Final report on Nemaska Lithium's Whabouchi project

– Impacts on the aquatic environment

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TABLE OF CONTENTS

1 Introduction

This final report is based on our preliminary report, submitted on November 28th, 2014, complemented by additional documentation listed in Section 5.2 (Additional documentation reviewed for the final report), provided by the Cree Nation of Nemaska about the Whabouchi lithium mine promoted by Nemaska Lithium. The report also incorporates comments, questions and discussions collected during our visit of the Nemaska Cree community on March 3-4, 2015. As defined in our mandate, our examination of these documents has focused on the projected effects of the eventual mining operation on the aquatic environment (e.g., on water quality and on fish habitat).

1.1 Important aspects of the (revised) mine plan

1.1.1 Nature of the ore deposit

According to the promoter, the ore deposit is the richest in North America and the second largest in the world (dimensions 1.3 km long x 300 m wide x 190 m deep). The deposit is relatively close to the earth's surface, and consequently the mine will be operated as an open pit for the first 20 years, followed by a shorter period of underground mining.

The lithium is present in the ore deposit as spodumene, a silicate mineral; there are no sulphides in the ore itself and although the host rock does contain some sulphides, these are not present in massive deposits but rather are dispersed at low concentrations in the host rock (average sulphide content = 0.14%).

1.1.2 Nature of the mining procedure

The procedures to isolate the lithium-bearing mineral are largely physical ones, involving blasting, rock crushing and rock screening, followed by the separation and purification of the mineral concentrate by flotation and by magnetic separation of iron-containing impurities. The concentrate will be sent south to Valleyfield, Quebec, for hydrometallurgical treatment.

A large quantity of waste rock will be generated for each ton of ore that is brought to the concentrator (overall stripping ratio of about 2.2:1) and this material will be sent to the Tailings and Waste Rock Pile

(TWRP). Tailings generated from the concentrator will consist of coarse material from the initial "dense media separation (DMS)" step and of finer material from the flotation step. These tailings will be co-deposited with the waste rock in the TWRP; the fine material from the flotation step will be pressed to remove most of the moisture content before it is sent to the TWRP.

Some chemicals will be used in the concentrator, notably in the flotation processes, but in principle all the process water will be recycled (see comment below – section 2.3.2). In other words, the planned mining operation is very different from what has been done in the more traditional mines that have operated in the Chibougamau, Val d'Or or Rouyn-Noranda areas for the past 60 or more years (sulphide minerals; often underground mines; acid rock drainage a pervasive problem).

2 Water quality and quantity

2.1 Geochemistry

Before undertaking a project of this magnitude, the promoter must establish the starting conditions, i.e., the state of the environment now, before the mine is developed. These starting conditions will then be used to compare to the state of the environment once the mine is operational, using the monitoring data that will be collected on a regular basis throughout the mine life. The background geochemical data presented in the original Environmental and Social Impact Assessment (ESIA) document were recognized by COMEX to be deficient, notably because:

- there were too few samples;
- some of the samples had been collected without taking the precautions that are needed to ensure sample integrity; and
- in many cases the detection limits of the analytical methods used in the laboratory were too high, resulting in many results being reported as "undetectable".

We agree with the COMEX evaluation and note that the promoter carried out additional sampling and analysis campaigns in 2014. The deficiencies noted by COMEX and by us were addressed in the 2014 campaigns and the background data are now of better quality.

Surface water. Surface water in the Whabouchi region is acidic, with low alkalinity, low hardness and low mineralization (all as expected for surface waters on the Precambrian Shield in northern Quebec –

see Bobée et al. (1977)). According to the original data presented in the ESIA, certain water quality criteria (Quebec or Canada) were exceeded, notably for copper, iron, lead and zinc. To determine whether these data were credible, the promoter collected new surface water samples at 12 stations located in lakes and streams around the projected mine site; the sampling took place at 3 different periods (spring, summer and autumn) in 2014. According to these new geochemical data (Roche Ltée 2014e), in some of the surface waters that were sampled the concentrations of some metals (e.g. aluminum, iron, copper) and metalloids (e.g., arsenic) do exceed water quality guidelines that are designed to protect aquatic life. For example, arsenic concentrations exceed water quality criteria (WQC) in Spodumene Lake and copper concentrations at two sites in Mountain Lake also exceed the WQC. It should be pointed out here that it is not unusual for background metal concentrations to be higher than normal in mineralized areas, i.e., in areas where mineral deposits are close to the Earth's surface. These natural background levels must be taken into account in the design of the monitoring programme and in the interpretation of the data generated by the monitoring network.

Ground water. The aquifer present in the unconsolidated surface deposits is considered to be very local and discontinuous, whereas the ground water in the bedrock fractures is considered as regional. Ground water quality varies from acidic to alkaline, with total dissolved solid (TDS) concentrations varying from low to intermediate. In the original ESIA document, the groundwater concentrations of certain metals (Cu, Zn and Hg) were reported to be higher than the (Quebec and/or Canada) criteria, but some doubt existed as to the reliability of these results. New groundwater samples were collected by the promoter in June 2014, according to the sampling protocol recommended by the Quebec Department of the Sustainable Development, Environment and Climate Change (MDDELCC). Based on these new geochemical data (Roche Ltée 2014d), the background concentrations of some metals (notably copper) were above the MDDELCC water quality criteria for groundwater resurgence (i.e., for groundwater that feeds a stream or lake). As in the case of the surface water samples, these baseline levels for groundwater must also be taken into account in the design of the monitoring programme and in the interpretation of the resulting data.

2.2 Hydrology

Runoff coefficients are used by hydrologists to calculate how much of the incident precipitation (rain or snow) will contribute to surface runoff (streams and rivers). By removing trees and excavating ditches, the construction of the mine will modify the runoff coefficients in the catchments that lie within the mine site. For example, the BV4 and BV5 watersheds will be affected by the presence of the waste rock and tailings pile and there will be reduced flow towards creeks B, C, E and F because they will be cut off from part of their former watershed (Nemaska Lithium 2013). Pumping of water from the pit could cause significant draw-downs of the water table and reduce flow in Creek C.

These changes in the hydrological regime may also affect fish habitat (stream depth, stream flow, stream connectedness – see section 3). In answering one of the questions from COMEX (see Roche Ltée (2014a), pp. 6-110), the promoter noted that the flow in creeks C and F will be reduced by 34 and 88% respectively, and that the flow leaving lakes 2, 27 and 28 will be reduced by 47, 67 and 81% respectively. The promoter noted that the decrease in level of the lakes will be negligible (1-4 cm), but this reasoning seems to us to miss the point; the major effect will not be on the lake or stream levels but rather on the hydraulic retention time in each lake, on the loadings of organic matter entering the lake from its catchment and on the stream velocities. All of these factors can potentially affect the quality of the fish habitat.

One of the main effects of the deforestation and excavation of the mine site will be to promote physical erosion and increase the concentration of suspended solids in the streams draining the area. The promoter recognizes this and foresees various mitigation measures. It is planned to minimize clear cutting and to promptly restore the vegetation cover in such areas; to ensure the free circulation of water and the connectedness of the hydrological network; to limit work along the shores of water bodies and streams; to use manual methods to cut vegetation around water bodies and streams when cutting cannot be avoided; and to install sediment barriers and sedimentation basins to minimize introduction of solid material into water bodies and streams (Nemaska Lithium 2014a; see section 20.3).

In the summary of the ESIA (see Nemaska Lithium (2013), p.38), the promoter mentions that at the end of the mine life, during the closure stage, the sedimentation basins will be dismantled. It is not clear to us why the basins will be dismantled, since suspended solids will continue to be generated during the site closure period. We would suggest that the sedimentation basins be maintained, at least until the end of the closure period. After closure, the pit will be allowed to fill, creating a new water body, but this process will be very slow (> 40 years).

2.3 Nature of the projected effluent(s) from the mining operation

2.3.1 General context.

All effluent(s) from an operating mine in Quebec must respect «Directive 019», issued by the MDDELCC (http://www.mddelcc.gouv.qc.ca/milieu_ind/directive019/). This directive, revised in 2012, sets limits for the concentrations of various substances in the mine effluent (e.g., acidity, suspended solids, major cations and anions, trace metals), and also outlines how the mine's solid wastes are to be characterized and handled. The solid wastes considered by Directive 019 include waste rock, tailings, and the suspended sediments that are collected in the sedimentation ponds. Directive 019 requires that these mine wastes be subjected to various standard leaching tests, which are designed to determine to what extent the solid wastes can liberate harmful chemical substances in soluble form. For those mine residues that are found to be «leachable», Directive 019 also defines the necessary leak-proofing measures that should be applied to ensure groundwater protection.

2.3.2 Effluent

The promoter states that recirculation of water will be maximized and that no process water used in the concentrator will be released to the receiving environment (Nemaska Lithium 2013)[1]; it is stated that the only industrial wastewater (except for entrapped (interstitial) water in tailings (less than 5% w/w)) will come from cleaning the heavy machinery at the maintenance garage, and that it will be treated by a specialized company. Although the objective of total recycling of the process water is laudable, we are unsure whether or not it will be feasible. The experience of the Raglan mine in northern Quebec, which also initially aimed for complete recycling, suggests that the buildup of reagents and waste products in the process water may eventually compromise the efficiency of the concentrator and necessitate some release. This point should be raised with the promoter.

To evaluate the potential impacts of the release of process water to the environment, it is essential to know the chemical nature of the reagents that will be used in the concentrator. In the revised mine plan

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[1] Tailings to be deposited in the TWRP will have a moisture content of about 6% (target number), and this water will necessarily contain process water. Water requirements (to compensate for the "losses" to the TWRP and elsewhere in the process) will be 101 m^3 / h or 28 L / s, a value that suggests an upper limit for the "flow" to the TRWP.

(Nemaska Lithium 2014a), the chemical products to be used in the concentrator are mentioned by their trade names, but there is little or no indication of their chemical composition, e.g.,

- nature of the dense medium used in the DMS step = ferrosilicon;
- nature of the flotation agent = AERO 3030C collector and fuel oil for mica; FA-2, AERO 855, diesel fuel and MIBC for spodumene;
- nature of dispersant = dispersant D618 and caustic soda in the desliming step;
- nature of the thickening agent = Magnafloc (polyacrylamide) in the spodumene concentrate dewatering and storage step.

Detailed information about the chemical nature of these reagents and the concentrations used in the concentrator should be requested from the promoter.

Ignoring a possible contribution from process water, the effluent would consist of water derived from the pit dewatering and of surface runoff originating from the tailings and waste rock pile, the overburden pile, the ore supply stockpiled near the mill and the area around the mill and concentrator; quantitatively, the two most important contributions are water pumped out of the pit and runoff from the TRWP. With respect to this latter source, static tests and some humidity cell kinetic tests were completed on samples to determine their acid generation potential and the leaching potential of the rock. The majority of results showed that waste rock was not acid-generating according to the Directive 019 criteria. Nearly half the rocks were classified as "leachable for copper" according to Directive 019**.** However, the kinetic tests showed a non-leachable potential for metals in the long term. Overall, the leaching experiments conducted on the samples of host rock suggest that oxidation of sulphides and the generation of acid rock drainage will not be a problem.

In the revised mine plan, there is a single point of effluent discharge in Mountain Lake. This is discussed in more detail in Section 3. The promoter states that, when required, the effluent will be "treated" before release, but we were unable to determine the details of the proposed method of treatment (e.g., presumably flocculation to minimize suspended solids concentration?). In the ESIA summary document (see Nemaska Lithium (2013), p.8) it is stated that "The water will only require a treatment for suspended matters before being released in the environment", but under *Mitigation Measures* in the same document (p.46) it is stated that to reduce impact, the main mitigation measures include "Collecting and treating all contaminated water before release in the aquatic environment". Furthermore, Nemaska Lithium apparently committed with COMEX to install a water treatment facility at the mine pit water basin which could be operated as required (Roche Ltée 2014g). Clarification of these points regarding effluent "treatment" should be sought from the promoter, as well as a clear indication of how they plan to deal with emergencies.

2.3.3 Water balance and water quality model

Golder Associates used the data from the leaching experiments carried out on the waste rock and tailings samples, as well as the background water quality data, to develop a water balance model and a simple water quality model (Golder Associates 2013). The water balance model was used to quantify flows generated within the footprint of the projected mine and then a mass balance model, using the pre-mine monitoring and geochemical data, was used to estimate water quality for each of the components of the water balance. The water balance model appears pretty straightforward, with inputs based on long-term values for precipitation (rainfall and snowfall) and estimates of run-off coefficients and evapotranspiration, but the water quality model is less convincing.

For the water quality model, background water qualities for site-specific surface water, rainwater and groundwater were incorporated to represent the natural flows. However, as mentioned earlier (section 2.1), the original background water quality sampling/analyses were not performed adequately. The model was re-run in 2014 (Roche Ltée 2014h) with the new geochemical data that had been generated earlier in the year (Roche Ltée 2014d,e). In the case of the inputs from the waste rock and tailings, the geochemical data from the humidity cell tests were divided into the first flush or early-time data, and the steady-state or long-term data. The first flush data typically had elevated dissolved anion and cation concentrations, derived from dissolution of readily solubilised secondary minerals and from the smaller grains of the crushed material, whereas the data obtained later in the leaching experiments had lower solute concentrations, corresponding to the much slower dissolution of the parent material. It is important to note that the water quality model ignores possible interactions among the chemical constituents present in a given water mass, e.g., precipitation or adsorption reactions, or transformations mediated by microorganisms (nitrogen cycle) – see Golder Associates (2013), p.15. In addition, the model does not consider suspended solids or pH.

Ignoring the preceding caveats concerning the water quality model, we note that no predicted average annual concentrations exceeded Directive 019 effluent criteria, but concentrations of some metals were predicted to exceed the surface water quality criteria for protection of aquatic life (acute and chronic toxicity). Similar results were obtained when the model was re-run by Roche Ltée (2014h) with the new geochemical data as inputs. From our reading – see Golder Associates (2013, p.31) and Roche Ltée

(2014h, p.27) – these exceedances are for the effluent before dilution, i.e., not for effluent after mixing with the receiving waters, and thus are not surprising. Among the metals for which the concentrations in the undiluted effluent exceeded the surface water quality criteria (i.e., aluminum, Al; beryllium, Be; copper, Cu; iron, Fe; lead, Pb; mercury, Hg; selenium, Se), the only case where the projected mining activity was largely responsible for the exceedance was for copper. For the other metals, the exceedances could be largely attributed to background contributions from either the local surface water or groundwater.

The water quality model also considered explosives use, as a source of nitrogen and sodium. Large amounts of explosives will be used for blasting purposes (estimated at around 1,200,000 kg per year), and reported losses of N from explosives use range from 1 to 6%, depending on factors linked to their handling or mishandling, including spillage or blast inefficiency; for their calculations, Golder Associates used a 1% loss estimate. Nitrate and ammonium concentrations were predicted to be high in the water pumped from the pit, but the model does not account for the oxidation of NH_4 or the possible denitrification of NO_3; these reactions are largely controlled by the microbial populations in a given water body.

The water quality model does not deal with interactions among the chemical constituents leached from the solid wastes and it assumes the individual constituents, once in solution, are conservative (i.e., that they don't form solid precipitates or undergo transformations). In this sense the model is "conservative" and the predicted concentrations might be considered to represent an upper limit for what will be present in the effluent. However, the model also includes "scaling factors" to account for differences between the laboratory leaching tests and the real-world conditions (e.g., differences in particle size of the materials, in the contact time between the water and the solids, in the temperature). The scaling factors used in the present case (0.1, 0.1 and 0.5 respectively) mean that the original predictions of the model were divided by 200. These scaling factors are similar to those used in other modelling exercises, but no other justification is offered by the modellers. We suggest that a sensitivity analysis should be performed to determine how variations in these scaling factors would affect the predicted concentrations in the effluent.

2.4 Impact of dust on aquatic and terrestrial environments

During our meetings with the Nemaska Cree Band Council and during the public assembly, several questions were asked concerning the mine as a source of dust. This question was addressed by the promoter in the original ESIA (Nemaska Lithium 2013). Potential sources of dust include: the roads that will be used by the large trucks hauling the ore and waste rock from the pit to the mill, and hauling the waste rock and tailings to the TWRP; the trucks themselves (i.e., their load); and the TWRP itself. Judging from the documents that we have examined, wind erosion of the TWRP itself shouldn't be a major source of dust, since damp tailings will be co-deposited with the waste rock. In addition, the promoter intends to build the TRWP to its final planned height and revegetate it progressively during the mine life (rather than wait until mine closure to carry out the revegetation). On the other hand, to minimize the dust generated by truck traffic on the mine roads and by the rock crushing activities in the mill, the promoter will have to implement a program of dust control (e.g., imposing a speed limit on the vehicular traffic, using water as a dust suppressor on the roads, and installing dust scrubbers on the air vents from the crusher and concentrator building).

The effects of the dust generated by the mine activities and transported on the wind should be largely physical in nature. The fine particles constituting the dust are expected to be unreactive silicates and oxides, derived from the igneous host rock in which the spodumene ore resides. When they land on a water body, they will tend to sink to the bottom without dissolving; when they land on terrestrial vegetation, they will tend to wash off in the next precipitation event and then remain in the soil close to where the rain or melting snow lands.

2.5 Monitoring during mine operation, during the closure phase and after closure

The water quality parameters to be monitored and the frequency of measurements are those described in Directive 019 (see Roche Ltée (2014a), pp. 6:121-122). The parameters mentioned include acidity (pH), suspended solids, arsenic, copper, iron, lead and zinc. We suggest that several additional parameters should be added to this list. Given the results of the preliminary water quality modeling (Golder Associates 2013; Roche Ltée 2014h), beryllium, cadmium and copper would be candidates for addition to the list. In their report on the predicted water quality of runoff from the tailings and waste rock pile, Golder and associates recommend that the runoff be monitored closely to make sure that there is no evidence of the development of pockets of acid rock drainage in the TWRP – we agree.

The promoter plans to use Lake 18 and No-Name Creek as the control stations for the monitoring. For statistical reasons, it will be important to have not one but several control or reference sites, both in running waters and in lakes. We would suggest a minimum of three control river sites and three control lake sites, so that proper comparisons can be carried out between the control sites and the sites within or downstream of the mine site.

3 Aquatic biology

The potential impacts for aquatic organisms mainly originate from three sources: (1) Contamination of surface water, including metals, organic contaminants and suspended solids; (2) Obstacles to movements and migration and loss of habitat due to road culverts, changes in hydrology and mine development; and (3) Increased fishing pressure by non-native workers. Points 1 and 2 are discussed together below. The promoter has addressed Point 3 through their engagement to forbid fishing on mine property and to raise employee awareness on the issue.

Habitat for aquatic organisms in the area of the projected Nemaska Lithium mine consists of several small and shallow creeks and lakes, in addition to two large lakes, Spodumene Lake and Mountain Lake. Spodumene Lake is connected to nearby lakes by small creeks, while the Nemiscau River is the major input to Mountain Lake, which then flows into Lac Valiquette.

Three different approaches have been used to identify aquatic species that are present in the area expected to be impacted by the mine: literature searches to investigate overlap of known distribution ranges with the mine footprint, contacts with the local community for traditional knowledge, and direct field sampling. The last field sampling for which a report was available for the preliminary report (Golder Associates 2014) was carried out in September 2013 in order to complement missing or incomplete information from the early field surveys summarized in Nemaska Lithium (2013). Specifically, Creeks C, D, F and G were investigated for their potential as habitat and spawning grounds for brook trout, Mountain Lake was re-examined for potential spawning sites for walleye, and benthos was sampled in the area of Creek C where the discharge of an effluent was originally planned. In the revised mine plan, a single effluent is projected to be discharged directly in Mountain Lake. With this revision, no direct destruction of fish habitat is expected (Roche Ltée 2014f). However, the water management plan, which aims at protecting water quality in the area impacted by the mine site, was projected to lead to modifications of water levels. Accordingly, an additional survey was carried out in May-June 2014 to better quantify the impact of changed water levels on the fish habitat. In the most recent study available for this final report, Roche Ltée (2014f) estimated that the total surface of habitat considered as suitable for fish that may be affected by a decrease in water level is 4000-6000 m^2 in lakes (lakes 2, 3, 27, 28 and

30) and creeks (creeks B, C, E and F) combined. This habitat includes areas of variable quality used by fish for feeding and spawning. To compensate for this loss of fish habitat, Roche Ltée (2014f) proposes to create new spawning grounds, and to increase existing ones, for a total of 900 m^2. This would include 250 m^2 of created spawning grounds for brook trout in Creek A (upstream and downstream combined), and 650 m^2 of created spawning grounds for walleye (which could also benefit lake whitefish and sucker) at the mouth of Creek D in Mountain Lake, in Creek I upstream and downstream and at the outlet of Lake Kuskapish. The created spawning grounds may be considered as habitat of high quality that, although smaller in area than the estimated total fish habitat affected by the mine, is expected to largely compensate for the loss of habitat of lower overall quality. This will need to be verified by proper monitoring.

Thirty-three species of fish have been identified as potentially present in the Nemiscau River subwatershed, including Lake sturgeon, which has a special status and has been reported by the local population to visit the area, and particularly the Nemiscau River. From these studies, Northern pike has been identified as the most abundant species and lake whitefish as the most valuable species for recreational fishing. From our perspective and after reviewing the documents, we consider that brook trout will be the most affected in creeks in and around the mine operation, through changes in hydrology and the construction of road culverts, leading to obstacles to migration and movement, and from sedimentation affecting spawning grounds. Unfortunately, none of the field surveys conducted to date has properly characterized and identified trout spawning grounds, probably because of the timing of the surveys which did not overlap with the trout spawning season. Nevertheless, given the abundance of small creeks in the area and the high level of connectivity of their habitat on a regional scale, we expect that effects of the mine on brook trout will remain local.

The mine will affect the water table level and as a consequence, water levels in lakes, fish habitat surface areas and fish movements in lakes and streams. Modeling suggests that water level and outflow will be reduced in lakes 2, 27 and 28 and in creeks C and F. Among these, the most interesting fish habitats are found in Lake 2 (brook trout present) and Creek C (moderate potential as brook trout habitat). Spodumene Lake is not expected to be affected in a major way by changes in water levels or by contamination. It is important however to point out that, according to Roche Ltée (2014e), before any mining activity this lake displays a low pH (lower than 5 occasionally) and high arsenic concentrations. These pre-exploitation water characteristics suggest that the lake is not an ideal fish habitat, and they must be considered in its long-term monitoring. Nevertheless, at least six species of fish are found in this lake (cisco, walleye, Northern pike, whitefish, white sucker and yellow perch) (Roche Ltée 2014b). Among these, small changes in mean water levels may decrease the surface of suitable spawning grounds for yellow perch and Northern pike. The latter species could be doubly affected if yellow perch recruitment decreased, since perch are an important prey for pike. Although we expect that impacts of the mine on fish in Spodumene Lake should remain minor, we recommend that a proper survey of fish community structure be conducted, and monitored throughout the operation and closure phases, in combination with water level and water quality monitoring.

In our opinion, the aquatic environment that is potentially the most vulnerable to impacts from the development of the lithium mine is Mountain Lake. This lake will receive the only effluent from the mine, at a depth of 4 meters in the north-western sector of the lake, a location that will lead to maximal dilution due to the strong current induced by the Nemiscau River flowing into Mountain Lake. Concerns were raised by ACEE/CEAA (2014a) regarding the potential for contamination of effluents by organic and inorganic contaminants and not only by suspended solids. The promoter insists that there will be no contamination, in contrast to the Lamont (2013) and Golder (2013) studies, which conclude otherwise, the promoter arguing that the Lamont and Golder estimates are “extremely conservative”. Although the promoter plans to monitor effluent quality, there does not appear to be a strategy to mitigate effluent contamination if it is demonstrated. The promoter states that Nemaska Lithium will “aim” at reaching the government objectives of effluent water quality, although there is no clear plan to treat the effluent other than for suspended solids. If the effluent needs treatment for contaminants, no method is proposed. Finally, it is not clear what will happen to all the contaminated recycled process water from the concentrator after mine closure; this water will be contaminated by diesel fuel and other unknown chemicals, as discussed earlier. Similarly, although the risk of acid generation by the waste rock and tailings pile is estimated to be low, if it were to occur then the drainage could contaminate Mountain Lake unless a proper water protection plan was implemented. The promoter has not yet properly justified the decision not to install (ground)water protection. All of this leads us to identify Mountain Lake as the water body of most concern.

Mountain Lake is a large, mostly shallow water body with an important input of clean water from the Nemiscau River. Wave action and surface currents induced by the dominant winds from the west have created an ideal spawning area for walleye at the north eastern end of the lake, characterized by rocks, boulders and very little fine sediment, in contrast to other shores of the lake. Given that the mine effluent will be discharged in Mountain Lake, it is therefore critical to ensure that it will not affect aquatic life in general, and walleye spawning grounds in particular. Using criteria applicable to the receiving environment, the majority of water quality parameters of the undiluted effluent are predicted to be lower than criteria for acute and/or chronic toxicity of the Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC) and also lower than recommendations for the protection of aquatic life of the Canadian Council of Ministers of the Environment (CCME) (WSP 2014). However, simulations suggest that some parameters may occasionally exceed these guidelines. Even if these occasional excesses may largely be due to naturally high concentrations of some contaminants in surface or ground water, regulations require that a proper effluent mixing zone allow meeting all criteria applicable to the protection of aquatic organisms in the receiving environment. The dispersion of the effluent in Mountain Lake has therefore been modeled (WSP 2014), and an effluent dilution of 100-fold was used to determine the area within which effluent toxicity may occur. The reasoning here is that once the effluent has been diluted 100-fold with water from the receiving environment, predicted concentrations of contaminants will be lower than the provincial and federal guidelines for the protection of aquatic life. Overall, we agree with this approach, which is consistent with the generally accepted practice of tolerating the presence of a limited mixing zone and applying the guidelines for the protection of aquatic life at the boundaries of this zone. The modeling suggests that the 1:100 effluent mixing zone never exceeds 25 metres from the diffuser and is usually less than 5 metres (WSP 2014). The simulations for the Spring period indicate that the effluent will be rapidly diluted and flushed downstream with little mixing into the rest of the lake. During the Summer and Autumn periods, mixing of the effluent with the lake water is more complete, but even in the worst scenario modelled (Scenario 5, for October; WSP 2014) the effluent would be diluted more than 400-fold once it reaches potential walleye spawning grounds. Nevertheless, especially given the uncertainties remaining about the exact composition of the effluent (see Section 2.3.2), we cannot exclude the possibility that fine particles could choke the spawning grounds and that contaminants could affect walleye hatchlings. Roche Ltée (2014b) specifically suggested that the potential spawning sites in Mountain Lake be monitored for impacts of effluents. Since previous field surveys were not conducted during the walleye spawning season, they did not allow confirmation of use by walleye of potential spawning sites in Mountain Lake. A field campaign was therefore conducted in May 2014 to validate walleye spawning sites in that lake (Roche Ltée 2014c). That campaign again missed the peak of walleye spawning season (water temperatures at the time of sampling exceeded 12˚C which is the temperature at which spawning usually ends), but nevertheless limited walleye and sucker spawning was confirmed at the mouth of Creek D in Mountain Lake.

In its answer to QC128 (Roche Ltée 2014b), the promoter states that Nemaska Lithium will carry out a detailed monitoring of fish populations in Mountain Lake to determine effects on growth, reproduction, population status, and metal contamination (mercury and unidentified metals). Variables examined would include age, size, gonad index, condition factor and liver index. The promoter proposes to compare data obtained in the water bodies under the influence of the mine with comparable data from reference habitats. This is the appropriate approach, although both reference zones and zones of potential impact that will be monitored in Mountain Lake need to be identified and validated. Furthermore, as suggested for surface water quality monitoring in Section 2.5, several reference sites need to be monitored in order to capture natural variability and to provide a range of reference values against which values measured in the zones of potential impact can be compared. It is also crucial to properly characterize these variables prior to mine opening and at least once a year for the life of the mine. The fish monitoring strategy proposed by the promoter is still theoretical. It proposes to select two non migratory species and to carry out samplings in August. The species of most interest would likely be both brook trout and walleye, although a bottom-feeding fish like sucker, or young yellow perch, could be of high relevance as well. The frequency of fish sampling is not indicated, other than that it will be adjusted depending on the detection of effects. The promoter proposes to investigate specifically the potential walleye spawning grounds of Mountain Lake, which is in our view the most important fish habitat to monitor in the impacted area. Measures would include water chemistry, substrate quality and use by spawners. For the latter, however, it is not clear how this will be achieved by sampling in August.

In response to QC133 in Roche Ltée (2014a), there is mention of an earlier study that has established reference values for fish metal concentrations in Mountain Lake. These data should be examined closely for their relevance and validity. These reference values will be very important for the long-term monitoring.

Other than the potential impacts on Mountain Lake, described above, we do not anticipate significant impacts of the mine on other aquatic environments. The operation phase will cause the loss of Lake 29, which is not considered to be fish habitat, and Creek F, which is considered as habitat of low quality for brook trout and which is also small (half a kilometer in length).

Regarding other aquatic and wetland organisms, the studies performed by various consultants (Roche Ltée 2014a) did not identify any special-status species of plants, amphibians or reptiles in the areas that could be affected by modifications of water levels.

Finally, the Environmental and Social Impact Assessment (ESIA) area was defined by the promoter as a 10 km radius circle around the mine (Nemaska Lithium 2013). The Cree community's question about the contours of the ESIA area (Is choosing a perfect circular zone (with a radius of 10 km) the most appropriate choice of area to be studied for impacts? Shouldn't the study zone follow the natural landscape (the rivers, mountains, wind)? (Unknown author and date)) is legitimate. Nevertheless, our examination of the available documentation on the lithium mine project reassures us that any impact will be contained within this 10 km radius, except perhaps for the effluent which could potentially impact the watershed downstream of Mountain Lake.

4 Summary and Recommendations

In this section, we summarize our recommendations for the Cree Nation of Nemaska related to our mandate to examine the studies and reports listed in Section 5, to identify potential impacts of the lithium mine on water quality and aquatic organisms and to make recommendations for long monitoring of these impacts. Recommendations are presented below in *italics and numbered (ex. RCM1).*

In our preliminary report we noted that four additional campaigns had been carried out in 2014 to obtain acceptable reference or baseline values for surface water metal concentrations, since some of the data submitted in the 2013 ESIA report were considered unreliable. The reports from these campaigns have been submitted (Roche Ltée 2014d,e); based on our reading of these reports, the deficiencies noted in the earlier sample collection and analysis protocols have been addressed.

(RCM1) It is important to ensure that reliable data have indeed been obtained as these data will be used as reference values to evaluate the impact of mine operations on water quality during the exploitation and closure phases.

A proper analysis of risk to the aquatic environment would require a better knowledge of the chemical composition of the reagents used in the concentrator and their concentrations, as discussed in Section 2.3.2. We are aware that the promoter claims that 100% of all process water used in the concentrator will be recycled, but we consider that this claim may be overly optimistic. Even if it was correct, one cannot exclude accidental losses of this water into the watershed and the only way to properly assess the associated risk is to know the detailed composition of the process water.

(RCM2) We therefore recommend that the chemical composition of process water be made available and that this information be incorporated into the environmental monitoring programmes for water and fish.

One concern that comes back throughout the environmental impact assessment process and which we also noted is that the promoter insists that the only issue with the single effluent that will be discharged in Mountain Lake is suspended solids, and that, as a consequence, only this component of effluent quality will be treated through the use of sedimentation basins. However, various studies performed by consultants on behalf of the promoter indicate that several organic and inorganic contaminants may end up contaminating the effluent. The promoter indicates that Nemaska Lithium intends to closely monitor the quality of the effluent in order to ensure compliance with Directive 019, but does not indicate anywhere the type of treatment that will be used in case contaminants are found to be present in the effluent.

(RCM3) We recommend that the promoter submit a detailed plan of action in case of non-compliance of the effluent with Directive 019.

(RCM4) We also recommend (see Section 2.5) that the list of water quality parameters for effluent analysis described in Roche Ltée (2014a, pp. 6:121-122) be expanded to include beryllium, cadmium and copper.

(RCM5) As discussed in Section 2.2, the sedimentation basins should be decommissioned only when mine closure is completed.

In our preliminary report, we noted weaknesses in the water quality model, notably with respect to the baseline geochemical data that were used. This problem has been resolved in the updated water quality model (Roche Ltée 2014h), where the revised mine plan and the new background water quality data have been incorporated. In addition, the model itself should be improved so as to account for chemical interactions among the predicted solutes as well as microbial transformation of explosive-derived nitrogen compounds.

(RCM6) We recommend that the updated water balance and water quality model be subjected to a sensitivity analysis, to determine how variations in the model's scaling factors affect the predicted concentrations in the effluent (see Section 2.3.3).

As reviewed in the present report, the exploitation of the mine may impact fish through modifications in water levels affecting habitat, and through water contamination. Note that although the mine effluent will undoubtedly contain some metals, they will not accumulate in the native fish to levels that could pose a risk to human health. The only metal that is known to accumulate to dangerous levels in fish is mercury, and this metal is not present at appreciable concentrations in the lithium ore or in the waste rock. However, we cannot evaluate the risk for human health of organic contaminants that could be released in the effluent. Note that only lipophilic organic contaminants would be of potential concern, but since we lack information on the composition of the process water that may partly end up in the effluent and be dispersed into Mountain Lake, we are unable to quantify this risk.

The promoter acknowledges that the mine will affect between 4000 and 6000 m^2 of fish habitat through changes in water levels (see Section 3). The Promoter proposes to compensate these impacts by creating new spawning grounds, or expanding existing ones, in several locations that would benefit brook trout, walleye and to a lesser extent lake whitefish and sucker.

(RCM7) Although we agree with the overall approach proposed, we recommend that the success of these new spawning grounds be monitored annually.

Members of the Cree Nation of Nemaska have expressed their concern that fish avoid spawning grounds created with sharp-edged coarse rock. Proper monitoring of the success of created spawning grounds will allow the promoter to implement appropriate corrective measures if needed, such as further improvements of these spawning grounds or the addition of new ones, over the long term.

The promoter proposes to monitor fish populations in Lake 2 and Creek C, in order to determine if changes in water level will impact these populations. Specifically, they propose to determine if the exploitation of the mine will affect the abundance, size distribution and condition as well as contaminants in the flesh of these brook trout populations (Roche Ltée 2014f). Parameters to be monitored include weight and length, sex and gonad maturation status, deformities, parasites and analysis of flesh and liver for contaminants. To our knowledge, no other monitoring of impacts on fish is planned. The list of contaminants to be analyzed is not provided. In our opinion, the monitoring plan proposed for fish is incomplete.

(RCM8) The promoter needs to submit a detailed protocol for the monitoring of fish. This monitoring program should include:

- *proper background (pre-operation) sampling;*
- *a publically available sampling schedule;*
- *establishment of several reference sites in nearby lakes and creeks (minimum of three of each) outside of the impact zone of the mine (this is essential for the interpretation of effects on fish in impacted zones);*
- *monitoring of brook trout populations in Creek C and Lake 2 as the promoter proposes (Roche Ltée 2014f);*
- *monitoring of walleye population status and contamination in flesh and liver, in Mountain Lake;*
- *initial survey of potential fish habitat at the outlet of Mountain Lake, flowing into Lac Valiquette, where the effluent will ultimately end up, and inclusion of this downstream site if demonstrated as fish habitat;*
- *monitoring of population status and contamination for Northern pike and yellow perch in Spodumene Lake;*
- *compilation of a detailed list of the contaminants that will be measured on a routine basis in fish flesh and liver.*

(RCM9) We recommend that a committee composed of members of the Cree Nation of Nemaska, which could include external advisers appointed by them, oversee over the long term the monitoring of the impacts of the mine on fish populations and fish contamination.

This committee would not only ensure that proper monitoring is conducted, but would also be in charge of making monitoring data available and communicating with members of the community who may be concerned about impacts on fish populations and about health risks linked to the human consumption of fish.

Finally, several members of the Cree Nation of Nemaska have expressed their concerns about the lack of case studies that could support the promoter's claim that the mine will not significantly impact water quality and fish.

(RCM10) We recommend that studies of long-term impacts of similar mines on water quality and fish be made available to the Cree Nation of Nemaska.

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Roche Ltée (2014e). Étude des impacts sur l'environnement et le milieu social – projet Whabouchi : Qualité des eaux de surface et des sédiments. Rapport d'activités. N/Réf : 107034.001. 593 pp.

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