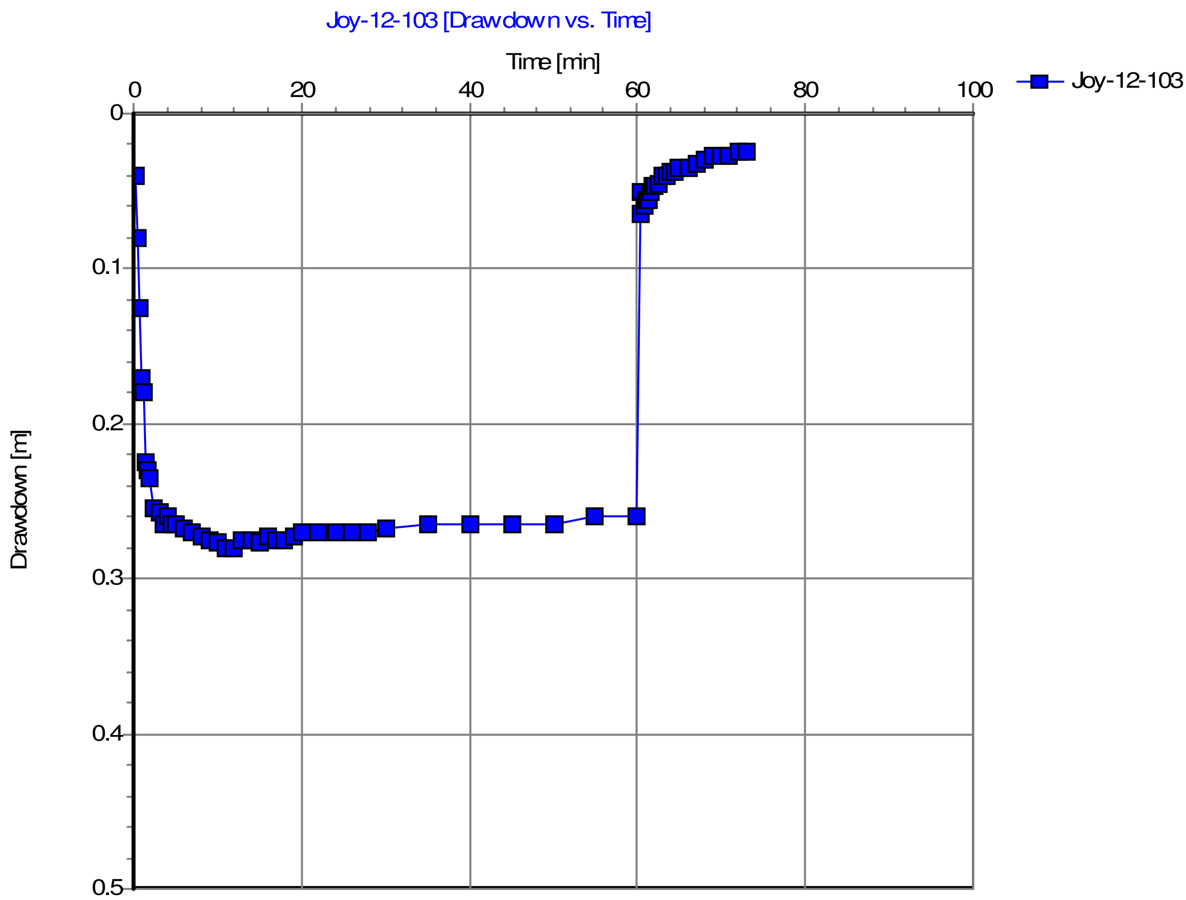
Test parameters:	Pumping Well:	Joy-12-102	Aquifer Thickness:	153 [m]
	Casing radius:	0.0475 [m]	Confined Aquifer	
	Screen length:	45.5 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	25.42962 [m³/d]		
	Pumping Time	60 [min]		

Comments:

Evaluated by: Stantec

Evaluation Date: 18/12/2012

Stantec Consulting Ltd. 40 Highfield Park Drive Dartmouth, NS. B3A 0A3 Phone: 902 468 7777	**Pumping Test Analysis Report**	
	Project:	Joyce Lake
	Number:	121810649.
	Client:	Labec Century



Pumping Test: **Joy-12-103**

Analysis Method: **Drawdown vs. Time**

Analysis Results:

Test parameters:				
	Pumping Well:	Joy-12-102	Aquifer Thickness:	153 [m]
	Casing radius:	0.0475 [m]		
	Screen length:	45.5 [m]		
	Boring radius:	0.0475 [m]		
	Discharge Rate:	25.42962 [m³/d]		

Comments:

Evaluated by: Stantec

Evaluation Date: 18/12/2012