APPENDIX W

Joyce Lake Water Management Plan

Stantec

Memo

To:	Georgi Doundarov Labec Century Iron Ore Inc.	From:	Sundar Premasiri & Sheldon Smith Markham
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Reference: Open Pit –Joyce Lake Water Management Plan

This memo describes the water management plan for the open pit including Joyce Lake initial dewatering and subsequent operational dewatering. Extraction of iron ore under Joyce Lake will require dewatering of Joyce Lake prior to the advance of mining under and within the Lake footprint. The water management plan for open pit mining operation is illustrated in Figure 1 and involves the following:

- Diversion of Joyce Lake catchment area runoff around the open pit and the shoreline of Joyce Lake via runoff interception in perimeter ditches;
- Initial dewatering of Joyce Lake;
- Collection and pumping of groundwater seepage via open pit perimeter dewatering wells;
- Collection and pumping of incident precipitation and direct runoff from within the open pit; and
- Collection and pumping of runoff from the Joyce Lake footprint (Joyce Lake operational dewatering).

Each of the above water management components are discussed in detail below.

Diversion of Joyce Lake Catchment Runoff

Two perimeter ditches, Joyce Lake North Perimeter Ditch (JLNPD) and Joyce Lake South Perimeter Ditch (JLSPD), will be used for the following:

- Collection and diversion of Joyce Lake catchment area runoff around the open pit and the shoreline of Joyce Lake;
- Collection and diversion of Joyce Lake initial dewatering;
- Collection and diversion of groundwater seepage from the open pit perimeter dewatering wells; and
- Collection and diversion of Joyce Lake operational dewatering.

Collected water in the perimeter ditches, JPNPD and JPSPD, will be discharged to Stream T3 downstream of the Joyce Lake outlet. The JPNPD will collect surface runoff from 49.3 ha of the Joyce Lake catchment area and JPSPD will collect surface runoff from 89.3 ha of the Joyce Lake catchment area. Tables 1 and 2 provide the peak flows from the Joyce Lake catchment area to

the perimeter ditches for various design return periods, maximum Joyce Lake initial dewatering rates and Phase 1 groundwater dewatering from pit perimeter wells. Maximum initial dewatering rate of Joyce Lake and Phase 1 maximum groundwater dewatering rate in addition to peak surface runoff rates from Joyce Lake catchment area will provide maximum perimeter ditch design flows over the operation of open pit mine.

Table 1 Peak Flow Rates for Joyce Lake North Perimeter Ditch

Return Period (Years)	Peak Flow from Joyce Lake Catchment Area (m^3/s)	Maximum Pumping Rate from Joyce Lake (m^3/s)	Pumping Rate from Dewatering Wells (m^3/s)[1]	Total Flow (m^3/s)
2	0.387	0.130	0.015	0.532
5	0.533	0.130	0.015	0.678
10	0.628	0.130	0.015	0.773
25	0.748	0.130	0.015	0.893
50	0.836	0.130	0.015	0.981
100	0.927	0.130	0.015	1.07

[1] maximum pumping rate for Phase 1

Table 2 Peak Flow Rates for Joyce Lake South Perimeter Ditch

Return Period (Years)	Peak Flow from Joyce Lake Catchment Area (m^3/s)	Maximum Pumping Rate from Joyce Lake Footprint (m^3/s)	Pumping Rate from Dewatering Wells (m^3/s)[1]	Total Flow (m^3/s)
2	0.701	0.130	0.015	0.846
5	0.965	0.130	0.015	1.11
10	1.14	0.130	0.015	1.28
25	1.36	0.130	0.015	1.50
50	1.51	0.130	0.015	1.66
100	1.68	0.130	0.015	1.82

[1] maximum pumping rate for Phase 1

The perimeter ditches shall be designed:

- to convey 1:100 Year peak flows with a minimum 0.5 m freeboard; and
- to be non-erodible during the 1:10 Year flood event.

Steeper channels shall be designed with check dams to reduce flow energy and potential channel erosion.

Joyce Lake Initial Dewatering

Phase 1 of pit development will occur on land southwest of Joyce Lake. Phase 2 pf pit development advances into the footprint of Joyce Lake. Joyce Lake initial dewatering is expected to occur during Phase 1 of pit operations.

A bathymetric survey of Joyce Lake indicated that it has an approximate volume of 3 Mm^3 with the deepest part of the Lake at its western end where the open pit will be located. Therefore, initial dewatering of Joyce Lake has to be completed before the open pit advances into Joyce Lake. The mining plan indicates that the Open pit advances into the Joyce Lake at the end of summer Year 2 of operation (CIMA, 2013). Therefore, initial dewatering of Joyce Lake must be completed before the end of summer Year 2. Initial dewatering of Joyce Lake therefore has been planned to occur for approximately 153 days from July 1, Year 1 after the spring freshet to November 30, Year 1. Initial dewatering rates for the dewatering period are shown in Figure 2. The maximum expected dewatering rate is 260 L/s. Maximum flows pumped and diverted downstream to the Joyce Lake outlet due to Joyce Lake initial dewatering, groundwater perimeter dewatering wells and the diverted flows from the Joyce Lake catchment area is 300 L/s. The existing maximum monthly flow at the downstream of Joyce Lake outlet is estimated to be 303 L/s during the spring freshet.

The Joyce Lake dewatering rate was developed based on assessing the maximum spring freshet discharge rate from the Lake to the downstream receiving water outlet system. Joyce Lake outlet flow discharges to an extensive linear bog wetland feature before eventually discharging into Timmins Bay via an Unnamed Lake. The maximum spring freshet flows are flows that the receiving system experiences under existing and natural conditions. Joyce Lake dewatering will extend these elevated flows for the period of time required to dewater the Lake.

Joyce Lake dewatering during year 1 is proposed because the early summer of year 2 will be needed to construct internal dams and sump pits in Joyce Lake necessary to commence operational dewatering of Joyce Lake prior to pit advance into the Lake footprint.

Open Pit Perimeter Groundwater Dewatering

Operation of the open pit mine will require dewatering of groundwater to ensure that the water table is maintained below the floor of the pit and more than 25 m from the pit walls. WESA (2014) evaluated various groundwater dewatering configurations using a three-dimensional numerical groundwater flow model. Four phases of dewatering were considered: Phase 1 involves dewatering below a pit bottom elevation of 480 masl; Phases II, III and IV involved pit bottom elevations of 460, 420, and 380 masl, respectively. The final bottom elevation of the pit will be approximately 380 masl.

Two cases were considered for groundwater dewatering. The base case involved complete dewatering of Joyce Lake. The optional case involved partial dewatering of Joyce Lake with construction of a berm situated approximately 100 to 200 m from the limits of the open pit. Two scenarios of Joyce Lake bottom sediments considered for the optional case as the permeability of the Joyce Lake bottom sediments has not been assessed in the field. Table 3 presents the simulated

numbers of wells and total pumping rates for each of the four mine dewatering phases associated with the base case and two optional scenarios.

Table 3 Pumping Rates for Mine Dewatering – Groundwater (WESA, 2014)

Case	Scenario	Description	Phase	Pit Bottom Elevation (masl)	Simulated No. of Dewatering Wells	Total Pumping Rate (m^3/d)
Base	n/a	Joyce Lake completely dewatered	I	480	7	2,640
			II	460	7	3,330
			III	420	7	4,870
			IV	380	7	5,710
Optional	1	Joyce Lake dewatered (silty sediments at bottom of lake)	I	480	7	2,870
			II	460	7	3,720
			III	420	7	5,550
			IV	380	8	6,510
Optional	2	Joyce Lake partially dewatered (sandy sediments at bottom of lake)	I	480	8	3,520
			II	460	8	4,620
			III	420	9	6,910
			IV	380	10	7,680

Construction of a dam across the Joyce Lake will likely involve underwater construction and require specialized equipment (e.g. barge) and skilled personnel (e.g. divers). Failure of the dam would flood the open pit mine and compromise the safety of the workers in the open pit mine and would also interrupt the mine operation until the pit is completely dewatered. Operational groundwater dewatering costs associated with partially dewatered Joyce Lake will be higher than that of completely dewatering Joyce Lake. Therefore, it is recommended that Joyce Lake be completely dewatered prior to the open pit mine advances into the Lake. Figure 1 shows the groundwater dewatering perimeter wells for the recommended option. Figure 2 shows the groundwater dewatering rate throughout the life of the Project. The maximum groundwater dewatering rate is approximately 66 L/s.

Pit perimeter dewatering wells will pump non-contact background concentration groundwater suitable for direct discharge to the environment. Therefore, this water management plan proposes that perimeter drawdown wells discharge directly into the Joyce Lake and open pit perimeter ditches for conveyance to the downstream receiving environment.

Reference: Open Pit – Joyce Lake Water Management Plan

Open Pit Dewatering

Dewatering of the open pit will begin with the start of pit construction and will continue throughout the project. The total area of the open pit mine is 20.9 ha. Surface runoff from pit surfaces and groundwater inflows need to be dewatered for open pit mining. Runoff will be collected in sump(s) inside the open pit and will be pumped into a perimeter ditch around the overburden (OB) and waste rock (WR) stockpiles as shown in Figure 1. The OB and WR perimeter ditch will convey the open pit dewater into sediment pond SP1 prior to release to Attikamagen Lake. Open Pit dewatering rates are shown in Figure 2 throughout the life of the Project. The maximum dewatering rate is 17 L/s (Table 5). During large storm events, runoff will be detained in the sump and will be pumped into the OB and WR perimeter ditch at a maximum pumping rate 17 L/s. The estimated runoff volume is 15,100 m^3/s during the 1:100 Year storm event and it will take approximately 10 days to completely dewater the open pit at a pumping rate of 17 L/s.

Joyce Lake Operational Dewatering

Operational dewatering of Joyce Lake will start after the initial dewatering is completed and will continue throughout the life of the Project. Three shallow internal berms (dams) are proposed to collect runoff from the Joyce Lake footprint as shown in Figure 1. The proposed berms also prevent the non-contact groundwater seepage and runoff water from the Joyce Lake footprint entering into the open pit and becoming mine contact water. Collected runoff in the Joyce Lake footprint will be pumped into the perimeter ditches, JLNPD and JLSPD, to discharge downstream of the Joyce Lake outlet. Joyce Lake operational dewatering rates are shown in Figure 2 throughout the life of the Project. The maximum pumping rate for each of the three sump areas is 10 L/s. During the large storm events, the runoff will be detained in the sump areas and will be pumped to the perimeter ditches at a maximum pumping rate of 10 L/s. Table 3 provides the estimated runoff volume for the three sump areas for various storm events. It will take approximately 8 to 9 days to completely dewater the 1:100 Year runoff volume in the Joyce Lake footprint at pumping rate of 10 L/s.

Table 4 Runoff Volume – Joyce lake Footprint

Sump Area ID	Drainage Area (ha)	Runoff Volume (m3)					
		2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
JL1	10.5	2,884	3,895	4,561	5,408	6,043	6,662
JL2	11.2	3,102	4,190	4,906	5,817	6,500	7,166
JL3	11.7	3,224	4,354	5,098	6,044	6,754	7,446

Berms shall be designed to contain 1:100 Year runoff volume with 0.5 m freeboard.

Reference: Open Pit – Joyce Lake Water Management Plan

Recommended Pump Capacities

Recommended maximum pump capacities for the Joyce Lake initial dewatering, open pit groundwater dewatering, open pit surface runoff dewatering and Joyce Lake operational dewatering are provided in Table 5.

Table 5 Recommended Maximum Pump Capacities

Dewatering Scenario	Total Maximum Pump Capacities (L/s)	Comment
Joyce Lake initial dewatering	260	
Open Pit groundwater dewatering	66	7 dewatering wells, Pump capacity for each well is approximately 10 L/s.
Open Pit surface water dewatering	17	
Joyce Lake Operational Dewatering	32	Three sumps associated with three berms. Pump capacity for each sump is approximately 10 L/s

Closure Plan

After operation and maintenance works cease in the open pit and Joyce Lake, three berms in the Joyce Lake will be demolished and all the dewatering will cease to allow refilling of the open pit and Joyce Lake. However, it is recommended the perimeter ditches continue to divert the runoff from the Joyce Lake catchment area to Stream T3 to provide the required environmental maintenance flows to the downstream receiver. Once the open pit and Joyce Lake filling is completed, the perimeter ditches will be breached to allow the surface runoff into the open pit and Joyce Lake and the reestablishment of Joyce Lake outflows via is existing outlet. The details for decommissioning will be provided in the Rehabilitation and Closure Plan that will be prepared under the Newfoundland and Labrador *Mining Act*.

Reference: Open Pit – Joyce Lake Water Management Plan

STANTEC CONSULTING LTD.

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Prepared by:

Sundar Premasiri, Ph.D., P.Eng.
Senior Hydrotechnical Engineer
Tel:(905) 944-7751
Fax: (905) 474-9889
sundar.premasiri@stantec.com

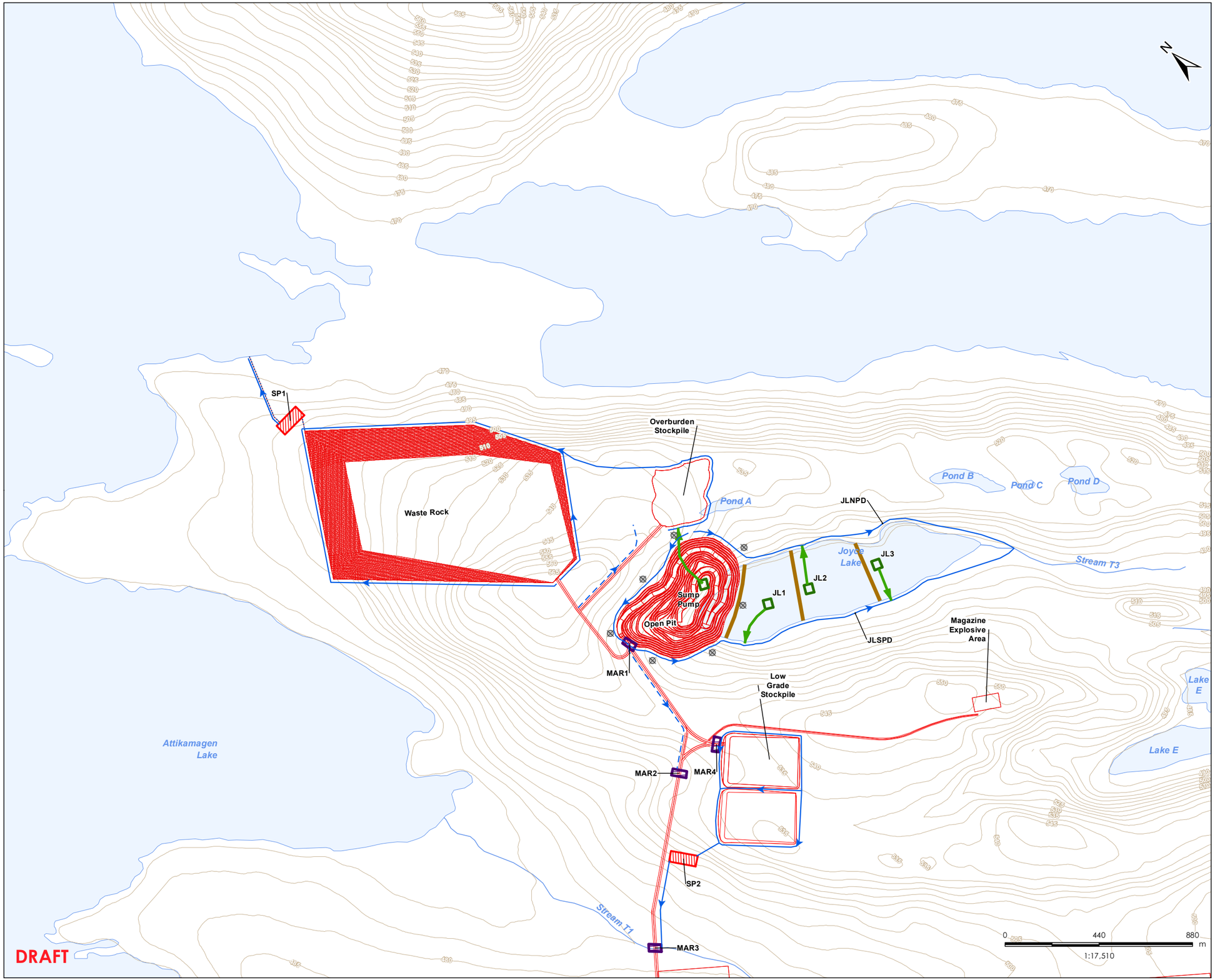
DRAFT

Reviewed by:

Sheldon Smith, MES., P.Geo.
Senior Hydrologist
Tel: (905) 415-6405
Fax: (905) 474-9889
sheldon.smith@stantec.com

Attachment: Figure 1 Proposed Open Pit – Joyce Lake Water Management Plan
Figure 2 Dewatering and Flow Diversion Rates

c. Angelo Grandillo - BBA
Ken Lam – Labec Century Iron Ore Inc.
Dana Feltham - Stantec
Colleen Leeder - Stantec



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Legend

- Dewatering Well
- Proposed Project Features
- Contour (5m)
- Perimeter Diversion / Collection Ditch
- Roadside Ditch
- Berm
- Pipes
- Watercourse
- Waterbody
- Access Road Crossing
- Pump Sump Location
- Sediment Pond

Notes

1. Coordinate System: NAD 1983 UTM Zone 19N
2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.

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Client/Project

Labec Century Iron Ore Inc.
Joyce Lake
Direct Shipping Iron Ore Project

Figure No.
1

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Title

Proposed Open Pit - Joyce Lake Water Management Plan

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Figure 2 Dewatering and Flow Diversion Rates