APPENDIX V

2012 Fish and Fish Habitat Baseline Study and 2013 Update

CENTURY
IRON MINES CORP.

Joyce Lake Direct Shipping Iron Ore Project

Fish and Fish Habitat Baseline Study

121-18002-00

November 2013

GENIVAR

CENTURY

Joyce Lake Direct Shipping Iron Ore Project

Fish and Fish Habitat Baseline Study

Final Version

Martin Larose, Project Director

121-18002-00 November 2013

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EXECUTIVE SUMMARY

Reference to be cited:

GENIVAR. 2013. Joyce Lake Direct Shipping Iron Ore Project. Fish and Fish Habitat Baseline Study. Report prepared for Labec Century Iron Ore. 129 p. and appendices.

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 northeast of the Town of Schefferville, Québec. The Joyce Lake Direct Shipping Iron Ore Project (the Project) lies on a peninsula of land in Attikamagen Lake and all physical elements of the Project lie within Labrador. The mine will produce up to two million tonnes (Mt) of product per year. The ore will be transported to the existing rail line owned by Tshiuetin Rail Transportation Inc. for transportation to the Port of Sept-Îles.

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

To support the EA process, a Fish and Fish Habitat Baseline Study was undertaken in 2012 to determine if waterbodies and streams found within the Study Area provide habitat for fish species and also to characterize these habitats. A field campaign was conducted from July 22 to August 10 with the objectives to describe the aquatic habitats in lakes, ponds and streams that could potentially be affected by the project as well as to determine the fish species present. The field work was conducted in Attikamagen Lake, Joyce Lake, four unnamed ponds (identified as Ponds A, B, C and D for the purposes of the study) as well as two unnamed lakes (identified as Lakes E and F for the purposes of the study). Two streams located on Joyce Lake Peninsula and 23 preliminary stream crossings or potential crossings (determined based on the initial project layout, [Project Description and Provincial Registration, November 5, 2012]) were also characterized.

Joyce Lake is a small 37-ha waterbody adjacent to the proposed mining pit. Morphometric characteristics, Secchi depth, conductivity and fish sampling results indicate that Joyce Lake has a low biological productivity. Only pearl dace were found in the lake and the probability of finding other fish species is low. Additional fish sampling should be conducted to confirm the absence of any other fish species, especially in deep water. No inlet or outlet stream was found connecting to Joyce Lake. The closest pockets of water were observed 500 m downstream of Joyce Lake.

Lake E is a small waterbody characterized by the presence of three deep bays; the deepest being found in its eastern part (19 m). Fish sampling results confirmed that the productivity of Lake E is fairly productive. The three most abundant fish species were longnose sucker, white sucker and pearl dace. The other species found included lake trout, brook trout, burbot, and mottled sculpin. The deepest area of the lake, below 10 m, could be unsuitable for some species or some fish life stages due to the low concentration of dissolved oxygen. Lake E discharges into HO-T02, a tributary of Hollinger Lake. In the lowermost part of the Lake E outlet, a brook trout suitable spawning habitat was found.

Lake F is a small and shallow 3.8-ha lake. This small lake could freeze to the bottom during winter due to the low water depth, mean water depth being only 0.48 m, or anoxic conditions could develop under ice cover. Three fish species were found in Lake F (longnose sucker, white sucker, and brook trout) and the CPUE was relatively high. Two small connecting stream were found; one flowing in and one flowing out into Iron Arm.

For the region, Attikamagen Lake is a fairly productive waterbody surrounding Joyce Lake Peninsula. Two areas were characterized: Iron Arm and Bay 2. Many patches of bur-reed were found near the

shores as well as several rush and sedge marshes. One suitable brook trout spawning habitat was identified on the eastern shore of Iron Arm near Lake F. In the non-littoral zone, the substrate is predominantly silt, with sand and clay in similar proportions. A total of seven fish species were found in Attikamagen Lake, the round whitefish and the lake trout being the two most abundant. The other species found were: longnose sucker, white sucker, pearl dace, mottled sculpin, and threespine stickleback.

Based on the results of fish sampling efforts, Ponds A, B, C, and D are fishless waterbodies located near Joyce Lake. They are not connected to any other waterbody and no connecting stream was found. These four ponds were not considered to be fish habitat.

During the field campaign, 23 stream sections identified as preliminary stream crossings or potential stream crossings were characterized. These were identified based on the project layout available at that time. During the preparation of the Baseline Study report, a new project infrastructure layout was produced (revised). Some stream crossings were relocated, while an additional one was identified.

Three crossings were characterized from the ground at the intercept point of the revised project layout: CR10A, CR17 and CR20. In CR10A the presence of brook trout was confirmed and the stream provide good habitat for juvenile (pond habitat). CR17 is a section of the Gilling River, with good habitat for northern pike (dense aquatic vegetation), but several species could be found in the river due to the proximity of Astray Lake. Finally, CR20 is a slow/moderate type of habitat with a dense cover of aquatic vegetation (bur-reed). CR20 area provides good habitat for northern pike, the presence of which was confirmed by fish sampling.

In many streams, the initial crossings were relocated, specifically CR07, CR10, CR11, CR12, CR14, CR15, CR16, CR21, and CR23. CR10 and CR23 provide good habitat for northern pike while CR11, CR12 and CR15 have good potential for brook trout. Due to the little information available for the area upstream from CR07 and CR16, it is unclear if the revised road layout crosses fish habitat or not since some sections of the stream were underground. For CR21, only small pockets of water were observed during the field campaign. It was not considered to be a fish habitat.

One additional stream crossing (CR17A) was identified based on the high-resolution aerial photographs, but no information can be obtained since the stream is too small and the vegetation cover is too dense to observe the stream bed.

Concerning the initial stream crossings CR01, CR02, CR06, CR09 and CR19 no streams were found during the field campaign and there is no sign of any stream bed based on the high-resolution aerial photographs. There is no fish habitat in these areas as opposed to what is indicated on 1:50,000 topographic maps.

PRODUCTION TEAM

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Matthew Chong	Geologist
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GENIVAR Inc.

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Nancy Imbeault	Editing

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1 INTRODUCTION

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) northeast of the Town of Schefferville, Québec. The Joyce Lake Direct Shipping Iron Ore (DSO) Project (the Project) lies on a peninsula of land in Attikamagen Lake and all physical elements of the Project lie within Labrador (Figure 1).

The mine will produce up to two million tonnes (Mt) of product per year. The ore will be transported to the existing rail owned by Tshiuetin Rail Transportation Inc., and further onto the Québec North Shore and Labrador Railway (QNS&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 environmental assessment (EA) under the Newfoundland and Labrador *Environmental Protection Act* (NL EPA) and associated Environmental Assessment Regulations. Under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) the Project is a Designated Project pursuant to Section 15(a) Regulations Designating Physical Activities and will require federal EA.

1.1 Project Overview

The Joyce Lake mining prospect lies in an undeveloped area adjacent to the small Joyce Lake waterbody 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 by ground via an existing road to Iron Arm and then by helicopter to Joyce Lake.

The Project consists of mining a high grade deposit of hematite iron in western Labrador, approximately 20 km northeast of Schefferville, as shown in Figure 1. The physical works for the proposed Joyce Lake Project subject to assessment are located wholly in Labrador. The mine area lies within two map-staked licences (309 claims) covering 12,665 hectares (ha).

The physical elements of the Project include the Joyce Lake mining area, options for conveyance across Iron Arm (ice bridge, barge), 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. 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, an accommodation camp, and ancillary buildings (e.g., offices, workshops, warehouse/storage areas, worker facilities, mobile equipment storage). All structures will be constructed so that they can be moved from the site and re-used elsewhere when no longer required for this Project.

The Project's estimated annual production of iron ore is provided in Table 1, and is based on current exploration information. The current estimated target production is 2 Mt/yr of ore. The first four years of operation would 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: Estimated Annual Production of Iron Ore in Phase I and Phase II for the Joyce Lake Project

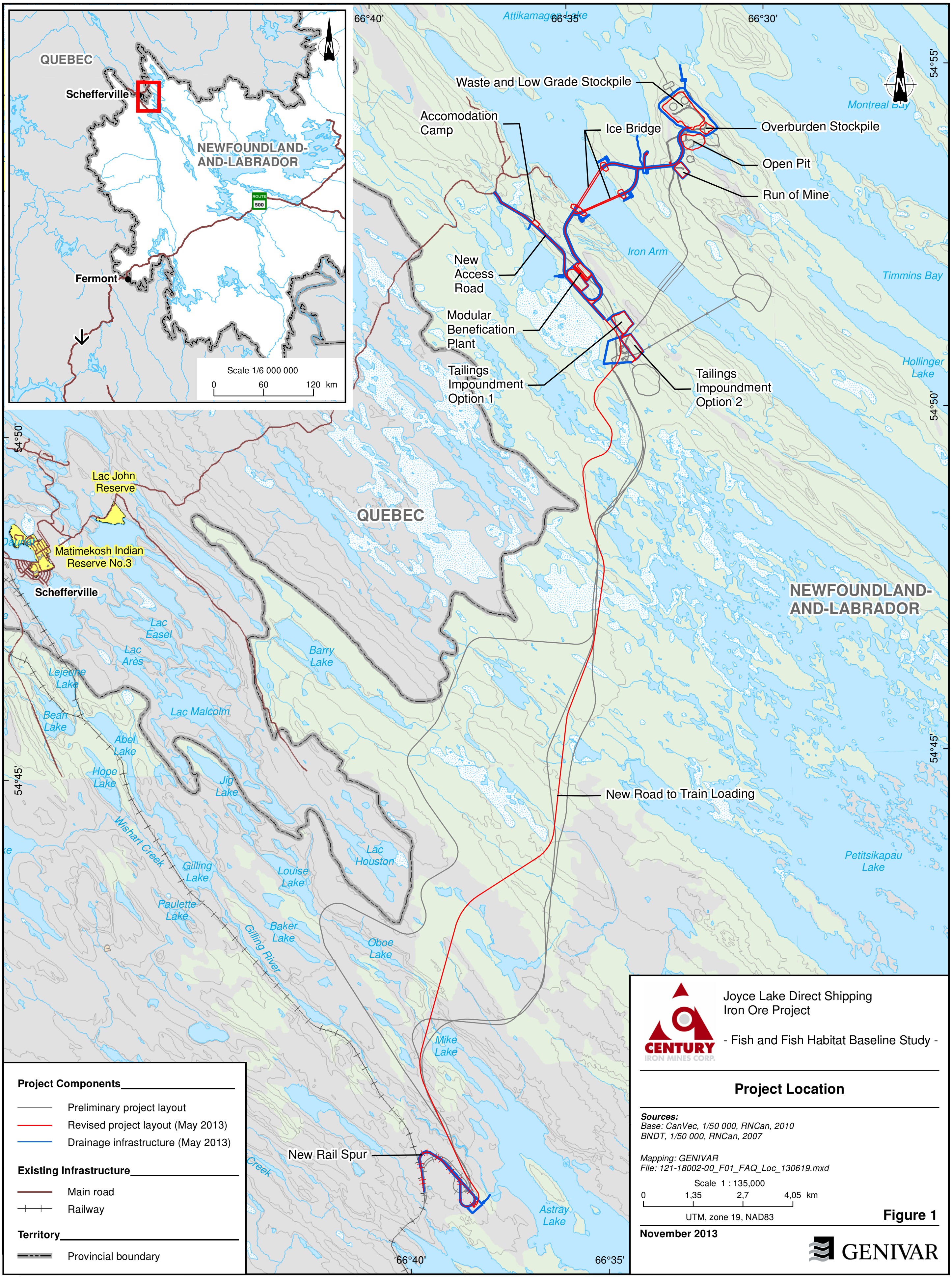
Product	Unit	Estimated Production by Year							
		2014	2015	2016	2017	2018	2019	2020	2021
Phase I Ore (DSO; 60% Fe)	tonne	-	999,000	1,987,000	1,986,000	1,987,000	TBD[1]	TBD[1]	TBD[1]
Phase II Ore (55% Fe)	tonne	-	-	-	-	-	TBD[1]	TBD[1]	TBD[1]
Waste Rock Low Grade	tonne	949,000	11,584,000	15,662,000	5,375,000	140,000	TBD[1]	TBD[1]	TBD[1]

[1] TBD: To be determined.

Phase I construction would 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 four years of production (2015 to 2018), 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.

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.

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 250 days per year (during the warmer months). 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.


QUEBEC
Schefferville
NEWFOUNDLAND-AND-LABRADOR
Fermont
500
Scale 1/6 000 000
0 60 120 km
66°40'
66°35'
66°30'
54°55'
54°50'
54°45'
Attikamagen Lake
Montreal Bay
Waste and Low Grade Stockpile
Accomodation Camp
Ice Bridge
Overburden Stockpile
Open Pit
Run of Mine
Iron Arm
Timmins Bay
New Access Road
Modular Beneficiation Plant
Tailings Impoundment Option 1
Tailings Impoundment Option 2
Hollinger Lake
Lac John Reserve
Matimekosh Indian Reserve No.3
Schefferville
QUEBEC
NEWFOUNDLAND-AND-LABRADOR
Lac Easel
Lac Arès
Lejeune Lake
Barry Lake
Lac Malcolm
Bean Lake
Abel Lake
Hope Lake
Jig Lake
New Road to Train Loading
Wishart Creek
Gilling Lake
Louise Lake
Lac Houston
Petitsikapau Lake
Paulette Lake
Baker Lake
Gilling River
Oboe Lake
Mike Lake
New Rail Spur
Creek
Astray Lake
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Territory
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CENTURY IRON MINES CORP.
Joyce Lake Direct Shipping Iron Ore Project
- Fish and Fish Habitat Baseline Study -
Project Location
Sources:
Base: CanVec, 1/50 000, RNCan, 2010
BNDT, 1/50 000, RNCan, 2007
Mapping: GENIVAR
File: 121-18002-00_F01_FAQ_Loc_130619.mxd
Scale 1 : 135,000
0 1,35 2,7 4,05 km
UTM, zone 19, NAD83
Figure 1
November 2013
GENIVAR

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 200 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.

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.

1.2 Organization of this Baseline Study

The remainder of this Fish and Fish Habitat Baseline Study outlines the scope, methodology, and results of the baseline program, and is presented in seven sections, as follows:

- Section 1: Introduction;
- Section 2: Objectives and Rationale;
- Section 3: Description of the Study Area;
- Section 4: Methods;
- Section 4: Results;
- Section 6: Summary and Closure;
- Section 7: References.

Additional supporting information and documentation is presented in the appendices.

2 OBJECTIVES AND RATIONALE

Section 34(1) of the revised *Fisheries Act* defines fish habitat as “spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes”. The main objective of the Fish and Fish Habitat Baseline Study was to determine if the waterbodies and streams found within the Study Area provide habitat for fish species.

The specific objectives of the study were to:

- describe the aquatic habitat in waterbodies and watercourses found within the Study Area;
- determine fish species in waterbodies and watercourses within the Study Area.

The rationale for determining if the waterbodies found within the Study Area provide fish habitat is to evaluate whether the proposed Joyce Lake DSO Project will be considered an activity that contravenes Section 35(1) of the *Fisheries Act*. Section 35(1) states that: “no person shall carry on any work, undertaking or activity that results in the harmful alteration or disruption, or the destruction, of fish habitat” unless the undertaking or the activity was authorized by the Minister and is carried out in accordance with the conditions established. In addition, the information presented in this baseline study will be used to assess the impacts of the project on fish and fish habitat.

3 DESCRIPTION OF THE STUDY AREA

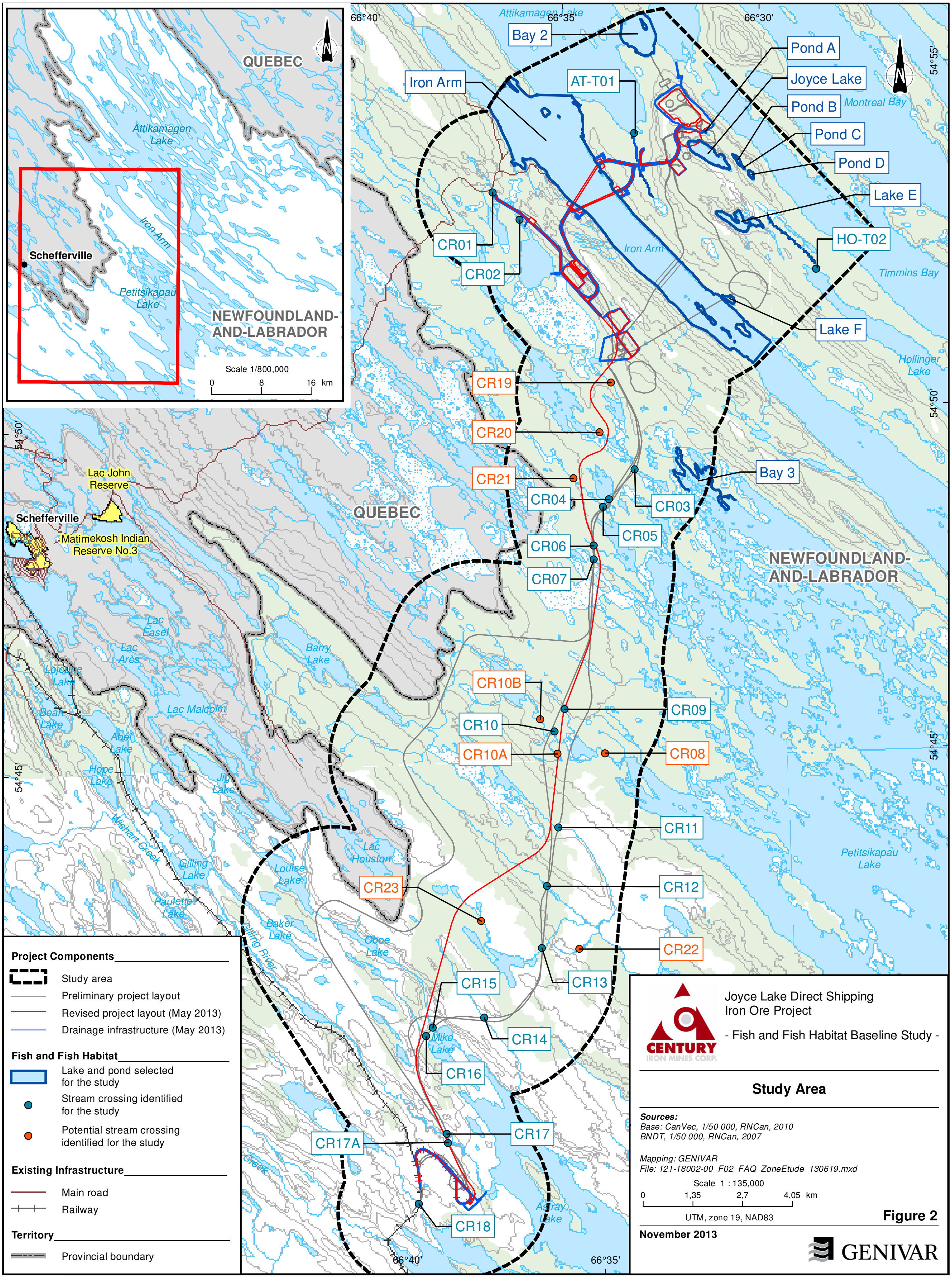
The lakes, ponds, and streams in this part of western Labrador form part of the Churchill River watershed. The Joyce Lake DSO Project lies on a peninsula of land in Attikamagen Lake, which drains south to Petitsikapau Lake via Iron Arm, then into Dyke Lake, the Ashuanipi River, and finally into the Smallwood Reservoir. The Smallwood Reservoir is the main source of water to the Churchill River. In the southern part of the Project Development Area, streams drain into Astray Lake which then drains to Dyke Lake. For the purposes of this study, the peninsula of land on which Joyce Lake is found, was named “Joyce Lake Peninsula”.

Project Development Area

The Project Development Area (PDA) is the most basic and immediate area of the Project. The PDA is limited to the anticipated area of physical disturbance associated with the construction or operation of the Project. For this Project, the mine area lies within two map-staked licences (309 claims) covering 12,665 hectares (ha). The PDA includes the mining area, conveyances across Iron Arm, a beneficiation plant on the mainland, a new haul road, access roads, an accommodation camp and a rail spur near the existing railroad (Figure 1).

Study Area

The Study Area is the maximum area within which Project-related environmental effects can be predicted or measured with a reasonable degree of accuracy and confidence. It includes the PDA and any adjacent areas where Project-related environmental effects may reasonably be expected to occur. The Fish and Fish Habitat Baseline Study Area includes the waterbodies and streams found on and around Joyce Lake Peninsula where the mining site is located (Figure 2). The streams found within the limits of a 2-km buffer surrounding the proposed infrastructures (initial and revised layouts) located on the mainland are also part of the Study Area. Table 2 lists the waterbodies, connecting streams, and stream crossings characterized during the field campaign.



QUEBEC
Attikamagen Lake
Iron Arm
Schefferville
Petitsikapau Lake
NEWFOUNDLAND-AND-LABRADOR
Scale 1/800,000
0 8 16 km
66°40'
66°35'
66°30'
54°55'
54°50'
54°45'
Attikamagen Lake
Bay 2
Iron Arm
AT-T01
Pond A
Joyce Lake
Pond B
Montreal Bay
Pond C
Pond D
Lake E
HO-T02
Timmins Bay
Lake F
Hollinger Lake
CR01
CR02
CR03
CR04
CR05
CR06
CR07
CR08
CR09
CR10
CR10A
CR10B
CR11
CR12
CR13
CR14
CR15
CR16
CR17
CR17A
CR18
CR19
CR20
CR21
CR22
CR23
Bay 3
Lac John Reserve
Schefferville
Matimekosh Indian Reserve No.3
QUEBEC
NEWFOUNDLAND-AND-LABRADOR
Lac Easel
Lac Ares
Barry Lake
Lejeune Lake
Bean Lake
Lac Malcolm
Abel Lake
Hope Lake
Jig Lake
Mishant Creek
Gilling Lake
Lac Houston
Louise Lake
Paulette Lake
Baker Lake
Oboe Lake
Gilling River
Mike Lake
Creek
Astray Lake
Petitsikapau Lake
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File: 121-18002-00_F02_FAQ_ZoneEtude_130619.mxd
Scale 1 : 135,000
0 1,35 2,7 4,05 km
UTM, zone 19, NAD83
Figure 2
November 2013
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Table 2: List of Waterbodies, Connecting Streams and Stream Crossings Characterized during the Field Campaign (see Figure 2 for locations)

Name	Coordinates	
	Latitude	Longitude
Joyce Lake	54° 53' 45.0" N	66° 31' 25.5" W
Bay 2 (Attikamagen Lake)	54° 55' 32.0" N	66° 33' 05.5" W
Iron Arm (Attikamagen Lake)	54° 53' 00.8" N	66° 33' 57 0" W
Bay 3 (Petitsikapau Lake)	54° 49' 23.2" N	66° 32' 23.7" W
Pond A	54° 54' 04.5" N	66° 31' 28.7" W
Pond B	54° 53' 38.8" N	66° 30' 41.4" W
Pond C	54° 53' 31.3" N	66° 30' 32.2" W
Pond D	54° 53' 25.1" N	66° 30' 21.5" W
Lake E	54° 52' 45.4" N	66° 30' 40.9" W
Lake F	54° 51' 37.6" N	66° 31' 01.7" W
IA-T01	54° 53’ 44.6’’ N	66° 36’ 25.8’’ W
IA-T02	54° 53’ 40.9’’ N	66° 36’ 22.4’’ W
IA-T03	54° 53’ 38.1’’ N	66° 36’ 05.7’’ W
IA-T04	54° 52’ 30.7’’ N	66° 32’ 43.2’’ W
AT-T01	54° 54’ 05.8’’ N	66° 33’ 18.6’’ W
LE-T01	54° 52’ 53.7’’ N	66° 31’ 06.7’’ W
LE-T03	54° 52’ 48.1’’ N	66° 30’ 21.9’’ W
LE-T04	54° 52’ 37.1’’ N	66° 30’ 37.3’’ W
LE-E05	54° 52’ 39.4’’ N	66° 30’ 06.2’’ W
LF-T01	54° 51’ 34.1’’ N	66° 30’ 54.6’’ W
LF-E01	54° 51’ 41.2’’ N	66° 31’ 12.4’’ W
PE-TB3	54° 49’ 27.1’’ N	66° 32’ 29.4’’ W
HO-T02	54° 53' 16.2" N	66° 30' 38.2" W
CR01	54° 53' 17.8" N	66° 36' 56.0" W
CR02	54° 52' 53.3" N	66° 36' 16.3" W
CR03	54° 49' 11.2" N	66° 33' 34.7" W
CR04	54° 48' 46.0" N	66° 34' 15.1" W
CR05	54° 48' 39.5" N	66° 34' 24.7" W
CR06	54° 48' 05.8" N	66° 34' 40.4" W
CR07	54° 47' 53.8" N	66° 34' 41.2" W
CR08	54° 45' 03.6" N	66° 34' 34.2" W
CR09	54° 45' 43.4" N	66° 35' 33.4" W
CR10	54° 45' 24.3" N	66° 35' 49.6" W

Table 2: List of Waterbodies, Connecting Streams and Stream Crossings Characterized during the Field Campaign (see Figure 2 for locations) (continued)

Name	Coordinates	
	Latitude	Longitude
CR10A	54° 45' 04.3" N	66° 35' 46.5" W
CR10B	54° 45' 35.2" N	66° 36' 11.1" W
CR11	54° 44' 00.0" N	66° 35' 48.7" W
CR12	54° 43' 09.3" N	66° 36' 09.1" W
CR13	54° 42' 15.1" N	66° 36' 20.1" W
CR14	54° 41' 15.7" N	66° 37' 50.7" W
CR15	54° 41' 08.4" N	66° 39' 09.2" W
CR16	54° 41' 01.0" N	66° 39' 19.9" W
CR17	54° 39' 35.4" N	66° 38' 53.7" W
CR18	54° 38' 34.7" N	66° 39' 39.5" W
CR19	54° 50' 28.1" N	66° 34' 05.5" W
CR20	54° 49' 44.6" N	66° 34' 25.4" W
CR21	54° 49' 05.1" N	66° 35' 07.8" W
CR22	54° 42' 12.9" N	66° 35' 23.4" W
CR23	54° 42' 40.3" N	66° 37' 50.3" W

4 METHODS

4.1 Desktop Research

Desktop research was undertaken to determine if there were any existing information in published literature regarding fish and fish habitat in the Study Area or in the Schefferville region. The information found during this research was reviewed prior to the field campaign.

4.2 Field Survey

4.2.1 Pre-Survey Planning

Prior to the field work, a work plan was prepared in collaboration with Stassinu Stantec team members. A list of waterbodies, connecting streams, and stream crossings selected for the study was established based on the initial project information available and topographic maps (1:50,000), and field methods were detailed. However, it was assumed that some changes would be required on site due to the lack of detail on the maps and to the limited accessibility to the streams.

In order to conduct fish sampling for scientific purposes in the Province of Newfoundland and Labrador an experimental fisheries licence is required from the Department of Fisheries and Oceans. An Experimental Fisheries Licence was issued to conduct fish sampling in the waterbodies and streams within the Study Area (Licence No. NL-1404-12).

4.2.2 Field Methods

All field activities were conducted between July 22 and August 10, 2012.

4.2.2.1 Waterbodies and Connecting Streams

Bathymetry

Bathymetric surveys were carried out in the lakes and ponds to determine their morphometric characteristics. The bathymetry was implemented using a depth sounder Garmin Map 521s. In Joyce Lake and Iron Arm, the bathymetric surveys were conducted by Century's employees. Century's survey was conducted on October 20, 2011 in Joyce Lake and on July 22, 2012 in Iron Arm. The bathymetric data were collected using a Humminbird 385ci depth sounder.

The collected data provided information on waterbodies such as mean and maximal depths, and volume of water. In addition, the bathymetry is required for the classification of fish habitat based on the Bradbury et al. (2001) method.

Water Chemistry

At the deepest location within the waterbodies, water temperature, dissolved oxygen, conductivity, pH, and turbidity were measured approximately 0.5 m below the water surface using a YSI 556 multiparameter water quality meter. In addition, temperature and dissolved oxygen were measured each metre down to 14 m and then each 2 metres until the bottom was reached using the same multiparameter instrument. The Secchi depth was measured using a Secchi disc to determine the approximate depth of the photic zone.

Substrate and Aquatic Vegetation Mapping

In shallow water and when the water was very clear, substrate data were collected by looking over the shaded side of a boat. Below the photic zone, sediment was sampled using a Petite Ponar grab to collect data on substrate type. The substrate was classified based on the nine categories proposed in Bradbury et al. (2001) as follows:

- Littoral zone (located near the shores at a depth above the photic limit):
  - Coarse substrate / No vegetation;
  - Medium substrate / No vegetation;
  - Fine substrate / No vegetation;
  - Coarse substrate / Vegetation;
  - Medium substrate / Vegetation;
  - Fine substrate / Vegetation;
- Non-littoral zone (below the photic limit):
  - Coarse/Pelagic;
  - Medium/Pelagic;
  - Fine/Pelagic.

This method was applied in waterbodies where the presence of fish was confirmed. Coarse substrate includes bedrock and boulder, medium substrate is composed of rubble, cobble and/or gravel, and fine substrate includes sand, silt, clay and muck. Table 3 shows the substrate categories used and adapted from Grant and Lee (2004).

In addition, plant species were identified within the vegetation zones delineated. Maps of appropriate scale and a GPS (Garmin Map 78s) were used on the field to delineate substrate categories and vegetation.

Table 3: Substrate Categories

Categories	Code	Description
Bedrock	R	Continuous solid rock exposed
Boulder	B	Rocks ranging from 25 to >100 cm in diameter
Rubble	G	Rocks ranging from 14 to 25 cm in diameter
Cobble	C	Rocks ranging from 3 to 14 cm in diameter
Gravel	V	Small stones from 0.2 to 3 cm in diameter
Sand	S	Grains ranging from 0.006 to 2 mm in diameter
Silt/Clay/Mud	L	Very fine sediment particles, usually <0.006 mm in diameter
Muck/detritus	MO	Organic material from dead organisms

Note: Adapted from Grant and Lee (2004)

Shoreline Description

Shorelines were described in terms of substrate, gradient, and riparian vegetation, and divided into homogenous segments based on substrate composition. Segments were located using a Garmin GPS Map 78s (accuracy of 3 m). The percent coverage of each substrate class was estimated visually. In each segment, the shoreline gradient was qualified (low, moderate, steep) and the percent coverage of arborescent, shrubby and herbaceous vegetation found within a 15-m riparian zone was also estimated. Photographs were taken for each segment and for any relevant components observed.

Connecting streams (tributaries flowing in or flowing out of the lakes) were identified and characterized. The following information was also collected for at least the lowermost 100 m of each tributary: average depth, average width, surface velocity, habitat type, substrate composition, cover, riparian vegetation, stream bank stability, and any obstructions to fish passage. Habitat types are described in Table 4.

For both lakes and connecting streams, suitable spawning habitats were also identified and described (substrate, size, compaction, organic material, periphyton, etc). Any other relevant information such as beaver dams, cabins, launching ramps, or the presence or signs of wildlife was noted. Photographs were taken for each segment and for all noteworthy features.

Table 4: Description of Habitat Types Used to Characterize Streams

Habitat Type	Habitat Parameter	Description
Fast water	Mean water velocity: >0.5 m/s; stream gradient: >4 %	
Rapid	General description:	Considerable white water present
	Mean water velocity	>0.5 m/s
	Mean water depth:	< 0.6 m
	Substrate:	Usually dominated by boulders and rubble with finer substrates possibly present in smaller amounts. Large boulders typically break the surface.
	Stream gradient:	Generally 4-7 %
Falls/Chute/ Cascade	General description:	The dominating feature is a rapid change in stream gradient with most water free-falling over a vertical drop or series of drops.
	Mean water velocity:	>0.5 m/s
	Mean water depth:	Variable and will depend on degree of constriction of stream banks.
	Substrate:	Dominated by bedrock and/or large boulders.
	Stream gradient:	>7 % and can be as high as 100 %
Run	General description:	Relatively swift flowing, laminar and non-turbulent.
	Mean water velocity:	> 0.5 m/s
	Mean water depth:	> 0.3 m
	Substrate:	Predominantly gravel, cobble and rubble with some boulders and sand in smaller amounts.
	Stream gradient:	Typically < 4 %
Moderate water	Mean water velocity: 0.2 to 0.5 m/s; stream gradient: > 1 and < 4 %	
Riffle	General description:	Relatively shallow and characterized by a turbulent surface with little or no white water.
	Mean water velocity:	0.2 to 0.5 m/s
	Mean water depth:	< 0.3 m
	Substrate:	Typically dominated by gravel and cobble with some finer substrates present, such as sand. A small amount of larger substrates may be present, which may break the surface.
	Stream gradient:	> 1 and < 4 %
Steady/Flat	General description:	Relatively slow-flowing.
	Mean water velocity:	0.2 to 0.5 m/s
	Mean water depth:	> 0.2 m
	Substrate:	Predominantly sand and finer substrates with some gravel and cobble.
	Stream gradient:	<1 and < 4 %
Slow water	Mean water velocity: generally < 0.2 m/s; stream gradient: < 1 %	
Plunge/ trench/ debris/ pools	General description:	Generally caused by increased erosion near or around a larger, embedded object in the stream such as a rock or a log or created by upstream water impoundment.
	Mean water velocity:	<0.2 m/s
	Mean water depth:	> 0.5 m depending on stream size
	Substrate:	Highly variable
	Stream gradient:	Generally <1 %
Eddy	General description:	Relatively small pools caused by a combination of damming and scour.
	Mean water velocity:	Typically < 0.4 m/s, but can be variable.
	Mean water depth:	> 0.3 m. May vary depending on obstruction type, orientation, streambed and bank material and flows experienced.
	Substrate:	Predominantly sand, silt and organics with some gravel in smaller amounts.
	Stream gradient:	Variable

Adapted from DFO NL (2012)

Fish Sampling

Fish sampling was conducted in Joyce Lake, as well as in six unnamed ponds/lakes located on the peninsula. These were identified as Ponds A, B, C, D and Lakes E and F for the present study. In addition, fish sampling was also conducted in two areas in Attikamagen Lake: in Iron Arm and in a bay named Bay 2 (Figure 2). Fishing was carried out using gillnets, fyke nets, minnow traps, and seine nets. Gillnets were checked every two hours during the day and remained overnight only when the catches were not abundant. Gear specifications are provided in Table 5 while gear locations and fishing effort are given in Appendix A.

Table 5: Gear Specifications

Gear type	Code	Specifications
Gillnet	FE	6 panels of 3.8 m with mesh sizes: 25, 32, 38, 51, 64, 76 mm
Fyke net	VV	0.6 X 0.6 m opening; with wings and lead; 0.6 mm mesh size
Minnow trap	BO	41 cm long, 21 cm in diameter and 2.5 cm opening
Seine net	SE	1.8 m X 22.8 m; 6 mm mesh size

Gillnets were set perpendicular to the shore and small mesh sizes were set nearshore and offshore in alternation. Fyke nets were also set perpendicular to the shore. Minnow traps were distributed in shallow water in habitat favourable to small species (aquatic vegetation, covered by overhead vegetation, near shelter such as boulders or fallen trees, etc.). These traps were baited with bread. Finally, seine nets were used in shallow water where the bottom was relatively even and free of large debris. The time was noted, and the water temperature and water depth were measured at each fishing station during installation.

When fishing gears were retrieved from the water, all dead fish were collected and placed into a bag identified to the station and carried to a temporary laboratory for measurement. Fish caught alive were identified, measured (total length) and released. Dead fish were identified, measured (total length) and weighted. Sex and gonad development stage were also determined for brook trout, lake trout, round whitefish, longnose sucker, and white sucker. In each lake, bone structures were also collected on the first 50 specimens of each species in the event age determination would be required as complementary information. Abnormalities and parasites were noted when observed.

4.2.2.2 Stream Crossings

The footprint of the road, linking the proposed processing plant to the existing road and to the train loading station, was preliminary at the time the field work was conducted (initial project layout [Project Description and Provincial Registration, November 5, 2012]). In the event the project layout would change, a few additional stream sections were selected and identified as potential crossings.

Habitat Description

Stream crossings were characterized over approximately 250 m upstream and downstream from the intercept point. When the helicopter could not land near the intercept point, another part of the stream was characterized to provide a general idea of the type of habitat found in the stream. Stream crossings were divided into homogenous segments based on habitat types (Table 3). In each segment, the following information was collected: length, mean width, water depth, flow velocity, type of habitat (flow pattern), number of pools and dimensions, substrate composition, bank description (high water mark, riparian vegetation cover, sign of erosion), presence of aquatic vegetation and cover, fish barrier, shelter and suitable spawning habitats.

Temperature, conductivity, pH and dissolved oxygen were measured using YSI 63 and Oakton 300 water quality meters in each stream.

In addition to that 500 m section, a search of good-quality habitat and fish passage obstruction was conducted in a 2-km buffer upstream and downstream of the intercept point in the case the road footprint were to change.

Electrofishing

Electrofishing was conducted to determine the fish species found within the stream potentially crossed by the road. However, due to transport and delivery delays, the electrofisher was only available to the field crew starting on August 7. Heavy rainfall raised the water level in the streams from 40 to 50 cm from the beginning (July 22) to the end (August 10) of the field campaign. The high water levels made electrofishing impossible in some streams.

Index electrofishing stations covered 6 to 120 m² depending on the stream width, water depth and flow velocity. No blocknets were installed upstream or downstream, and only one sweep was conducted in each station. Each station was described: water temperature, station length and width, mean water depth, flow pattern, flow speed, vegetation cover and substrate composition. Station coordinates and fishing time were recorded. Fish captured were identified, measured (total length) and released.

4.2.3 Data Analysis

All the data collected were tabulated in various tables and all raw data are appended to the report. Data and results are summarized in tables and maps for each lake, pond and stream characterized.

Water Quality

The dissolved oxygen values were compared to the minimum requirement of fish determined using the following equation (Turgeon, 1985):

$$D.O. = \frac{0.353352 \times \left(760 + \left(\frac{A}{10}\right)\right)}{33.5 + T}$$

Where:

D.O.	:	Dissolved oxygen (mg/L)
T	:	Water temperature (ºC)
A	:	Altitude of the waterbody (m)

Lake Morphometry

The shoreline development index (D_L) and the volume development index (D_V) were calculated for each lake and pond. The equations for these two indices are as follows:

$$D_L = \frac{C}{2\sqrt{S * \pi}}$$

$$D_V = \frac{\overline{D}}{Dmax} * 3$$

Where:

D_L	:	Shoreline development index
D_V	:	Volume development index
C	:	Circumference or perimeter (m)
S	:	Surface area (m²)
$\overline{D}$	:	Mean depth (m)
Dmax	:	Maximum depth (m)

Fish Population

The number of fish captured was determined for each species, fishing gear, and sampling station. In each waterbody, mean length was calculated for each species. In addition, mean mass and mean Fulton's coefficient factor (K) were calculated on fish weighted:

$$K = \frac{M * 10^5}{L^3}$$

Where:

K : Fulton's coefficient of condition

M : Fish fresh weight (g)

L : Fish total length (mm)

When there was enough data for one species, the weight-length equation was estimated using a power function (Ricker, 1980):

$$M = a * L^b$$

Where:

M : Fish fresh weight (g)

L : Fish total length (mm)

a and b : Constants

The Relative Stock Density index (RSD) and the Proportional Stock Density index (PSD) were calculated for game fish: lake trout, brook trout and northern pike. These indices quantify length-frequency data. The length categories used are presented in Table 6 (MEF, 1994). The RSD index is calculated as:

$$RSD = \frac{\text{Number of fish} \geq \text{specified length}}{\text{Number of fish} \geq \text{stock length}} \times 100$$

The PSD index is defined as:

$$PSD = \frac{\text{Number of fish} \geq \text{quality length}}{\text{Number of fish} \geq \text{stock length}} X100$$

Catch per unit effort, expressed as number of fish caught per unit of effort (CPUE) and biomass of fish caught per unit effort (BPUE), and relative abundance are calculated for each lake. In lakes where fish sampling was conducted only during the day, the catch per unit effort is reported as number of fish caught per gear-day, where a gear-day represents approximately 6 hours. For overnight sets, CPUE is given as the number of fish caught per gear-night, a gear-night being approximately 18 hours.

When the mass-length relation was determined for a specific species in a lake, the mass of the fish of that species that were not weighted was determined so as to calculate the total biomass of fish captured in the lake.

Table 6: Length Categories for Lake Trout, Brook Trout and Northern Pike

Categories	Length (mm)		
	Lake trout	Northern pike	Brook trout
Sub-stock	< 300	< 350	< 150
Stock	300-509	350-529	150-249
Quality	510-659	530-709	250-324
Preferred	660-809	710-859	325-399
Memorable	810-1,019	860-1,119	400-499
Trophy	≥ 1,020	≥ 1,120	≥ 500

Source: MEF (1994)

Fish Habitat Classification/Quantification

The classification and quantity of fish habitat in lakes found on Joyce Lake Peninsula was determined using DFO Guide for lacustrine habitat (Bradbury et al., 2001).

4.3 Photo-Interpretation

The field work was conducted using the initial project layout. Therefore, some streams or parts of streams, now included in the Study Area, were not covered by the field program. The habitats found in these streams were characterized using photo-interpretation and habitat characteristics were validated from data collected on the field in similar habitats. In addition, fish barriers were searched downstream from the proposed crossings to provide information on fish species potentially present.

4.4 Quality Assurance/Quality Control (QA/QC) Procedures

The Quality Assurance/Quality Control (QA/QC) Program includes planning, organization, communication, fieldwork, data analysis, reporting and the review of completed work. The QA/QC Program included the following elements:

- Experienced professionals with a good understanding of the project and of its objectives;
- A kick-off meeting with the study team to present the project and the baseline study objectives;
- Trained and experienced technical teams of at least two persons;
- Use of standard methods, with equipment in good condition and appropriate for the work to be carry out;
- Preparation of specific protocols including the type of sample required, measurements required, sampling methods, etc.;
- Use of field forms;

- Use of recent and standard reference documents;
- Control of data tabulation;
- Conservation of original data and data analysis results (hard copy and electronic);
- Revision of all documents produced by qualified professionals.

5 RESULTS

5.1 Desktop Research

A total of 25 species, are reported to occur throughout the fresh waters of Labrador (Bradbury et al., 1999). According to NML (2009), 11 fish species were found in the Schefferville region and these include:

- brook trout (*Salvelinus fontinalis*);
- lake trout (*Salvelinus namaycush*);
- burbot (*Lota lota*);
- lake chub (*Couesius plumbeus*);
- lake whitefish (*Coregonus clupeaformis*);
- round whitefish (*Prosopium cylindraceum*);
- longnose sucker (*Catostomus catostomus*);
- white sucker (*Catostomus commersoni*);
- northern pike (*Esox lucius*);
- slimy sculpin (*Cottus cognatus*);
- ouananiche (Landlocked Atlantic salmon; *Salmo salar*).

Brook trout is widely distributed in streams while lake trout is commonly found in regional lakes. According to NML (2009), ouananiche migrates every year, to spawn, up Howell River, which discharges into Astray Lake.

No specific information was found in the Study Area concerning fish species and fish habitat.

5.2 Lakes and Connecting Streams

A total of 10 fish species were found in the Study Area: longnose sucker, white sucker, lake chub, threespine stickleback (*Gasterosteus aculeatus*), mottled sculpin (*Cottus bairdi*), burbot, pearl dace (*Margariscus margarita*), round whitefish, brook trout and lake trout. None of these are listed under the Newfoundland and Labrador *Endangered Species Act* or the federal *Species at Risk Act*.

This section presents the results of the fieldwork, conducted from July 22 to August 10, 2012, to determine fish species found in the Study Area and to describe the fish habitat present in ponds, lakes and streams.

5.2.1 Attikamagen Lake

Morphometry

Attikamagen Lake is a large waterbody with a surface area of 27,053 ha characterized by the presence of numerous bays (Figure 2). The perimeter of this lake is 780 km and the shoreline development index is 13.4, which is typical of highly productive lakes. The shoreline development reflects the potential for greater development of littoral communities in proportion to the volume of the lake (Wetzel, 2001).

Considering the size of Attikamagen Lake and the small size of the project, only parts of it were characterized in 2012; these parts being Iron Arm and a bay located on the north side of Joyce Lake peninsula, named Bay 2 (Figures 3a to 3d and 4).

Iron Arm

Iron Arm is the connection between Attikamagen Lake and Petitsikapau Lake. Iron Arm covers a surface area of 4,032 ha (Figure 5). The bathymetric survey was conducted only in the central part of Iron Arm. The maximum depth reaches 34.8 m in a pool located at the head of the channel. Shallow waters are found mainly on the eastern shore of Iron Arm and in its southern part (Figures 3a to 3d).

Bay 2

Bay 2 is characterized by shallow waters, with a mean water depth of 2.0 m and a maximum water depth of 6.5 m (Figure 6). It covers a surface area of 78 ha and the shoreline is 3.3 km long.

Water Chemistry

The temperature-oxygen profiles in Iron Arm and in Bay 2 showed that no thermal stratification was established during the field survey (Figures 5 and 6). However, the two profiles were not measured at the deepest area in the lake. Therefore the thermocline could be present below 10 m or it could develop later during the summer. The surface temperature was around 15.5 °C and the dissolved oxygen was 7.83 mg/L in Iron Arm and 9.64 mg/L in Bay 2. The minimum dissolved oxygen requirement for fish was reached in the first 10 m of water. The water showed no particular colour and the Secchi depth was 7.8 and 6.0 m in Iron Arm and Bay 2, respectively. These values are quite high and, in general, representative of low-productivity lakes. The acidity of a waterbody may increases its transparency by promoting settlement of particulate matter. In Attikamagen Lake, the pH is slightly alkaline with pH values of 7.43 and 7.70. The conductivity is higher as compare to the other waterbodies found in the Study Area, with 50.0 and 47.0 µS/cm measured in Iron Arm and Bay 2, respectively. A high conductivity reflects, in general, an important quantity of electrolytes, and confers to the lake a greater potential of production.

Project Components

Revised project layout (May 2013)

Drainage infrastructure (May 2013)

Fishing

FE-01 — Gear type; Sequential number

RWF 42 — Number of capture

LT 1 — Species

Species

× No fish

WS White sucker

TSS Threespine stickleback

PD Pearl dace

RWF Round whitefish

LT Lake trout

Fishing Gear

Minnow trap (BO)

Gill net (FE)

Segmentation

Fish barrier

Shoreline segment

Stream segment

Type of habitat

Fast water

S4 MO-C-S — Substrate; Segment number

IA-T01-S1 MO-B — Substrate; Segment number; Stream number; Iron Arm

Substrate

R	Bedrock
B	Boulder (250 to 1,000 mm)
G	Rubble (140 to 250 mm)
C	Cobble (30 to 140 mm)
V	Gravel (2 to 30 mm)
S	Sand (0.006 to 2 mm)
MO	Organic material

Habitat Characteristics

5 Isobathe (Equidistance: 2 m)

Water physico-chemistry

Potential spawning ground (SAFO)

Aquatic vegetation

Flow direction

Existing Infrastructure

Main road

Cabins

CENTURY IRON MINES CORP.

Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Iron Arm

Sources:
Base: CanVec, 1/50 000, RNCan, 2010
Orthophoto: Mosaïque photo XEOS

Mapping and inventory: GENIVAR 2012
File: 121-18002-00_F03_FAQ_Iron_Arm_Atlas_130619.mxd

Scale 1:15 000

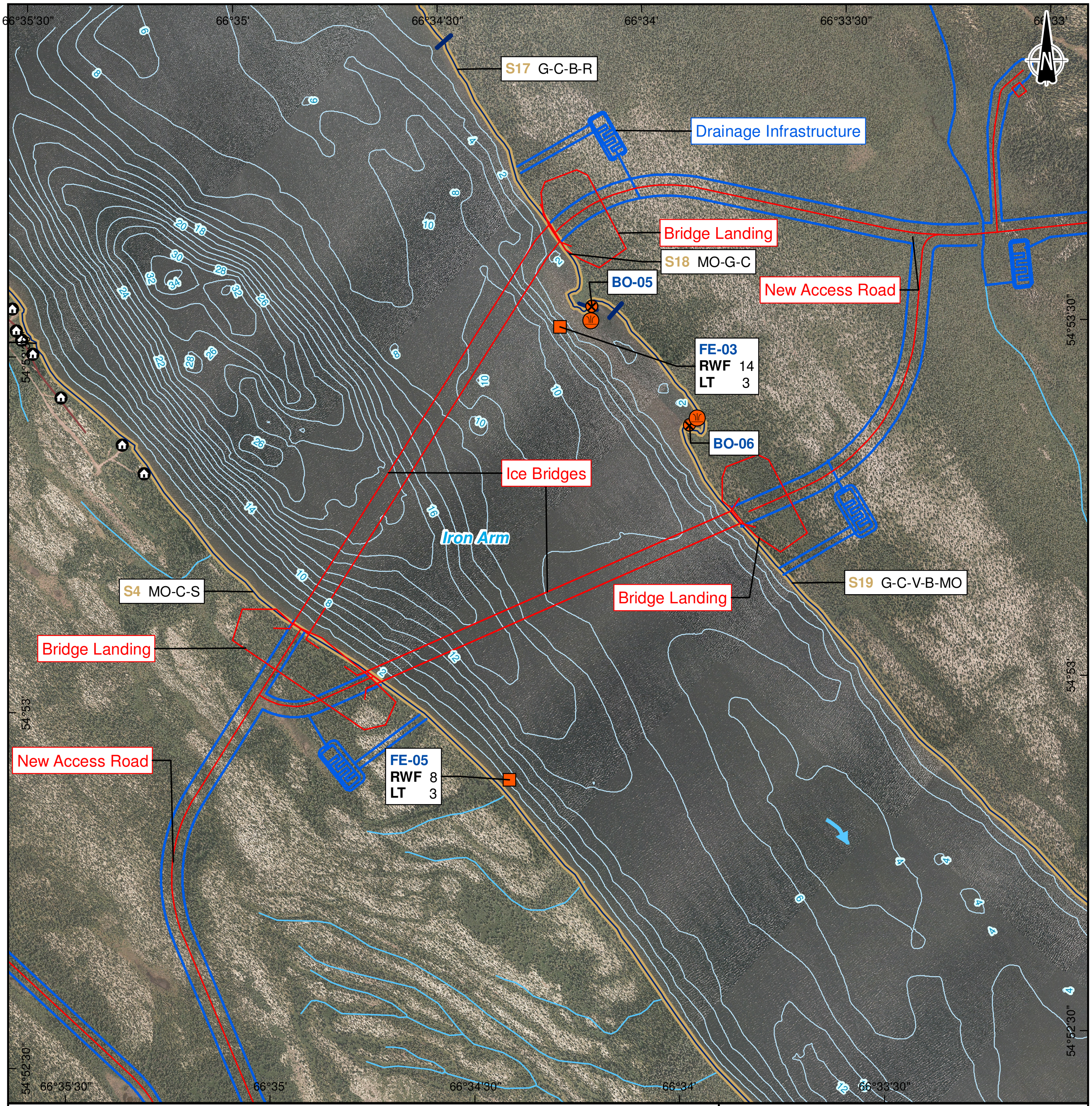
0 150 300 450 m

UTM, zone 19, NAD83

Figure 3a

November 2013

GENIVAR



Project Components

Revised project layout (May 2013)

Drainage infrastructure (May 2013)

Fishing

FE-01 — Gear type, Sequential number

RWF 42 — Number of capture

LT 1 — Species

Species

× No fish

WS White sucker

TSS Threespine stickleback

PD Pearl dace

RWF Round whitefish

LT Lake trout

Fishing Gear

Minnow trap (BO)

Gill net (FE)

Segmentation

Fish barrier

Shoreline segment

Stream segment

Type of habitat

Fast water

S4 MO-C-S — Substrate, Segment number

IA-T01-S1 MO-B — Substrate, Segment number, Stream number, Iron Arm

Substrate

R Bedrock

B Boulder (250 to 1,000 mm)

G Rubble (140 to 250 mm)

C Cobble (30 to 140 mm)

V Gravel (2 to 30 mm)

S Sand (0.006 to 2 mm)

MO Organic material

Habitat Characteristics

5 Isobathe (Equidistance: 2 m)

Water physico-chemistry

Potential spawning ground (SAFO)

Aquatic vegetation

Flow direction

Existing Infrastructure

Main road

Cabins

CENTURY IRON MINES CORP.

Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Iron Arm

Sources:

Base: CanVec, 1/50 000, RNCan, 2010

Orthophoto: Mosaïque photo XEOS

Mapping and inventory: GENIVAR 2012

File: 121-18002-00_F03_FAQ_Iron_Arm_Atlas_130619.mxd

Scale 1:15 000

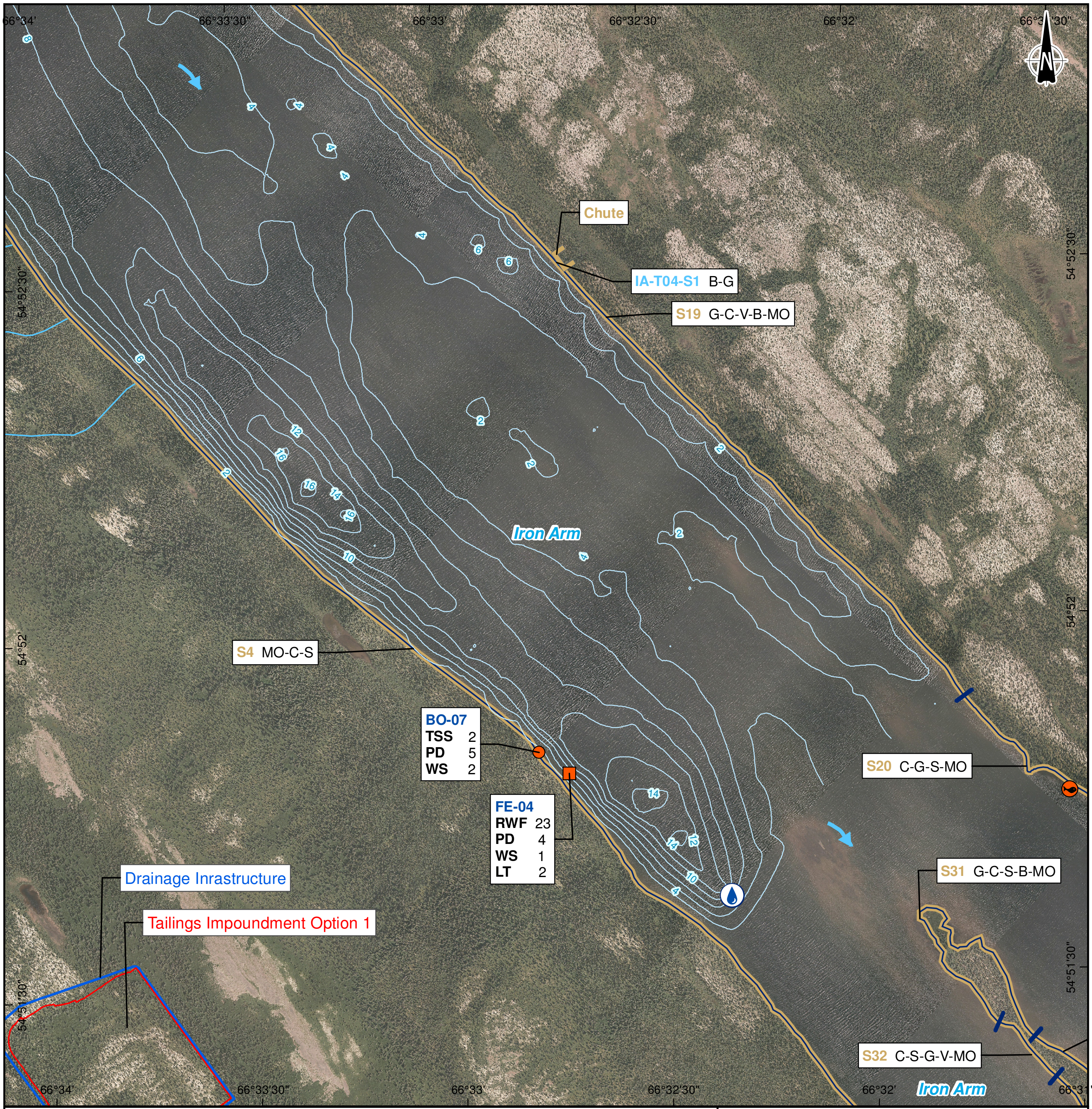
0 150 300 450 m

UTM, zone 19, NAD83

Figure 3b

November 2013

GENIVAR



Project Components
- Revised project layout (May 2013)
- Drainage infrastructure (May 2013)

Fishing

FE-01		
RWF	42	
LT	1	

Gear type; Sequential number; Number of capture; Species

Species
- × No fish
- WS White sucker
- TSS Threespine stickleback
- PD Pearl dace
- RWF Round whitefish
- LT Lake trout

Fishing Gear
- Minnow trap (BO)
- Gill net (FE)

Segmentation
- Fish barrier
- Shoreline segment
- Stream segment

Type of habitat
- Fast water

S4 MO-C-S — Substrate; Segment number

IA-T01-S1 MO-B — Substrate; Segment number; Stream number; Iron Arm

Substrate
- R Bedrock
- B Boulder (250 to 1,000 mm)
- G Rubble (140 to 250 mm)
- C Cobble (30 to 140 mm)
- V Gravel (2 to 30 mm)
- S Sand (0.006 to 2 mm)
- MO Organic material

Habitat Characteristics
- 5 Isobathe (Equidistance: 2 m)
- Water physico-chemistry
- Potential spawning ground (SAFO)
- Aquatic vegetation
- Flow direction

Existing Infrastructure
- Main road
- Cabins

CENTURY IRON MINES CORP.

Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Iron Arm

Sources:
Base: CanVec, 1/50 000, RNCan, 2010
Orthophoto: Mosaïque photo XEOS

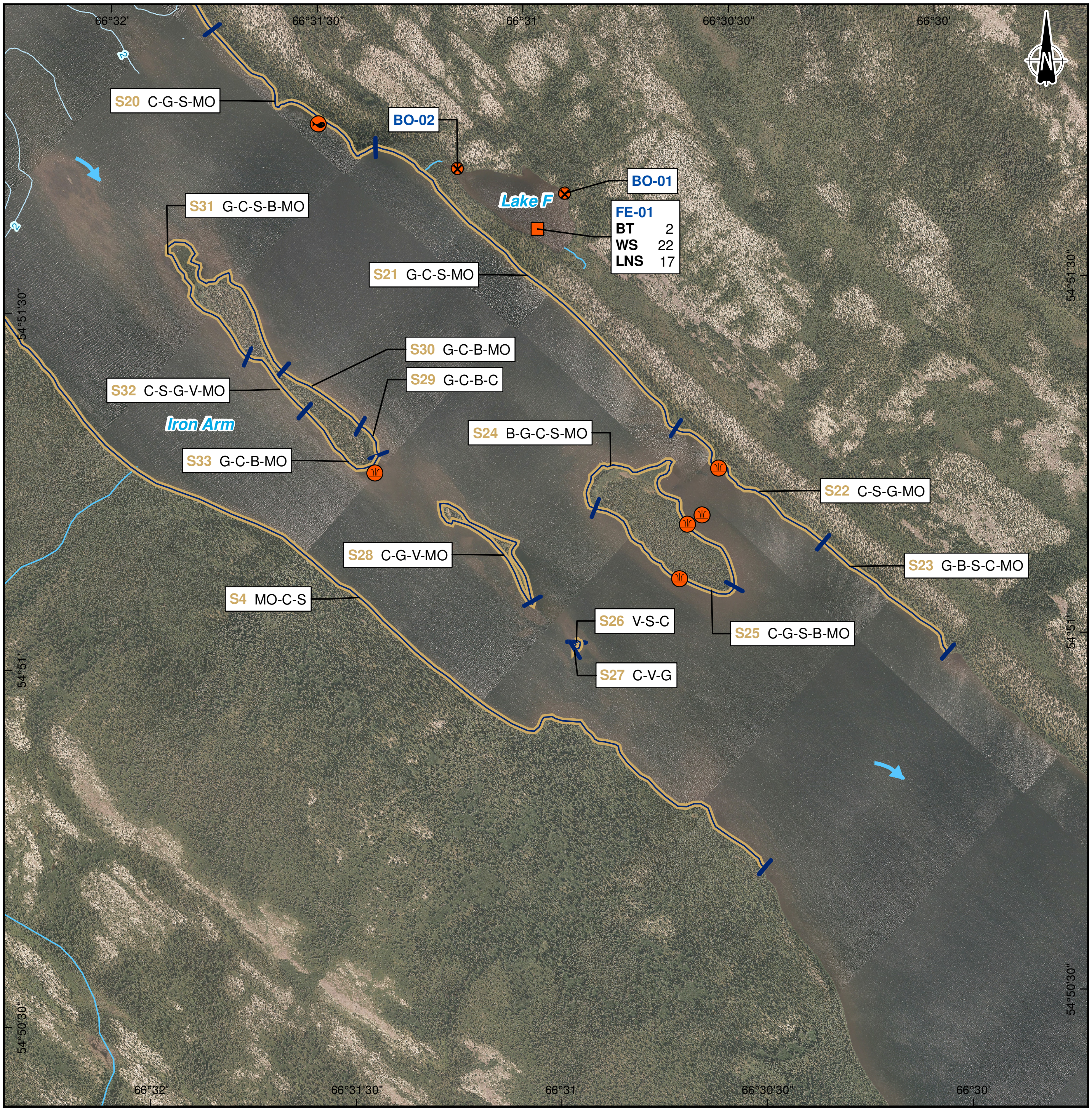
Mapping and inventory: GENIVAR 2012
File: 121-18002-00_F03_FAQ_Iron_Arm_Atlas_130619.mxd

Scale 1:15 000
0 150 300 450 m
UTM, zone 19, NAD83

Figure 3c

November 2013

GENIVAR



Project Components

Revised project layout (May 2013)

Drainage infrastructure (May 2013)

Fishing

- Gear type
- Sequential number
- Number of capture
- Species

FE-01
RWF 42
LT 1

Species

×	No fish
WS	White sucker
TSS	Threespine stickleback
PD	Pearl dace
RWF	Round whitefish
LT	Lake trout

Fishing Gear

Minnow trap (BO)

Gill net (FE)

Segmentation

Fish barrier

Shoreline segment

Stream segment

Type of habitat

Fast water

S4 MO-C-S — Substrate, Segment number

IA-T01-S1 MO-B — Substrate, Segment number, Stream number, Iron Arm

Substrate

R	Bedrock
B	Boulder (250 to 1,000 mm)
G	Rubble (140 to 250 mm)
C	Cobble (30 to 140 mm)
V	Gravel (2 to 30 mm)
S	Sand (0.006 to 2 mm)
MO	Organic material

Habitat Characteristics

5 — Isobathe (Equidistance: 2 m)

Water physico-chemistry

Potential spawning ground (SAFO)

Aquatic vegetation

Flow direction

Existing Infrastructure

Main road

Cabins

CENTURY IRON MINES CORP.

Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Iron Arm

Sources:
Base: CanVec, 1/50 000, RNCan, 2010
Orthophoto: Mosaïque photo XEOS

Mapping and inventory: GENIVAR 2012
File: 121-18002-00_F03_FAQ_Iron_Arm_Atlas_130619.mxd

Scale 1:15 000

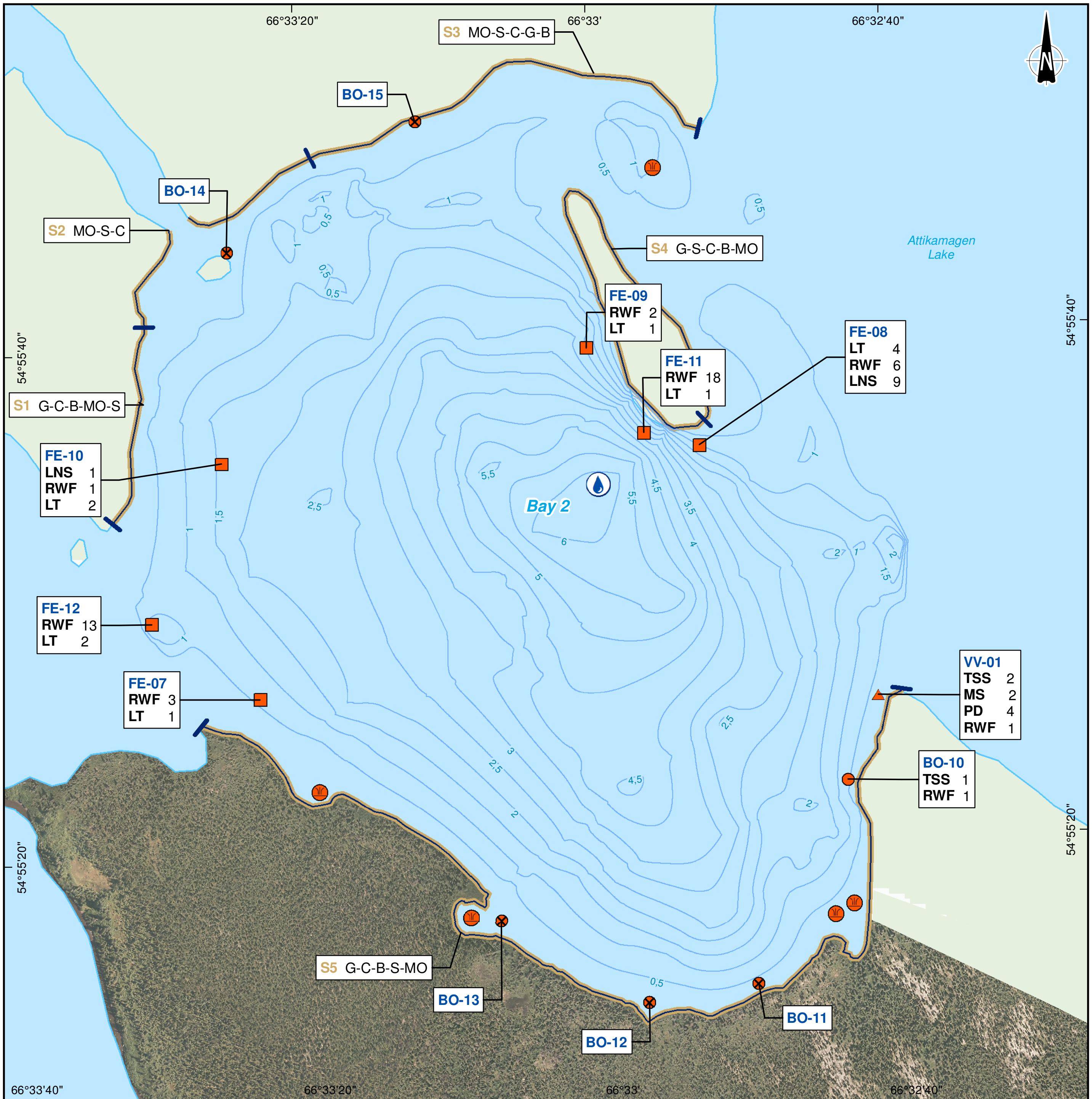
0 150 300 450 m

UTM, zone 19, NAD83

Figure 3d

November 2013

GENIVAR



Fish Sampling

- FE-08 — Gear type / Sequential number
- LT 4, RWF 6, LNS 9 — Number of capture
- Species

Species

×	No fish
LNS	Longnose sucker
MS	Mottled sculpin
TSS	Threespine stickleback
PD	Pearl dace
RWF	Round whitefish
LT	Lake trout

Fishing Gear

- Minnow trap (BO)
- Gill net (FE)
- Fyke net (VV)

Segmentation

- Shoreline segment
- S2 MO-S-C — Substrate / Segment number

Substrate

B	Boulder (250 to 1,000 mm)
G	Rubble (140 to 250 mm)
C	Cobble (30 to 140 mm)
S	Sand (0.006 to 2 mm)
MO	Organic material

Habitat Characteristics

- 5 — Isobathe (Equidistance: 0.5 m)
- Water physico-chemistry
- Aquatic vegetation

CENTURY IRON MINES CORP.

Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Bay 2

Sources:
Base: CanVec, 1/50 000, RNCan, 2010
Orthophoto: Mosaïque photo XEOS

Mapping and inventory: GENIVAR 2012
File: 121-18002-00_F04_FAQ_Bay_2_130619.mxd

Scale 1:7 000
0 70 140 210 m
UTM, zone 19, NAD83

Figure 4

November 2013

GENIVAR

Iron Arm

Watershed: Petitsikapau Lake **Latitude:** 54°53'00.8" N
Altitude (m): 477 **Longitude:** 66°33'57.0" W

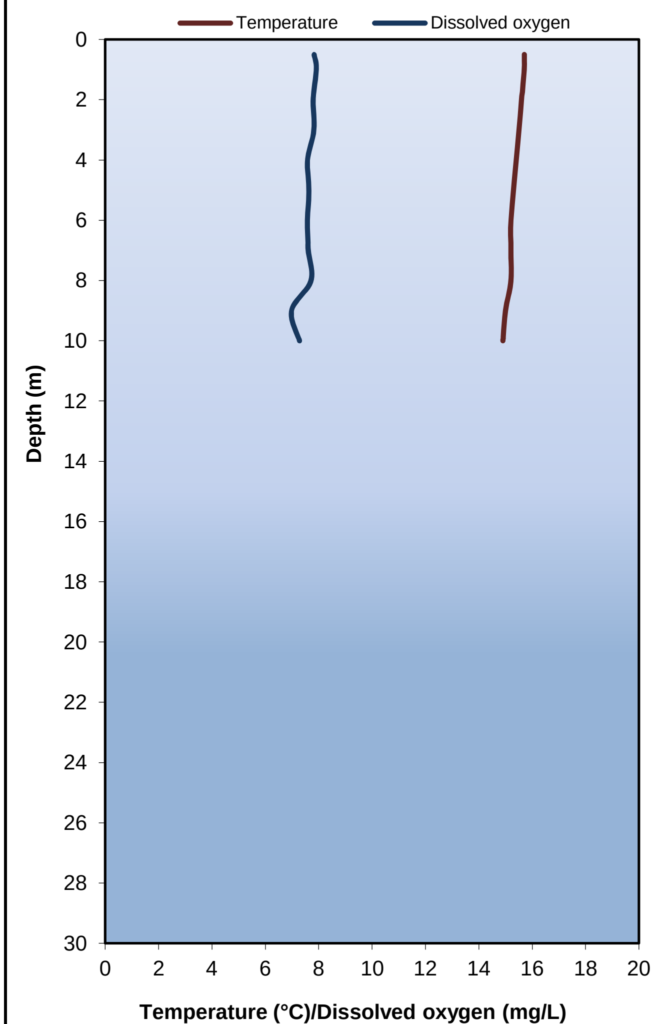
Morphometry

Surface area (ha): 4,032
Perimetre (m): Not determined
Volume (m³): Not determined
Maximum length (km): Not determined
Mean depth (m): Not determined
D_L[2]: Not determined
D_V[3]: Not determined
Island (#): 6
Connecting streams: 18

Water physico-chemistry

Date: July 29, 2012 **Maximum depth (m):** 34.8

Depth (m)	Temperature (°C)	Dissolved oxygen (mg/L)[1]	Min. requirement (mg/L)
0.5	15.7	7.83	5.80
1.0	15.7	7.91	5.80
2.0	15.6	7.79	5.81
3.0	15.5	7.82	5.82
4.0	15.4	7.58	5.84
5.0	15.3	7.63	5.85
6.0	15.2	7.58	5.86
7.0	15.2	7.61	5.86
8.0	15.2	7.71	5.86
9.0	15.0	6.98	5.88
10.0	14.9	7.28	5.90



Colour: Clear **Conductivity (µS/cm):** 50.0
pH: 7.43 **Transparency (m):** 7.8

[1] Minimum requirement for fish (Turgeon, 1985); the values shown in red indicate that the dissolved oxygen concentration is below the minimum requirement.
[2] Shoreline development index
[3] Volume development index

Figure 5. Morphometric Characteristics and Water Physicochemistry in Iron Arm

Attikamagen Lake, Bay 2

Watershed: Petitsikapau Lake **Latitude:** 54°55'32.0" N
Altitude (m): 477 **Longitude:** 66°33'05.5" W

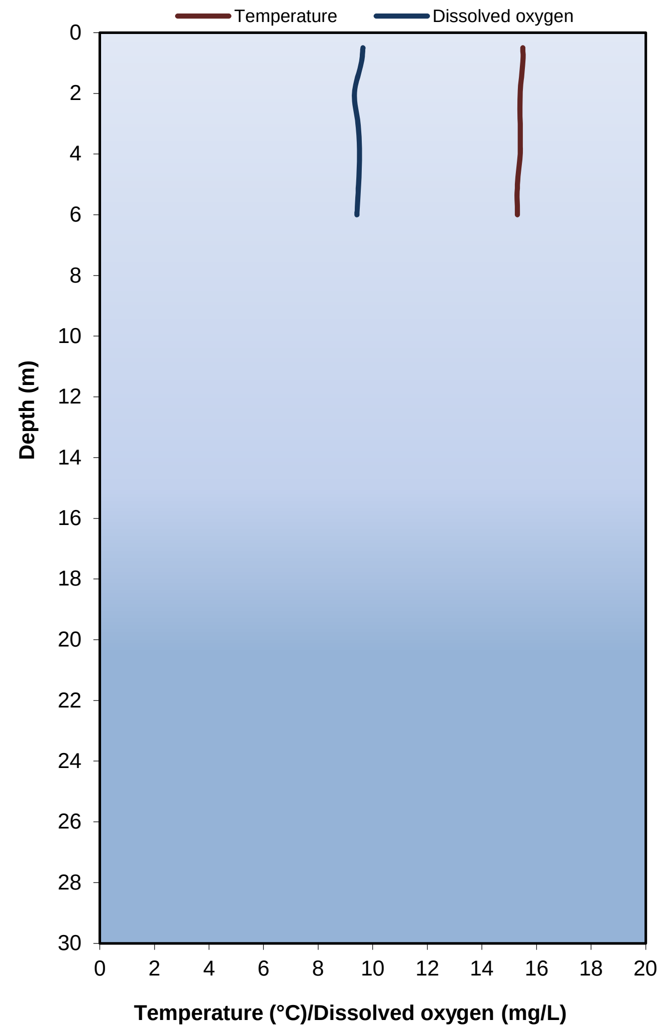
Morphometry

Suface area (ha):	78.0	**D_L²:**	Not determined
Perimetre (m):	3,303	**D_V³:**	Not determined
Volume (m³):	Not determined	**Island (#):**	1
Maximum length (km):	Not determined	**Connecting streams:**	0
Mean depth (m):	2.0		

Water physico-chemistry

Date: July 30, 2012 **Maximum depth (m):** 6.5

Depth (m)	Temperature (°C)	Dissolved oxygen (mg/L)[1]	Min. requirement (mg/L)
0.5	15.5	9.64	5.82
1.0	15.5	9.58	5.82
2.0	15.4	9.33	5.84
3.0	15.4	9.46	5.84
4.0	15.4	9.52	5.84
5.0	15.3	9.48	5.85
6.0	15.3	9.42	5.85



Colour: Clear **Conductivity (µS/cm):** 47.0
pH: 7.70 **Transparency (m):** 6.0

[1] Minimum requirement for fish (Turgeon, 1985); the values shown in red indicate that the dissolved oxygen concentration is below the minimum requirement.
[2] Shoreline development index
[3] Volume development index

Figure 6. Morphometric Characteristics and Water Physicochemistry in Bay 2

Fish Population

On July 29 and 30 2012, a fish sampling was conducted in Iron Arm and in Bay 2 using gillnets, a fyke net and minnow traps (Figure 7; Appendices A and B). Fishing gear was set during the day only and fished for approximately 6 hours. A total of seven fish species were caught, with the round whitefish and lake trout being the two most abundant with relative abundances of 70.6 and 10.8 %, respectively. The other species found were longnose sucker, white sucker, pearl dace, mottled sculpin and threespine stickleback, accounting for less than 5 % each. Gillnets provided the highest yield, with 14.5 captures per gear-day, and a biomass of 3,557 g per gear-day (Figure 7). This is relatively high considering that a gear-day represents only 6 hours and indicates that Attikamagen Lake is quite productive.

The round whitefish have a mean length of 215.9 mm and a mean weight of 81.6 g (Figure 7). The length-frequently distribution indicates that fish from 200 to 250 mm were the most abundant. Small specimens of less than 100 mm, probably juveniles, were also caught.

Lake trout have a mean length of 528.6 mm and a mean weight of 1,503 g. However, the length-frequency varies widely (Figure 7). Smaller specimens ranged from 250 to 400 mm while bigger fish were between 500 and 750 mm. Lake trout were mostly distributed in the quality (50) and stock (25) categories, and the PSD index is 72. According to Anderson and Weithman (1978), a balanced population has, in general, a PSD index between 30 and 70. A PSD index of 72 indicates the presence of a greater number of large specimens, but in the case of lake trout this could be influenced by the gear type selectivity and by a low fishing effort only during the day. Juvenile lake trout are rarely caught using gillnets and fyke nets near the shoreline.

Lacustrine Habitats

Iron Arm

The substrate along the shoreline is mostly composed of cobble and rubble (Figure 3; Appendix C). However, in the small bays near the cabins on the west shore, the substrate is predominantly muck, with some cobble and sand. In these two bays, segments S2 and S3, four aquatic vegetation zones were identified (VE-02 to VE-05; Photos 9 and 10, Appendix D). These were composed of bur-reed (*Sparganium sp.*) and rush (*Juncus sp.*). Segment S4 covers most of the west shoreline and no aquatic vegetation was found in this segment.

Segments S10, S11 and S24 to S33 are located around the islands found in Iron Arm. The substrate of the islands' shoreline is variable: mostly composed of cobble and rubble, while in some segments boulders or gravel can be predominant. Bur-reed was found in segments S10 (VE-06), S24 (VE-12), and S33 (VE-15; Photos 11, 16 and 19, Appendix D). Sedge (*Carex sp.*) was found in S24 (VE-13) and S25 (VE-14) and rushes were also present in S24 (Photos 17 and 18, Appendix D). Terns were observed during the field work on one of the island (segment S11).

The eastern shoreline is described in segments S12 to S23. S13 and S18 are small bays where muck is the predominant substrate constituent. The bay in S13 presents an important aquatic vegetation zone (VE-07) of approximately 720 m² (rush and sedge) and in S18 (VE-09; Photo 13, Appendix D) bur-reed is found in an area of approximately 250 m². Rocky points are found in segments S12 and S16 (Figure 3; Appendix C). In the remaining segments on the eastern shore, cobble and rubble are commonly present. Aquatic vegetation was observed in segments S15 (VE-08), S19 (VE-10), and S22 (VE-11; Photos 12, 14 and 15, Appendix D). In segment S20, a suitable brook trout spawning habitat was identified. The substrate was predominantly gravel and sand.

In the context of the Water and Sediment Quality Baseline Study, one sediment sample was collected in Iron Arm, in the non-littoral zone (about 10 m deep). The substrate was predominantly silt, approximately 50 %, while fine sand and clay were approximately 20 % each (GENIVAR, 2013).

Bay 2

The shoreline along Joyce Lake peninsula (S5) is predominantly rubble and cobble, and four aquatic vegetation zones were observed (VE-2 to VE-5; Appendix C; Photos 21 to 24, Appendix D). The northern part of Bay 2 presents two segments with fine substrate (B2-01 and B2-04), while the other two are composed of rubble with sand, cobble and boulders.

Connecting Streams

Several small streams discharge into Iron Arm (Figures 3a to 3d). However, most of these are probably intermittent watercourses. During the field work conducted in July-August 2012, four streams were found, and these are labelled IA-T01 to IA-T04 (Figure 3; Appendix E).

IA-T01 is a small watercourse located in Iron Arm's west shore and discharges into a small bay near the cabins (Photos 1 and 2, Appendix D). This stream is fed by runoff from the upstream surrounding areas. The stream was characterized along 75 m until it became partially underground (Figure 3; Appendix E). The underground sections of the stream were determined to act as a barrier to fish passage. Muck was the main substrate component and there was no aquatic vegetation in the stream. The stream cover was 30 % overhanging and 40 % overhead, mostly composed of shrubby riparian vegetation.

IA-T02 is a small watercourse located in the same small bay than IA-T01 near the cabins (Photos 3 and 4, Appendix D). This stream is also fed by runoff from the upstream surrounding areas. The stream was characterized on 85 m (Figure 3; Appendix E). There is no barrier to fish passage in the stream. Cobble was the main substrate component, with rubble and muck. Aquatic vegetation cover was approximately 5 %. The stream cover was 5 % overhanging, and mostly composed of herbaceous and ericaceous species.

IA-T03 is a small watercourse located in Iron Arm's west shore and discharges into a small bay adjacent to the bay where IA-T01 and IA-T02 are found (Photos 5 to 7, Appendix D). This stream is fed by runoff from the upstream surrounding areas and was characterized up to the first fish barrier found (Figure 3). In segment S1,

Attikamagen Lake

Date: July 29-30, 2012 **Overnight set:** No

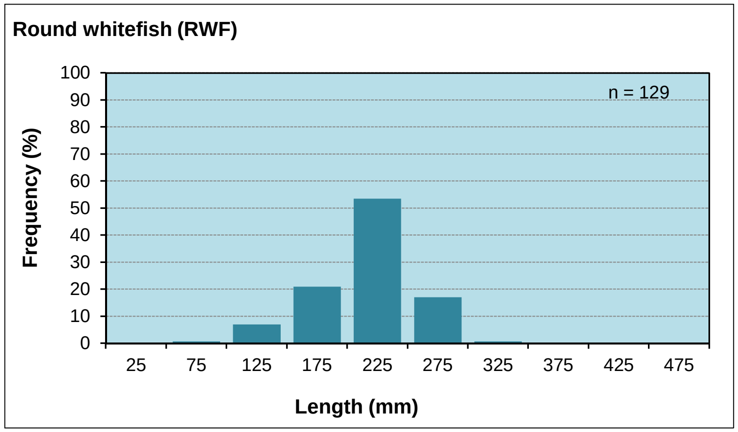
Fishing Effort and Yield

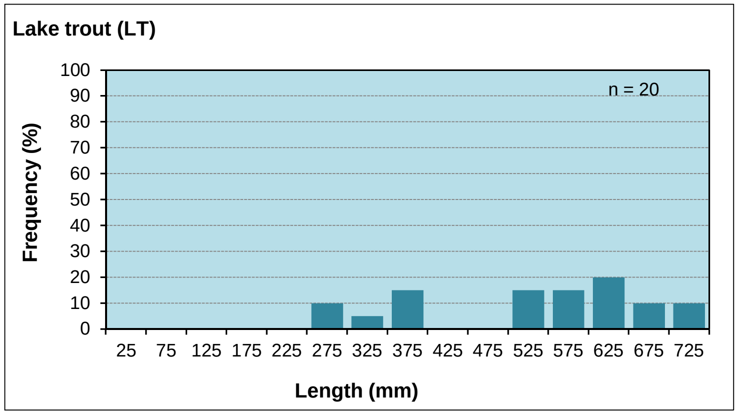
Gear	Number of gear	Species[1]	Capture	Biomass (g)	CPUE[2]	BPUE[3]
Gillnet	12	LNS	**10**	1841.0	0,8	153.4
		WS	**4**	99.2	0,3	8.3
		PD	**4**	60.1	0,3	5.0
		RWF	**135**	10352.8	11,3	862.7
		LT	**21**	30333.4	1,8	2,527.8
		Total	**174**	**42,668.5**	**14.5**	**3557.2**
Fyke net	1	MS	2	3.6	2.0	3.6
		TSS	2	4.1	2.0	4.1
		PD	4	8.2	4.0	8.2
		RWF	1	2.6	1.0	2.6
		Total	**9**	**18.5**	**9.0**	**18.5**
Minnow trap	15	WS	2	ND	0.1	ND
		TSS	3	ND	0.2	ND
		PD	5	ND	0.3	ND
		RWF	1	ND	0.1	ND
		Total	**11**	**ND**	**0.7**	**0.0**

Fish Population Characteristics

Parameters		RWF	LT	LNS	WS
Mean length ± S.D. (mm):		215.9 (40.0)	528.6 (143.0)	193.6 (114.5)	125.3 (24.9)
Mean weight ± S.D. (g):		81.6 (40.4)	1503.1 (1023.6)	184.1 (465.9)	24.8 (18.4)
Mean condition factor:		0.728	0.831	-	-
Weight-length equation:		$W = 6x10^{-6}xL^{3.027}$	$W = 4x10^{-6}xL^{3.110}$	-	-
Sex ratio:	Male	68.7%	76.2%	-	-
	Female	14.5%	23.8%	-	-
	Juvenile or not determined	16.8%	0.0%	-	-
PSD index		-	72	-	-
RSD:	Sub-stock	-	10	-	-
	Stock	-	25	-	-
	Quality	-	50	-	-
	Prefered	-	15	-	-
	Memorable	-	0	-	-
	Trophy	-	0	-	-

Length Frequency





[1] Species: LNS: Longnose sucker; WS: White sucker; PD: Pearl dace; RWF: Round whitefish; LT: Lake trout; MS: Mottled sculpin; TSS: Threes spine stickleback.

[2] Catch per unit effort: Number of capture per day; where a day is approximately 6 hours.

[3] Biomass per unit effort: Biomass per day; where a day is approximately 6 hours

Figure 7: Fish Sampling Results in Attikamagen Lake

the stream is crossed by a gravel road and there is a small pool upstream a culvert (Appendix E). This segment has a mean width of 0.9 m and the mean water depth is 0.05 m. The substrate is mainly composed of sand and cobble, and aquatic vegetation covers approximately 15 % of the segment. The stream cover in segment S1 was 10 % overhanging and 10 % overhead; mostly composed of ericaceous and herbaceous species. The upstream segment (S2) is only 15 m long, has a mean width of 0.3 m and a mean water depth of 0.25 m. The substrate is composed of sand, rubble and muck. A 0.30-m high fall was determined to act as a barrier to fish passage.

IA-T04 is a small watercourse located on the east shore of Iron Arm (Figure 3; Appendix E). This stream is also fed by runoff from the upstream surrounding areas and is probably connected to a wetland (Figure 3). This stream was only characterized on the lowermost 2 m since a 1.3-m high fall was present and prevents fish passage (Photo 8, Appendix D).

5.2.2 Joyce Lake

Morphometry

Joyce Lake is a small 37.0-ha waterbody that lies on a peninsula of land in Attikamagen Lake (Figure 8). The bathymetric survey indicates that the maximum depth (23.0 m) is reached in the northern part of the lake. The mean water depth is 7.7 m (Figure 9). Joyce Lake shoreline development index is 1.44, which indicates that the lake has a relatively round shape with few bays. The volume development index is 1, which indicates a conical shape. Lakes with shoreline development and volume development indices near 1 have, in general, a low biological productivity.

There is no island and no connecting stream in Joyce Lake. The outlet shown on Figure 8 appears to be ephemeral (or intermittent) on the surface and in part underground. Joyce Lake drains most likely underground and pockets of water were found approximately 500 m south of the lake.

Water Chemistry

The temperature-oxygen profile in Joyce Lake is typical of a heterograde dimictic lake (Figure 9; Wetzel, 2001). The thermocline was present between 6 and 10 m and an increase of oxygen was observed in the metalimnion. The dissolved oxygen concentration in the deepest two metres was below the minimum requirement for fish.

The water showed no particular colour and the Secchi depth was 7.5 m, which is quite similar to what was measured in Attikamagen Lake. This value is quite high and is generally representative of a low productivity lake. The pH is slightly alkaline with a value of 7.77. However, the pH value decreases from the top to the bottom of the water column to reach a very low value of 5.24 near the bottom of the lake. Low pH value in depth may be due to higher CO_2 concentrations near the bottom (Wetzel, 2001). The conductivity is very low (11.0 µS/cm) and also representative of a low productivity lake.

Fish Population

On August 1st, 2012, fish sampling was conducted in Joyce Lake using gillnets and minnow traps (Figure 10; Appendices A and B). Fishing gear were set during the day and fished for approximately 6 hours. A total of 119 pearl dace were captured in the traps (14.9 captures per gear-day). Pearl dace was the only fish species found in this lake. Gillnets did not catch any fish, but despite the low fishing effort, the probability of finding another species remains very low. A similar effort (6 hours) was expended in Attikamagen Lake and many fish species, even lake trout and burbot which tend to be found in deep cold water, were caught in gillnets set in shallow water.

The number of pearl dace caught per unit effort is relatively high considering that a gear-day represents only 6 hours. This could be explained by the absence of predator and of any other fish species in the lake. Pearl dace mean length was 73.5 mm (Figure 9). The length-frequency histogram indicates that specimens from 70 to 80 mm were predominant.

Lacustrine Habitats

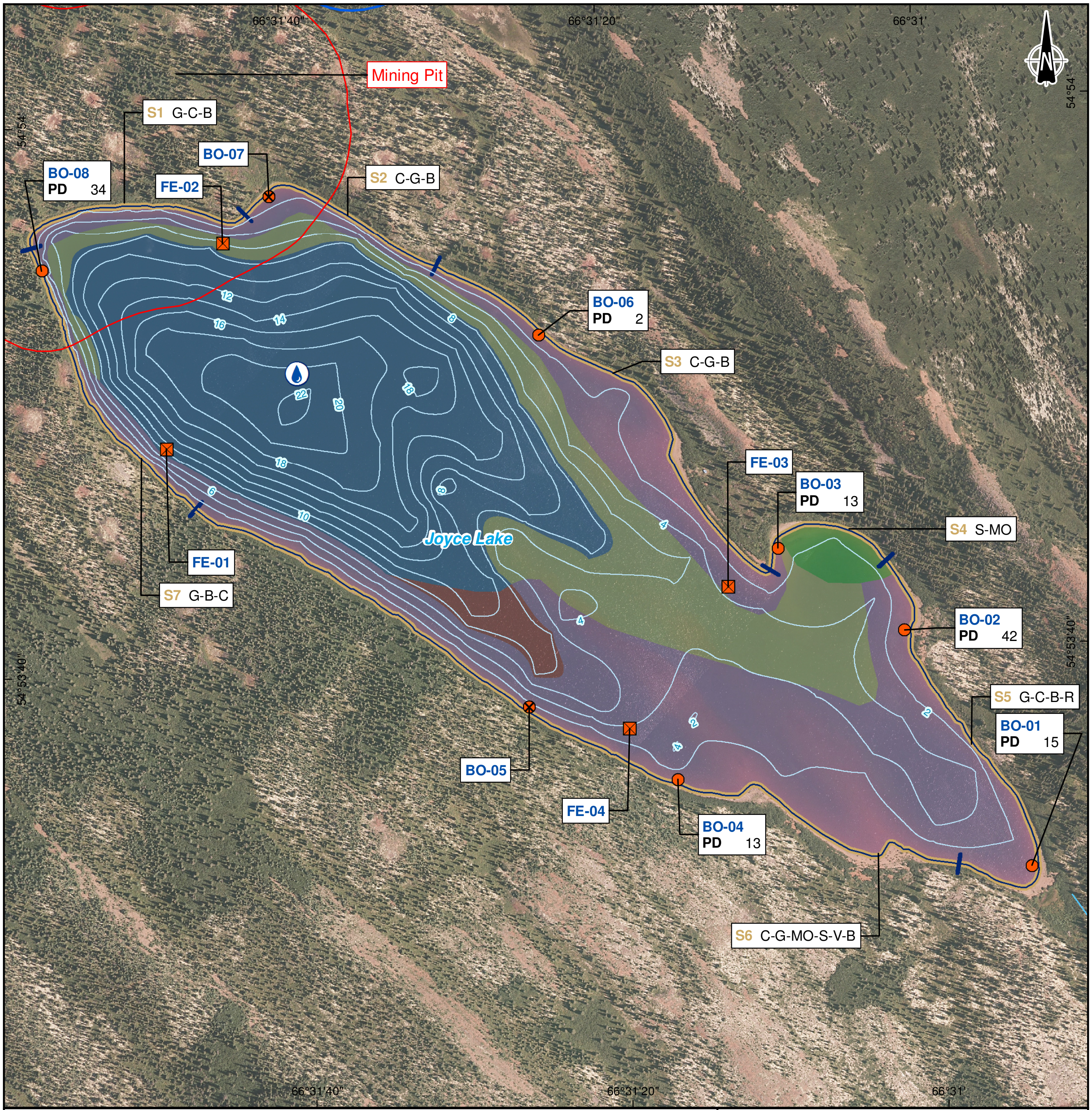
The shoreline substrate was mainly composed of cobble and rubble (Appendix C). However, segment S4 was predominantly sand (90 %), with some organic material (10 %), whereas segment S7 was composed of rubble (40 %), boulders (40 %) and cobble (20 %; Figure 8). The riparian vegetation was mainly composed of shrubs.

The habitat classification is shown on Figure 8. In the littoral zone, coarse substrate without vegetation is predominant, followed by fine substrate without vegetation. Only a small area with fine substrate and vegetation was found near segment S4. In the non-littoral zone, fine substrate (mostly reddish silt and clay) is dominant but coarse substrate was also found. The number of suitable habitat equivalent units for pearl dace, calculated using lacustrine habitat model presented by Bradbury et al. (2001), is 99,916 m² (Appendix F).

5.2.3 Pond A

Morphometry

Pond A is a small waterbody adjacent to Joyce Lake (Figure 11). During the field work, the water level was very low (Photo 25, Appendix D). The surface area of the pond, when the water level reaches its maximum height, is approximately 0.75 ha. However, in August 2012, the wetted area was only 0.13 ha (Figure 12). The maximum depth was 1.5 m during the field work, but could be approximately 3.25 m when the water level reaches its maximum. No connecting stream was found during the field characterization and there is no sign of any intermittent tributary or outlet based on the high-resolution aerial photographs.



Project Components

Revised project layout (May 2013)

Fish Sampling

BO-01 PD 15 — Gear type; Sequential number; Number of capture; Species

Species

× No fish

PD Pearl dace

Fishing Gear

Minnow trap (BO)

Gill net (FE)

Segmentation

Shoreline segment

S7 G-B-C — Substrate; Segment number

Substrate

R	Bedrock
B	Boulder (250 to 1,000 mm)
G	Rubble (140 to 250 mm)
C	Cobble (30 to 140 mm)
V	Gravel (2 to 30 mm)
S	Sand (0.006 to 2 mm)
MO	Organic material

Habitat Characteristics

5 — Isobathe (Equidistance: 2 m)

Water physico-chemistry

Non-Littoral Zone

Fine substrate

Coarse substrate

Littoral Zone

Coarse substrate without vegetation

Fine substrate without vegetation

Fine substrate with vegetation

CENTURY IRON MINES CORP.

Joyce Lake Direct Shipping Iron Ore Project

- Fish and Fish Habitat Baseline Study -

Joyce Lake

Sources:
Base: CanVec, 1/50 000, RNCan, 2010
Orthophoto: Mosaïque photo XEOS

Mapping and inventory: GENIVAR 2012
File: 121-18002-00_F08_FAQ_Joyce_Lake_130619.mxd

Scale 1:6 500

0 65 130 195 m

UTM, zone 19, NAD83

Figure 8

November 2013

GENIVAR