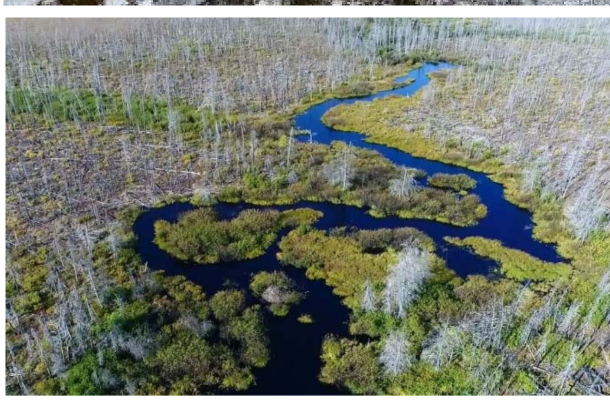
GALAXY

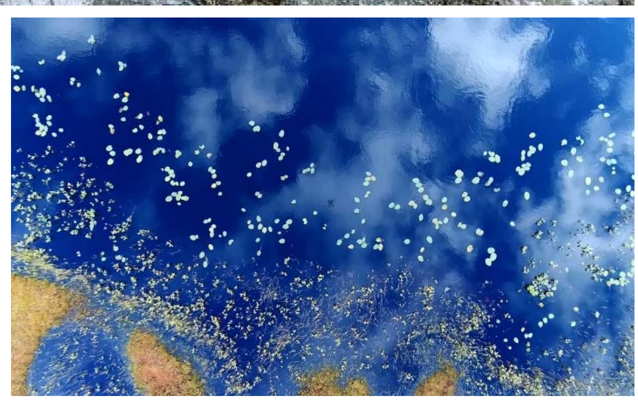
JAMES BAY LITHIUM MINE

ENVIRONMENTAL IMPACT ASSESSMENT

VOLUME 2: MAIN REPORT (CHAPTERS 6 TO 11)

OCTOBER 2018





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JAMES BAY LITHIUM MINE

ENVIRONMENTAL IMPACT ASSESSMENT

GALAXY LITHIUM (CANADA) INC.

VOLUME 2: MAIN REPORT (CHAPTERS 6 TO 11)

PROJECT N^O.: 171-02562-00
DATE: OCTOBER 2018

Environmental Impact Assessment Presented to:

Environmental and Social Impact Review Committee (COMEX)
(File no.: 3214-14-055)
and
Canadian Environmental Assessment Agency

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The environmental impact assessment report for the James Bay Lithium Mine project is also available in French. The two versions are meant to be identical, however, if differences occur the French version prevails.

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TABLES OF CONCORDANCE

The following tables present the concordance between the information presented in the environmental impact assessment (EIA) of the James Bay Lithium Mine project of Galaxy Lithium (Canada) and the requirements set out in the documents titled *Guidelines for the Preparation of an Environmental Impact Statement pursuant to the Canadian Environmental Assessment Act, 2012* of the Canadian Environmental Assessment Agency (CEAA) and *Directive pour le projet de mine de lithium Baie James* of the Ministère du développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC).

Table 1: Table of concordance between the sections of the CEAA guidelines and the EIA

Section of the CEAA guidelines		Corresponding chapter or section of the EIA
1.	INTRODUCTION AND OVERVIEW	
1.1.	The proponent	1.1; 1.2; 1.6
1.2.	Project overview	1.5; 4
1.3.	Project location	1.4; 1.5.1; 6.1; 6.2; 6.3; 6.4; 8.5.4.1;
1.4.	Regulatory framework and the role of government	2.4; 6.4.3
2.	PROJECT JUSTIFICATION AND ALTERNATIVES CONSIDERED	
2.1.	Purpose of the project	2.3
2.2.	Alternative means of carrying out the project	3, 4.14
3.	PROJECT DESCRIPTION	
3.1.	Project components	4.1 to 4.12
3.2.	Project activities	4.4 to 4.13
3.2.1.	Site preparation and construction	4.4
3.2.2.	Operation	4.5 to 4.12
3.2.3.	Decommissioning and abandonment	4.13
4.	PUBLIC CONSULTATION AND CONCERNS	
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5.	CONSULTATION WITH INDIGENOUS NATIONS AND CONCERNS RAISED	
5.1.	Aboriginal nations and consultation activities	5
6.	PROJECT EFFECTS ASSESSMENT	
6.1.	Project setting and baseline conditions	6
6.1.1.	Atmospheric, light and noise environment	6.2.10; 6.2.11; 6.2.12
6.1.2.	Geology and geochemistry	6.2.2; 4.1, 4.7
6.1.3.	Topography, terrestrial environments and soil	6.2.4; 6.2.5; 6.2.6; 6.2.9
6.1.4.	Riparian and wetland environments	6.2.7 and 6.3.1 to 6.3.6
6.1.5.	Groundwater and surface water	6.2.6; 6.2.7; 6.2.8
6.1.6.	Fish and fish habitat	6.3.3; 6.2.7

Table 1: Table of concordance between the sections of the CEAA guidelines and the EIA (cont.)

Section of the CEAA guidelines			Corresponding chapter or section of the EIA
	6.1.7.	Migratory birds and their habitats	6.3.5
	6.1.8.	Species at Risk	6.3; 8.5.4; 9.1.2.2
	6.1.9.	Indigenous peoples	2.4; 6.4; 8.6.2
	6.1.10.	Other changes to the environment arising as a result of a federal decision or due to changes on federal lands, in another province or outside Canada	N/A
	6.1.11.	Human environment	6.4
6.2.	Predicted changes to the physical environment		7.2
	6.2.1.	Changes to atmospheric, sound and light environments	7.2.5; 7.2.6; 7.2.7
	6.2.2.	Changes to groundwater and surface water	7.2.2; 7.2.3; 7.2.4
	6.2.3.	Changes to riparian, wetland and terrestrial environments	7.2.1; 7.2.2; 7.2.3
6.3.	Predicted effects on valued components		7.2; 7.3; 7.4
	6.3.1.	Fish and fish habitat	7.2.2; 7.2.3; 7.2.4; 7.3.4
	6.3.2.	Migratory birds	7.3.5
	6.3.3.	Species at risk	7.3
	6.3.4.	Indigenous peoples	7.4
	6.3.5.	Other valued components that may be affected as a result of a federal decision or due to effects on federal lands, another province or outside Canada	N/A
6.4.	Mitigation measures		7.1
6.5.	Significance of residual effects		7.1 to 7.5
6.6.	Other effects to consider		8 and 9
	6.6.1.	Effects of potential accidents or malfunctions	9
	6.6.2.	Effects of the environment on the project	9.2.1
	6.6.3.	Cumulative effects assessment	8
7.	SUMMARY OF ENVIRONMENTAL EFFECTS ASSESSMENT		
	Summary of Environmental Effects Assessment		7.5
8.	FOLLOW-UP AND MONITORING PROGRAMS		
8.1.	Follow-up program		10.3; 10.4
8.2.	Monitoring Program		10.2

Table 2: Table of concordance between the sections of MDDELCC directive and the EIA

Section of the MDDELCC directive			Corresponding chapter or section of the EIA
1	BACKGROUND		
1.1	Presentation of the proponent		1.1; 1.2
1.2	Context relating to the project		1.5; 1.6; 2; 4; 6.1.1;
1.3	Purpose of the project		2.3
2.	LOCATION AND TECHNOLOGY CHOICES		
2.1	Location and route variants		3.1.2; 3.1.3; 3.2.5, 4.14
2.2	Technological variants		3.1.1; 3.2.1 to 3.2.4; 3.3; 3.4, 4.15
3	PROJECT DESCRIPTION		
3.1	Description of the deposit and the facilities		4.1 to 4.3; 4.11
3.2	Extraction		4.5
3.3	Ore processing		4.6
3.4	Waste and tailings management		4.8
3.5	Water management		4.9
3.6	Water balance		4.9.3 to 4.9.6
3.7	Treatment and discharge of contaminated water		4.9
	3.7.1	Water treatment	4.9.1 to 4.9.3; 4.10.2
	3.7.2	Effluent(s)	4.9; 4.10.2
3.8	Related developments and projects		
	3.8.1	Access infrastructure	4.11.2; 4.11.3
	3.8.2	Lodging infrastructure	4.11.4
	3.8.3	Transportation and storage of fuels or hazardous materials	4.10.4; 4.13.1; 4.13.3; 4.16.2
	3.8.4	Borrow pits	4.4.3; 4.4.5; 4.8.2; 4.9.4
	3.8.5	Concentrate transport	4.12
	3.8.2	Energy supply	3.4; 3.5; 4.3
	3.8.2	Employment and training	1.6.3; 2.3; 4.13, 6.4.3.4
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4.2	Description of the relevant components		
	4.2.1	Biophysical environment	6.2; 6.3
	4.2.2	Archeological and cultural potential	6.4.9
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Table 2: Table of concordance between the sections of MDDELCC directive and the EIA (cont.)

Section of the MDDELCC directive		Corresponding chapter or section of the EIA
6.	MITIGATION MEASURES, RESIDUAL IMPACTS AND COMPENSATORY MEASURE	
6.1	Mitigation of impacts	7.1 to 7.4
6.2	Residual impacts and compensatory measures	7.1 to 7.5; 8.6.2
7.	RISK MANAGEMENT	
7.1	Risks of technological accidents	9.3
7.2	Safety measures	9.3
7.3	Preliminary emergency response plans	9.4
8	MONITORING AND FOLLOW-UP PROGRAM	
8.1	Monitoring program	10.2
8.2	Environmental and social tracking program	10.3; 10.4

ABBREVIATIONS AND ACRONYMS

Acronym	Definition
ANFO	Ammonium Nitrate / Fuel Oil
ARIA	*Analyse, Recherche et Information sur les Accidents* (database)
CAPEX	Capital expenditures
CCME	Canadian Council of the Ministers of the Environment
CBHSSJB	Cree Board of Health and Social Services of James Bay
CDPNQ	*Centre de données sur le patrimoine naturel du Québec*
CEAAg	Canadian Environmental Assessment Agency
CEAA	*Canadian Environmental Assessment Act*
CFPBJ	Centre de formation professionnelle de la Baie-James
CHRD	Cree Human Resources Department
CMC	Community Miyupimaatisiiun (health) Centre
CNG	Cree Nation Government
COMEX	Review committee
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRRNTBJ	Regional Commission on Natural Resources and the James Bay Territory
CSB	Cree School Board
CTEU-9	Water leaching test
DMS	Dense media separation
DUC	Ducks Unlimited Canada
EC	Environment Canada
EC/ha	Equivalent-couple per hectare
EDOs	Effluent Discharge Objectives
EIA	Environmental impact assessment
EIJB	Eeyou Istchee James Bay
EIJBRG	Eeyou Istchee James Bay Regional Government
EMP	Emergency measures plan
ÉPOQ	*Étude des populations d'oiseaux du Québec*
EQA	*Environment Quality Act*
GCC	Grand Council of the Crees
GHG	Greenhouse gas
INSPQ	Institut national de santé publique du Québec
ISQ	Institut de la statistique du Québec
JBNQA	James Bay and Northern Québec Agreement

Acronym	Definition
LDL	Laboratory detection limit
Li_2O	Lithium oxide
LNG	Liquefied natural gas
LPFS	Low-pressure feed system
MABA	Static test to predict acid generation potential
MDDELCC	Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques
MDMER	*Metal and Diamond Mining Effluent Regulations*
MEND	Mine Environment Neutral Drainage program
MERN	Ministère de l'Énergie et des Ressources naturelles
MFFP	Ministère des Forêts, de la Faune et des Parcs
MIACC	Major Industrial Accidents Council of Canada
MRNF	Ministère des Ressources naturelles et de la Faune
MSSS	Ministère de la Santé et des Services sociaux du Québec
MTMDET	Ministère des Transports, de la Mobilité durable et de l'Électrification des transports
Non-PAG	Non-potentially acid generating
OPEX	Operating expenditures
PAG	Potentially acid generating
RES	*Résurgence dans les eaux de surface*
SARA	*Species at Risk Act*
SDBJ	Société de développement de la Baie-James
SOPFEU	Société de protection des forêts contre le feu
SPLP	Synthetic Precipitation Leachate Procedure
TCLP	Toxicity Characteristic Leachate Procedure
TJCM	Table jamésienne de concertation minière
URSTM	Unité de recherche et de service en technologie minérale (UQAT)
VCs	Values components
WEDC	Wabannutao Eeyou Development Corporation
WNS	White-nose syndrome
WSI	Weh-Sees Indohoun
WTP	Water treatment plant

GLOSSARY

Term / Symbol	Description
Accident	Any unforeseen and sudden event that causes or is likely to cause personal injuries or damage buildings, facilities, materials, the environment or living beings.
Acid-generating potential	The acid-generating potential associated with the oxidation of tailings.
Acute toxicity	A biological test result that exceeds the standard threshold of mortality of the tested species. It measures the inherent capacity or potential of a toxic substance to cause adverse effects (mortality) in a living organism. In the present context, it refers to a mine effluent that reaches the acute lethality level.
Anthropogenic	Refers to phenomena that essentially result from man's direct or indirect intervention.
Aquifer	A geological stratum or formation that is sufficiently porous and permeable to stock a significant quantity of water while being sufficiently permeable to allow water to flow freely through it.
Aquifer potential	The capacity to provide a high and sustained flow of groundwater. This potential depends on the geometrical characteristics, hydraulic conductivity and recharge rate of the aquifers.
Auto-ignition temperature	The lowest temperature of a hot surface from which, under certain specific conditions, the ignition of a flammable substance in the form of a mix of gas or vapour with air is possible.
Background concentration	The concentration of a chemical substance that corresponds to said substance's ambient presence.
Banded gneiss	Gneiss in which dark and light decimetric horizons alternate regularly.
Basalt	A volcanic magmatic rock produced by rapidly cooled magma and characterized by the following mineralogical composition: plagioclase (50%), pyroxenes (25–40%), olivine (10–25%) and magnetite (2–3%).
Beaver pond	A body of water that is usually shallow (a few metres deep) and was created by the presence of a beaver dam.
Benthic invertebrates	Small animals that do not have a spine (such as insects and mollusks) and that live at the bottom of water bodies.
Carbon oxide equivalent (CO_2 eq.)	A unit used to compare the radiative forcing of a GHG to carbon dioxide.
Claim	The only exploration mineral title on public land that confers on its holder the exclusive right to search for mineral substances, with the exception of surface mineral substances.
Compensatory measure	A measure, excluding the planned treatment of the mine's wastewater, aimed at compensating the residual impacts of the implementation of a project.
Concentrate	A substance of value that results from the spodumene concentration process and that contains approximately 6% of lithium oxide (Li_2O).
Contaminants	A solid, liquid or gaseous matter, microorganism, sound, vibration, ray, heat, odour, radiation or any combination thereof that is likely to somehow alter the quality of water or the environment.
Contaminated water	Water in which the concentration of any chemical substance exceeds its natural concentration because of mining activities (D019).
Criteria	Concentrations of a contaminant that, if they are exceeded, risk causing a complete or partial loss of the use for which they were established.

Term / Symbol	Description
Dense media separation	A density separation process that uses different material densities to apply gravity separation. This robust process is effective to separate minerals, mineralized bodies and metallic waste.
Deposit	A series of mineral layers in the ground. A mineralized zone that is large enough to justify its commercial development.
Dewatering	The action of evacuating infiltration water from a mine.
Diabase	A mafic igneous, holocrystalline rock that is equivalent to volcanic basalt or plutonic gabbro and is slightly modified by metamorphism.
Dike	A long construction designed to contain water.
Dyke (geology)	In geology, a dyke (or dike) is a tabular body of magmatic rock that has penetrated into a fracture through different layers of rock. Dykes cut through pre-existing rock vertically or quasi-vertically. A dyke can also be composed of sedimentary deposits in a pre-existing fissure.
Drainage system	A system that is used namely to intercept the mine site's drainage water and direct it to treatment units. It can also designate a system used to redirect uncontaminated runoff water to the periphery of the mine site.
Effect	The consequence of an accident: toxic concentration, thermal radiation, thermal load, overpressure.
Effect threshold	A value of toxic concentration (ppm or mg/m^3), thermal radiation (kW/m^2), thermal load ((kW/m^2)4/3•s) or overpressure (kPa) from which effects on life or health could be observed within an exposed population or structural damage could result.
Effluent Discharge Objectives	The maximum concentrations and loads of different contaminants that may be released into a receiving environment while ensuring the maintenance or retrieval of their uses.
Elevation	The vertical distance measured between a point located on the Earth's surface and a reference surface (usually the mean sea level).
Emission factor	A factor relating activity data to increased or decreased GHG levels.
Exfiltration	The movement of water from a saturated substrate through the surface of this substrate under the effect of a hydraulic gradient.
Expected detection limit	The detection limit associated with the analytical method of a given parameter specified in the list of analytical methods published by the Centre d'analyse environnementale du Québec of the Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques du Québec.
Extraction	The action of removing mineral material from excavation - open pit or underground.
Extraction capacity	The maximum quantity (in tons per day) of material that is extractable under optimal equipment conditions.
Filter press	An intermittently operating filter consisting of a series of flat vertical filtering surfaces into which the pulp to be filtered is injected under pressure. The pulp is released by separating the filter plates.
Final effluent	Mine wastewater that is no longer treated before being released at the discharge point into the receiving environment or a sewer system.
Final effluent discharge point	A point beyond which an operator no longer has control over the final effluent and can no longer improve its quality.
Flammable (or explosive) limits	When mixed with the oxygen in air, certain gasses or vapours emitted by certain liquids are flammable within the limits of a determined concentration range. Said limits are expressed in % by volume in the air with respect to the ambient temperature and atmospheric pressure. They are called: • LFL: lower flammable limit (or LEL: lower explosive limit); • UFL: upper flammable limit (or UEL: upper explosive limit).

Term / Symbol	Description
Flashpoint (for liquids)	The lowest temperature at which a liquid, at atmospheric pressure, emits a sufficient quantity of vapours to ignite in the presence of a flame.
Flood period	A significant increase in the water flow (and consequently the level) of a watercourse, a lake or a reservoir, most often attributable to precipitations or melting snow.
Flooded area	A terrestrial environment that has recently been affected by a rise of the water level attributable to an external activity, such as the construction of a beaver dam, without, however, having defined limits such as a beaver pond, or presenting hygrophile plants (e.g., rising waters along a lake's shores because of a beaver dam restricting its outflow).
Flow facies	The aspect of a watercourse defined by water height, flow speed and type of substrate. There are eight types of flow facies: waterfalls, cascades, rapids, rises, channels, meanders, basins and estuaries.
Fluvial deposits	Well-stratified deposits carried by a watercourse and composed of gravel, sand and—in lesser proportions—loam, clay and (occasionally) organic matter.
Forest management unit	A basic territorial unit used to manage the forest in such a way as to supply wood processing plants. It is also on the basis of this unit that potential annual sustainable yields are established.
Forest stand	A group of trees that forms a rather homogeneous whole, in terms namely of floristic composition, structure, age and spatial distribution to set is apart from neighbouring stands.
Formation (geological)	A body of rock identified by its lithologic features and stratigraphic position.
Freeboard	The vertical distance separating the embankment crest and the maximum water level in the tailings area.
Freshwater	Water drawn from the natural environment (surface water or groundwater) or from an aqueduct.
Geochemistry	The study of the chemical behaviour of the elements, in particular in rocks (magmatic, metamorphic and sedimentary) as well as in water (coastal and marine) and the atmosphere.
Geological province	A geological province is an extensive continental region that corresponds to a morphostructural set of the terrestrial globe. There are three main types of geological provinces, which are occasionally divided into subtypes: cratons, mountain ranges corresponding to zones of recent orogeny and magmatic provinces.
Geology	A science that includes the study of the parts of the Earth that can be observed directly and the development of hypotheses to reconstitute their history and explain how they fit together. The main geological disciplines are petrography, la mineralogy, la crystallography, volcanology, sedimentology, geochemistry, stratigraphy, tectonics, structure, paleontology and geomorphology.
Geomorphology	The study of the evolution of the Earth's topographic features and the causes of this evolution. This science is midway between geology and geography.
Glaciofluvial deposits	Continental sediments originating from matter ripped off by a glacier and carried by a watercourse.
Global warming potential	A factor that describes the impact of the radiative forcing of one unit of a given greenhouse gas compared to one equivalent unit of carbon dioxide for a defined period.
Gneiss	Metamorphic rock from the continental crust that contains particles of quartz, mica, plagioclase feldspar and (occasionally) alkali feldspar that are all visible to the naked eye.
Greenhouse gas	Gaseous component in the atmosphere, both natural and artificial, that absorbs and re-radiates the infrared radiation of a specific wavelength emitted by the surface of the Earth, the atmosphere and the clouds.
Greenhouse gas source	A physical unit or process that releases a GHG into the atmosphere.
Groundwater flow system	The hydrodynamic characteristics of the movement of groundwater in an aquifer over time.
Hauling road	A road taken by motor vehicles in an open-pit mine.

Term / Symbol	Description
Hazardous material	A material which, by reason of its properties, is a hazard to health or to the environment and which is explosive, gaseous, flammable, poisonous, radioactive, corrosive, oxidizing or leachable or is designated as a hazardous material, and any object classed by regulation as a hazardous material by virtue of the *Environment Quality Act.*
High water	Elevation of the water level following abundant rainfalls or melting snow or ice.
High-water mark	This line is located at the natural high-water mark, i.e., where the predominance of aquatic plants passes to a predominance of terrestrial plants or, if there are no aquatic plants, where the terrestrial plants stop towards the body of water. This mark delineates the shorelines and shores of lakes and watercourses.
Home range	The area where an animal normally lives and that enables it to satisfy its basic needs.
Hydraulic conductivity	A property of geological materials that characterizes the ease with which they allow the movement of water.
Hydraulic property	Hydraulic properties make it possible to analyze in quantitative terms the capacity of a geological formation to contain water and allow it to flow. These properties depend on the proprieties of the liquid, i.e., water, and the physical properties of the environment with respect to water storage and flow.
Hydrogeological conditions	A set of elements and characteristics that define the hydrology (groundwater science) and geology of a sector. It includes, among other things, the hydrostratigraphic units, granulometry and hydraulic properties of geological materials as well as groundwater levels and characteristics.
Hydrogeological property	Refer to Hydrogeological conditions.
Hydrogeological unit	A permeable and porous geological unit, delimited by one or several impermeable units, the whole of which has a structure that allows to form and feed, as least temporarily, a groundwater table within the permeable unit.
Hydrogeology	A geological discipline that studies groundwater (the underground flow of water, the search for groundwater, the evaluation of reservoirs, possible catchments and flows).
Hydrostratigraphic units	Geological units (superficial deposits or rocks) that are characterized by a distinct flow of the groundwater in consideration of their respective permeability levels.
Ignition	The state of a burning body.
In situ	Latin expression that means on site.
Invasive alien species	An invasive alien species is a plant, animal or microorganism (virus, bacterium or fungus) that is introduced outside of its natural range. Its establishment and spreading may constitute a threat to the environment, economy or society.
Land use	The traditional and contemporary use of resources and the full occupation of the traditional territory.
Lands in the domain of the State or public lands	Public lands in Québec.
Leaching	The dissolution of certain mineral constituents.
Leaching tests	These tests make it possible to establish the risks associated with the potential leaching of toxic substances into the groundwater table.

Term / Symbol	Description
Lithium	A soft alkaline metal that is silver-white in colour and that has the lowest molar mass and density of all metals. Its lightness and high reactivity make it particularly suitable for use in the manufacturing of batteries as well as in a variety of industrial processes. The applications of lithium are highly diverse and include the manufacturing of glass and ceramics, lubricants, polymers and pharmaceutical products, the purification of air and, recently and especially, the manufacturing of lithium ion batteries.
Lithostratigraphic	In geology, regarding lithostratigraphy, the branch of stratigraphy that analyzes the organization of strata based on lithologic criteria (composition of the sediments or rocks, including physical and chemical characteristics such as colour, mineralogical composition, harness or grain size).
Lixiviation	A technique consisting of using a solvent, namely water flowing in the soil or a substrate containing toxic products, to extract soluble products.
Low water level	The lowest recorded level of a watercourse or any other body of water.
Low-water period	The period of the year during which the flow of a watercourse reaches its lowest level (minimum flow).
Lugeon test	The Lugeon test consists of injecting pressurized water into a cavity comprised of a portion of a drilling of known dimensions and of measuring the injection rate at different pressure levels over a given period.
Marsh	A wetland that is dominated by herbaceous vegetation (emergent, grass-like or broad-leaved) growing in a mineral or organic soil. Shrubs and trees, when present, cover at least 25% of the environment’s surface area. A marsh is usually connected to fluvial, riparian and lacustrine areas and its water level varies according to tides, flooding and evapotranspiration. A marsh may be flooded on a permanent, semi-permanent or temporary basis.
Maternity	A fauna breeding site.
Measurement site	The location where water samples are taken to analyze the quality of the final effluent and measure the flow and the pH. The measurement site is located immediately upstream of the final effluent discharge point.
Mine	A set of surface and underground infrastructures, with the exception of pits covered by the *Regulation respecting pits and quarries* (R.Q. c.Q-2, r.2), designed to extract mineral for economic purpose.
Mine site	A site on which unfolds or had unfolded work to explore or develop a mineral deposit, to extract or process the material. Includes, without limiting the generality of the foregoing, mines, surface infrastructures, storage areas, stockpile areas, and basins as well as adjacent cleared or disrupted sectors.
Mine water	Water, not including domestic wastewater, that is pumped from a mine excavation to keep it dry during exploration and development operations.
Mining lease	A mineral title that confers on its holder, on a given public territory, the exclusive right to mine mineral substances, except for those found on the surface. Since 1966, mining leases have replaced mining claims for new applications to operate.
Mitigation measure	A measure designed to reduce or eliminate the adverse effects of a project.
Modelling	The design of a model, i.e., a diagram representing a defined system, chosen following its intended use, followed by the development of a simulator (or an analogue, digital or other simulation model) of the system.

Term / Symbol	Description
Observation well	A well used to observe, on an episodic or regular basis, a characteristic of the groundwater that may vary: level, chemical quality, temperature, etc. More specifically, a well used to measure the hydraulic load of a water table, in general near its surface, by surveying the depth of the table, and to observe its natural or influenced variations, through periodic measurements (less rigorously than when using a piezometer).
Organic deposits	Deposits that are composed of more or less decomposed organic matter.
Organic matter	A substance of biological origin that results from the decomposition of plant debris, dejections and animal carcasses.
Outcrop	An exposure of rock or mineral deposit that can be seen on the surface, i.e., that is not covered by soil or vegetation.
Outflow	A watercourse that releases the water of a lake or pond.
Overburden	The unconsolidated natural layer of sediments that must be penetrated to reach the economic material, i.e., soil that does not contain any material of value to mining companies.
Peatland	A wetland in which the production of organic matter, regardless of the composition of the plant remains, has prevailed over its decomposition. The result is a natural accumulation of peat that constitutes organic soil. Peatland soil is either poorly or very poorly drained and the groundwater table is usually at the same depth as the soil or close to its surface. There are two main types of peatland—ombrotrophic (bogs) and minerotrophic (fens)—that are fed by different water sources. Peatland may be wooded or not (open). Wooded peatland is covered with trees that measure more than 4 m in height over 25% or more of its surface.
Permeability test	In the case of this impact study, the permeability tests conducted on site consisted of collecting a known volume of water from a well and evaluating how quickly it rises through the water table. How quickly the water rises makes it possible to establish the hydraulic conductivity of a determined horizon.
Piezometer	A tube well with a screened extremity used to measure the piezometric level at a specific point.
Piezometric high	The zone where the elevation of the water table is at its highest.
Piezometric level	The depth of the upper limit of the water table.
Pit	Refers to the excavated zone in the shape of a funnel in the open-pit mining process.
Pit wall	The sides (walls) of the pit.
Pond	A wetland with a water level of less than 2 m during the low-water season. It is characterized by the presence of floating or submerged aquatic vegetation as well as emergent vegetation covering at least 25% of the environment's surface area. Temporary ponds, often called vernal or forest pools, are shallow (< 1 m), isolated and usually fed in water by precipitations, melting or the water table. Ponds retain stagnant water in the spring for a period of approximately two months and then dry out during the summer. Given they are not inhabited by fish, they tend to favour species that are adapted to the recurrent flooddrought cycles such as salamanders and certain frog species.
Post-rehabilitation	The period that follows the end of the rehabilitation work planned to return the receiving environment to a satisfactory state for its protection.
Pumping test	Continuous pumping at a regular flow in a pumped well such as to generate a permanent flow until the water level is stable in the pumped well and the observation wells drilled around the pumped well. This test makes it possible to measure the drawdown of the water table in the observation wells during the pumping (downward flow) and once the pumping has stopped (upward flow) and, in turn, to measure the permeability coefficient.
Radius of impact	The distance measured from the source of an effect to the selected effect threshold.

Term / Symbol	Description
Receiving environment	The environment in which the project unfolds and that is likely to be affected by the completion of the project.
Recharge	The recharge corresponds to the quantity of water that enters the aquifer after infiltrating the surface and renews the groundwater.
Recirculation	Action by which mine wastewater is retrieved to be reused in equipment and processes.
Reduction	The mitigation of flood peaks due to the reduction and lag of the water volumes.
Reference state	The characteristics of an environmental component as they were before the project.
Regular monitoring	The complete environmental monitoring (weekly, three times weekly and acute toxicity) of the final effluent.
Resurgence	Refer to Resurgence water.
Retention basin	A retention structure designed to contain runoff water.
Rim	The edge of a well
Risk analysis	The use of information such as to identify the hazards and estimate the probability and seriousness of adverse effects on people or populations, the environment and property.
Scarification	An operation by which the indurated surface of a pavement (or a layer of pavement) is at once isolated from the pavement's underlying structure and reduced to blocks through ploughing using a machine such as a harrow, a rake arm or a scarifier.
Sediment	An unconsolidated deposit of detritic, chemical or organic origin formed by the grouping of small and larger particles or precipitated matter having been transported separately.
Sedimentation basin	A retention structure designed to retain water long enough for the suspended solids to settle at the bottom of the basin before the water is released.
Seismic	Which relates to earthquakes or which is prone to earthquakes.
Shoreline	The part of a lake or watercourse that extends from the high-water line to the centre of the body of water.
Sorption	The uptake and retention of a substance (the sorbed) on the surface (adsorption) as well as within (absorption, in the broader sense) another substance (the sorbent).
Special status species	Special status species are plant and animal species at risk according to the MDDELCC, i.e., those that are designated as threatened or vulnerable Québec by virtue of the *Act respecting threatened or vulnerable species* and those that are likely to be designated as such as well as plant and animal species that are at risk in Canada by virtue of the *Species at Risk Act*.
Spodumene	Spodumene is a silicate of aluminum and lithium. It is the most important mineral making up commercially mined lithium in the world.
Spodumene-bearing pegmatite	The minerals contained in lithium (spodumene, petalite, lepidolite, amblygonite) are namely associated with rocks such as rare-metal granitic pegmatites. These granitic pegmatites often constitute peraluminous instructive complexes.
Spot sample	The volume of undiluted effluent collected at a given time.
Stockpile	Land where mineral substances, topsoil, concentrates or mine tailings are accumulated.
Stratigraphy	The science that studies the succession of sedimentary deposits, generally laid out in layers (or strata). The study of the order in which layers of rock that make up the Earth's crust formed over geological times.

Term / Symbol	Description
Surface mineral substances	Peat; sand including silica sand; gravel; limestone; calcite; dolomite; common clay and argillaceous rocks used in the manufacture of clay products; all types of rocks used as dimension stone, crushed stone, silica or mineral in the making of cement; and every mineral substance that is found in its natural state as a loose deposit, except the tilth, as well as inert mine tailings, where such substances and tailings are used for construction purposes, for the manufacture of construction materials, or for the improvement of soils *(chapter I-1, Mining Act)*.
Surface or superficial deposits	Unconsolidated sediments (clay, sand, gravel, stones, etc.) of various origins, natures, morphologies and thicknesses that rest on the surface of the bedrock.
Swamp	A wetland that is dominated by woody, shrub or tree vegetation (covering more than 25% of the environment's surface area) that grows in a mineral soil that is poorly or very poorly drained. A riverine swamp is seasonally flooded or characterized by a high-water table and a water flow that is high in dissolved minerals. As for an isolated swamp, it is fed by runoff water or resurgences of the water table.
Tailings	Solid or liquid substances, with the exception of the final effluent, resulting from the extraction, preparation, enrichment and separation of an economic material, including the sludge and dust resulting from the treatment or purification of mine wastewater or air emissions. Are considered as tailings the slag and sludge, including sewage sludge, released during the treatment by pyrometallurgy, hydrometallurgy or electroextraction. Are also considered as tailings the substances released during the extraction of a marketable substance from tailings and that correspond to those already defined in the first two paragraphs. Are excluded the tailings resulting from the working of a pit within the meaning of the *Regulation respecting pits and quarries* (R.Q., c.Q-2, r.2).
Tallyman	A trapper in charge of supervising other trappers and whose primary responsibility is managing animal populations within the limits of the land for which he is responsible.
Topsoil	Surface soil that is composed of a mix of organic matter as well as sand, silt and clay or a combination thereof and that is conducive to vegetation growth.
Traditional activities	Refer to Traditional practices.
Traditional practices (traditional activities)	All of the traditional hunting, fishing, gathering and general activities as well as land and resource use activities for livelihood, ritual and social purposes.
Treatment capacity	The maximum quantity of material (in tons per day) that is treatable under optimal equipment conditions.
Tributary	A watercourse that flows into a larger watercourse or into a lake (affluent).
Unconsolidated deposits	Unconsolidated matter that covers a deposit or the bedrock.
Water table	The underground water table that feeds catchment works. The water table is the first table of groundwater under the soil surface.
Watercourse	Any water mass that flows into a bed at a regular or intermittent rate, including those created or modified by human intervention as well as the St. Lawrence River and the Gulf of St. Lawrence and all seas surrounding Québec.
Watershed	A watershed is a territory, bounded by drainage divides, over which water flows to a single point called an outflow.
Wetland	Wetlands comprise all sites that are saturated with water or flooded during a sufficiently long period to exert an influence on the "soil" and "vegetation" components, to the extent they are present.
Wind erosion	Erosion caused by the wind.
Winter concentration area (or wintering area)	A forest territory of variable size that is used as shelter by a large or small group of crevids during the winter.

Term / Symbol	Description
	Explosion Hazard.
	Flammable Material.
	Oxidizing.
	Compressed Gas.
	Corrosive.
	Harmful of Fatal.
	Harmful.
	Health Hazard.
	Harmful to the Environment.

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6 DESCRIPTION OF THE RECEIVING ENVIRONMENT

6.1 GEOGRAPHIC FRAMEWORKS AND PROJECT STUDY AREAS

6.1.1 GEOGRAPHIC FRAMEWORK

The James Bay Lithium Mine project is in the Nord-du-Québec administrative region, on the territory of the Eeyou Istchee James Bay Regional Government. It is located approximately 10 km to the south of the Eastmain River, 100 km east from James Bay, and the Eastmain Cree village (Map 1-1). The project is on Category III lands of the JBNQA.

The central geographical coordinates in UTM (zone 18, NAD83) of the project site are presented below:

— X: 358,891
— Y: 5,789,180

The lands subject to the mining claim of the James Bay Lithium Mine project (Project Property) are easily accessed by the James Bay road that connects Matagami and Radisson. This road crosses the James Bay Property at kilometre 381 of the road, close to the km 381 truck stop (*relais routier)* managed by the SDBJ at that kilometre point.

6.1.2 LOCAL STUDY AREA

The local study area primarily consists of the mine site and a right-of-way within which certain components may be influenced by the project, more specifically, the components from physical and biological environments such as soils, water, sediments and flora.

This study area is located on both sides of the James Bay road, at kilometre 381 of the road, in the same location as the km 381 truck stop, well known to visitors who take the road to James Bay at 52° north latitude.

The local study area covers an area of 36.9 km^2, 6.7 km from east to west and 5.5 km from north to south. Map 6-1 shows this area.

6.1.3 OTHER STUDY AREAS

To precisely analyze the impacts of the project, other study areas have been delimited for certain environmental components. The need to consider other study areas is justified by the fact that, in some cases, the project will only influence components that are located near the proposed mine, while for other aspects, the effects will instead be felt on a broader scale than the local study area. In these specific cases, the new study areas are presented and justified in the section dealing with these components.

6.2 PHYSICAL ENVIRONMENT

6.2.1 CLIMATE

The climate of the study area is of subarctic continental type according to Köppen's classification of climates. It is characterized by a very cold and long winter and a short and cool summer with limited rainfall, but which lasts all year long.

The most representative and complete weather station to characterize the climatic conditions of the study area is La Grande Rivière Airport (code: 71827) positioned at coordinates 53° 38' 00'' N, 77° 42' 00'' W, at an altitude of 195 m and located approximately 162 km to the north of the proposed mining facilities. The climate data presented below are taken from the Environment Canada (EC) climate normals directory for the period 1981-2010 (EC, 2018). Climate normals are averages of weather variables over a predetermined period of 30 years established by the World Meteorological Organization (WMO) providing a consistent and objective comparison of the climate between different regions.

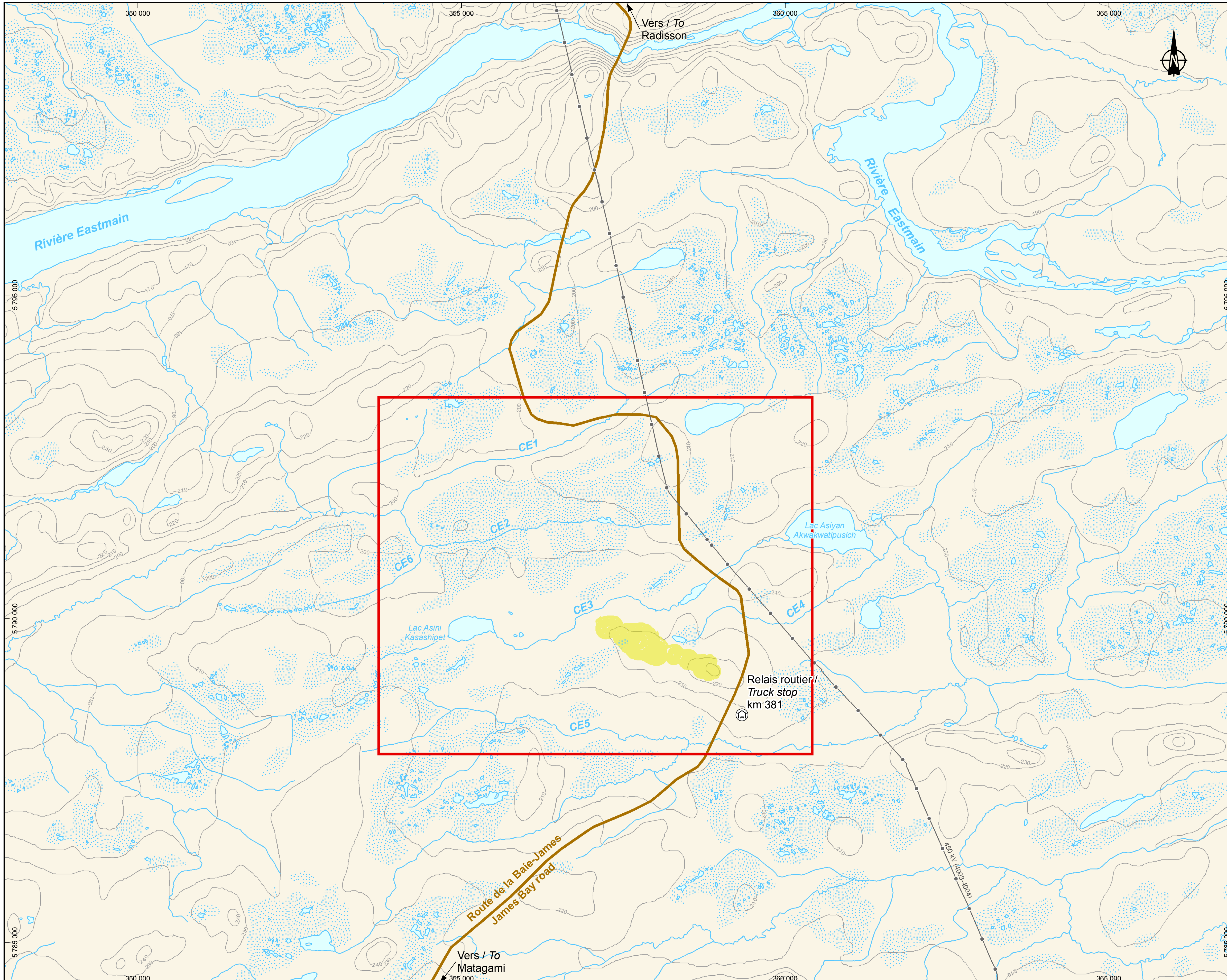
6.2.1.1 TEMPERATURE

The mean, maximum and minimum monthly average temperatures are presented in Table 6-1. The coldest month is January with an average temperature of -23.2°C, and July is the warmest month with an average temperature of 14.2°C. The monthly temperature ranges vary from 6 to 12.5°C, where March is the month with the greatest temperature range.

The extreme temperatures (record) having been recorded at La Grande Rivière Airport station are -44.6°C in February 1979 and 37.3°C in July 2015.

Table 6-1: Monthly average mean, maximum and minimum daily air temperatures at La Grande Rivière airport station (1981 to 2010 period)

Month	Mean (°C)	Maximum (°C)	Minimum (°C)	Temperature range (°C)
January	-23.2	-18.5	-28.0	9.5
February	-21.6	-15.9	-27.3	11.4
March	-14.5	-8.2	-20.7	12.5
April	-5.0	0.6	-10.6	11.2
May	4.3	10.3	-1.6	11.9
June	10.8	17.3	4.2	13.1
July	14.2	20.4	8.0	12.4
August	13.1	18.6	7.6	11.0
September	8.1	12.3	3.8	8.5
October	1.7	4.8	-1.5	6.3
November	-6.1	-3.1	-9.1	6.0
December	-16.0	-12.0	-19.9	7.9
Annual (average)	**-2.9**	**2.2**	**-7.9**	**10.1**



Projet mine de lithium Baie-James / *James Bay Lithium Mine Project*

Zone d'étude locale / *Local study area*

Composante du projet / *Project Component*

Fosse / *Open pit*

Hydrographie / *Hydrography*

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau / *Stream*

Milieu humide / *Wetland*

Infrastructures / *Infrastructure*

Relais routier / *Truck stop*

Route principale/ *Principal road*

Ligne de transport d'énergie / *Transmission line*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement /

Environmental Impact Assessment

Zone d'étude locale /

Local Study Area

Sources :

CanVec, 2017

Données du projet / Project data, Galaxy, 2017

Cartographie / Mapping : WSP

No Ref : 171-02562-00_wspT065_EIE_c6-1_ZE_181015.mxd

0 0,5 1 km

UTM 18, NAD83

Carte / *Map* 6-1

wsp

Table 6-2 shows the average number of days for each month when the maximum temperature is equal or lower and the minimum temperature above the freezing point. These measurements show that for the period from December to February, on average, only two days are reported with a minimum temperature above 0°C. In turn, the months of June, July, August and September do not show any day with a maximum temperature less than or equal to the freezing point. The proportion of days when a negative temperature has been recorded is 43%.

Table 6-2: Average number of days with temperatures above and below the freezing point at the La Grande Rivière airport station (1981 to 2010 period)

	Number of days	
	Maximum temperature	Minimum temperature
Month	<=0°C	>0°C
January	31	0
February	27	1
March	26	5
April	14	16
May	2	29
June	0	30
July	0	31
August	0	31
September	0	30
October	4	27
November	22	8
December	30	1
Annual (total)	**156**	**209**

6.2.1.2 *PRECIPITATION*

The monthly average precipitation is presented in Table 6-3. The annual precipitation at EC's La Grande Rivière Airport station is 697.2 mm, of which 453.8 mm is rain and 261.3 mm is snow. The month of September is the wettest with 110.6 mm of equivalent precipitation (rain and snow). The least rainy month is February with a total average of 21.9 mm. It is also noted that there can be snowfall on average throughout the entire year, except in July and August.

The maximum daily precipitation recorded at this station is 66.4 mm of rain in August 2000 and 25.8 cm of snow in November 1985. The recurrence of rainfall 1:1000 year (24 h) was assessed at 101.6 mm, whereas the melt 1:100 year (30 days) is 388.5 mm.

6.2.1.3 *WIND*

Table 6-4 shows the average monthly speeds and prevailing direction of wind between 1981 and 2010 at La Grande Rivière Airport station. The average annual wind speed is 14.5 km/h. The month of September is the windiest with an average speed of 15.9 km/h. The least windy month is January with a speed of 13.6 km/h. The direction of prevailing wind is primarily from a western sector throughout the entire year, except for October, November and December when the prevailing direction is from a southern sector.

The maximum hourly wind speed recorded at La Grande Rivière Airport station is 93 km/h with a southwesterly direction, while the maximum recorded gust is 122 km/h. These values were recorded during October 1984.

Table 6-3: Monthly mean precipitation averages at La Grande Rivière airport station (1981-2010 period)

Month	Rainfall (mm)	Snowfall (cm)	Total precipitation (mm)
January	0.1	33.1	30.9
February	1.2	23.0	21.9
March	3.4	28.6	29.4
April	12.7	21.0	32.7
May	27.9	11.9	39.0
June	62.6	2.6	65.3
July	78.5	0.0	78.5
August	91.0	0.1	91.1
September	106.9	4.0	110.6
October	56.2	32.4	87.3
November	11.6	60.3	67.9
December	1.7	44.4	42.6
Annual (total)	**453.8**	**261.3**	**697.2**
* The total in mm represents the water equivalent of the melted snow and the rain.			

Table 6-4: Monthly source of wind and average speed at La Grande Rivière airport station (period from 1981 to 2010)

Month	Average speed (km/h)	Prevailing source	Maximum hourly speed (km/h)	Maximum speed direction
January	13.6	West	57	Northwest
February	13.7	West	56	West
March	14.2	West	72	West
April	14.4	West	63	Southeast
May	14.9	West	61	Southwest
June	15.1	West	65	Southeast
July	13.7	West	65	South
August	14.3	West	65	Southwest
September	15.9	West	74	West
October	15.4	South	93	Southwest
November	15.3	South	74	West
December	13.8	South	67	West
Year (average)	14.5	**West**	-	-

The seasonal distribution and total wind direction frequencies between 1981 and 2010 are shown in Figure 6-1 as a histogram. Analysis of the histogram indicates that more than 48 % of wind, regardless of the time of the year, varies in direction in a sector from south to west. Winter and summer are the seasons with the greatest wind frequency from the west with values of 22 % and 21 % respectively. The northeastern sector has the lowest total wind frequency with a percentage of 7.6 %. The other wind directions have relatively similar frequencies and do not show much variability. Figure 6-2 presents the wind rose generated from weather data generated using the WRF model (Weather Research and Forecast) and ERA-Interim climate reanalysis generated by ECMWF (European Centre for Medium-Range Weather Forecasts) for the 2011 to 2015 years.

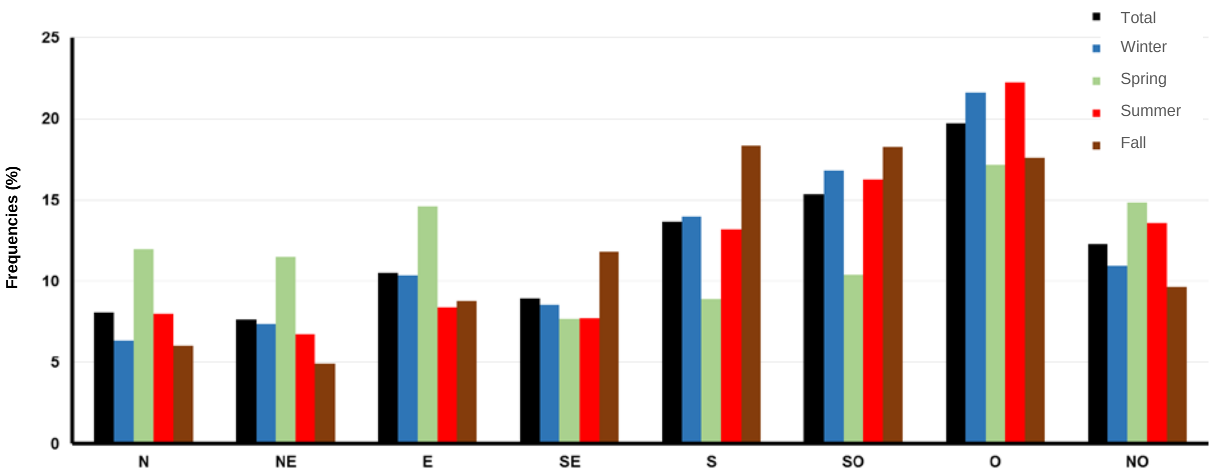


Figure 6-1: Histogram of wind direction frequencies at La Grande Rivière Airport station (period from 1981 to 2010)

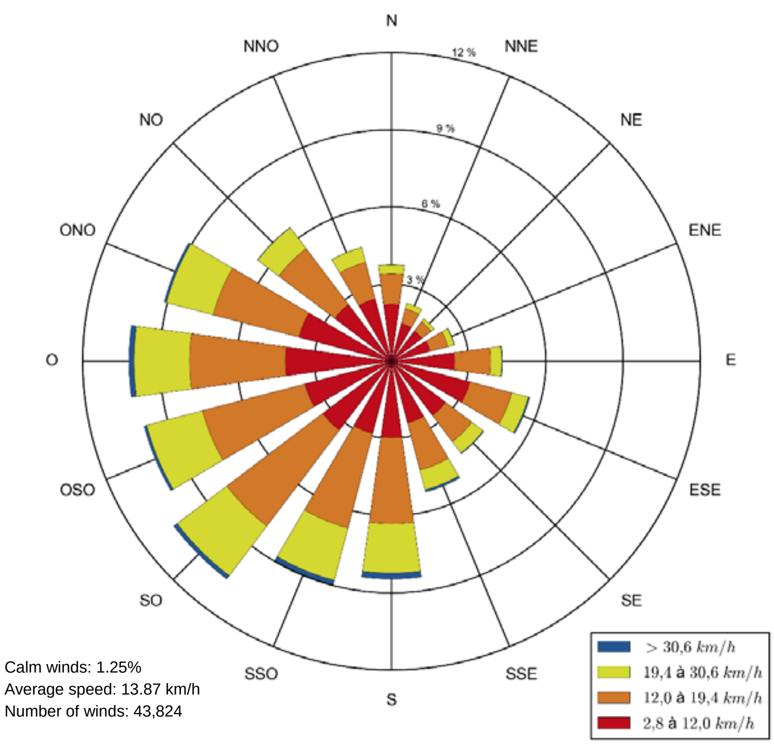
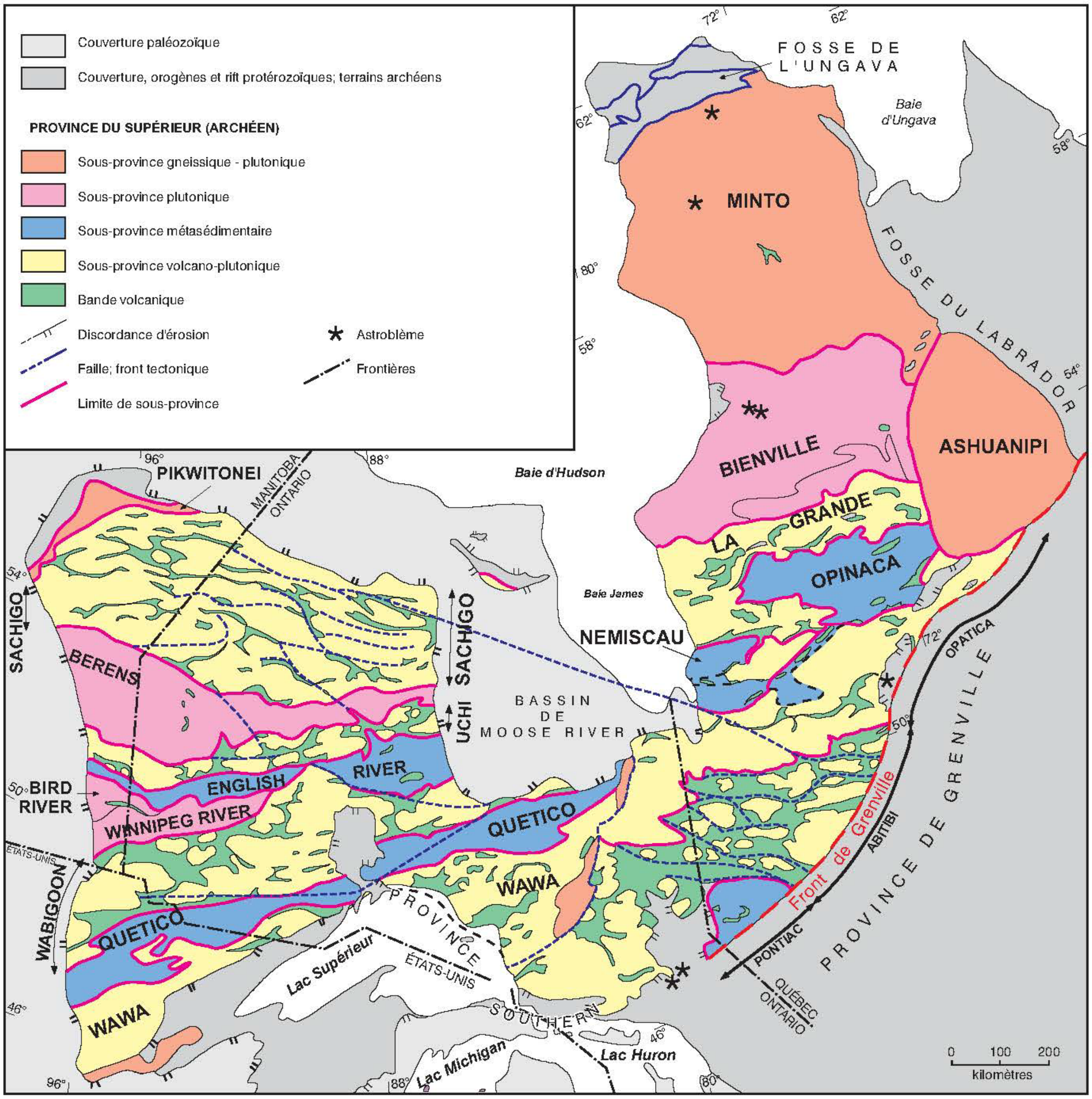


Figure 6-2: Wind rose

6.2.2 GEOLOGY

Located in the heart of the Canadian Shield, the study area is in the northeastern part of the Superior Geological Province and is part of the volcano-plutonic La Grande Subprovince (MRNF, 2004) (Map 6-2). This area includes a volcano-sedimentary assemblage assigned to the Eastmain Group.



Map 6-2: Superior province

Source: MRNF, 2004.

The study area is part of the Eastmain greenstone belt and, more specifically, lies within the Lower Eastmain Group. It is dominated by metavolcanic rocks (amphibolites of mafic to felsic grade associated with Komo formation), metasedimentary rocks and minor gabbroic intrusions (Broad Oak, 2009 in SRK Consulting, 2010).

The chronology of the assemblage that led to La Grande Subprovince dates back to the Archaean era (4.0 to 2.5 Ga). During this period, two phases of volcanic and tectonic deformation occurred. Between the two, the basins of the

Auclair formation were formed (> 2,546 ± 50 Ma). A third more recent phase of retrograde metamorphism during the Proterozoic era (2.5 Ga to 0.541 ± 0.1 Ga) left abundant flecks and dykes. In the study area, the formation is said to date from the second deformation phase, during late-stage or post-tectonic intrusions, at the end of the Archean era (> 2.697 Ma) (Broad Oak, 2009 in SRK Consulting, 2010).

The Auclair formation dominates the surface geology of the study area (Broad Oak, 2009 in SRK Consulting, 2010). In fact, a paragneiss with metamorphic minerals (probably sedimentary in origin) occupies a large part of this area (Map 6-3). Amphibolized and amphibolite basalts belonging to the Komo Formation outcrop on both sides of the James Bay road. Immediately to the south of the basalts is a spodumene pegmatite dyke. More specifically, it is mineralized lithium in solid phase in the form of spodumene, of igneous origin. It is in the Lithium-Cesium-Tantalum (LCT) family and of albite-spodumene type (SRK Consulting, 2010).

In the northeastern portion of the study area, a monogenic to polygenic conglomerate and sandstone denotes belonging to the greenstone belt (Broad Oak, 2009 in SRK Consulting, 2010). Also, a diabase dyke crosses the central portion of the study area on a north-south axis. Finally, we note the presence of felsic and intermediate tuffs at the northern limit border of the study area. Lastly, spodumene consists of white to green prismatic and striated crystals and in the form of lithium-containing mica in pseudomorphic flat aggregates (Broad Oak, 2009 in SRK Consulting, 2010).

6.2.3 STRUCTURE AND SEISMIC ACTIVITY

Eastern Canada is a stable continental region of the North American plate, therefore, has relatively low seismic activity. The Superior Province, in which the study area is located, has overall experienced tectonic stability since 2.6 Ga (Percival, 2007; RNCan, 2017*a*).

Seismic hazard is the most violent ground motion likely to occur in a region, based on a given probability. Ground motions are defined by spectral-acceleration values of the soil that is used in the design of foundations. In the study area, the *National Building Code* 2015 (RNCan, 2017*b*) establishes the probability of an occurrence at 0.000404 per year. This means that for a 50-year recurrence period, there is a 2% chance that an earthquake will cause greater than expected ground motion (RNCan, 2017*b*). The site is in a very low seismic hazard area. In this regard, there is no issue regarding the geological aspects of the soil that are discriminating in the study area.

6.2.4 PHYSICAL GEOGRAPHY

The study area is in the James subregion of the Canadian Shield (RNCan, 2006). It occupies the northern part of the Abitibi lowlands and James Bay natural province, near the intersection with the Grande Rivière low hills and Mistassini highland provinces. This natural province has a plain relief slightly inclined toward James Bay (MDDELCC, 2017*a*).

The topography of Abitibi and James Bay lowlands is low and softened, and ranges from 200 to 350 m in altitude. Rocky outcrops are common and often correspond to striated spodumene hills or ridges of dykes rising up to 30 m above the surrounding plain. They are separated by depressions varying from a few hundred meters to more than 10 km. Within the study area, the elevation varies from some tens of meters at the most.

6.2.5 GEOMORPHOLOGY

The study area experienced a complex sequence of quaternary episodes: glaciation, regional readvances, marine and lacustrine invasions. This dynamic left thick fine deposits (clay, silt and fine sand) in the depressions, occupied by peat bogs. The project site is located near organic deposits, rocky outcrops and fluvial deposits (Map 6-4). Moreover, a large part of the surface is covered with peat bogs.

The territory was completely covered by the Wisconsinan glacier during the last glacial episode. This ice cover has lead to the planing of summits in the region, the overdeepening of valleys and the establishment of glacial deposits in the valleys.

At the project site, the bedrock can be found from a depth of 1.8 m. The rocky surface is covered in some places, with sandy units approximately 3 m thick and whose granulometry varies from fine to coarse. These units are interlayered with gravel beds. In other places, some exploratory trenches have silt and clay beds at the base. These sandy units are covered with a peaty horizon with a thickness varying between 0 and 0.8 m. Also, some areas may be characterized by the presence of isolated islets of permafrost, since the area is in the sporadic permafrost zone. These islets can be found mainly in peat bogs. Given the little difference in elevation in the study area, there is no particular problem regarding the stability of surface deposits.

6.2.6 HYDROGEOLOGY

The assessment of hydrogeological conditions at the project site was carried out using data collected in 2017 and 2018 during the investigation campaigns. Compiling data made it possible to determine the different hydrogeological units, to assess the hydraulic properties and to assess the piezometry as well as the quality of the groundwater. Details of the methods used and results are presented in the Expert survey on the hydrogeology (WSP, 2018*a*). This section summarizes the content of this study.

6.2.6.1 METHODOLOGY

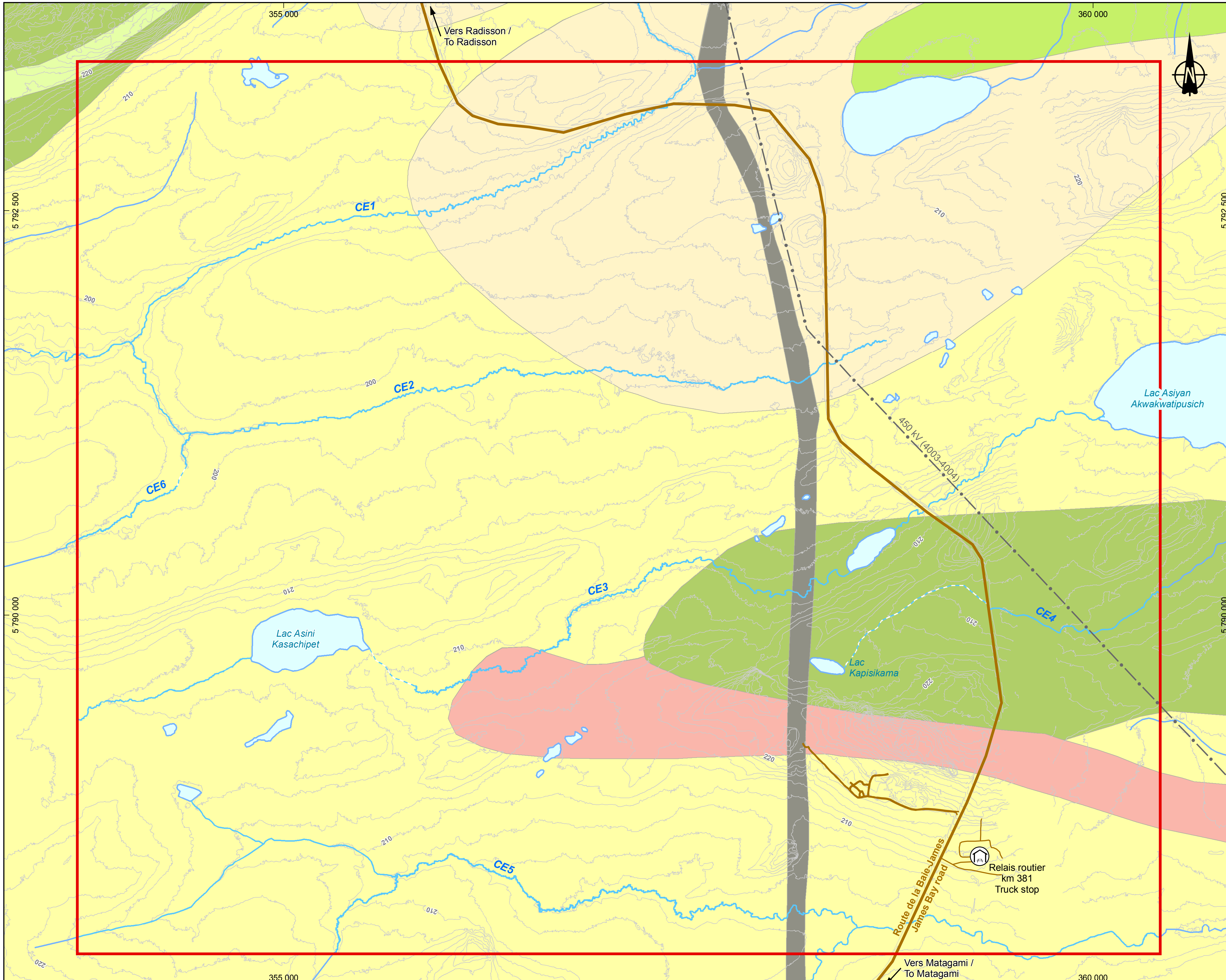
During the hydrogeological and geotechnical work in the fall of 2017 and winter of 2018, 77 drillings were done, including three open-rock wells. Of these, 36 were built into observation wells or piezometers. Also, additional stratigraphic surveys (trenches) provided information on the stratigraphy of the study area. The location of the different surveys carried out in the study area is shown on Map 6-5.

During the various field campaigns, 36 groundwater samples were taken at 20 wells or piezometers in order to establish the initial environmental state. Soil samples were also collected from the drilling and trench sites. In addition, the results of surface water samples were used to determine the characteristics of the receiving environments for readjusting the criteria for metals. Finally, permeability tests and a pumping test were performed to obtain the hydraulic properties of different hydrostratigraphic units.

6.2.6.2 HYDROSTRATIGRAPHIC UNITS

The following hydrostratigraphic units were identified, during drilling, from the surface:

- Peat: Several peatlands have developed on the poorly drained surface of very compact marine deposits. They are vast and very numerous, so that they cover the deposits on approximately 72 % of the territory. Some peatlands have also developed in the rock and till depressions. The abundance of these wetlands shows poor soil drainage conditions. The peat unit is characterized by organic deposits capable of reaching 3.2 m in thickness.
- Littoral sand: In some areas, there are sandy deposits established during the retreat of the Tyrell Sea. These littoral deposits cover the marine deposits. During investigative work, they were rarely identified, except for one area to the south of the pit (PO1 and PO2).
- Clay: A layer of clay deposits (marine deposits) is found on the lower grounds between the rock ridges and till. The thickness of clay deposits can reach 10 m depending on the drilling performed. In the study area, this unit is completely covered by the peat unit.
- Till: In the region, the cover of glacial materials is rather discontinuous. These shapes are elongated and oriented along a WSW-ENE axis that indicates the direction of the regional ice flow. The till of the area is characterized by a very dense material with no apparent structure and by the sporadic presence of sand and gravel lenses. This till consists mainly of silty and gravelly sands with traces of clay. The drillings suggest a thickness of up to 20 m.
- Rock: This unit consists mainly of metasedimentary rocks such as paragneisses and schists as well as mafic and intermediate volcanic rocks such as basalts, andesites, volcaniclastic rocks and, locally, alkaline volcanic rocks.



Zone d'étude locale / *Local study area*

Courbe de niveau (équidistances 2 m) / *Contour (interval 2 m)*

Infrastructures / *Infrastructure*

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Géologie / *Geology*

Pegmatite à spodumène / *Pegmatite with spodumene*

Conglomérat monogénique à polygénique et grès / *Monogenic to polygenic and sandstone conglomerate*

Paragneiss à minéraux métamorphiques / *Paragneiss with metamorphic minerals*

Basalte amphibolitisé et amphibolite / *Amphibolitized basalt and amphibolite*

Tuf intermédiaire / *Intermediate tuff*

Tuf felsique à intermédiaire / *Felsic to intermediate tuff*

Diabase / *Diabase*

Hydrographie / *Hydrography*

CE2 Numéro du cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine

Étude d'impact sur l'environnement

Environmental Impact Assessment

Géologie / *Geology*

Sources :

Canvec : 1 : 50 000, RNCan, 2015

BDGA : 1 : 1 000 000, RNCan, 2011

Géologie / Goelogy : Sigeom, 2017

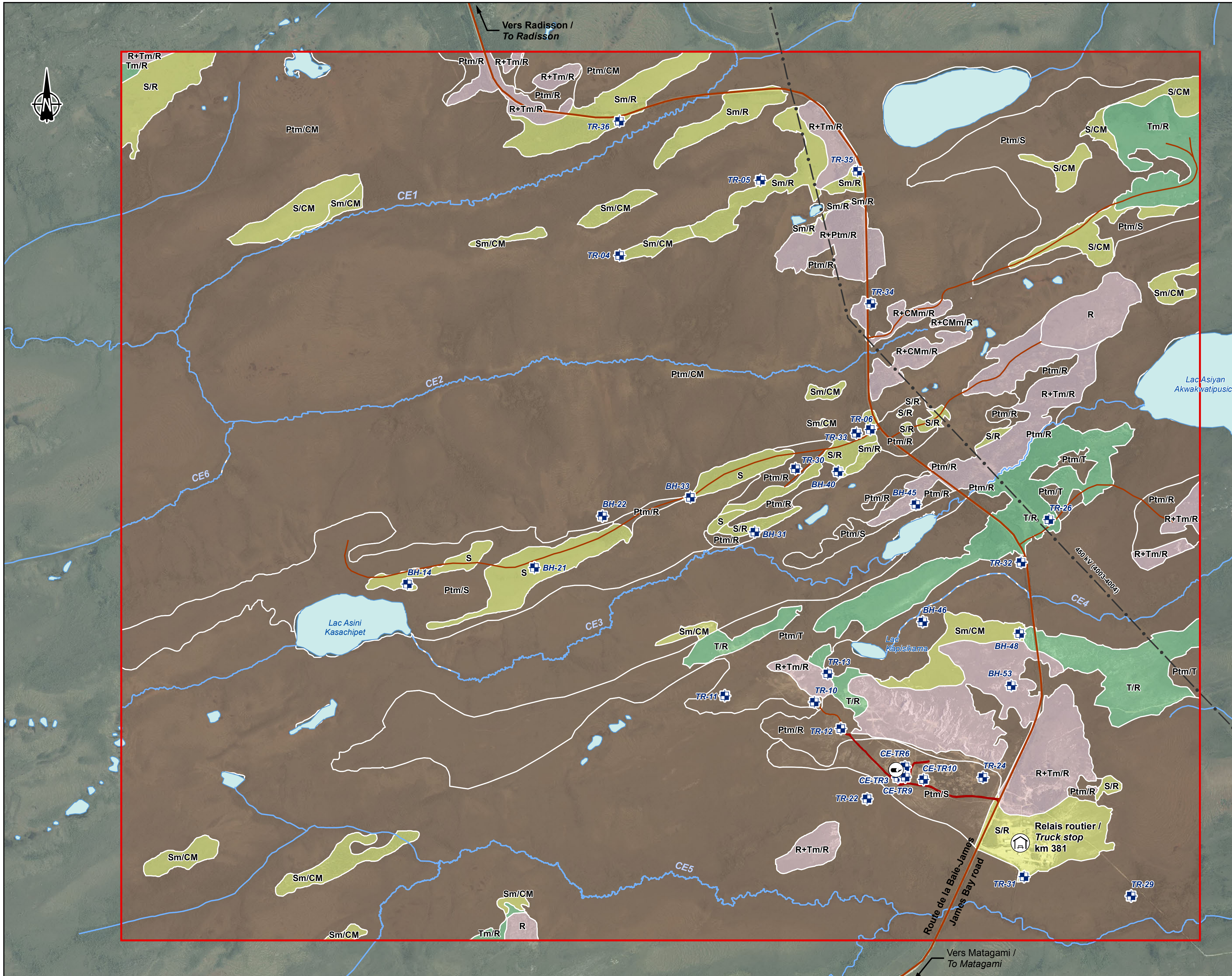
No Ref : 171-02562-00_wspT056_ElEmp_c6-3_geologie_180903.mxd

0 240 480 m

UTM 18, NAD83

Carte / *Map* 6-3

wsp



Zone d'étude locale / *Local sutdy area*

Site d'échantillonnage des sols / *Soil sampling site*

Infrastructures / *Infrastructure*

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Lieu d'enfouissement en territoire isolé (LETI) / *Remote landfill*

Dépôts de surface / *Superficial Deposits*

R	Roc / *Rock*
R+CMm/R	Roc avec placage d'argile mince (<2 m) et discontinu / *Rock with veneer of thin (<2 m) and discontinuous clay*
R+Tm/R	Roc avec placage de till mince (<2 m) et discontinu / *Rock with veneer of thin (<2m) and discontinuous till*
R+Ptm/R	Roc avec placage de tourbe mince (<2 m) et discontinu / *Rock with veneer of thin (<2m) and discontinuous peat*
S	Sable / *Sand*
S/CM	Sable (2 à 6 m) sur argile / *Sand (2 to 6 m) on clay*
S/R	Sable (2 à 6 m) sur roc / *Sand (2 to 6 m) on rock*
Sm/CM	Sable mince (<2 m) sur argile / *Thin sand (<2 m) on clay*
Sm/R	Sable mince (<2 m) sur rock / Thin sand (<2 m) on rock
T/R	Till (2 à 6 m) / *Till (2 to 6 m) on rock*
Tm/R	Till mince (<2 m) sur roc / *Thin till (<2 m) on rock*
Ptm/CM	Tourbe mince (<2 m) sur argile / *Thin peat (<2 m) on clay*
Ptm/R	Tourbe mince (<2 m) sur roc / *Thin peat (<2 m) on roc*
Ptm/S	Tourbe mince (<2 m) sur sable / *Thin peat (<2 m) on sand*
Ptm/T	Tourbe mince (<2 m) sur till / Thin peat (<2 m) on till

Hydrographie / *Hydrography*

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement / *Environmental Impact Assessment*

Géomorphologie et sites d'échantillonnage des sols / *Geomorphology and Soil Sampling Sites*

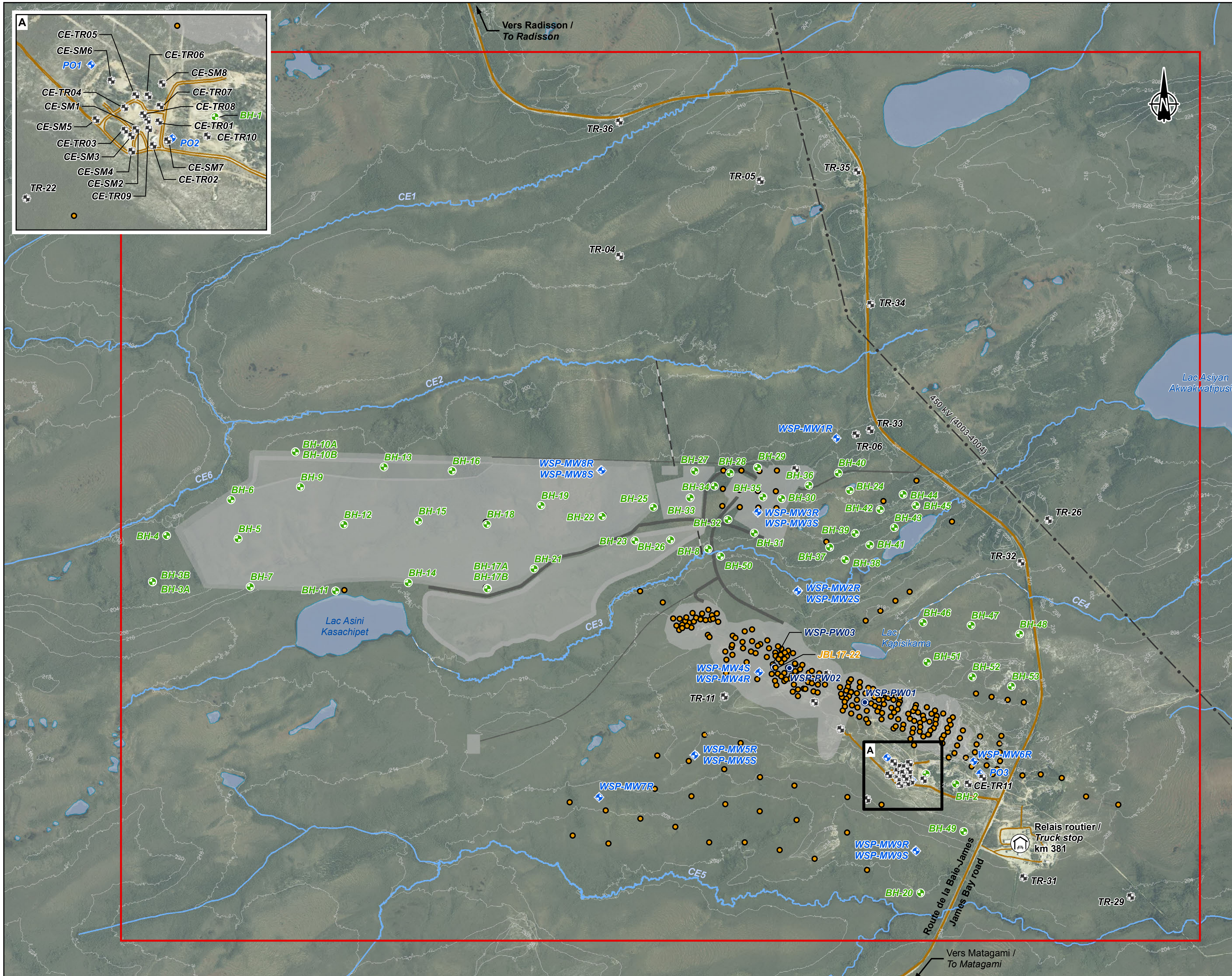
Sources :
Orthoimage : Galaxy, août / august 2017
Photo interpretation : WSP 2018

No Ref : 171-02562-01_wspT090_EIE_c6-4_sols_180903.mxd

0 240 480 m
UTM 18, NAD83

Carte / *Map* 6-4

wsp



Zone d'étude locale / *Local study area*

Courbe de niveau (équidistance des courbes 2 m) / *Contour (interval 2 m)*

Forage d'exploration / *Exploration drill hole*

Puits d'observation / *Observation well*

Puits de pompage / *Pumping well*

Tranchée / *Trench*

Sondage géotechnique / *Geotechnical borehole*

Composantes du projet / *Project Component*

Infrastructures minières / *Mining infrastructure*

Route / *Road*

Infrastructures / *Infrastructure*

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Hydrographie / *Hydrography*

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement /
Environmental Impact Assessment

Sondages hydrogéologiques /
Hydrogeological Boreholes

Sources :
Orthoimage : Galaxy, août / august 2017
Inventaire / Inventory : WSP 2018

No Ref : 171-02562-01_wspT111_EIE_c6-5_hg_sondage_180903.mxd

0 240 480 m
UTM 18, NAD83

Carte / *Map* 6-5

wsp

6.2.6.3 *GRANULOMETRIC ANALYSIS*

Soil samples were taken during drilling for granulometric analysis. As mentioned earlier, the surface soils identified in the study area are mainly till and clay deposits. Till consists mainly of silty sand with varying proportions of gravel. The clay deposit consists of silt and clay including traces of sand. Table 6-5 presents the results summary for the granulometric analysis performed.

Table 6-5: Summary of results for the granulometric analysis performed

Unit	Number of samples	Average interval (m)	Lithology	Average granulometric results (%)
Clay deposits	15	3.14 to 3.74	Silt and clay, traces of sand	Silt 54.8
				Clay 42.4
				Sand 2.8
Sandy deposits (till)	37	3.22 to 3.81	Silty and gravelly sand, traces of clay	Sand 46.5
				Silt 30.6
				Gravel 20.3
				Clay 2.6

6.2.6.4 *HYDRAULIC PROPERTIES OF MATERIALS*

The hydraulic properties of the materials were determined for each unit from the work carried out in the study area, namely:

- granulometric analysis (52 analysis);
- pumping test (one test at well WSP-PW03);
- permeability tests (30 tests on 18 wells).

All these analysis makes it possible to determine parameters, such as the hydraulic conductivity and the storage coefficient depending on the different units encountered.

The permeability contrast between the different units will influence the groundwater flow patterns. Table 6-6 presents the compilation of hydraulic conductivity data per unit determined. The rock unit was subdivided into three entities following field observations and from the geology of the site.

Table 6-6: Compilation of hydraulic conductivity data

Lithostratigraphic unit	Minimum (m/s)	Maximum (m/s)	Average (m/s)
Clay deposits	3.56×10^{-12}	4.19×10^{-9}	9.96×10^{-10}
Sandy deposits (till)	4.29×10^{-9}	1.05×10^{-3}	9.61×10^{-6}
Rock (paragneiss)	1.76×10^{-7}	7.03×10^{-5}	4.51×10^{-6}
Rock (spodumene pegmatite)	1.08×10^{-8}	4.6×10^{-7}	4.3×10^{-8}
Rock (amphibolitised and amphibolite basalt)	2.72×10^{-8}	1.61×10^{-6}	2.79×10^{-7}

6.2.6.5 *PIEZOMETRIC LEVELS*

As part of the work, 38 drillings, including 23 observation wells, were subject to water level measurements on one or more occasions between August 2017 and May 2018. A piezometric map (Map 6-6) was generated using the measurements taken in all wells intercepting the rock in May 2018. All surveys are shown in Table 6-7.

Table 6-7: Piezometric readings

Well number	Well depth (m)	Elevation of the middle of the screen (m)	Height of the rim above ground level (m)	Screened unit	Campaigns 1 and 2			Campaign 3		
					Depth of water level wrt ground level (m)	Piezometric elevation (m)	Date	Depth of water level wrt ground level	Piezometric elevation (m)	Date
WSP-PW01	126.2	-	0.28	Rock	-	-	-	2.70	224.89	May 6, 2018
WSP-PW03	169.5	-	0.80	Rock	4.25	213.01	February 2018	4.22	213.04	May 5, 2018
WSP-MW1R	6.1	200.62	0.86	Rock	-	-	-	0.86	205.11	May 3, 2018
WSP-MW2R	10.8	196.97	1.03	Rock	-	-	-	9.20*	197.82	May 5, 2018
WSP-MW3R	12.2	199.48	0.92	Rock	0.68	209.05	February 2018	0.42	209.31	May 3, 2018
WSP-MW4R	7.6	210.32	0.57	Rock	1.09	215.33	August 2017	0.40	216.02	May 3, 2018
WSP-MW5R	13.1	201.12	0.80	Rock	1.21	212.26	February 2018	0.48	212.99	May 5, 2018
WSP-MW6R	10.7	220.62	0.62	Rock	4.91	224.91	August 2017	4.98	224.84	May 4, 2018
WSP-MW7R	7.8	201.21	0.79	Rock	1.16	207.10	February 2018	0.97	207.29	May 3, 2018
WSP-MW8R	12.2	192.62	0.86	Rock	0.74	202.73	February 2018	0.72	202.75	May 3, 2018
WSP-MW9R	18.9	187.20	0.97	Rock	-	-	-	-0.25	205.60	May 4, 2018
BH-3A	8.23	194.35	0.56	Rock	-	-	-	0.12	201.70	May 2, 2018
BH-10A	11.5	189.24	0.48	Rock	-	-	-	-0.04	200.23	May 1, 2018
BH-15	9.56	195.12	1.08	Rock	-	-	-	0.10	202.03	May 1, 2018
BH-45	4.62	205.82	1.35	Rock	-	-	-	-0.03	208.94	May 1, 2018
BH-47	12.83	205.05	1.36	Rock	-	-	-	1.65	210.09	May 1, 2018
WSP-MW2S	4.57	204.15	0.81	Rock	0.34	206.85	February 2018	0.21	206.98	May 5, 2018
WSP-MW3S	4.3	206.90	0.85	Surface deposits	0.75	208.92	February 2018	0.17	209.50	May 3, 2018
WSP-MW4S	4.4	213.51	0.63	Surface deposits	1.17	215.23	August 2017	0.33	216.07	May 5, 2018
WSP-MW5S	4.6	210.32	0.71	Surface deposits	0.80	212.59	February 2018	0.30	213.09	May 5, 2018
WSP-MW8S	4.3	200.41	0.99	Surface deposits	-	-	-	0.40	202.78	May 3, 2018
WSP-MW9S	4.6	202.28	0.95	Surface deposits	-	-	-	0.10	205.26	May 4, 2018

Table 6-7: Piezometric reading (cont.)

Well number	Well depth (m)	Elevation of the middle of the screen (m)	Height of the rim above ground level (m)	Screened unit	Campaigns 1 and 2			Campaign 3		
					Depth of water level wrt ground level (m)	Piezometric elevation (m)	Date	Depth of water level wrt ground level	Piezometric elevation (m)	Date
PO-1	7.28	215.89	0.56	Surface deposits	-	-	-	5.44	216.17	May 4, 2018
PO-2	8.5	214.01	0.57	Surface deposits	5.07	215.36	February 2018	5.74	214.69	May 4, 2018
BH-1	11.43	210.78	0.99	Surface deposits	-	-	-	5.01	215.07	May 1, 2018
BH-10B	8	193.11	0.23	Surface deposits	-	-	-	0.72	199.64	May 1, 2018
BH-14	16	203.86	1.09	Surface deposits	-	-	-	1.23	211.93	May 1, 2018
BH-18	6.32	201.38	0.24	Surface deposits	-	-	-	-0.04	203.72	May 1, 2018
BH-23	11.05	204.75	1.07	Surface deposits	-	-	-	0.66	208.99	May 1, 2018
BH-27	8.18	202.46	1.17	Surface deposits	-	-	-	0.14	204.62	May 1, 2018
BH-29	14.02	202.90	1.30	Surface deposits	-	-	-	1.92	206.68	May 1, 2018
BH-3B	8.23	197.66	0.61	Surface deposits	-	-	-	0.28	201.66	May 2, 2018
BH-31	8.84	205.33	1.36	Surface deposits	-	-	-	0.12	207.91	May 1, 2018
BH-36	8.18	205.84	1.59	Surface deposits	-	-	-	0.57	208.17	May 1, 2018
BH-37	6.63	204.15	1.40	Surface deposits	-	-	-	0.08	208.58	May 1, 2018
BH-41	6.22	205.38	1.41	Surface deposits	-	-	-	-0.11	207.18	May 1, 2018
BH-49	17.96	199.90	1.40	Surface deposits	-	-	-	4.50	206.90	May 1, 2018
BH-50	5.28	206.32	1.43	Surface deposits	-	-	-	0.39	206.93	May 1, 2018

* Value not stabilized.

The pit sectorrepresents a piezometric head. Groundwater flow would occur radially from this piezometric head toward the surrounding watercourses. Water levels recorded prior to snowmelt in February 2018 are between 0.03 m and 0.84 m lower than those recorded at the beginning of May 2018, for an average variation of 0.36 m. Surveys carried out at different times of the year (August, February and May) show seasonal variations in water levels.

In the future pit sector, the water depth levels of the bedrock aquifer range from -0.40 to 4.98 m, and the piezometric elevation ranges from 213.03 to 224.89 m. A variation of -0.03 to 0.84 m is observed between August 2017 and May 2018 and a variation of -0.67 to 0.13 m between February 2018 and May 2018 in the wells of this sector.

In the area south of the pit, the water depth levels of the bedrock aquifer range from -0.25 to 1.16 m, whereas the piezometric elevation ranges from 205.6 to 212.98 m. A variation of 0.19 to 0.73 m was observed between February and May 2018 in the wells of this sector.

Finally, in the future waste rock stockpiles sector and the industrial and administrative area, the water depth levels of the bedrock aquifer varies between -0.11 and 1.92 m, whereas the piezometric elevation ranges from 199.6 to 211.93 m. A variation of 0.02 to 0.58 m was observed between February and May 2018 in the wells of this sector.

The horizontal gradient in the study area ranges from 0.03 to 0.001.

6.2.6.6 *AQUIFER CLASSIFICATION*

According to the MDDELCC's Système de classification des eaux souterraines (MDDEFP, 2012), groundwater can be class I, II or III based on its hydrogeological properties, quality and use potential. A class I groundwater body is an irreplaceable source of drinking water. A class II hydrogeological formation is a current or potential source of drinking water. Class II formations have an acceptable water quality of sufficient quantity. Lastly, a class III hydrogeological formation cannot be used as a source of drinking water (poor quality and insufficient quantity).

Based on the information collected as part of the investigations for this study, the rock corresponds with a class II fractured aquifer, meaning the aquifer is a potential source of drinking water. The extent of the glaciofluvial deposits (till unit) naturally has good potential as an aquifer. Therefore, it is considered a class II aquifer.

6.2.6.7 *AQUIFER VULNERABILITY*

The till in the study area is mainly comprised of silty and gravelly sand with traces of clay. It is moderately permeable and has low aquifer potential. The rock is a fractured aquifer, with low potential. The rock aquifer is most vulnerable where the rock is outcropping, in fracture zones or where the granular deposits are thin. Metamorphic rock does not have strong filtering properties. Overall, the rock aquifer is considered vulnerable, but with a weak potential.

The DRASTIC[3] system for measuring the vulnerability of groundwater reflects the level of contamination risk based on hydrogeological properties. This evaluation method was developed by the United States Environmental Protection Agency (US EPA). The DRASTIC system is based on three basic assumptions:

- the sources of contamination are at ground level;
- contaminants move from ground level to the aquifer;
- contaminants have the same mobility as water.

Based on the hydrogeological properties of the site, a groundwater vulnerability index of 137 was assessed for surface deposits and of 105 for the upper portion of the rock, which equates to a medium[4] level of vulnerability based on the levels described in the *Water Withdrawal and Protection Regulation* (WWPR, section 53). Table 6-8 shows the details of the weighting for each factor.

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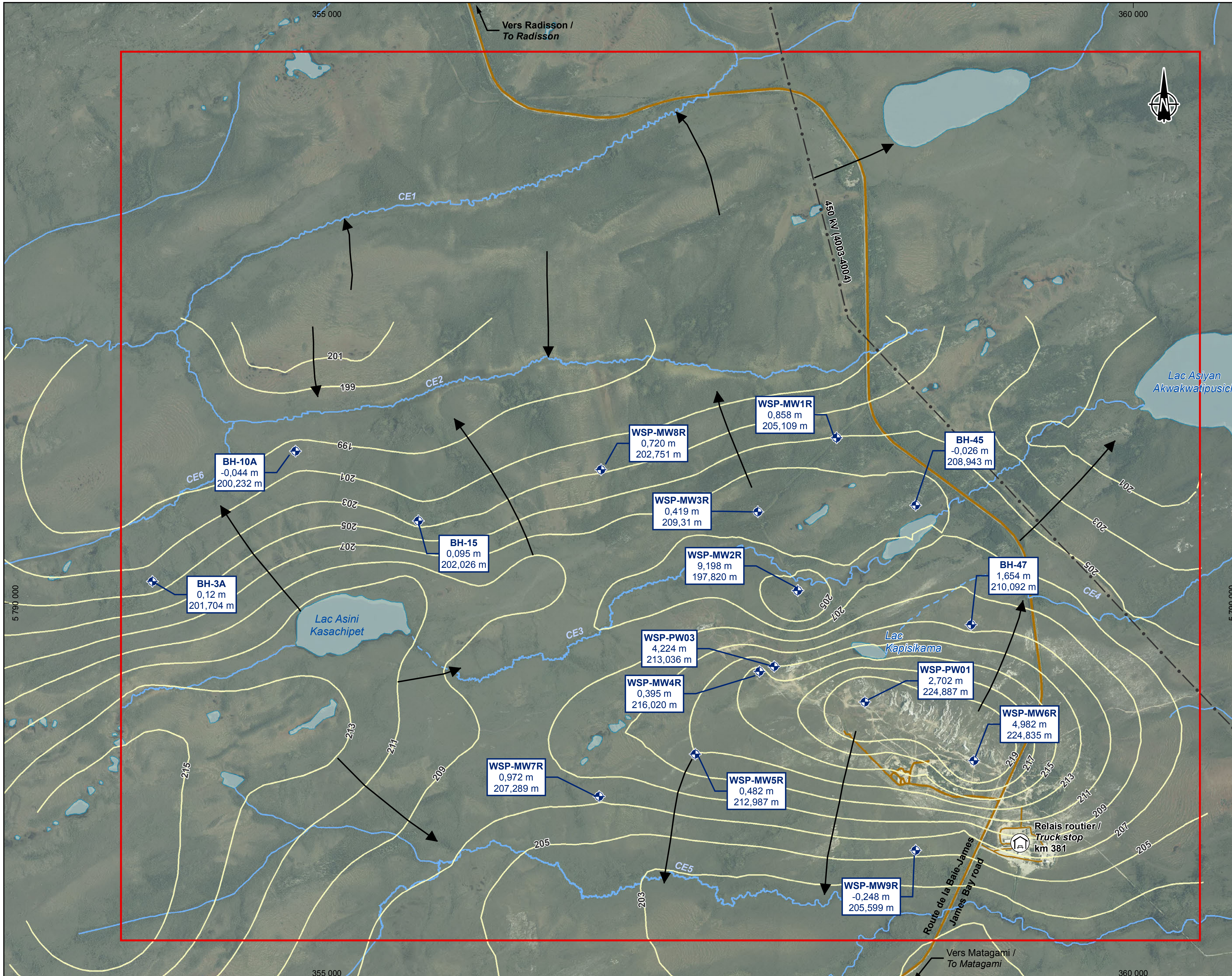
[3] Aquifer vulnerability index: D=Depth to water; R=Recharge, A=Aquifer media, S=Soil media, T=Topography (slope), I=Impact of the vadose zone media, C=Hydraulic conductivity

[4] Vulnerability ratings: "Low": a rating equal to or less than 100 for the entire protection zone; "Medium": a rating less than 180 for the entire protection zone, except if a "low" rating has been assigned; "High": a rating equal to or greater than 180 in any part of the protection zone. (WWPR, section 53)



Zone d'étude locale / *Local study area*

Puits d'observation / *Observation well*

BH-45
-0,026
208,943 m

Nom du puits d'observation / *Name of observation well*

Profondeur du niveau d'eau p/r sol / *Water level depth from ground*

Élévation piézométrique (m) / *Piezometric elevation (m)*

Courbe piézométrique / *Piezometric contour*

Sens d'écoulement de l'eau / *Direction of water flow*

Infrastructures / *Infrastructure*

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Hydrographie / *Hydrography*

CE3 Numéro de cours d'eau/ *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Piézométrie / *Piezometry*

Sources :
Orthoimage : Galaxy, août / august 2017
Piézométrie, WSP 2018

No Ref : 171-02562-01_wspT113_EIE_c6-6_hg_piezo_180903.mxd

0 240 480 m
UTM 18, NAD83

Carte / *Map* 6-6

wsp

Table 6-8: Aquifer vulnerability

Unit	Physical parameters	Typical value or interval	Weight	Associated weight	Subtotal	DRASTIC per unit
Till unit	D – Depth to water table	Between 0.0 and 5.7 m	5	9	45	137
	R – Recharge	Between 10 and 30 cm per year	4	7	28	
	A – Aquifer media	Till	3	5	15	
	S – Soil media	Till / clay silt	2	4	8	
	T – Topography (slope)	Slope between 2 and 12%	1	7	7	
	I – Impact of vadose zone	Till or clay	5	5	25	
	C – Aquifer conductivityr	Between 0.02 and 29 m/d	3	3	9	
Rock unit	D – Depth to water table	Between 0 and 4.9 m	5	6	30	105
	R – Recharge	Between 0.1 and 15 cm per year	4	5	20	
	A – Aquifer media	Rock: igneous or altered metamorphic/basalt rock	3	4	12	
	S – Soil media	Till / clay silt	2	4	8	
	T – Topography (slope)	Slope between 2 and 12%	1	7	7	
	I – Impact of vadose zone	Till or clay	5	5	25	
	C – Aquifer conductivity	Between 0.0008 and 0.83 m/d	3	1	3	

6.2.7 HYDROGRAPHY

6.2.7.1 *WORK COMPLETED*

A field campaign was completed in summer 2017 to characterize the five watercourses in the study area, which were named creeks CE1 to CE5 (Map 6-7). A pluviometer was installed and water level probes were placed in each watercourse to take continuous measurements over the course of slightly more than three months. Moreover, stream gauging (measurement of flow) took place on three occasions opposite the water level probes. Finally, some bathymetric surveys were completed on watercourses CE3 and creek CE5 as well as in lakes in the study area. Following the evolution of the project and associated studies, a second field campaign was carried out in the summer of 2018 to carry out cross sectional surveys of the CE2, CE3 and CE4 creeks as well as additional gaugings on the six streams under study (including CE6).

The characteristic flows of the six watercourses, which are flood flow, monthly and low-water means, were calculated in theory and compared with the measurements taken during the field campaign. The mean monthly flows were estimated using interbasin transfer at the Rivière à l'Eau Claire reference station (090605). The rational method was used on the pluviometer data from the Grande Rivière A station (7093715) to estimate the flood flow. The interbasin transfer method was also used on the Rivière à l'Eau Claire station data for comparative purposes. Low-water flow was estimated using the linear regression method developed by the MDDELCC, adapted for the Nord-du-Québec region. The interbasin transfer method was also used on the Rivière à l'Eau Claire and Rivière Saint-Louis station (040212) data for comparative purposes. The methodology used to calculate the characteristic flows is provided in detail in the *Hydrological technical study* (*Étude spécialisée sur l'hydrologie)* (WSP, 2018b).

Finally, the characteristic water levels in the CE2, CE3 and CE4 creeks were estimated by one-dimensional hydraulic modeling using the HEC-RAS software. A total of 54 cross sections were identified and modeled. The models were calibrated using water level and flow data measured in the field in June 2018. More details on the methodology used to mount and calibrate the models are available in the *Hydrological technical study* (*Étude spécialisée sur l'hydrologie)* (WSP, 2018b).

6.2.7.2 *WATERSHEDS*

The study area is located inside the Eastmain River watershed. It has an area of approximately 46,000 km² and drains water from several lakes and rivers. In the study area, creeks CE1, CE2 and CE6 flow to the west, towards the Miskimatao River, and then join the Eastmain River. Creeks CE3, CE4 and creek CE5 flow to the east and also join the Eastmain River. Note that the study area watershed represents a very small percentage of the Eastmain River watershed (total of 0.1%).

Map 6-7 shows the watershedsof the watercourses in the study area in their entirety, meaning all basins downstream from the confluence with the next watercourse. Table 6-9 shows the watersheds surface area. The study area includes undeveloped, very small and negligibly sloped watersheds as well as many wetlands that cause a significant reduction in watercourse flow. Photos of the watercourses are available in the *Hydrological technical study* (*Étude spécialisée sur l'hydrologie)* (WSP, 2018b).

Table 6-9: Surface area of the watersheds of the creeks studied

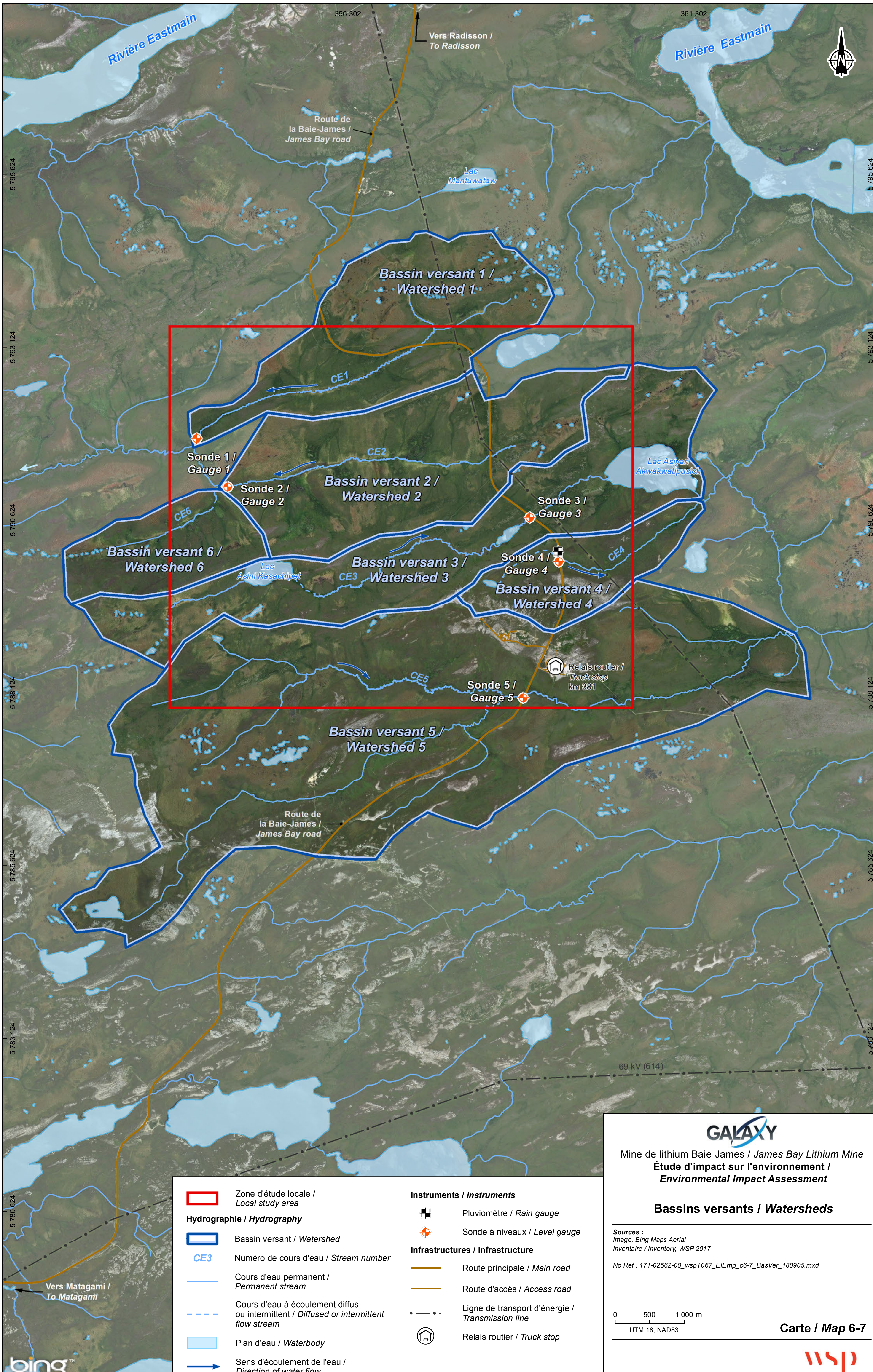
Nom	Surface area (km^2)
North side (CE1, CE2 and CE6)	**20.36**
CE1	7.63
CE2	9.07
CE6	3.11
South side (CE3, CE4 and CE5)	**48.76**
CE3	10.33
CE4	3.03
CE5	27.01

6.2.7.3 *TYPICAL FLOWS AND WATER LEVELS*

This section presents the estimated typical flows upstream of the six watercourses in the study area. Table 6-10 shows the mean monthly flow estimated by interbasin transfer. The annual specific flow of watercourses in the study area is estimated to be 18.7 L/s/km².

Table 6-10: Mean monthly flow in the studied creeks estimated by interbasin transfer

	Creek flow (L/s)					
Month	CE1	CE2	CE3	CE4	CE5	CE6
January	72	85	97	29	254	29
February	55	65	75	22	195	22
March	47	55	63	18	165	19
April	56	66	75	22	196	23
May	243	288	329	97	859	99
June	246	292	332	98	869	100
July	168	199	227	67	594	68
August	174	207	236	69	617	71
September	171	203	231	68	605	70
October	195	232	264	78	690	79
November	173	206	234	69	612	70
December	115	137	156	46	407	47



356 302
361 302
5 795 624
5 793 124
5 790 624
5 788 124
5 785 624
5 783 124
5 780 624
Rivière Eastmain
Rivière Eastmain
Vers Radisson /
To Radisson
Route de
la Baie-James /
James Bay road
Lac
Mantuwataw
Bassin versant 1 /
Watershed 1
CE1
CE2
Sonde 1 /
Gauge 1
Sonde 2 /
Gauge 2
Bassin versant 2 /
Watershed 2
Lac Asiyan
Akwakwatipusich
Sonde 3 /
Gauge 3
CE6
Bassin versant 6 /
Watershed 6
Lac
Asini Kasachipet
CE3
Bassin versant 3 /
Watershed 3
Sonde 4 /
Gauge 4
CE4
Bassin versant 4 /
Watershed 4
Relais routier /
Truck stop
km 381
CE5
Sonde 5 /
Gauge 5
Bassin versant 5 /
Watershed 5
Route de
la Baie-James /
James Bay road
69 kV (614)
Vers Matagami /
To Matagami
bing
Zone d'étude locale /
Local study area
Hydrographie / Hydrography
Bassin versant / Watershed
CE3
Numéro de cours d'eau / Stream number
Cours d'eau permanent /
Permanent stream
Cours d'eau à écoulement diffus
ou intermittent / Diffused or intermittent
flow stream
Plan d'eau / Waterbody
Sens d'écoulement de l'eau /
Direction of water flow
Instruments / Instruments
Pluviomètre / Rain gauge
Sonde à niveaux / Level gauge
Infrastructures / Infrastructure
Route principale / Main road
Route d'accès / Access road
Ligne de transport d'énergie /
Transmission line
Relais routier / Truck stop
GALAXY
Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement /
Environmental Impact Assessment
Bassins versants / Watersheds
Sources :
Image, Bing Maps Aerial
Inventaire / Inventory, WSP 2017
No Ref : 171-02562-00_wspT067_EIEmp_c6-7_BasVer_180905.mxd
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UTM 18, NAD83
Carte / Map 6-7
wsp

Table 6-11 shows the flood flow as estimated by the rational method. This method was used because it considers the physical characteristics of the watershed, such as the watercourse slope and the buffering due to wetlands and lakes, unlike the interbasin transfer method. The flood flow varies between 0.3 and 1.7 m^3/s in the study area over the two-year period.

Table 6-11: Flood flow in the studied creeks estimated using the rational method

	Creek flow (m^3/s)					
Return period	CE1	CE2	CE3	CE4	CE5	CE6
2 year	0.62	0.67	1.02	0.41	1.71	0.33
10 years	1.00	1.14	1.67	0.71	2.72	0.56
25 years	1.19	1.37	1.99	0.86	3.22	0.68
50 years	1.33	1.54	2.23	0.97	3.60	0.76
100 years	1.47	1.71	2.46	1.08	3.98	0.85

The low-water flows estimated using the linear regression method are presented in Table 6-12. This method was used because it seems to be perfectly adapted for the small watersheds in the Nord-du-Québec region, while still being conservative, and the order of magnitude of the results was validated using the interbasin transfer method (details provided in the sector study).

Table 6-12: Low-water flows in the studied creeks estimated using the linear regression method

	Creek flow (L/s)					
Period	CE1	CE2	CE3	CE4	CE5	CE6
$Q_{2,7}$ annual	13	15	17	5	45	5
$Q_{10,7}$ annual	6	7	8	2	22	3
$Q_{5,30}$ annual	8	10	11	3	30	3
$Q_{2,7}$ summer	31	37	42	12	110	13
$Q_{10,7}$ summer	14	16	19	5	49	6
$Q_{5,30}$ summer	29	35	40	12	104	12

The above-mentioned characteristic flow rates were then entered as a limiting condition upstream of the hydraulic models, to obtain an estimate of the characteristic water levels in the creeks CE2, CE3 and CE4. The results of these simulations are presented in the *Hydrological technical study* (*Étude spécialisée sur l'hydrologie)* in the form of hydraulic profiles and characteristic waterlines (WSP, 2018b).

6.2.8 SURFACE WATER AND GROUNDWATER QUALITY

6.2.8.1 SURFACE WATER

This section presents the main characteristics of the water quality of watercourses in the study area. The comparison between the results obtained and the surface water quality criteria recognized by the federal and provincial Departments of the Environment established a reference point for surface water quality in the study area. A report produced by WSP, the *Aquatic inventory and baseline study* (*Étude spécialisée sur l'habitat aquatique)* (WSP, 2018c) provides details on the methodology used, the work carried out and the results obtained.

METHODOLOGY

Surface water sampling took place monthly for nine stations six times between June and November 2017 to have a representation of annual variation. The stations were selected to present representative information on the aquatic environment. The locations of the surface water sampling stations are shown on Map 6-8.

Surface water quality was measured using physiochemical measurements *in situ* and chemical analysis in the lab.

The following *in situ* measurements were taken at each sampling station:

- physiochemical data of the water: temperature (°C), dissolved oxygen (% and mg/L), conductivity (µS/cm) and pH;
- description and photos of the watercourse or body of water at the sampling site.

As for the chemical analysis completed in the laboratory, Table 6-13 shows the median and standard deviation for each of the six samples from each station.

SURFACE WATER QUALITY CRITERIA

To put the natural concentrations observed in 2017 into context, they have been compared to the most stringent surface water quality criteria (CCME, 2017; MDDELCC, 2017b). These standards are the following:

- MDDELCC:
  - criterion for the prevention of the contamination of aquatic organisms (CPC[OE]);
  - chronic water quality criterion for the protection of aquatic life (CCAL).
- CCME:
  - Water quality recommendations (fresh water), protection of aquatic life – long-term effects.

CONCENTRATIONS OBSERVED

In the study area, we found only two potential human sources of surface water contamination: a remote landfill and a km 381 truck stop with a gas station. Otherwise, the study area is natural and is not affected by any forms of pollution that originate directly from human activity. Considering the location and specific nature of these potential sources of contamination, the concentrations of the different parameters measured in the surface water of the water courses in the study area correspond to levels of natural origin.

In situ measurements

The physiochemical measurements were taken *in situ* using a multiparameter probe. The measured pH values varied between 3.37 and 6.27. The pH values were therefore lower than the two MDDELCC criteria and the CCME recommendation (between 6.5 and 9) at all the stations. These results show that the surface water is more acidic than the water quality recommendations/criteria. The nature of the soil in the study area is likely to explain these deviations. Flooding vegetation and forest soils consumes dissolved oxygen and releases minerals and nutritious elements, including carbon dioxide (CO_2), which contributes to the acidification of water. This acidification also slows down the decomposition of organic material.

During campaigns 1, 2 and 4, the dissolved oxygen concentration varied between 0.94 and 9.30 mg/L. These concentrations are lower than the CCME recommendation for each sampled station. Values lower than the CCME recommendation and the MDDELCC'S CCAL criteria were also recorded at certain stations during other sampling campaigns. Similar to the pH measurements, the amount of dissolved oxygen is also outside of the bounds recommended by the CCME or the MDDELCC and can also be explained by the nature of the soil found in the area, which acidifies the surface water and decreases oxygen concentration.

Zone d'étude locale / *Local study area*

Sites d'échantillonnage / *Sampling Sites*

- Filet expérimental / *Multi mesh experimental gill net*
- Pêche électrique / *Electrofishing*
- Seine / *Beach seine*
- Filet à grandes mailles / *Large mesh experimental gill net*
- Filet à petites mailles / *Small mesh net*
- Grand verveux / *Big fyke*
- Petit verveux / *Little fyke*
- Benthos / *Benthos*
- Eau et sédiments / *Water and sediments*
- Station de pêche / *Fishing station* (2012)

Hydrographie / *Hydrography*

- Barrage de castor / *Beaver dam*
- CE3 Numéro de cours d'eau / *Stream number*
- Cours d'eau permanent / *Permanent stream*
- Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*
- Littoral des cours d'eau / *Watercourses shoreline*

Infrastructures / *Infrastructure*

- Route principale / *Main road*
- Route d'accès / *Access road*
- Ligne de transport d'énergie / *Transmission line*
- Relais routier / *Truck stop*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Stations de pêche et de qualité de l'eau /
Fishing and Water Quality Stations

Sources :
Orthoimage : Galaxy, août / august 2017
Inventaire / Inventory: WSP 2017

No Ref : 171-02562-00_wspT072_EIEmb_c6-8_poisson_eau_180821.mxd

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UTM 18, NAD83

Carte / *Map* 6-8

wsp

Table 6-13: Median and deviation for each parameter analyzed over six inventory campaigns

Parameters	Units	Station																	
		1A		1B		2A		2B		3A		3B		4A		5A		5B	
		Median	Deviation	Median	Deviation	Median	Deviation	Median	Deviation	Median	Deviation	Median	Deviation	Median	Deviation	Median	Deviation	Median	Deviation
Basic descriptors																			
Total Alkalinity (in $CaCO_3$)	$mg\ L^{-1}$	0.5	1.6	4	2	0.5	1.1	1.25	2.16	0.5	2.0	0.75	4.21	2.05	11.09	0.5	2.8	3.5	4.8
Dissolved Organic Carbon	$mg\ L^{-1}$	31.125	6.155	28.3	5.3	23.4	4.7	28.05	6.28	20.9	8.7	25.7	7.2	22.8	7.3	24	8.6	26.3	5.6
Suspended Solids (SS)	$mg\ L^{-1}$	1.125	1.047	1.5	2.0	-3	3.8	1.5	1.3	-3	1.1	-3	1.0	4	1.8	2	2.3	4	3.1
Total Dissolved Solids	$mg\ L^{-1}$	56	16.2	78	13.4	68	14.5	74	13.7	58	7.1	-60	13.8	68	13.4	68	12.3	68	11.6
Turbidity	NTU	0.4	0.2	0.65	1.15	0.9	0.4	0.65	0.79	1	1.0	0.85	0.26	1	2.8	1.4	2.4	1.25	1.02
Hardness (in $CaCO_3$)	$mg\ L^{-1}$	3.82	1.77	6.01	1.10	6.61	1.49	5.625	0.857	3.7	1.4	4.07	0.61	6.27	3.14	4.765	1.269	6.37	1.27
Nutrients																			
Ammonia Nitrogen (NH_3-NH_4)	$mg\ N\ L^{-1}$	0.01	0	0.015	0.008	0.01	0.002	0.01	0.008	0.01	0.010	0.01	0	0.01	0.02	0.0175	0.010	0.01	0.01
Total Nitrogen	$mg\ N\ L^{-1}$	0.312	0.190	0.491	0.184	0.38775	0.127	0.344	0.188	0.329	0.145	0.426	0.101	0.337	0.119	0.15	0.163	0.397	0.135
Nitrates	$mg\ N\ L^{-1}$	0.005	0.005	0.005	0.100	0.005	0	0.005	0.032	0.005	0.009	0.005	0.011	0.01	0.039	0.005	0.014	0.005	0.065
Nitrites	$mg\ N\ L^{-1}$	0.005	0	0.005	0.004	0.005	0	0.005	0.006	0.005	0.009	0.005	0.007	0.005	0.010	0.005	0.007	0.005	0.006
Trace Phosphorus	$mg\ P\ L^{-1}$	0.0059	0.0020	0.0122	0.0048	0.0124	0.0031	0.0086	0.0031	0.0065	0.0035	0.0160	0.0037	0.0181	0.0051	0.0084	0.0036	0.0189	0.0058
Major ions																			
Bicarbonates	$mg\ L^{-1}$	0.5	1.6	4	1.7	0.5	1.1	1.3	2.2	0.5	2.0	0.8	4.2	2	10.8	0.5	2.8	3.5	4.8
Bromides	$mg\ L^{-1}$	0.05	0	0.05	0	0.05	0	0.05	0	0.05	0	0.05	0	0.05	0	0.05	0	0.05	0
Calcium	$mg\ L^{-1}$	0.79	0.41	1.43	0.30	1.85	0.43	1.32	0.24	1.18	0.48	1.19	0.20	1.70	1.08	1.37	0.39	1.73	0.38
Carbonates	$mg\ L^{-1}$	0.75	0	0.75	0	0.75	0	0.75	0	0.75	0	0.75	0	0.75	0	0.75	0	0.75	0
Chlorides	$mg\ L^{-1}$	1.64	0.54	1.29	0.50	6.17	3.81	1.44	0.50	0.62	3.57	0.49	0.45	2.72	2.72	0.55	0.41	1.71	0.67
Magnesium	$mg\ L^{-1}$	0.4185	0.1825	0.6265	0.0978	0.4713	0.1034	0.5795	0.0792	0.1840	0.0559	0.2680	0.0412	0.4890	0.1966	0.3300	0.0838	0.4810	0.0962
Potassium	$mg\ L^{-1}$	0.2805	0.2001	0.4185	0.1524	0.3475	0.1506	0.3395	0.1655	0.1840	0.1214	0.1920	0.0841	0.3870	0.2140	0.3340	0.1313	0.3845	0.1234
Sodium	$mg\ L^{-1}$	1.585	0.616	1.545	0.253	4.460	1.768	1.535	0.234	0.494	0.151	0.766	0.284	2.280	1.611	0.966	0.413	1.690	0.426
Sulfates	$mg\ SO_4\ L^{-1}$	0.2015	0.0820	0.2090	0.0835	0.4250	0.2319	0.2020	0.1814	0.3470	0.7040	0.2270	0.1386	1.1800	0.5809	0.2370	0.5209	0.4350	0.2210
Trace metals																			
Aluminium	$mg\ L^{-1}$	0.096	0.029	0.290	0.050	0.280	0.067	0.248	0.042	0.074	0.013	0.192	0.035	0.287	0.115	0.168	0.048	0.199	0.039
Antimony	$mg\ L^{-1}$	0.0000185	0.0000649	0.0000278	0.0000364	0.0000025	0.0000224	0.0000073	0.0000195	0.0000100	0.0000276	0.0000025	0.0000176	0.0000025	0.0000122	0.0000025	0.0000119	0.0000038	0.0036910
Silver	$mg\ L^{-1}$	0.0000015	0.0000149	0.0000015	0.0000010	0.0000015	0.0000071	0.0000015	0.0000016	0.0000015	0.0000055	0.0000015	0.0000022	0.0000015	0.0000012	0.0000015	0	0.0000028	0.0000145
Arsenic	$mg\ L^{-1}$	0.0004	0.0002	0.0009	0.0004	0.0005	0.0002	0.0007	0.0003	0.0018	0.0006	0.0020	0.0005	0.0028	0.0006	0.0008	0.0002	0.0011	0.0006
Barium	$mg\ L^{-1}$	0.002155	0.000726	0.004380	0.000875	0.006845	0.001443	0.003900	0.000804	0.002430	0.000876	0.003820	0.000891	0.009010	0.001476	0.003600	0.000980	0.004815	0.001008
Beryllium	$mg\ L^{-1}$	0.0000045	0.0000019	0.0000115	0.0000068	0.0000115	0.0000034	0.0000095	0.0000039	0.0000030	0.0000189	0.0000095	0.0000065	0.0000220	0.0000064	0.0000083	0.0000018	0.0000120	0.0000034
Boron	$mg\ L^{-1}$	0.00165	0.00086	0.00225	0.00103	0.00195	0.00082	0.00215	0.00156	0.00015	0.00094	0.00130	0.00137	0.00215	0.00086	0.00140	0.00071	0.00140	0.00082
Cadmium	$mg\ L^{-1}$	0.0000125	0.0000028	0.0000160	0.0000057	0.0000215	0.0000082	0.0000150	0.0000044	0.0000120	0.0000080	0.0000230	0.0000039	0.0000300	0.0000065	0.0000183	0.0000048	0.0000180	0.0000038
Chromium	$mg\ L^{-1}$	0.0005675	0.0001607	0.0009800	0.0002058	0.0012800	0.0003330	0.0008900	0.0002270	0.0005700	0.0002303	0.0009000	0.0002274	0.0010300	0.0002344	0.0008600	0.0003877	0.0009850	0.0001937
Cobalt	$mg\ L^{-1}$	0.0001145	0.0000375	0.0003980	0.0001795	0.0004315	0.0001405	0.0003835	0.0002020	0.0000600	0.0000310	0.0001890	0.0000427	0.0005020	0.0001506	0.0001258	0.0000466	0.0002230	0.0000900
Copper	$mg\ L^{-1}$	0.00027	0.00033	0.00029	0.00028	0.00057	0.00031	0.00032	0.00008	0.00019	0.00006	0.00038	0.00010	0.00064	0.00016	0.00035	0.00013	0.00030	0.00012
Iron	$mg\ L^{-1}$	0.63	0.28	1.37	0.52	1.81	0.89	1.16	0.54	1.52	0.67	1.62	0.39	2.34	0.63	2.17	0.60	1.94	0.75
Lithium	$mg\ L^{-1}$	0.0005	0.0005	0.0015	0.0008	0.0005	0.0002	0.0010	0.0007	0.0005	0.0002	0.0045	0.0023	0.0100	0.0029	0.0005	0.0002	0.0008	0.0006
Manganese	$mg\ L^{-1}$	0.02495	0.00641	0.04655	0.01714	0.04465	0.01466	0.04640	0.01828	0.02140	0.00628	0.02480	0.00180	0.01985	0.00229	0.01485	0.00419	0.02535	0.00843
Mercury	$mg\ L^{-1}$	0.000001	0	0.000001	8.165E-07	0.000001	0	0.000001	8.165E-07	0.000001	1.3416E-06	0.000001	1.2247E-06	0.000001	0	0.000001	3.5355E-07	0.000001	0
Molybdenum	$mg\ L^{-1}$	0.000035	0.000045	0.000050	0.000036	0.000035	0.000016	0.000040	0.000028	0.000020	0.000021	0.000060	0.000026	0.000080	0.000106	0.000038	0.000068	0.000040	0.000030
Nickel	$mg\ L^{-1}$	0.000175	0.000092	0.000655	0.000169	0.000630	0.000156	0.000550	0.000118	0.000150	0.000066	0.000380	0.000113	0.001320	0.000336	0.000230	0.000115	0.000425	0.000120
Lead	$mg\ L^{-1}$	0.000375	0.000132	0.000355	0.000131	0.000503	0.000170	0.000315	0.000124	0.000440	0.000151	0.000510	0.000102	0.000460	0.000137	0.000343	0.000064	0.000375	0.000121
Selenium	$mg\ L^{-1}$	0.00004875	0.000169	0.0000775	0.0001828	0.000125	0.00016033	0.000225	0.00022796	0.00015	0.00008036	0.0000575	0.00019268	0.000275	0.00018521	0.00013	0.00012192	0.0001225	0.00015214
Strontium	$mg\ L^{-1}$	0.00898	0.00389372	0.0171	0.00343492	0.02185	0.00663639	0.01635	0.00292552	0.0095	0.00343635	0.0115	0.00220162	0.02785	0.01402023	0.014475	0.00316808	0.01805	0.0043967
Uranium	$mg\ L^{-1}$	0.0000025	0.0000058	0.0000145	0.0000063	0.0000205	0.0000064	0.000011	0.0000039	0.0000025	0.0000121	0.000013	0.000006	0.000044	0.0000212	0.0000138	0.0000047	0.000019	0.0000064
Vanadium	$mg\ L^{-1}$	0.00001	0.00013	0.00001	0	0.00001	0.00007	0.00001	0	0.00001	0	0.00001	0.00027	0.00001	0	0.00001	0.00008	0.00001	0.00011
Zinc	$mg\ L^{-1}$	0.0046	0.0009	0.0045	0.0007	0.0060	0.0019	0.0051	0.0013	0.0037	0.0015	0.0032	0.0010	0.0051	0.0026	0.0030	0.0011	0.0035	0.0008

Basic descriptors, major nutrients and ions

Overview

Based on the surface water analysis, the following observations can be made:

- Alkalinity is low, the median value is 0.75 mg/L. Therefore, this water can be qualified as fresh water. This fact explains the low ion concentrations that were observed.
- The number of suspended solids is low, with a median value of 3 mg/L, whereas the normal range is between 2 and 53 mg/L (MDDELCC, 2016).
- The amount of dissolved organic carbon is high, with a median value of 25.7 mg/L, whereas the normal range is between 2.3 and 11.2 mg/L (MDDELCC, 2016). These values can be explained by the presence of peatlands, which are an important source of organic carbon, within empty drainage basins.
- Water in these watercourses is clear, with a median value of 0.9 NTU, whereas the normal range is between 0.6 and 26 NTU (MDDELCC, 2016).
- The amount of all nutrients is low and all within the lower limits of the ranges for these parameters (MDDELCC, 2016).

Comparison to applicable criteria

During campaign 4 at station 4A, only one sample did not respect the CCAL criteria for nitrites. As this was a single sample and the concentrations of this element had been weak at other points in time and geographic locations, contamination cannot be excluded as an explanation of this excess. Sampling of nitrogenous elements is sensitive to external contamination.

Finally, except for nitrites at station 4A during campaign 4, the concentrations of basic descriptors were below the reference criteria for all stations and all sampling campaigns.

Metals

Overview

The levels of dissolved minerals were generally low. Of the 25 metals analyzed, aluminum, iron, manganese and strontium were found to have the strongest levels.

The greatest concentration of aluminum (0.486 mg/L) was measured at Station 4A during the 6th campaign. The expected metal concentration range in the surface water is between 0.012 and 2.25 mg/L (Jones and Bennett, 1986). Significantly, the same station had the highest concentration of arsenic observed (0.00316 mg/L) on two separate occasions, during the 2nd and 3rd campaigns.

Usually, in Canadian surface water, iron levels are less than 10 mg/L, but they can vary between 0.001 and 90 mg/L (NAQUADAT, 1985). The most significant level of iron (3.90 mg/L) was observed at Station 2A during the 3rd campaign.

Manganese levels in Canadian surface water vary between 0.01 and 0.4 mg/L (NAQUADAT, 1985). Median concentration for this metal was observed at Stations 1B (0.04655 mg/L), 2A (0.04465 mg/L) and 2B (0.04640 mg/L).

Based on an American study (Skougstad and Horr, 1963), levels of strontium vary normally between 0.007 and 13.7 mg/L. The highest median concentration for this metal were observed at Stations 1B (0.171 mg/L), 2A (0.02185 mg/L), 2B (0.01635 mg/L), 3B (0.0115 mg/L) and 4A (0.02785 mg/L).

According to the different sources available, the concentration of dissolved minerals is within a natural range for Canadian surface water.

Criteria comparison

The concentration of dissolved minerals higher than CCME and MDDELCC criteria were observed at nine sampling stations. Levels of aluminum, arsenic and iron exceeded the CPC(EO) criteria (MDDELCC) at many stations. The is the most restrictive criteria. In addition, levels of aluminum and iron do not respect CCME recommendations in most samples. Table 6-14 indicates the number of exceeded criteria and recommendations.

Table 6-14: Number of surface water samples exceeding criteria

Parameter	Number of resurgences		
	CPC(EO)	CVAC	CCME
Physicochemical parameters (*in situ*)			
Oxygen	-	14	24
pH	32	32	32
Nutrients			
Nitrites	0	1	0
Trace metals			
Aluminium	45 (5 duplicates)	0	56 (5 duplicates)
Arsenic	55 (4 duplicates)	0	0
Beryllium	0	41 (3 duplicates)	0
Iron	58 (5 duplicates)	6 (1 duplicate)	58 (5 duplicates)
Manganese	7	0	0
Mercury	5	0	0
Lead	0	58 (5 duplicates)	0

Notes: CPC(EO) – *Critère de prévention de la contamination de l'eau ou des organismes aquatiques.*
CVAC - *Critère de vie aquatique chronique* (chronic aquatic life criterion).
CCME – Canadian Council of the Ministers of the Environment.

The natural content of beryllium and lead in the surface water of the study area seems generally higher than the CVAC criterion of the MDDELCC since the concentration of these metals exceeded the criteria threshold in many samples.

The highest concentration of beryllium (0.000027 mg/L) was measured at Station 1B during the first campaign. Station 2A had the highest concentration of lead (0.00079 mg/L) during the 3rd campaign.

In total, five metals exceeded one and/or both MDDELCC and/or CCME recommended criteria in the majority of samples collected at different stations. In fact, in addition to beryllium and lead, most of the collected samples indicated that the natural concentration of aluminum, arsenic and iron in surface water is greater than at least one criterion of water quality. There does not appear to be any variation between seasons, although mercury concentration exceeded the CPC (EO) criterion during the first sampling campaign in June 2017.

In addition, seven samples exceeded the CPC (EO) criterion for manganese over the six campaigns at different stations, and five more samples for mercury, but only in June.

RADIONUCLIDES

A radionuclide analysis of surface water was carried out in May 2018 on two separate samples taken in rivers CE2 and CE3. Only uranium 234 and 238 and thorium 228 were detected. The results show that radionuclide levels are below the standards prescribed by Canadian guidelines for managing naturally occurring radioactive materials.

SEASONAL VARIATIONS

For basic descriptors, turbidity and suspended solids (SS) show similar trends. Some increase in concentrations for these parameters were observed in late July and September.

In terms of nutrients, total nitrogen showed the same overall trend over the six campaigns. Nitrite levels generally increased in September and then declined in October and November. Phosphorus levels remained relatively constant throughout the period.

No particular trend can be detected for major ions. However, carbonate, calcium, magnesium and sodium showed stable levels over the entire sampling period.

Finally, for trace metals, elements that vary in their levels over time are antimony, beryllium, boron, cobalt, copper, molybdenum and selenium. However, no real trend is noticeable.

6.2.8.2 *GROUNDWATER QUALITY*

This section presents the main characteristics of groundwater quality in the study area. The comparison between the results obtained and recognized groundwater quality criteria permits the creation of a baseline for the quality of groundwater in the study area. *The hydrogeological technical study (L'étude spécialisé sur l'hydrogéologie)* (WSP, 2018*a*) details the methodology, work and the results.

METHODOLOGY

A total of 36 groundwater samples were collected from 20 observation wells or piezometer installations to determine the current status (baseline condition before work) of the site's hydrogeological environment. Sampling work was done in three separate campaigns. Sample wells and test dates are listed on table 6-15 and shown on Map 6-5.

Table 6-15: List of sampled wells

Survey	Test date	Survey	Test date
PO1	2017-08-31	WSP-MW4S	2017-08-31
	2018-05-04		2018-05-05
PO2	2017-08-31	WSP-MW5R	2018-05-05
	2018-05-04		2018-02-04
WSP-PW03	2017-08-31 (1)	WSP-MW5S	2018-05-05
	2017-08-31 (2)		2018-02-04
	2017-08-31 (3)	WSP-MW6R	2017-08-31
	2018-02-04		2018-05-04
	2018-05-05	WSP-MW7R	2018-05-03
WSP-MW1R	2018-05-03		2018-02-04
WSP-MW2R	2018-05-05	WSP-MW8R	2018-05-03
WSP-MW2S	2018-05-05		2018-02-05
	2018-02-04	WSP-MW8S	2018-05-03
WSP-MW3R	2018-05-03	WSP-MW9R	2018-05-04
	2018-02-04	WSP-MW9S	2018-05-04
WSP-MW3S	2018-05-03	BH-10R	2018-05-02
	2018-02-04	BH-10S	2018-05-02
WSP-MW4R	2017-08-31		
	2018-05-05		

Analytical program

The choice of parameters was based on the risks associated with the use of the site and on the requirements of *D 019* (MDDEP, 2012). Groundwater samples were analyzed for one or more of the following:

- Inorganic compounds (total cyanides, fluorides, nitrates, nitrites, total sulphides)
- Hydrocarbons (HP) C10-C50

— Major ions (bicarbonates, calcium, carbonates, chlorides, magnesium, potassium, sodium and sulphates)
— Dissolved metals (scanned)
— Acid-soluble metals (pumping test)
— Physiochemical parameters (alkalinity, conductivity, hardness, suspended solids, pH, total dissolved solids)
— Radionuclide (U-238, U-234, Ra-226, Pb-210, Th-232, Ra-228 and Th-228) – 2 samples

Water quality criteria

Considering the groundwater at the study site could end up in surface water, the results of chemical analysis were compared to the criteria for resurgence in surface water, or RSW (*résurgence dans les eaux de surface*, or RES) in the *Guide d'intervention: Protection des sols et réhabilitation des terrains contaminés* from the (Beaulieu, 2016). Potential recipients are streams and lakes. RSW quality criteria are calculated from the *Critères de qualité de l'eau de surface au Québec* (surface water quality criteria in Quebec) (MDDEFP, 2013). The value selected for each parameter corresponds to the lowest of the following four values:

— 1 X CVAA - *Critère de vie aquatique, aigu* (acute aquatic life criterion)
— 100 X CVAC - *Critère de vie aquatique chronique* (chronic aquatic life criterion)
— 100 X CPCO - *Critère de prévention de la contamination des organismes aquatiques* (criterion to prevent the contamination of aquatic organisms)
— 100 X CFTP - *Critère de faune terrestre piscivore* (fish-eating wildlife criterion)

The MDDELCC has established groundwater threshold alerts at concentrations that predict resource loss and risk to health, consumption and the environment. For a site located upstream of a body of water, the MDDELCC imposes a threshold equal to 50% of the value of RSW criteria. Since the study site is less than 1 km from several streams and lakes, a threshold alert of 50% was applied.

RESULTS

Physicochemical parameters

Conductivity, pH, dissolved oxygen and temperature measurements were taken *in situ* using a YSI probe during well sampling. The pH values measured in groundwater samples ranged from 4.38 to 8.98. The lowest pH of 4.38 was recorded in the WSP-MW8S well during the May 2018 campaign; and the highest pH of 8.98 was recorded in the MW05R well in February 2018. Electrical conductivity levels are generally low and range from 4 µS/cm to 543 µS/cm, indicating that the water in the study area is low in minerals. Conductivity tends to be lower in groundwater coming from unconsolidated deposits and higher in water from rock wells. Temperatures measured during the various sampling campaigns varied between 0°C and 10°C.

Major ions

Analyzing major ions makes it possible to describe different types of groundwater and compare water quality. The Piper diagram illustrates the similarities and differences between water samples and provides correlations. Figure 6-3 shows the proportion of major ions for all sampled wells. Generally, wells located in recharge areas have higher proportions of carbonates and calcium. When the waters have been in contact for awhile with the geological formations, chlorides, sulphates, sodium and/or potassium enrichment occurs downstream. Most samples from rock wells and wells in unconsolidated deposits have a similar geochemical signature, i.e., $Ca^2 + Mg^{2+}/HCO_3$ water types. Five samples (PW03 [3], MW5R and MW2R) have a sodium and potassium bicarbonate geochemical signature and a sample (MW5R) consists of sodium and potassium sulfate.

Metals

Of the samples analyzed during the sampling campaigns, 15 exceeded the RSW criteria for the following metals: silver, copper, manganese and zinc. In addition, 15 additional samples exceeded the alert threshold for one or another of the following: silver, barium, copper, manganese and zinc.

If we compare the results with drinking water criteria, some metals would exceed the criteria or recommendations. It is mainly arsenic (all samples exceed criteria except for three samples taken from unconsolidated deposits), aluminum and manganese.

Table 6-16 shows the number of threshold alerts exceeded and the RSW and drinking water sample criteria.

Table 6-16: Number of criteria exceeded in ground water samples

Parameter (TA/RSW/DW µg/l criteria)	2017–2018 campaign		
	Threshold Alerts (TA)	Resurgence in surface water (RSW)	Drinking water (DW)
Aluminium (- / - /100)	-	-	12/36
Silver (0.015/0.03/100)	4/36	1/36	0
Arsenic (170/340/0.3)	0	0	Only three samples were below drinking water criterion.
Barium (54/108/1000)	3/36	0	0
Copper (0.75/1.5/1000)	28/36	9/36	0
Manganese (275.5/551/50)	8/36	5/36	12/36
Zinc (8.5/17/5000)	8/36	2/36	0

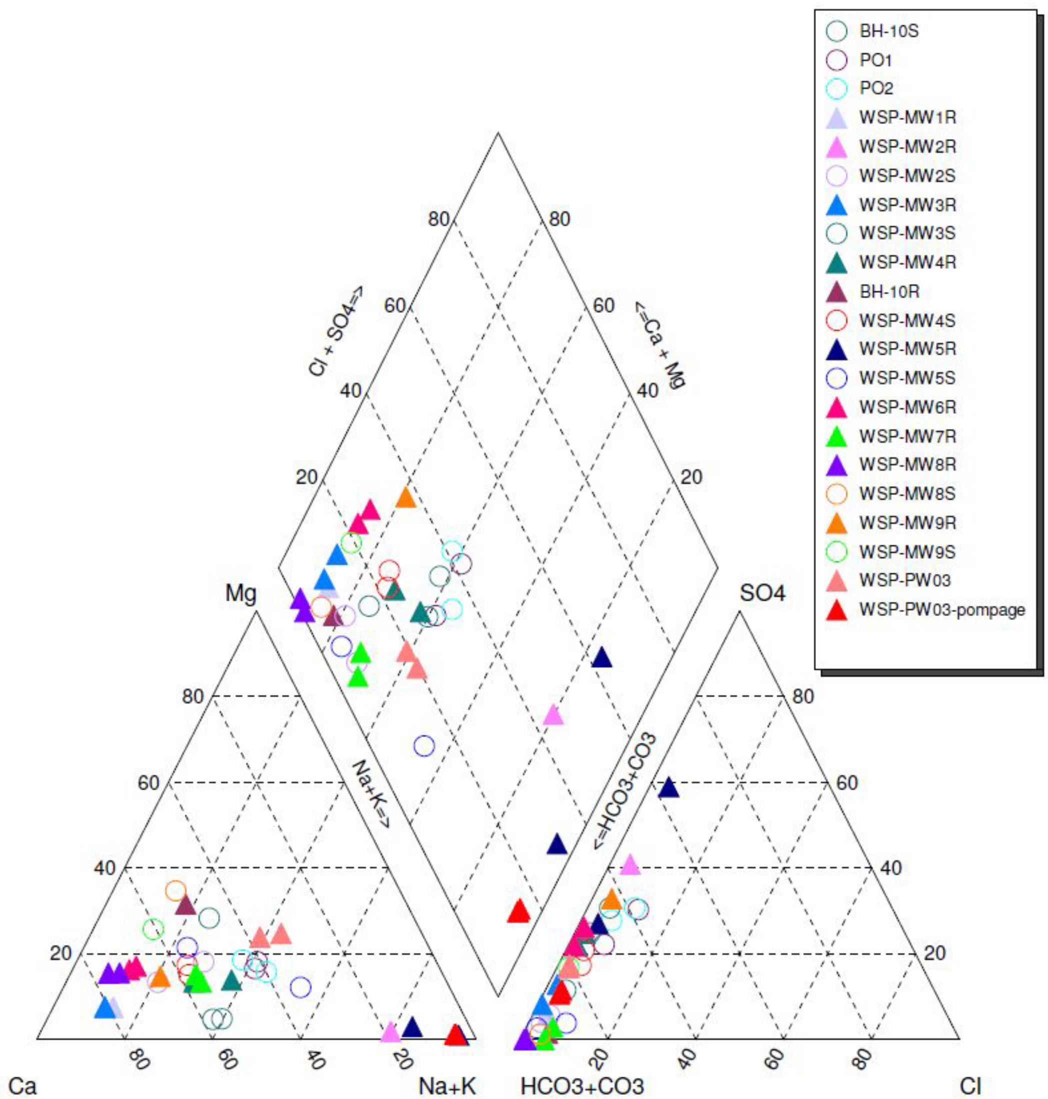


Figure 6-3: Ternary diagram showing the amounts of major ions in each of the groundwater samples

Other parameters

Ammonia nitrogen, cyanides, fluorides, nitrates, nitrites and total sulphides were analyzed in all samples. All samples had a concentration below RES criteria or the laboratory's detection limit.

Radionuclides

The various natural radionuclides, and their levels in the water, depend on the geological nature of the watershed and subsoil. Natural levels found in groundwater are due to the levels of radionuclides found in geological formations. Radionuclide analysis was conducted in February and May 2018 on two groundwater samples from wells intercepting different geological units, WSP-PW03 and WSP-MW7R. The levels of radium-228, thorium-230, radium-226, lead-210 and potassium-40 were all below detection limits. For thorium-232, levels were below the detection limit in WSP-PW03 and 0.01 Bq /L in WSP-MW7R. For uranium-234 and uranium-238, levels ranged from 0.001 to 0.02 Bq /L. For thorium-228, the levels varied between 0.5 and 0.6 Bq /L.

NATURAL BACKGROUND LEVELS

From the statistical analysis results, natural background levels (NBLs) were evaluated. The calculated values offer an initial concentration that represents the natural environment before development.

Parameters for which natural background levels were assessed are aluminum, arsenic, barium, copper, iron, lithium, manganese and zinc. Copper, barium, manganese and zinc exceeded the RES or threshold alert and more than 50% of the samples were above the laboratory's limit of detection (LOD). The other three parameters did not have any RES or threshold alert criteria, but the results provided an estimate of the natural levels.

Using the Shapiro-Wilk test, an evaluation of the normality determined that all the above parameters followed a normal or log normal distribution.

Anticipated exceedings

Depending on the analysis performed, barium, copper, manganese and zinc may on occasion exceed the RES criterion or the threshold alert in some wells.,. For silver, the concentrations show that natural levels could exceed the criteria. However, the number of analysis with concentrations below detection limits was too great to perform a statistical analysis.

New criteria

New threshold alerts and RES criteria were suggested from background levels results. The development of these new criteria varies from one parameter to the next, depending on whether the background levels are higher or lower than the RES criterion.

When background levels were above the existing RES criterion, the new criterion was established as equal to background levels and a new threshold alert was established as equal to half of background levels. When background levels were below the RES, the RES criterion was retained and the threshold alert was set at the highest value between 50% of the RES criterion and 120% of background level results.

The results are shown in Table 6-17. New RES criteria were defined for copper and new threshold alerts were defined for copper, manganese and zinc. As an indication, the values obtained were also compared to the drinking water criteria. Three parameters (aluminum, arsenic and manganese) have natural background levels that exceed the drinking water criteria.

Table 6-17: Calculation of natural background levels of metals in groundwater

Parameter/Lithology unit	Natural background levels (µg/L)	
	Unconsolidated deposits (till)	Roc
Aluminium	**284.2**	**182.0**
Arsenic	**0.31**	**0.7**
Barium	30.9	32.4
Copper	**1.4**	**2.6**
Iron	3,399	1,993
Lithium	8.8	266.1
Manganese	**295.5**	**327.2**
Zinc	**10.3**	**8.7**

LEGEND:

100 : Calculated NBL Value > RSW Criterion

100 : Calculated NBL Value > Threshold Alert

100 : Calculated NBL Value > Criterion / Drinking Water Recommendation

6.2.9 SOIL AND SEDIMENT QUALITY

6.2.9.1 *SOIL*

NATURAL BACKGROUND LEVELS

Evaluation of soil quality in the study area was based mainly on *Lignes directrices sur l'évaluation des teneurs de fond naturelles dans les sols* (Ouellette, 2012) and on *Guide de caractérisation physicochimique de l'état initial des sols avant l'implantation d'un projet industriel* (MDDELCC, 2015). Natural background levels (NBLs) of metals were determined based on soil samples taken at 28 soil sampling sites (18 exploration trenches and 10 drilling sites) spread out over the study area (Map 6-4).

The surveys were conducted in areas unaffected by anthropogenic activities, based on available information. In addition, samples were taken from natural, undisturbed stratigraphic units. The *Soil background concentration technical study (L'Étude spécialisée sur la teneur de fond naturelle dans les sols)* (WSP, 2018*d*) details the methodology used, the work carried out and the results obtained.

Four stratigraphic units are frequently found in the natural soils of the study area. First, a horizon of topsoil or peat is present at the surface. Beneath this unit, the natural soils are made up of an alternation of three main stratigraphic units. The first is composed of coarse sand to sand and gravel, containing pebbles and sometimes blocks. The second unit is composed of fine sand to silty sand, containing a little gravel in places. Last, a third unit of silt to clayey silt is sometimes found, mainly at depths. Thus, the calculations leading to the determination of NBLs were conducted using analysis results obtained on stratigraphic units described as being coarse sand (13 samples) and fine sand (17 samples), these being more widespread and thus most representative of the soils in the study area.

A separate statistical analysis was performed on the two stratigraphic units considered—the coarse sand unit and the fine sand unit—to establish the background levels. This analysis was carried out based on the analysis results of total metal contained in the soil samples. The NBLs were assessed based on the statistical analysis. The calculated values provided an initial level representative of the natural environment. Because of the substantial proportion of samples below the laboratory limit of detection (LOD), the following parameters were excluded from the analysis: antimony, silver, arsenic, cadmium, chromium, cobalt, copper, tin, mercury, molybdenum, nickel, lead, selenium, sodium and zinc.

The statistical analysis was thus performed for aluminum, calcium, hexavalent chromium, iron, lithium, magnesium, manganese, potassium, titanium and vanadium. Barium was also analyzed, but only for the fine sand unit.

The NBL was assessed for each parameter analyzed by setting the lower confidence limit at 95 % of the 90th percentile of the distribution of levels, except for barium in the fine sand unit, whose value was calculated using the upper whisker method. For the parameters for which an adjusted NBL was not calculated, the generic criterion "A" of the *Guide d'intervention* was set as the natural background level. The results obtained are presented in Table 6-18.

Table 6-18: Calculation of background levels of metals in soils

Parameter/Lithological unit	Natural background level (mg/kg)	
	Coarse sand unit	Fine sand unit
Aluminum	8,405	3,787
Antimony	-	-
Silver	0.5	0.5
Arsenic	5	5
Barium	240	35
Cadmium	0.9	0.9
Calcium	681	1,535
Chromium	100	100
Hexavalent chromium	**13.1**	3.4
Cobalt	30	30
Copper	65	65
Tin	5	5
Iron	7,339	6,311
Lithium	8	4
Magnesium	1,968	1,984
Manganese	75	76
Mercury	0.3	0.3
Molybdenum	8	8
Nickel	50	50
Lead	40	40
Potassium	746	1,059
Selenium	3	3
Sodium	-	-
Titanium	49	433
Vanadium	18	17
Zinc	150	150

LEGEND:

100 : NBL value = *Guide d'intervention* criterion "A"

100 : NBL value calculated and lying between *Guide d'intervention* criteria "C" and "D"

100 : NBL value calculated using statistical analysis

In the case of the three parameters analyzed for which generic criteria are set out in the MDDELCC (Beaulieu, 2016) *Guide d'intervention*—barium, hexavalent chromium and manganese—the calculated NBL was lower than the generic "A" criterion, except for hexavalent chromium in the coarse sand unit, which lay between the Guide's "C" and "D" criteria. For all the other parameters analyzed, no generic criterion is defined in the MDDELCC Guide.

It should be noted, however, that for a statistical analysis to be deemed reliable and representative, it should use at least 10 results above the LOD and/or a proportion of at least 50 % of the results analyzed should be above the LOD. In this study, the statistical analysis was performed on certain parameters that did not comply with these recommendations: calcium, lithium and vanadium for the coarse sand unit, and barium, hexavalent chromium, lithium and vanadium. The results of the statistical analysis for these parameters must therefore be interpreted cautiously.

REMOTE LANDFILL

A Phase II Environmental Site Assessment (ESA) was done in summer 2017 at the remote landfill close to the project site (Map 6-4) (WSP, 2018*e*). According to the results of the assessment, the estimated volume of buried residual materials (paper, plastic, metal, wood, fabric) is 756 m^3.

Soils whose levels of C_{10}-C_{50} petroleum hydrocarbons and total sulphur exceeded the "A" generic criteria of the MDDELCC *Guide d'intervention* and whose levels of metals exceeded the limits set out in Schedule I of the *Regulation respecting the landfilling and incineration of residual materials* (RLIRM) were updated during the work. These soils, a preliminary estimate of whose volume is approximately 3,000 m^3, are in contact with the residual materials of the remote landfill and are considered non-compliant for an industrial site because of their level of lead.

Also, soils whose surface level of chromium VI lay in the "B-C" range of the generic criteria were also updated in the survey performed at the base of a heap of treated-wood poles. The volume associated with this type of contamination was assessed at 5 m^3.

6.2.9.2 *SEDIMENTS*

This section presents the main characteristics of sediments quality in watercourses in the study area, to determine their current contamination level based on various criteria of sediment quality recognized by the provincial and federal gouvernments. In each watercourse, a sampling station made up of five substations was established. The location of stations is shown on Map 6-8. The *Aquatic inventory and baseline study* (*Étude spécialisée sur l'habitat aquatique)* (WSP, 2018*c*) provides details of the methodology used, the work carried out and the results obtained.

GRANULOMETRY

In all the granulometric analysis performed, samples were generally dominated by the fraction associated with sand, except for two samples taken from creek CE2 (station 2A, sample CE-2A-3: 47.9% and 2B, sample CE-2B-2: 26.4%) and one taken from creek CE5 (station 5B, sample CE-5B-5: 43.0%). The proportions of sand varied from 41.0% (station 2B, sample CE-2B-3) to 89.1% (station 2B, sample CE-2B-5). On average, the samples were composed of approximately 62 % sand, 20 % silt and clay and 18 % gravel.

The granulometry of some samples from creeks CE2 to CE5 could not be determined because they were composed exclusively of organic material (peat). These were samples CE-3A-1 to CE-3A-5, CE-3B-1 to CE-3B-5, CE-2A-4, CE-2B-1, CE-5B-3 and CE-5B-4, as well as the sample from creek CE4.

CHEMICAL CHARACTERISTICS

Tables 6-19 and 6-20 present statistics describing the levels measured in sediments as well as the sediment quality criterion.

The analysis results were compared with the sediment quality criteria of Environment Canada and the MDDELCC (EC and MDDEP, 2007) and Canadian sediment quality guidelines from the CCME. The criteria and recommendations are:

- EC and MDDELCC:
  - rare effect level (REL);
  - threshold effect level (TEL);
  - occasional effect level (OEL);

  - probable effect level (PEL);
  - frequent effect level (FEL).
- CCME:
  - interim sediment quality guidelines (ISQGs);
  - threshold effect level (TEL).

Integrative parameters

The analysis results for total oils and greases ranged from below the detection level at 5B (sample CE-5B-5) to 11,830 mg/kg at station 3A (CE-3A-2). The average value of samples analyzed was 2,236.56 mg/kg, but the standard deviation was relatively large (2,832.33 mg/kg). With regard to petroleum hydrocarbons, the results were below the detection limit at several stations and the maximum value was 940 mg/kg at station 5B (sample CE-5B- 1). The average value was 179.79 mg/kg and the standard deviation 219.03 mg/kg.

At Asiyan Akwakwatipusich lake, the total oil and grease level was 937 mg/kg and petroleum hydrocarbons were below the detection limit. No sign of past contamination was visible. However, it is plausible that this contamination might come from the road lying upstream of this lake.

No criterion or guideline is provided for total oils and grease or for petroleum hydrocarbons (C_{10}-C_{50}).

Inorganic parameters

Total organic carbon (TOC) values measured ranged from 0.38 mg/kg at station 5B (sample CE-5B-5) to 90.70 mg/kg at station 3A (sample CE-3A-2). The average value was 18.74 mg/kg. The average humidity of the samples analyzed was 56.12%. At Asiyan Akwakwatipusich lake, the TOC level was 2.9 mg/kg.

There is no criterion or guideline for TOC and humidity.

Trace elements and heavy elements

Analysis results for thallium showed levels below the detection limit. Analysis results for titanium showed the greatest variability, with values ranging from 42 mg/kg at station 3B (sample CE-3B-3) to 694 mg/kg at station 5B (sample CE-5B-1), with an average of 330 mg/kg and a standard deviation of 215 mg/kg.

At Asiyan Akwakwatipusich lake, the highest level was for titanium (932 mg/kg) and the lowest for thallium (7.5 mg/kg).

As with the integrative parameters and inorganic parameters, no criterion or guideline is defined for trace elements and heavy elements.

Metals and metalloids

Arsenic levels ranged from 0.75 mg/kg (half the detection limit) to 115 mg/kg for the sample from creek CE4. The average was 14.87 mg/kg, while the standard deviation was 24.70 mg/kg. Thus, up to 20 samples containing natural levels above the rare effects level (REL) criterion were observed. This is the most restrictive criterion, set at 4.1 mg/kg. Arsenic is the substance showing the greatest number of natural levels above the corresponding criterion.

Total chromium levels measured ranged from 1 mg/kg (half the detection limit) to 37 mg/kg (station 2B, sample CE-2B-1). The average was 20 mg/kg, while the standard deviation was 10 mg/kg. Comparing the samples against the REL criterion, total chromium presented eight values above the criterion, which is set at 25 mg/kg for this substance.

Cadmium values ranged from 0.15 mg/kg (half the detection limit) to 0.90 mg/kg (station 5B, sample CE-5B-1 and 2). Thus, five samples presented natural levels above the REL criterion.

Table 6-19: Average and standard deviation of levels measured in sediments

		CE-2A		CE-2B		CE-3A		CE-3B			CE-5A		CE-5B	
Substances	CE-1A	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	CE-4	Average	Standard deviation	Average	Standard deviation
Metals and metalloids														
Aluminum (mg/kg)	3,500	5,336	2,162	4,634	1,825	2,035	1,185	2,884	2,113	2,580	3,658	447	4,436	2,297
Antimony (mg/kg)	3.5	4	0	4	1	4	0	4	1	3.5	4	0	4	1
Silver (mg/kg)	0.25	0.25	0	0.25	0	0.25	0	0.25	0	0.25	0.25	0	0.25	0
Arsenic (mg/kg)	5.1	10.2	3.9	0.8	1.3	7.9	3.6	2.4	1.7	115.0	45.1	33.2	4.7	11.7
Barium (mg/kg)	27	51	20	31	8	24	11	22	12	23	17	9	30	15
Beryllium (mg/kg)	0.5	0.5	0	0.5	0	0.5	0	0.5	0	0.5	0.5	0	0.5	0
Bismuth (mg/kg)	2.5	2.5	0	2.5	1	2.5	0	2.5	1	2.5	7.0	5	2.5	1
Boron (mg/kg)	5	6	2	5	1	11	4	6	2	14	254	155	5	61
Cadmium (mg/kg)	0.15	0.15	0	0.15	0	0.15	0	0.15	0	1	0.66	0	0.15	0
Calcium (mg/kg)	948	2,722	1,209	1,788	521	7,678	2,556	3,980	1,768	12,400	1,289	4,540	2,373	1,276
Total chromium (mg/kg)	14	26	11	23	9	12	8	15	11	9	25	10	23	9
Cobalt (mg/kg)	2	3	2	3	1	2	1	2	1	1.5	2	0	3	2
Copper (mg/kg)	9	15	6	3	2	11	6	15	11	7.0	3	2	6	4
Tin (mg/kg)	2.5	2.5	0	2.5	1	2.5	0	2.5	1	2.5	2.5	0	2.5	1
Iron (mg/kg)	5,240	8,658	3,114	7,382	2,495	11,984	3,505	6,418	3,527	12,700	275,000	155,372	7,448	60,434
Magnesium (mg/kg)	1,610	2,658	910	2,568	952	779	549	924	948	576	208	258	2,374	1,101
Manganese (mg/kg)	53	107	41	84	25	100	32	56	35	27	265	223	88	60
Mercury (mg/kg)	0.04	0.02	0.01	0.01	0.00	0.05	0.06	0.08	0.04	0.09	0.01	0.03	0.05	0.08
Molybdenum (mg/kg)	1	1.0	0	1.0	0	1.0	0	2.0	2	27	1.0	11	1.0	4
Nickel (mg/kg)	6	11	4	8	3	5	3	6	5	7	3	3	9	4
Lead (mg/kg)	2.5	8.7	4.5	2.5	0.8	3.4	1.8	3.6	2.3	5.0	28.8	16.7	3.4	5.7
Potassium (mg/kg)	815	1,557	635	1,048	317	121	317	440	530	131	41	47	1,114	537
Silicon (mg/kg)	357	406	99	367	120	469	267	547	188	396	833	386	358	69
Selenium (mg/kg)	0.5	0.5	0	0.5	0	0.7	0	0.5	0	0.5	1.1	1	0.8	1
Sodium (mg/kg)	60	136	55	113	47	55	10	106	61	104	27	35	60	22
Zinc (mg/kg)	17	42	15	10	7	13	7	10	6	12	13	10	14	6
Integrative parameters														
Total oils and greases (mg/kg)	501	857	311	384	122	5,676	3,904	5,488	1,908	4,420	367	1,660	557	544
Petroleum hydrocarbons (C10 to C50) (mg/kg)	50	365	246	50	80	266	210	141	103	151	50	41	240	360
Inorganic parameters														
Total organic carbon (mg/kg)	3.49	4	2	2	1	50	27	53	20	4.5	5	1	5	3
Humidity (mg/kg)	30.6	46	17	26	9	88	15	85	29	79.5	48	14	44	18
Trace elements and heavy elements														
Lithium (mg/kg)	6	10	4	10	4	1	3	2	2	1	1	0	13	6
Thallium (mg/kg)	7.5	7.5	0	7.5	3	7.5	0	7.5	3	7.5	7.5	0	7.5	3
Strontium (mg/kg)	5	25	13	12	5	27	8	31	18	659	9	265	10	104
Titanium (mg/kg)	359	526	176	506	217	115	101	258	220	190	170	66	428	201
Uranium (mg/kg)	10	10	0	10	4	10	0	10	4	10	48	32	10	9
Vanadium (mg/kg)	12	23	8	25	13	9	5	11	8	30	76	23	13	9

Note: Sediments were sampled only once at stations 1A and 4.

Table 6-20: Number of criteria exceeded in sediment samples analyzed

Substances	CCME [a]				EC and MDDEP [b]			
	ISQG	TEL	PEL	REL	TEL	OEL	PEL	FEL
Arsenic (mg/kg)	15	0	6	20	15	13	6	5
Cadmium (mg/kg)	4	0	0	5	4	0	0	0
Total chromium (mg/kg)	2	0	0	8	2	0	0	0
Copper (mg/kg)	0	0	0	2	0	0	0	0
Mercury (mg/kg)	1	0	0	3	1	0	0	0
Lead (mg/kg)	2	0	0	3	2	0	0	0

a: Summary table of Canadian sediment quality guidelines.
b: Criteria for the assessment of freshwater sediment quality.

Lead levels ranged from 2.5 mg/kg (half the detection limit) to 46 mg/kg (station 5A, sample CE-5A-5). Three samples presented natural levels above the REL criteria.

Mercury levels ranged from 0.01 mg/kg (half the detection limit) to 0.20 mg/kg (station 5B, sample CE-5B-4). Three of the samples presented natural levels above the REL criteria.

Copper levels ranged from 2.5 mg/kg (half the detection limit) to 33 mg/kg (station 3B, sample CE-3B-4). Two samples presented natural levels above the REL criterion.

For Asiyan Akwakwatipusich lake, the cadmium level was 0.45 mg/kg, above the REL criterion. Total chromium level was 48 mg/kg, above the TEL criterion. Finally, mercury level was 0.1 mg/kg, above the REL criterion.

Radionuclides

An analysis of radionuclides was performed on sediments taken at stations 3B and 5B. This was performed on a homogenate of five samples taken from each station. This led to the finding that radionuclide levels were below the standards set out in the Canadian guidelines for the management of naturally occurring radioactive materials. For Asiyan Akwakwatipusich lake, only radium 226 in sediments was analyzed in 2012. The level of this substance was below the Canadian guidelines for the management of naturally occurring radioactive materials (WSP, 2018*c*).

6.2.10 AIR QUALITY

According to the National Pollutant Release Inventory (NPRI), the closest industrial activities are over 100 km away from the project site. Due to the project's location, air quality in the sector is then considered very good.

No air quality measurement is available for the study area. However, in its mining instruction guide, the MDDELCC proposes a set of specific initial levels for mining projects that are in northern areas (north of the 51st parallel) and remote from other sources of atmospheric contaminant emissions. These initial levels are presented in Table 6-21.

The document specifies no initial level for annual $PM_{2.5}$ levels. An initial level of 4.5 µg/m^3 is therefore proposed. This was set based on measurements taken at Pémonca station, located in an area representative of the study area, in comparison with other available stations (Map 6-9).

Table 6-21: Initial levels for northern projects

Compound	Period	Ambient level (µg/m^3)
Total particulate matter (TMP)	24 hours	40
Fine particulate matter ($PM_{2.5}$)	24 hours	15
	1 year	4.5[a]
Breathable particulate matter (PM_{10})	24 hours	21.8[b]
	1 year	5.5[b]
Carbon monoxide	1 hour	600
	8 hours	400
Nitrogen dioxide (NO_2)	1 hour	50
	24 hours	30
	1 year	10
Sulphur dioxide (SO_2)	4 minutes	40
	1 hour	21[c]
	24 hours	10
	1 year	2

a Level calculated based on data from Pémonca station.
b Value calculated by interpolation with PMT and $PM_{2.5}$.
c Based on the initial 4-minute concentration, converted for a one-hour period using the inverted formula of the *Clean Air Regulation.*

For respirable particle concentrations of less than 10 µm (PM10), no initial concentration is also specified in this document. Initial concentrations based on interpolation between PMT and $PM_{2.5}$ concentrations are therefore proposed. For the purposes of this calculation, an annual concentration of PMT of 8 µg / m^3, estimated at Lac-Édouard station, was used. Initial concentrations of 21.8 µg/m^3 for the 24-hour period and 5.5 µg/m^3 for the annual period are therefore obtained.

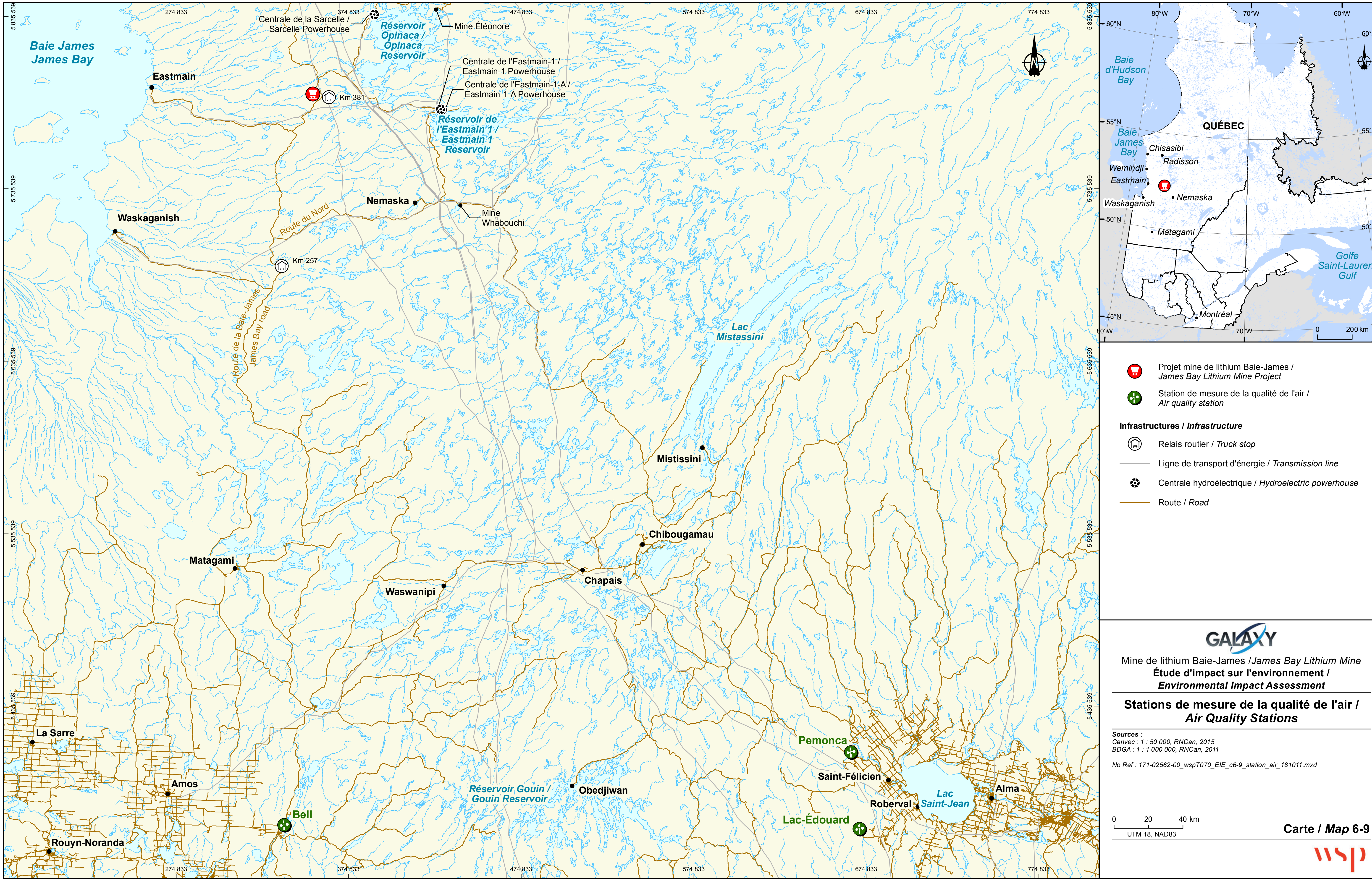
6.2.11 AMBIENT NOISE

The project site is close to two main sources of noise: the James Bay road and the km 381 truck stop. The surrounding environment is otherwise made up of predominantly softwood terrestrial vegetation and peatland.

Measurements of the soundscape were taken in 2011 at the project site, close to the road and at the km 381 truck stop. These measurements are still considered representative for 2017. The sound readings were taken at seven stations (P1 to P7) between October 7 and 9, 2011(Map 6-10).

Table 6-22 shows the equivalent sound levels recorded at the measuring stations for two periods of the day. The equivalent continuous sound level (L_{Aeq}) represents the average noise level during the measurement period. Minimum and maximum sound levels are also presented.

Residual noise at the proposed project site varied between 38 and 48 dB_A during the day and between 32 and 48 dB_A at night. Recorded levels at the km 381 truck stop were: 48 dB_A during the day and 47 dB_A at night. The James Bay road is the most important source of noise in the study area, with average sound levels of 56 and 61 dB_A during the day at points 3 and 6 respectively, with maximum values reaching 83 dB_A and 86 dB_A. No nighttime sound reading was taken at these two stations.



GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement /
Environmental Impact Assessment

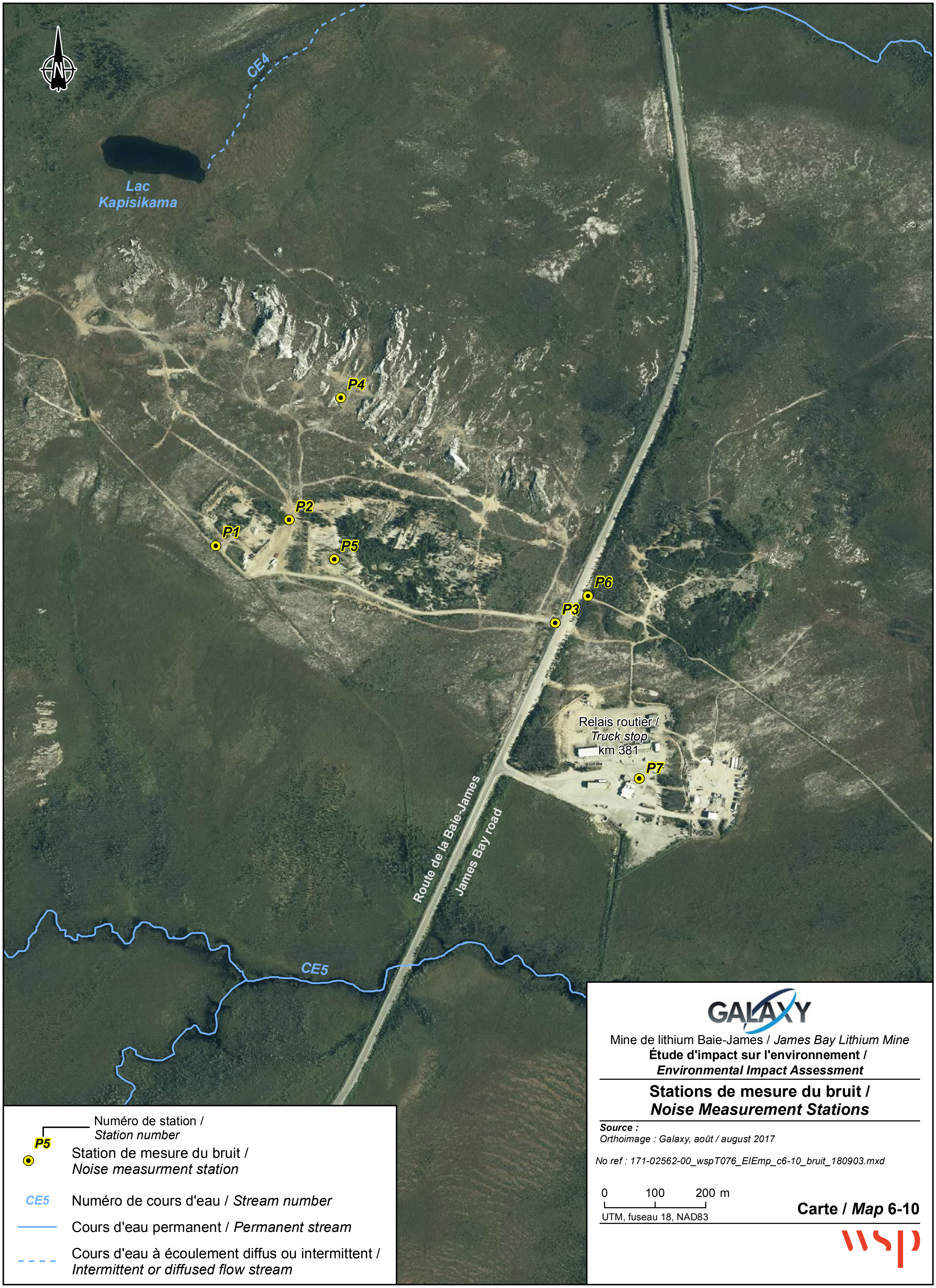
Stations de mesure de la qualité de l'air /
Air Quality Stations

Sources :
Canvec : 1 : 50 000, RNCan, 2015
BDGA : 1 : 1 000 000, RNCan, 2011

No Ref : 171-02562-00_wspT070_EIE_c6-9_station_air_181011.mxd

Carte / *Map* 6-9

wsp



Numéro de station / *Station number*

P5 Station de mesure du bruit / *Noise measurment station*

CE5 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement /
Environmental Impact Assessment

Stations de mesure du bruit / *Noise Measurement Stations*

Source :
Orthoimage : Galaxy, août / august 2017

No ref : 171-02562-00_wspT076_EIEmp_c6-10_bruit_180903.mxd

0 100 200 m

UTM, fuseau 18, NAD83

Carte / *Map* 6-10

wsp

For the study area, the noise criteria that apply are those of Zone IV of the document *Traitement des plaintes sur le bruit et exigences aux entreprises qui le génèrent* (MDDEP, 2006), namely 70 dB_A, except at campsites and the km 381 truck stop. At these two sites, the criteria to be respected are 55 dB_A during the day 50 dB_A at night, or the residual noise level, if higher.

Table 6-22: Sound measurements

	Noise level (dB_A)					
	Day (07:00 to 19:00)			Night (19:00 to 07:00)		
Measuring point	L_{Aeq}	Maximum	Minimum	L_{Aeq}	Maximum	Minimum
Point 1	48	56	29	32	36	26
Point 2	38	48	31	-	-	-
Point 3	56	83	35	-	-	-
Point 4	45	59	35	-	-	-
Point 5	44	59	24	48	70	20
Point 6	61	86	32	-	-	-
Point 7	48	67	39	47	66	38

6.2.12 ARTIFICIAL LIGHT AT NIGHT

The artificial light at night study area is shown on Map 6-11. The James Bay road crosses this area from south to north. It includes the James Bay road km 381 truck stop, the sole emitter of nocturnal artificial light in the study area. This zone also includes the main sensitive receptors that could be affected by the light emitted by project infrastructure. These sensitive receptors are the permanent and temporary Cree camps.

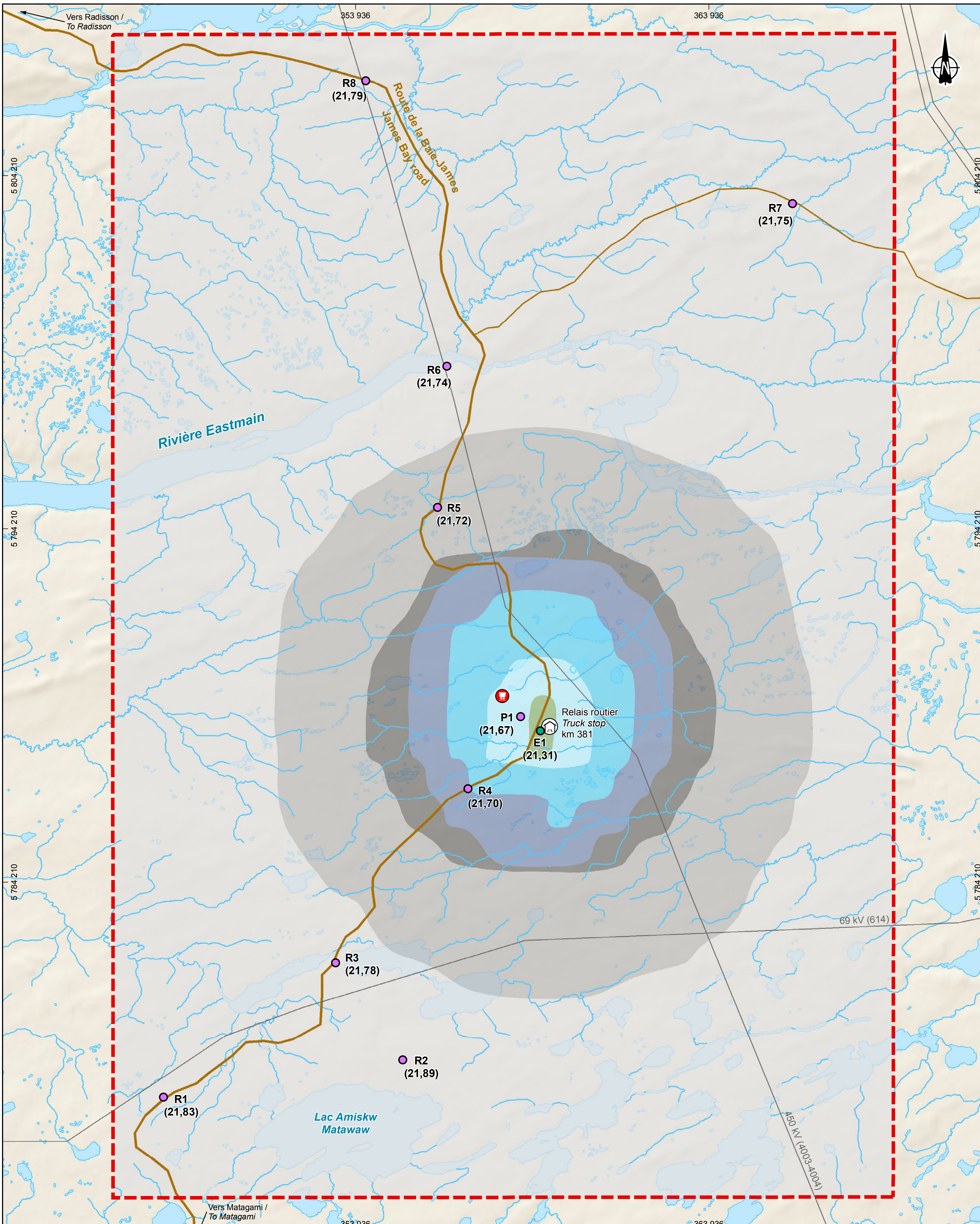
Sky clarity and intrusive light are measurable parameters that can be affected by an increase in nocturnal artificial light. To classify sky clarity and intrusive light conditions of the study area, a classification system developed by the International Commission on Illumination (CIE, 2003), with measurable limits defined by Narisada and Schreuder (2004), was used. This system provides four classification zones:

— very-low-luminosity sector (national parks or protected sites);
— low-luminosity sector (industrial, residential or rural areas);
— medium-luminosity sector (industrial or residential neighbourhood);
— high-luminosity sector (downtown and shopping areas).

Sky clarity limits are measured in $mag/arcsec^2$; the higher the value, the better the sky clarity. Limits for intrusive lights are measured in lux; the higher the value, the stronger the intrusive light.

Data from the *New World Atlas of Artificial Night Sky Brightness* by Falchi and coll. (2016) were used to present current sky brightness conditions in the study area. These data were imaged using a colour chart indicating sky brightness level, dark grey being the brightest sky and red the least bright for the sector under study. The values in this colour chart are in $mag/arcsec^2$ and the results obtained can be compared against measurements taken in the field. Data for the sector of the study are presented in Map 6-11.

The km 381 truck stop on the James Bay road is the sole emitter of nocturnal artificial light in the study area and it can be seen clearly. Little light is emitted by the km 381 truck stop and its effect on sky clarity fades rapidly with increasing distance. The project site is located within this area of influence, given its proximity to the km 381 truck stop.



Clarté du ciel / Sky Brightness

Mag/arcsec^2

- > 21,97
- 21,96-21,97
- 21,94-21,96
- 21,90-21,94
- 21,82-21,90
- 21,68-21,82
- 21,45-21,68
- 21,09-21,45
- 20,60-21,09
- 20,02-20,60
- 19,35-20,02
- 18,65-19,35
- 17,93-18,65
- < 17,93

Résultats de l'inventaire sur le terrain /
Result of the Field Inventory

Zone d'étude de l'ambiance lumineuse / *Sky brightness study area*

Station d'échantillonnage / *Sampling station*

E1 (21,72)
E = Émetteur / *Transmitter*
R = Récepteur / *Receptor*
P = Projet / *Project*

Résultats des mesures de clarté du ciel (mag/arcsec^2) / *Sky brightness measurement (mag/arcsec^2)*

Zone de la Commission internationale de l'éclairage (CIE) pour chaque station / *International Commission on Illumination zone (ICI) for each station*

- Zone C1
- Zone C2

Projet mine de lithium Baie-James / *James Bay Lithium Mine Project*

Infrastructures / *Infrastructure*

- Route principale / *Main road*
- Route d'accès / *Access road*
- Ligne de transport d'énergie / *Transmission line*
- Relais routier / *Truck stop*

Hydrographie / *Hydrography*

- CE3 — *Numéro de cours d'eau / Stream number*
- Cours d'eau / *Stream*
- Plan d'eau / *Waterbody*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement
Environmental Impact Assessment

Ambiance lumineuse / *Artificial Light at Night*

Sources :
World Shaded Relief, ESRI, 2014
Base carto / Cartographic base; CanVec 2017
Réseau routier / Road network; BDGA 2014

No Ref : 171-02562-00_wspT066_EIEal_c6-11_amb_lum_181011.mxd

0 1 2 km
UTM 18, NAD83

Carte / *Map* 6-11

wsp

In comparison with southern Quebec, where sky clarity is of poor quality because of the presence of many large cities, sky clarity in northern Quebec is excellent. Except for a few scattered small sectors, either villages or electrical facilities, practically the whole of northern Quebec has optimal sky clarity, that is, a sky entirely unaffected by artificial light.

6.2.12.1 *FIELD READINGS*

Readings were taken in the field to obtain occasional measurements of sky clarity, the presence of intrusive light and photographs of surrounding nocturnal landscapes. Measurements of sky clarity can also be used to validate the data provided in the 2016 *New Atlas*. Sampling stations were selected to be representative of the area, with particular attention to sectors likely to be affected by the project and light-emitting sources already present. Stations numbered with R represent sensitive receptors, those with E important sources of artificial light emissions and those with P project sectors. Measurements of intrusive light on the ground were obtained using a light meter (model TES 1336A) which provided results in lux for every station.

6.2.12.2 *RESULTS*

SKY CLARITY

The results of sky clarity measurements taken at each station are presented in Table 6-23 and Map 6-11. Based on the results obtained, each station was assigned to a CIE classification zone.

Table 6-23: Results of sky clarity measurements

Station[1]	Description	Measurement at zenith (mag/arcsec[2])	CIE zone
R1	Cree camp that seems no longer used	21.83	C1
R2	Forest trail close to Amiskw Matawaw Lake	21.89	C1
R3	Permanent Cree camp used year-round	21.78	C1
R4	James Bay road south of the km 381 truck stop	21.70	C1
R5	Cree camp that burned down in 2002	21.72	C1
R6	Temporary Cree camp on the shores of the Eastmain River	21.74	C1
R7	Track to the east of James Bay road	21.75	C1
R8	James Bay road north of the Eastmain River	21.79	C1
E1	Km 381 truck stop on the James Bay road	21.31	C2
P1	Project site	21.67	C1

1 R: receptor; E: emitter; P: project.
2 Narisada and Schreuder 2004.

The results show that there are two CIE environmental zones within the study area. Except for station E1 at the km 381 truck stop, all stations presented sky clarity measurements of above 21.4 mag/arcsec² and thus fall into CIE zone C1, representing sectors that are very little affected by nocturnal artificial light.

A reading of 21.31 mag/arcsec² was obtained at station P1, indicating that the area immediately around the km 381 truck stop lies within the CIE zone C2, that is, a sector of low luminosity. This was the lowest sky clarity reading taken during the surveys. It should be kept in mind that the km 381 truck stop is the only light emitter inside the study area. The effect of the light emitted by the km 381 truck stop fades very quickly, as shown by the measurement taken at station P1 (project site) at only 1.1 km from the km 381 truck stop, with a value of 21.67 mag/arcsec² (CIE zone C1). The highest sky clarity measurement was obtained at station R2, with a value of 21.89 mag/arcsec².

In summary, except for the area immediately around the km 381 truck stop, the entire study area is part of CIE zone C1. This is an area which is largely unaffected by nocturnal artificial light and in which sky clarity is excellent. As mentioned earlier, this type of sky is not found in or close to urbanized areas. It is totally absent from southern Quebec. However, this sky clarity is very common in northern Quebec.

INTRUSIVE LIGHT

The results of intrusive light measurements on the ground, taken at each station, are set out in Table 6-24. Based on the results obtained, each station was assigned to a CIE classification zone for intrusive light. These results show that, except for the Km 381 truck stop, no intrusive light was measured at the various stations.

A value of 0.12 lux was measured at E1 (km 381 truck stop), which puts it in CIE environmental zone E2, that is, a low-luminosity sector. No intrusive light was measured at the other stations in the study area, putting them in CIE zone E1. As with sky clarity, except for the area immediately around the km 381 truck stop, the entire study area is part of the CIE zone E1.

Table 6-24: Intrusive light measurement results

Station[1]	Description	Intrusive light (lux)	CIE zone
R1	Cree camp that seems no longer used	0	E1
R2	Forest trail close to Amiskw Matawaw Lake	0	E1
R3	Permanent Cree camp used year-round	0	E1
R4	James Bay road south of the km 381 truck stop	0	E1
R5	Cree camp that burned down in 2002	0	E1
R6	Temporary Cree camp on the shores of the Eastmain River	0	E1
R7	Track to the east of James Bay road	0	E1
R8	James Bay road north of the Eastmain River	0	E1
E1	Km 381 truck stop on the James Bay road	0.12	E2
P1	Project site	0	E1
1	R: receptor; E: emitter; P: project.		

NOCTURNAL LANDSCAPES

As mentioned earlier, there is only one emitter of nocturnal artificial light affecting the nocturnal landscapes within the study area, namely the km 381 truck stop on the James Bay road. Photographs of this emitter were taken from several viewpoints.

Photo 6-1 was taken close to station P1 (project site) towards the km 381 truck stop. The small luminous halo generated by the km 381 truck stop facilities can be clearly seen. An aurora borealis was visible in the sky at the time the photo was taken. Photo 6-2 shows a view of this aurora borealis from station R4. The km 381 truck stop and the small luminous halo it creates are also visible on this photograph. In addition, Photo 6-2 clearly shows the starry sky that was present during the night when surveys were made, demonstrating the quality of the nocturnal landscapes in the study area.

Photo 6-1: Luminous halo created by nocturnal artificial light emitted by the km 381 truck stop seen from station P1

Photo 6-2: View of the km 381 truck stop and an aurora borealis seen from station R4

6.3 BIOLOGICAL ENVIRONMENT

6.3.1 *VEGETATION*

Vegetation inventories were carried out between July 24 and 31, 2017. The objective of these inventories was to characterize and delineate land and wetland plant groups, check for the presence of threatened or vulnerable plant species (or species likely to be designated) and seek out any plant species of traditional interest for Aboriginal people. A baseline characterization for metals in certain plants with a traditional use was also performed. The method used along with the findings are described in greater detail in the *Terrestrial vegetation baseline study (Étude spécialisée sur la flore)* (WSP, 2018*f*).

6.3.1.1 *METHODOLOGY*

PLANT GROUP CHARACTERIZATION AND DELINEATION

Prior to the field inventories, a photo interpretation of the plant groups in the study area which included 2011 data taken by WSP was conducted. Following the photo interpretation, the two environments (land and wetland) were spatially illustrated using polygons.

During the inventory planning phase, inventory plots were placed within each land or wetland group polygon. For the larger groups, several plots were provided for to ensure a better assessment.

The inventories were carried out between July 24 and 31, 2017 to validate the limits, the naming and the characterization of the groups identified at the time of the photo interpretation or during prior characterization work. Data entry records from the *in situ* database developed by WSP were completed in the field, which made it possible to note characteristics of the site habitats (WSP, 2018*f*). Data for each plot were gathered over a radius of around 10 m, representative of the general environment. Particular care was taken to ascertain the presence of invasive exotic plant species.

The inventories were primarily completed in the areas where the project infrastructure would be located. A total of 98 plots (comprised of 81 complete plots and 17 validation plots, all of them dispersed within 57 polygons) were inventoried (Map 6-12).

WETLANDS

Wetlands have particular botanical, biophysical and hydrological characteristics (Bazoge and coll., 2015). Table 6-25 provides a non-exhaustive list of the criteria or signs to consider when identifying wetlands (Bazoge and coll., 2015).

The wetlands observed in the study area were validated in the field following their delineation through photo interpretation. Because of this area's vast size, the natural high-water mark of the wetlands was not surveyed over their entire perimeter. Where photo interpretation results were inaccurate, changes to wetland high-water mark limits were made by applying the botanical method, which considers all the previously cited elements.

The study area's location in a Northern environment must, however, be considered when establishing the group's water balance. The list of mandatory and optional plants in the 2015 guide *Identification et délimitation des milieux humides du Québec méridional* (Bazoge and coll., 2015) was originally drawn up for southern Quebec and may hence be inaccurate in Northern environments. This is in part due to the fact that the water status of certain plant species varies according to their latitude. Such is the case for the black spruce (*Picea mariana*), which can be mostly found in the wetlands of the south yet is a dominant species in both land and wetland environments in northern Quebec. In those instances where the vegetation does not allow for determining a group's water balance, biophysical and hydrological factors, along with soil characteristics, are key.

Zone d'étude locale / *Local study area*

Infrastructures / *Infrastructure*

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

Hydrographie / *Hydrography*

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Littoral des cours d'eau / *Watercourses shoreline*

Espèce végétale susceptible d'être désignée / *Plant Species Likely to be Designated*

Carex sterilis

Parcelle d'inventaire / *Survey Plot*

P-15 Parcelle (numéro de parcelle) / *Plot (plot number)*

PF-09 Station d'échantillonnage des végétaux (numéro de station) / *Plant sampling station (station number)*

Peuplements terrestres / *Terrestrial Vegetation*

Affleurement rocheux / *Rock outcrop*

Arbustaie / *Scrubland*

Aulnaie crispé / *Alder forest*

Boisé / *Woodland*

Dénudé sec / *Dry barren land*

Pessière noire à lichen / *Black spruce lichen forest*

Pessière noire à aulnes / *Black spruce alder forest*

Pinède grise / *Jack pine forest*

Anthropique / *Anthropogenic*

Brûlis / *Burnt area*

Végétation terrestre dans l'emprise / *Terrestrial vegetation in right-of-way*

Peuplements humides / *Wetland*

Plan d'eau / *Waterbody*

Tourbière arbustive / *Shrubby peatland*

Tourbière boisée / *Treed peatland*

Tourbière ouverte / *Open bog*

Végétation humide dans l'emprise / *Wetland in right-of-way*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement / *Environmental Impact Assessment*

Groupements végétaux et espèces floristiques à statut particulier / *Plant Community and Special Status Plant Species*

Sources :
Orthoimage: Galaxy, août 2017
Inventaire / Inventory: WSP 2017

No Ref : 171-02562-00_wspT071_EIEmb_c6-12_vegetation_180903.mxd

0 240 480 m
UTM 18, NAD83

Carte / *Map* 6-12

wsp

Table 6-25: Wetland characterization criteria

Type	Criteria
Botanical	• Dominance of mandatory and optional plants in wetlands
Biophysical	• Water line (wharf, rocks, trees, etc.) • Waterborne debris – Deposit of sediments • Sulfurous odour (rotten eggs) in the ground • Depressions covered by a blackish litter generated by the faulty decomposition of organic matter • Rhizosphere effect (i.e., oxidation around the roots) – marked spots for the first 30 cm underneath the surface • Erosion of tree bark • Exposed shrub and tree roots • Moss lines on trunks • Hypertrophied stumps • Hypertrophied lenticels • Relatively shallow root systems • Adventitious roots
Hydrological	• Flooded ground surface • Waterlogged soil for the first 30 cm

The swamps and peatlands were mainly identified on the basis of the thickness of the sod layer. As per MDDELCC standards, peatlands are characterized by an organic surface layer (sod) in excess of 30 cm; below that, groups are considered swamps or marshes, depending on the type of vegetation present.

SPECIAL-STATUS PLANT SPECIES

A list of the species likely to be found in the study area was drawn up prior to proceeding with the field inventories. In conjunction with the available database on study area habitats (2011 inventories, 2017 photo interpretation), the following works helped to establish the list of potential species:

- a guide created by the Centre de données sur le patrimoine naturel du Québec (CDPNQ) and the MDDELCC: *Les plantes vasculaires en situation précaire au Québec* (Tardif and coll., 2016);
- *Flore laurentienne* (Frère Marie-Victorin and coll., 2002);
- *Guide de reconnaissance des habitats forestiers des plantes menacées ou vulnérables - Abitibi-Témiscamingue et Nord-du-Québec (secteur sud-ouest)* (Labrecque and coll., 2014);
- the guide entitled *Plantes rares du Québec méridional* (Sabourin, 2009);
- the book *Sedges of Maine – A Field Guide to Cyperaceae* (Arsenault and coll., 2013).

The information gathered made it possible to identify 15 species that could possibly be present in the study area habitats. While inventorying, the search for special-status plant species mainly focused on the plant habitats and groups likely to host these taxa, i.e.:

- the banks of watercourses;
- open or wooded fens;
- wet meadows;
- rocky outcrop areas;
- open sandy areas.

A request was also submitted to the CDPNQ to obtain a list of the special-status species located in a radius of about 20 km from the centre of the study area.

PLANT SPECIES OF TRADITIONAL INTEREST FOR ABORIGINAL PEOPLE

The traditional use of plants by Cree communities in James Bay was investigated while reviewing the literature. This included looking over the various articles and databases listing the plants used by these communities, to prepare the most comprehensive list possible (Uprety and coll., 2012). The species' scientific and common names (in French, English and Cree) were also noted. Information was obtained on the growth habits of these plants (trees, shrubs, herbaceous plants and mosses) as well as the plant parts used by Cree communities.

CHEMICAL CHARACTERIZATION

A baseline characterization of the metals in some of the plants with traditional uses was also conducted to identify the initial concentration of certain metals in the various plants present at the project site. The sector sampled is adjacent to the planned project infrastructure. The initial characterization generated a profile of the metal content of the structural tissues (leaves, fruit, branches) of the six plants species found at the study site, namely:

- Blueberry (*Vacccinium spp.*);
- Labrador tea (*Rhododendron groenlandicum*);
- Sheep laurel (*Kalmia angustifolia*);
- Alder (*Alnus spp.*);
- Black spruce (*Picea mariana*);
- Tamarack (*Larix laricina*).

The field sampling activities in the study area were done on September 25, 2017. A total of 30 composite samples of structural tissues (leaves, fruit, branches), five for each plant species, were gathered in the study area and sent to the laboratory to analyze for 24 different metals. The samples were obtained at 11 stations located in various habitats at the project site. The location of the sampling stations are shown on Map 6-12.

6.3.1.2 *RESULTS*

PLANT GROUPS

On a regional scope, the study area is situated at the northeastern boundary of the Abitibi and James Bay Lowlands natural province, a zone characterized by large even plateaus dotted with hills and featuring vast fens and bogs often beginning at the shores of James Bay and extending 100 km inland (DUC, 2016). The inventories done confirm that the habitats in the study area are in line with this description.

The main factor in the forest dynamics of the region is the fire cycle (MFFP, 2017*a*). Forest fires therefore have a major impact on plant group structure and composition.

The mapping of recent fires (1970 to now) in the study area (MFFP, 2017*b*) shows forest fires caused by lightning in 2005, 2009 and 2013 (Map 6-13). The 2009 burn did not cover the entire study area, having mostly impacted the western section. The 2005 and 2013 fires, however, wreaked havoc on large sections of the study area, among them the zone near the km 381 truck stop and the project sector. Evidence of the recent fires is still visible, notably through the sparse nature of the newly growing black spruce and jack pine.

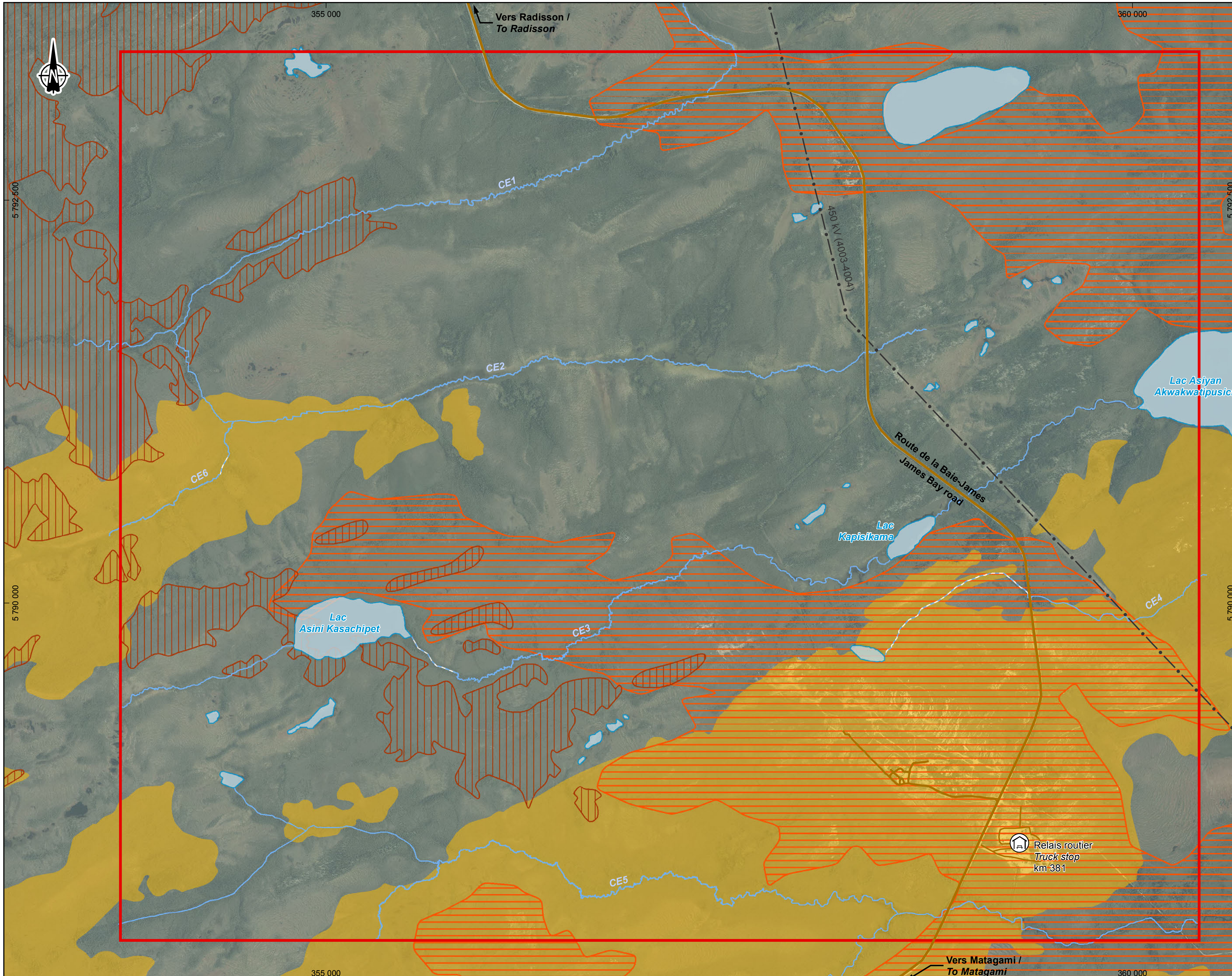
In spite of the ecosystem's adjustment to the dynamics of the forest fires, successive fires over the past 15 years have impacted the study area to the point where the short- and long-term development of existing stands could be disrupted. In fact, a greater number of repeated disturbances could significantly curtail their regeneration.

Map 6-12 shows the plant groups present in the study area and Table 6-26 illustrates the size of the plant groups within this area.

Land environments

Land environments account for 682.99 ha—or a mere 18.5%—of the study area. Field inventories allowed for specifying the data obtained from photo interpretation and reclassifying the land environments into 10 distinct groups.

In general, the land groups are mostly found along and east of the James Bay road (Map 6-12). Land groups are primarily found on sloped terrain covered with sand (hence, on rocky outcrops) or thin soil containing less than 15 cm of organic matter. The rock at these sites is usually observed less than 30 cm from the surface.



Zone d'étude locale / *Local study area*

Feux (année) / *Fire (year)*

2005

2009

2013

Infrastructure / *Infrastructure*

Route principale / *Main road*

Route d'accès/ *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

Hydrographie / *Hydrography*

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau /*Waterbody*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Feux de forêt récents / *Recent Forest Fires*

Sources :
Orthoimage : Galaxy, août / august 2017
Feux de forêt / Forest fires : MFFP Québec, 2018
Inventaire / Inventory : WSP 2017

No Ref : 171-02562-00_wspT075_EIEmb_c6-13_feux_180903.mxd

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Carte / *Map* 6-13

wsp

Table 6-26: Plant groups identified in the study area

Plant groups	Surface area (ha) in the study area	Representativeness (%)
Terrestrial environment		
Rocky outcrop	53.55	1.5
Scrubland	244.21	6.6
Green alder	7.66	0.2
Wooded area	4.58	0.1
Burns	161.65	4.4
Dry barren	21.40	0.6
Land footprint	10.13	0.3
Black spruce-lichen stand	114.61	3.1
Black spruce-moss stand	49.69	1.3
Jack pine stand	15.51	0.4
Terrestrial environment subtotal	**682.99**	**18.5**
Wetlands		
Wetland footprint	16.03	0.4
Pond	7.24	0.2
Shrub peatland	722.16	19.6
Wooded peatland	786.72	21.3
Open peatland	1,211.81	32.9
Wetland subtotal	**2,743.96**	**74.4**
Hydrous environment		
Wetland footprint	0.39	0.0
Lake	65.85	1.8
Shrub peatland	25.80	0.7
Wooded peatland	13.82	0.4
Open peatland	112.14	3.0
Hydrous environment subtotal	**218.00**	**5.9**
Human environments		
Human environment subtotal	**43.52**	**1.2**
Total	**3,688.47**	**100.0**

The presence of rocky outcrops and the many recent forest fires have resulted in the lack of a tree stratum in several land groups. The rocky outcrops, scrubland, green alder, burns and stripped zones are thus dominated by their shrub layer.

As for the scrubland and burns, their shrub layer is mainly comprised of the jack pine and black spruce regenerated after the forest fires. In these groups, the trembling aspen (*Populus tremuloides*) and white willow (*Salix sp.*) are usually found alongside the two dominant softwood species. Underneath, there is often velvetleaf huckleberry (*Vaccinium myrtilloides*) and sheep laurel (*Kalmia angustifolia*), which further attest to the more xeric water balance of these groups.

Land alder, i.e., groups dominated by green alder (*Alnus alnobetula subsp. Crispa)*, are most often observed on steep roadside slopes or on sites that were stripped or filled in during the construction of the roads. The alder is thick and nearly monospecific.

The black spruce-lichen stand and the jack pine forest are the two main land groups observed in land wooded areas. In both cases, the velvetleaf huckleberry, sheep laurel and regenerating black spruce are generally the dominant species in the shrub layer; the spruce forest, in turn, are often home to Labrador tea (*Rhododendron groenlandicum*). Lichen dominate the muscinal stratum and moss is usually found in slight depressions.

The other undefined wooded areas correspond to land plant groups identified during the photo interpretation of the study area but not physically visited during the field inventories. They are notably located outside of the priority zones targeted for the project infrastructure implementation. Given the limited diversity of the habitats identified during the field inventories, it would be reasonable to assume that these undefined groups mostly consist of blackspruce-lichen forest and jack pine forest.

The study area also includes human environments (over 43.52 ha or 1.2% of the surface area), among them the km 381 truck stop facilities, the James Bay road, the off-road trails and the access roads for drilling activities, as well as a remote landfill.

Wetlands

Wetlands prevail in the study area, covering 2,743.96 ha (74.4% of the total surface area being studied). Following the field inventories, the wetland plant groups of the study area were classified into four types: open peatlands, shrub peatlands, wooded peatlands and the wetland zones in the right-of-way for Hydro-Québec transmission lines. Some larger ponds were also found inside the peatlands.

The wooded and shrub peatlands of the study area are mainly marked by the presence or absence of a tree cover. Black spruce and heath account for the vast majority of the vegetation found in both groups. Heath is mostly comprised of Labrador tea and leatherleaf (*Chamaedapne calyculata*) and the herb layer includes three-leaved Solomon's seal (*Maianthemum trifolium*) and some sedge grasses, among them water sedge (*Carex aquatilis var. aquatilis*), few-seeded sedge (*Carex oligosperma*) and three-seeded sedge (*Carex trisperma*). Onsite observations appear to indicate that the shrub peatlands are actually young wooded peatlands.

On the territory being studied, shrub peatlands distinguish themselves from open peatlands, first because of much thicker regenerating black spruce, sometimes in conjunction with tamarack (*Larix laricina*). In the open peatlands, the shrub layer is usually dominated by heath. In the overall study area, the continuity among the various types of peatlands results in the creation of large wetlands where open, shrub and wooded peatlands converge. Also, some of the bigger shrub peatlands include smaller areas comprised of open peatlands with ponds.

The propagation of forest fires over the past two decades has impacted the distribution of wooded and shrub peatlands in the study area. Today, they are increasingly found in the northern part of the study area, which happens to be the section least affected by the recent burns. Notably, some of the open peatlands identified at the site are in fact former wooded peatlands that have burned in the recent past.

While most of the open peatlands are not very diversified (comprised mostly of heath), some of the ones located along watercourses consist of a greater variety of grass species and shrubs. The same could be said about the richness of the plant association in the shrub peatlands located along watercourses, where tamarack usually prevails over black spruce as far as the regeneration of shrub species is concerned. These more diversified bordering peatlands correspond to fens, which differ from bogs depending on their water supply. Bogs are wetlands essentially supplied by rainwater (rain and snow), while the water supply of fens also includes flowing water enriched by minerals culled from the soil of neighbouring habitats (Leboeuf and coll., 2012). Because of this variance in water supply, bogs are more acidic and host fewer nutrients than fens; this has an impact on the composition and diversity of the area's vegetation.

Fens are hence able to rely on a much vaster wealth of species. In addition to heath and tamarack, speckled alder (*Alnus incana subsp. rugosa*), scrub birch (*Betula glandulosa*), sweet gale (*Myrica gale*) and willows (*Salix sp.*) are all found in the shrub layer of these fens. The herb layer is dominated by sedge, which includes several species of sedge grass (*Carex aquatilis var. aquatilis, Carex canescens, Carex lenticularis var. lenticularis*, *Carex oligosperma*, *Carex pauciflora, Carex rostrata, Carex trisperma*) and cottongrass (*Eriophorum angustifolium subsp.*

angustifolium, *Eriophorum vaginatum var. spissum*, *Eriophorum virginicum*). The fens located next to calcium-rich soil will contain a particularly wide variety of plant species (Grondin and coll., 2005).

The bogs in the study area are nevertheless the largest and most frequently encountered groups. The inventories carried out made it possible to confirm that these environments have characteristics of the wetlands and peatlands encountered throughout the James Bay territory (Payette and Rochefort, 2001).

Hydrous environments, which include lakes and watercourses (drainage bed and adjacent wetlands comprising the littoral), cover 218 ha or 5.9% of the study area.

SPECIAL-STATUS PLANT SPECIES

The CDPNQ registers include no mention of threatened or vulnerable plant species within a 20-km radius of the centre of the study area.

Only one plant species with a special status was identified (on two occasions) during the inventories carried out in the summer of 2017. The species observed was the sterile sedge (*Carex sterilis*), a species likely to be designated as threatened or vulnerable. The populations identified during the inventories conducted were in a shrub peatland-like habitat with shallow pond zones, some of which were dry. These environments were rich in plant life and contained species usually associated with an alkaline substrate (*Dasiphora fruticosa*; *Menyanthes trifoliata*, etc.).

The first instance, located near plot P-22, included around 3,000 individuals over an area of approximately 500 m^2 (Map 6-12). This remote environment appeared ideal for the species and the tufts gathered were thick and healthy. In the second instance, the number of individuals could not be ascertained, seeing as the species could not be positively identified at the time of gathering. However, the type of habitat in which the species was collected corresponds to its preferred habitat, which implies that several individuals were likely present.

The inventories determined that most of the groups (wetland and land) had a very limited potential for comprising threatened or vulnerable plant species, mainly due to the environment's weak biodiversity and numerous disturbances such as severe forest fires, which significantly modified the plant communities in the study area over the last few years. Based on the data regarding habitats in the study area and the preferred habitats of special-status species gathered during the 2017 inventories, Table 6-27 depicts the potential presence of the 15 species targeted prior to the inventories being conducted.

Table 6-27: Plant species with a special status identified in or near the James Bay region or located near or potentially present in the study area

Common name	Latin name	Provincial / federal status	Priority status/ranking[1]	Habitat	Potential presence
Great northern aster	*Canadanthus modestus*	Likely/none	S2	• Mostly wetlands (sandy shores, wet meadows, swamps) • Occasionally on land (urban terrain) • On limestone soil • Conducive to sun-loving plants	Low
Sterile sedge	*Carex sterilis*	Likely/none	S2	• Open or wooded fens, rocky or gravel shores • Sometimes on rocky outcrops; On limestone soil • Conducive to hemisciaphilous plants	High (presence confirmed)
Calypso	*Calypso bulbosa* var. *americana*	Likely/none	S3	• Palustrine (swamps, wooded fens) and land (coniferous/softwood forests, deciduous forests) environments • Conducive to plants that thrive in the shade	Low

Table 6-27: Plant species with a special status identified in or near the James Bay region or located near or potentially present in the study area (cont.)

Common name	Latin name	Provincial / federal status	Priority status/ranking[1]	Habitat	Potential presence
Slenderleaf sundew	*Drosera linearis*	Likely/none	S3	• Fens and flats containing marly lakes, usually in limestone environments • Conducive to sun-loving plants	Low
Largeleaf avens	*Geum macrophyllum* var. *perincisum*	Likely/none	S2	• Wet meadows, banks of watercourses, muskegs and forest edges • Conducive to sun-loving plants	Medium
Ojibway waterwort	*Elatine ojibwayensis*	Likely/none	S1	• Banks of rivers and streams, marshes Usually in shallow water • Conducive to sun-loving plants	Low
Robinson's hawkweed	*Hieracium robinsonii*	Likely/none	S3	• Rocky or clay banks, dry rocks and sandy backfill, often near waterfalls or rapids • Conducive to sun-loving plants	Medium
Golden hedge-hyssop	*Gratiola aurea*	Likely/none	S3	• Banks • On sandy or silty substrates • Conducive to sun-loving plants	Low
Wooly benchheather	*Hudsonia tomentosa*	Likely/none	S3	• Glade hosting jack pine stands on sand dunes or terraces, maritime dunes or barrens, sandy banks • Conducive to sun-loving plants	Low
Northern twayblade	*Neottia borealis*	Likely/none	S2	• Land environment • Coniferous forests, rocky outcrops • On alkaline soil • Conducive to plants that thrive in the shade	Low
Rayless mountain groundsel	*Packera indecora*	Likely/none	S2	• Wet meadows, banks of watercourses and wooded fens • Conducive to sun-loving plants	Medium
Purple meadow-rue	*Thalictrum dasycarpum*	Likely/none	S2	• Boggy banks, glades and wet meadows	Low
Northern gooseberry	*Ribes oxyacanthoides* subsp. *oxyacanthoides*	Likely/none	SH	• Rocky or gravel shores • Sometimes on exposed sand • Conducive to sun-loving plants	Low
McCall willow	*Salix maccalliana*	Likely/none	S2	• Rocky and gravel lake shores, swamps, wooded peatlands (bogs/fens) • Conducive to sun-loving plants	Medium
False mountain willow	*Salix pseudomonticola*	Likely/none	S1	• Rocky and gravel shores, swamps, wooded bogs • Conducive to sun-loving plants	Low

1 S ranking (sub-national): score assigned to an element at the provincial or federal level which designates priority in regard to conservation (scores range from S1 to S5, in order of decreasing priority). Elements ranked S1, S2 and S3 are considered precarious or stressed. A score of SH denotes what is deemed an historical occurrence, meaning that no such occurrence has been observed or noted over the past 40 years.

INVASIVE EXOTIC PLANT SPECIES

Invasive exotic plant species are comprised of plants introduced into zones outside of their natural distribution areas and which could threaten the new environment and its biodiversity. Given their dispersion capabilities and rapid growth, these species have competitive advantages over native species, allowing them to prevail within the plant community of a given environment and possibly even locally eliminate certain native species.

No invasive exotic plant species was observed in the study area during the inventories. While the issue of invasive exotic plant species is not as widespread in northern Quebec as in other areas, care should be taken to ensure that they do not propagate further.

PLANT SPECIES OF TRADITIONAL INTEREST FOR ABORIGINAL PEOPLE

The plant inventory was conducted while paying particular interest to the presence of plants traditionally used by the Cree people. The documents referred to (Uprety and coll., 2012) list 546 species or groups of species that are potentially used for medicinal purposes by Aboriginal people throughout Canada.

Overall, 27 of the plants present in the field are used by the Cree. Five of them are tree species, 16 of them shrub species, five more of them herbaceous species and the remaining one, a nonvascular muscinal species (Table 6-28).

The species with medicinal uses observed in the field are common to both the study area and this part of the Quebec territory.

Table 6-28: Vascular and nonvascular plants traditionally used by the Cree found in the study area

Scientific name	French name	English name	Cree name	Parts used
Trees				
Larix laricina	Mélèze laricin	Tamarack	Waachinaakan	Inner bark
Picea mariana	Épinette noire	Black spruce	Inaatuk	Cones
Pinus banksiana	Pin gris	Jack pine	Ushichishk	Cones and inner bark
Populus tremuloides	Peuplier faux-tremble	Trembling aspen	Mitos, mitosinipiah	Inner bark
Prunus pensylvanica	Cerisier de Pennsylvanie	Pine cherry	Pasuwiymayatik, pasisawimin, pusawemina	Bark and roots
Shrubs				
Alnus alnobetula subsp. *crispa*	Aulne crispé	Green alder	Mathato	Leaves
Alnus incana subsp. *rugosa*	Aulne rugueux	Mountain alder	Utuspii	Bark
Andromeda polifolia var. *latifolia*	Andromède glauque	Glaucous-leaved bog rosemary	Kakouboushk	Small branches
Empetrum nigrum subsp. *nigrum*	Camarine noire	Crowberry	Askiminasiht, ebshjimend	Fruit
Gaultheria hispidula	Petit thé	Creeping snowberry	Unknown	Leaves and fruit
Juniperus communis var. *depressa*	Genévrier commun déprimé	Juniper	Kaahkaachiiminaahtikw	Roots
Juniperus communis var. *megistocarpa*	Genévrier commun	Juniper	Kaahkaachiiminaahtikw	Roots
Juniperus horizontalis	Genévrier horizontal	Creeping juniper	Ahaseminanatik, masekesh, masikeskatik	Small branches and fruit
Kalmia angustifolia	Kalmia à feuilles étroites	Sheep laurel	Uschipikwh	Leaves

Table 6-28: Vascular and nonvascular plants traditionally used by the Cree found in the study area (cont.)

Scientific name	French name	English name	Cree name	Parts used
Shrubs (cont.)				
Rhododendron groenlandicum	Thé du Labrador	Labrador tea	Kachebuk	Leaves
Rubus idaeus	Framboisier sauvage	Raspberry	Athoskan, athoskunatikwah, ayosikan, uyooskan, ayuwskun, ayooskunak, anosh'kanek	Stems, roots and fruit
Salix bebbiana	Saule de Bebb	Willow	Nipisigibi, nipisiah, nipisi, nipisis, atikwupamuk, wekope, nepiseatik, nepise, nipistakwah	Small branches, stems and inner bark
Salix planifolia	Saule à feuilles planes	Tea-leaved willow	Waskayabaduk	Bark
Salix sp.	Saules	Willow	Utusphi	Inner bark
Vaccinium myrtilloides	Bleuet	Blueberry	Sipikomin, ithinimina, iynimin, iyinimin, inimena	Stems, roots and fruit
Viburnum edule	Pimbina	Low bush-cranberry	Moosomina, mosomina, moosominahtik	Small branches, buds, stems and leaves
Herbaceous				
Equisetum sylvaticum	Prêle des bois	Horsetail	Mistatimosoy, okotawask, enskowusk, kiychiwiykusk	Whole plant
Geocaulon lividum	Comandre livide	Northern comandra	Unknown	Fruit
Maianthemum canadense subsp. *Canadense*	Maïanthème du Canada	Wild lily-of-the-valley	Sosowipukosak, soskopukwagoh	Leaves
Nuphar variegata	Grand nénuphar jaune	Yellow pond lily	Waskitipak, oskitipak, waskutamo, waskatamo, waskatamow, oskotamo, pwakumosikum	Whole plant
Sarracenia purpurea	Sarracénie pourpre	Pitcher plant	Ayigadash	Whole plant
Mosses				
Sphagnum fuscum	Sphaigne brune	Peat moss	Uske, muskak, askiyah, mikaskwahkawow, asaskumkwa, eskiya, awasistche	Whole plant

CHEMICAL CHARACTERIZATION

It should be noted that there are no threshold criteria for the parameters analyzed for these plants. At this time, no standard has been set by the Canadian Council of Ministers of the Environment (CCME) or the MDDELCC for the presence of metals in vegetation. In the case at hand, the analysis therefore serves only to document the baseline concentrations of metals present in the leaves/needles, fruits and branches of the six species sampled in the study area.

Table 6-29 compares the means among all samples for the different parameters measured. This table also provides the mean total for each parameter for the 30 samples as well as the standard deviation for each parameter among the species averages.

Table 6-29: Comparison of means for parameters measured in the tissues of six plant species

Parameter	Blueberry (mg/kg)	Labrador tea (mg/kg)	Sheep laurel (mg/kg)	Alder (mg/kg)	Black spruce (mg/kg)	Tamarack (mg/kg)	All samples (mg/kg)	Standard deviation (mg/kg)
Aluminum (Al)	200	30	51	108	155	42	98	69
Antimony (Sb)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-
Silver (Ag)	0.031	0.004	0.007	0.010	0.019	0.009	0.013	0.010
Arsenic (As)	0.137	0.032	0.061	0.090	0.067	0.070	0.076	0.035
Barium (Ba)	44	62	49	76	34	54	53	15
Beryllium (Be)	0.004	0.002	0.002	0.015	0.002	0.002	0.004	0.005
Boron (B)	6.5	9.2	7.5	11.0	7.4	19.1	10.1	4.7
Cadmium (Cd)	0.098	0.005	0.006	0.022	0.016	0.037	0.031	0.035
Chromium (Cr)	0.261	0.039	0.064	0.170	0.049	0.039	0.104	0.092
Cobalt (Co)	0.217	0.023	0.022	4.452	0.101	0.044	0.810	1.786
Copper (Cu)	5.2	4.5	6.0	9.1	3.2	2.4	5.1	2.4
Iron (Fe)	115	34	30	107	36	36	60	40
Lithium (Li)	0.124	0.010	0.015	0.842	0.089	0.020	0.183	0.326
Manganese (Mn)	980	660	255	516	726	618	626	239
Mercury (Hg)	0.005	0.005	0.006	0.005	0.013	0.012	0.008	0.004
Molybdenum (Mo)	0.130	0.036	0.144	0.596	0.014	0.012	0.155	0.223
Nickel (Ni)	1.57	0.47	1.22	5.54	0.99	0.74	1.75	1.90
Lead (Pb)	0.672	0.175	0.246	0.331	0.180	0.148	0.292	0.198
Selenium (Se)	0.04	0.03	0.05	0.01	0.03	0.33	0.08	0.12
Strontium (Sr)	16	18	33	57	16	28	28	16
Titanium (Ti)	3.2	1.0	0.8	1.7	1.5	1.3	1.6	0.8
Uranium (U)	0.008	0.002	0.001	0.003	0.003	0.002	0.003	0.002
Vanadium (V)	0.258	0.040	0.045	0.143	0.057	0.043	0.098	0.088
Zinc (Zn)	44	25	26	48	55	30	38	13

Overall, the chemical characterization of the 30 samples of six plant species showed that the concentrations measured in the leaf, branch and fruit tissues were relatively low and indicated a growth environment that was affected little by local or regional industrial activities. Table 6-29 nonetheless reveals that, of the 24 metals analyzed, seven showed elevated average concentrations: aluminum (98 mg/kg), barium (53 mg/kg), boron (10.1 mg/kg), iron (60 mg/kg), manganese (626 mg/kg), strontium (28 mg/kg) and zinc (38 mg/kg). These seven metals showed higher concentrations across all plant species analyzed. The plant species found on the site are nonetheless adapted to these metal-bearing soils and are therefore capable of tolerating high metal concentrations. Plants can regulate the input of metals in soil and thereby reduce its toxicity.

Table 6-29 also compares the means for the different parameters measured among all samples for the species collected. We note that, compared with other species analyzed, blueberries showed particularly high concentrations of aluminum (200 mg/kg), iron (115 mg/kg) and manganese (980 mg/kg). The alder tissue samples, on the other hand, showed an elevated average concentration of aluminum (108 mg/kg), barium (76 mg/kg), iron (107 mg/kg) and strontium (57 mg/kg) compared with the other plant species. In black spruce, average concentrations of aluminum (155 mg/kg) and zinc (55 mg/kg) were significantly higher than the total average results compiled for all species. Among Labrador tea, sheep laurel and tamarack, none of the three stood out significantly for the parameters analyzed versus the total mean.

6.3.2 TERRESTRIAL FAUNA

6.3.2.1 LARGE FAUNA

SPATIAL BOUNDARIES AND METHODOLOGY

Three species of large mammals are likely to frequent the study area: caribou (*Rangifer tarandus caribou*), moose (*Alces alces americana*) and black bears (*Ursus americanus*).

Caribou, and woodland caribou especially, are a sensitive component of the natural environment. This species benefits from dual protection, at both the federal and provincial levels. For these reasons, a study area for large fauna was defined primarily with caribou in mind. The study area corresponded to a 50-km radius from the centre of the proposed mine, which amounts to an area of roughly 7,850 km² (Map 6-14). This limit was established in accordance with the guidelines for managing woodland caribou habitat (Équipe de rétablissement du caribou forestier du Québec, 2013*a*),[5] which specify in point 6 that the minimum area of units of analysis for the habitat disturbance rate for woodland caribou is 5,000 km².

Activity of large fauna in the study area was determined based on different information sources, i.e., data from various government organizations, scientific articles and reports published on mammals in the area or on species biology, and on an aerial survey.

The Direction de l'aménagement de la faune du Nord-du-Québec of the MFFP confirmed that the moose and caribou survey was very limited in the study area. The only aerial survey data available from regional authorities were from a survey of moose per plot in hunting zone 22, conducted in 1991. The region, including the study area, was not formally covered by a survey devoted to woodland caribou. Casual observations of caribou were done during the 1991 survey, but they did not allow definite differentiation between migratory and woodland caribou. Telemetry positions reveal low activity of woodland and migratory caribou in the study area in recent decades. However, it should be noted that locations of collared caribou do not give a full picture of all caribou frequenting the territory. Similarly, the absence of caribou in a given sector does not mean the species is absent from the area.

Based on this information, and to better document use of the area of the proposed mine by caribou and moose, an aerial survey of large fauna was done in the winter of 2018 in a portion of the study area. The survey area selected for caribou covered an area of 1,600 km² and that for moose 100 km².

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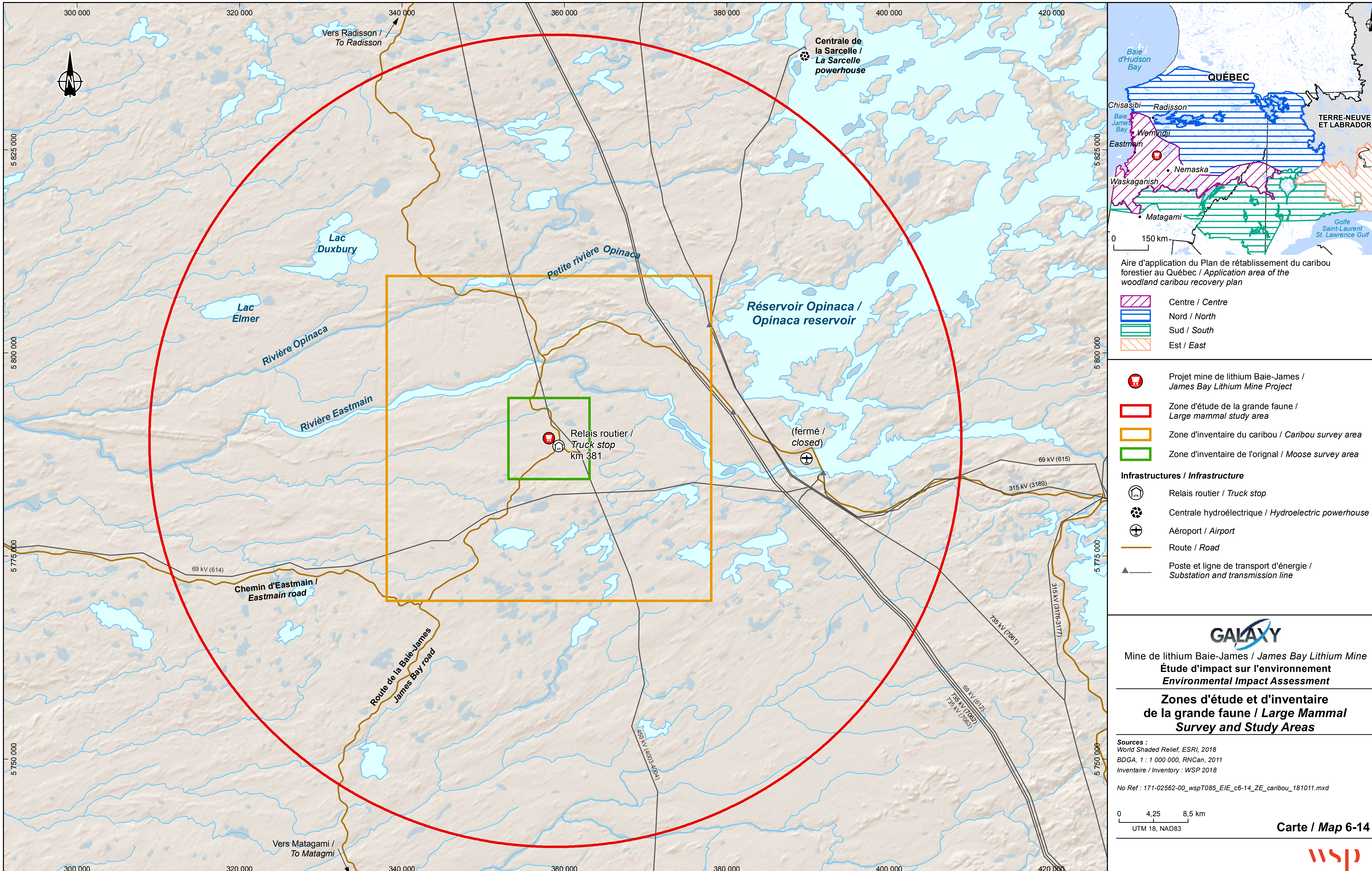
5 The Environment Canada Recovery Strategy for the Woodland Caribou recommends evaluating the effects of a project taking spatial scope into account, which includes range, as defined in Appendix J of the species recovery program. The project is located in the QC6 conservation unit, which is 621,562 km² in area. Since unit QC6 covers the majority of the range of woodland caribou in Québec, it would be unrealistic to analyze the effects of the project for the whole unit.



Vers Radisson /
To Radisson
Centrale de la Sarcelle /
La Sarcelle powerhouse
Lac Duxbury
Lac Elmer
Petite rivière Opinaca
Rivière Opinaca
Rivière Eastmain
Réservoir Opinaca /
Opinaca reservoir
Relais routier /
Truck stop
km 381
(fermé /
closed)
69 kV (615)
315 kV (3189)
69 kV (614)
Chemin d'Eastmain /
Eastmain road
Route de la Baie-James /
James Bay road
735 kV (7061)
315 kV (3176-3177)
69 kV (612)
735 kV (7062)
735 kV (7063)
450 kV (4003-4004)
Vers Matagami /
To Matagami
300 000
320 000
340 000
360 000
380 000
400 000
420 000
5 825 000
5 800 000
5 775 000
5 750 000
Baie d'Hudson
Hudson Bay
QUÉBEC
Chisasibi
Radisson
Baie James
James Bay
Wemindji
Eastmain
Nemaska
Waskaganish
Matagami
TERRE-NEUVE ET LABRADOR
Golfe Saint-Laurent
St. Lawrence Gulf
0
150 km
Aire d'application du Plan de rétablissement du caribou forestier au Québec / Application area of the woodland caribou recovery plan
Centre / Centre
Nord / North
Sud / South
Est / East
Projet mine de lithium Baie-James /
James Bay Lithium Mine Project
Zone d'étude de la grande faune /
Large mammal study area
Zone d'inventaire du caribou / Caribou survey area
Zone d'inventaire de l'orignal / Moose survey area
Infrastructures / Infrastructure
Relais routier / Truck stop
Centrale hydroélectrique / Hydroelectric powerhouse
Aéroport / Airport
Route / Road
Poste et ligne de transport d'énergie /
Substation and transmission line
GALAXY
Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement
Environmental Impact Assessment
Zones d'étude et d'inventaire de la grande faune / Large Mammal Survey and Study Areas
Sources :
World Shaded Relief, ESRI, 2018
BDGA, 1 : 1 000 000, RNCan, 2011
Inventaire / Inventory : WSP 2018
No Ref : 171-02562-00_wspT085_EIE_c6-14_ZE_caribou_181011.mxd
0
4,25
8,5 km
UTM 18, NAD83
Carte / Map 6-14
wsp

The method used was an exhaustive survey of the area. The survey techniques were defined based on the two target species. The survey plan for caribou involved doing equidistant overflights in a north-south direction, spaced 1.75 minutes of longitude (approximately 2 km) apart, consistent with the method used by the MFFP (Courtois and coll., 2001). This overflight was done at an altitude of roughly 200 m and at a maximum speed of 140 km/h. Identification of caribou trails and their characterization, including the counting and classification of animals (sex and age group), was done during a single helicopter overflight phase. Moose were surveyed by means of equidistant 500-m transects, applying the method used by the MFFP (Courtois, 1991).

The navigator/observer was responsible for guiding helicopter movements as well as for entering each observation using a sequential number. This was done using a Touchbook portable computer, in a record specially designed for this purpose. Records and photos were automatically geo-referenced in the database and figured in the flight plan on the screen, thereby preventing duplication of observations collected. Despite the fact that the field campaign targeted primarily caribou and moose, signs of presence or observations of other species of interest identified during overflights, such as grey wolves, were also noted.

The survey was done March 4 to 6, 2018, inclusive. Despite a sometimes partly cloudy sky, visibility allowed clear identification of the trail networks, even for small fauna (hares, ptarmigan). The very open forest environment, due largely to past fires, facilitated the detection of trail networks and animals in general.

CARIBOU

The report of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) established a national consensus regarding the different designatable units of caribou in Canada. Quebec is home to a significant portion of designatable unit no. 6 “boreal caribou” (COSEWIC, 2011), whose distribution in the boreal forest extends from Labrador across Quebec, toward Ontario and the prairie provinces to the Rockies and Northwest Territories. At the provincial level, boreal caribou are also known as “woodland caribou”.[6] The status of woodland caribou is distinct from that of eastern “migratory caribou” (unit no. 4), which includes the George River and Leaf River populations (herds). The study area is located in the overlapping area of the ranges of the woodland and migratory caribou of the Leaf River population (Couturier and coll., 2004). Therefore, animals of these two designatable units are likely to frequent the project study area.

Federal context for Woodland Caribou

In response to the recommendations (COSEWIC, 2002), woodland caribou were listed as a threatened species in Canada under the *Species at Risk Act* in June 2003. In developing its recovery strategy, EC adopted a probabilistic assessment approach to the level of self-sustainability of populations, based on the capacity of the range to sustain a population of woodland caribou. This approach focuses on assessing three key indicators: the demographic trend of the population, its size and the level of disturbance of the range. Therefore, a population judged to be self-sustaining will have a stable or growing demographic trend, a size exceeding the critical level and a low to moderate level of disturbance within the range occupied.

According to the strategy adopted, EC determined a disturbance rate of 35% to be moderate and corresponding to a likelihood of self-sustainability of 0.60. However, it must be considered that the 0.60 threshold is a minimum, since the likelihood that the population will not be self-sustaining remains significant at 0.40. The probabilistic approach applied by EC in 2008 was updated in 2011 to consider new data and analytical methods (EC, 2008, 2011). Notably, this update revealed, with even greater clarity, that 70% of the variation recorded in recruitment of woodland caribou populations is explained by a single variable, the habitat disturbance rate, which includes human and naturally induced (forest fires) disturbances.

For each local population, the recovery strategy for the woodland caribou in Canada (EC, 2012) designates the essential caribou habitat (conservation unit) based on three local factors: the habitat location, area and type. Of the six conservation units selected by Quebec in the analysis of the federal recovery strategy, three were assessed as non-self-sustaining, two as self-sustaining and one as being of uncertain status.

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[6] This designation will be used from this point onward in the environmental impact assessment.

The project study area is included in conservation unit QC6, an area of 621,562 km² that represents most of the range of woodland caribou in Quebec (Table 6-30). The disturbance rate in this unit was evaluated at 30% and the analysis concluded that it is likely that the population occupying it is self-sustaining.

Table 6-30: Level of disturbance and likelihood of self-sustainability for six conservation units used in the Woodland Caribou federal recovery strategy for Quebec

Conservation unit or local population (Quebec and Labrador)	Area (km²)	Level of disturbance (%)		Undisturbed habitat (%)	Likelihood of self-sustainability Risk assessment
		Forest fire	Human activity		
QC1- Val-d’Or	3,469	0.1	60	40	Unlikely: NSS
QC2- Charlevoix	3,128	4	77	20	Very unlikely: NSS
QC3- Pipmuacan	13,769	11	51	41	Unlikely: NSS
QC4- Manouane	27,164	18	23	61	As likely as not: NSS/SS
QC5- Manicouagan	11,341	3	30	67	Likely: SS
QC6- Remainder of occupied area	**621,562**	**20**	**10**	**70**	**Likely: SS**

Notes: NSS: not self-sustaining; NSS/SS: not self-sustaining or self-sustaining; SS: self-sustaining
Text in bold indicates the conservation unit affected by the project.
Disturbances where fire and human activities overlap were counted only once. Buffer zones of 0.5 km were applied to disturbances caused by human activities.
The status of these units remained unchanged between the 2011 and 2012 Environment Canada surveys.

Sources: EC, 2011 and 2012.

Provincial context for Woodland Caribou

Woodland caribou were designated as vulnerable in Quebec in February 2005 under the *Act respecting threatened or vulnerable species* (Order in Council 75, 2005). As a result, Quebec proceeded, within its areas of jurisdiction and obligation, to develop and implement a provincial woodland caribou recovery strategy prepared by the Équipe de rétablissement du caribou forestier du Quebec, a team which consists of various specialists and organizations involved in protecting this species. An initial Quebec woodland caribou recovery strategy was developed for the period 2005–2012 and a second was submitted to Quebec authorities in May 2013 (Équipe de rétablissement du caribou forestier du Québec, 2008, 2013b). The recovery team also prepared guidelines for managing woodland caribou, a first version of which was tabled in 2010, followed by a revised version in 2013 (Équipe de rétablissement du caribou forestier du Québec, 2010, 2013a). The project study area is in the central portion of the area of application of the Quebec woodland caribou recovery strategy (Map 6-14).

Density, demography and land use

Woodland caribou live in very low densities, ranging from one to two animals/100 km², according to surveys conducted in the 1990s (Courtois, 2003). Between 2000 and 2010, the MFFP intensified its woodland caribou survey efforts to harmonize, among other things, forest activities with maintenance of this species. The surveys conducted during this period in the range counted nearly 3,000 caribou over 190,234 km², for an average of 1.5 caribou/100 km² (Équipe de rétablissement du caribou forestier du Québec, 2013b).

Woodland caribou populations present in the Nord-du-Québec region are defined according to the patterns of land use by individual animals. Although most animals remain within the territory used by their population, there is nonetheless some movement of individuals between these populations (especially during rut or in spring). Despite these movements between populations, most of these individuals return to winter with their parent population. Membership of an individual to a given population is therefore determined by their location in the month of February each year. Even though most individuals return to winter with their parent population, it occasionally happens that some caribou “migrate” from one population to another.

The woodland caribou of the local population (herd) dubbed Nottaway, which occupies the territory north of Matagami, are the most likely to frequent the study area of the project. Note, however, that there may be exchange of individuals between this population and that of Témiscamie and Assinica populations. A report of a woodland caribou recovery study done by a work group from the Comité scientifique du Nord-du-Québec provides relevant scientific data, particularly regarding the Nottaway population (Rudolph and coll., 2012). It concludes that this population, like those of Témiscamie and Assinica further east, is considered not self-sustaining. According to this same study, the results of surveys done in 2003, 2007, 2009 and 2011 estimate the number of caribou in the Nottaway population to be 137, 50, 26 and 17 animals, respectively. Considering that the range of this population is estimated at 36,400 km^2, the approximate density in 2011 would be roughly 0.1 woodland caribou/100 km^2. An exhaustive survey was done covering the range of the Nottaway woodland caribou herd in 2016 (Szor and Brodeur, 2017). Based on the results of this survey, the population of the Nottaway herd was estimated to be 308 individuals, applying a detection rate of 85% (Courtois and coll., 2001).

The drop in the recruitment rate and the survival rate of adult females along with a disturbance rate higher than the threshold required to ensure persistence of the populations are the key elements supporting this conclusion. Legal and illegal hunting can also play an important role in woodland caribou mortality in the area where the mining project is planned. The study area is part of hunting zone 22, where the simultaneous presence of migratory and woodland caribou is likely in winter. However, before February 1, 2018, hunting of migratory caribou was permitted in sector B of hunting zone 22, north of the study area.[7] Even though this hunt targeted primarily migratory caribou, taking of woodland caribou was probable, especially in winters when migratory caribou frequented more southerly areas (Jean and Lamontagne, 2005).

According to information provided by MFFP representatives, a single woodland caribou with a telemetric collar frequented the study area from December 2008 to the end of March 2009 (Map 6-15). In the opinion of one MFFP representative,[8] analysis of movement patterns appeared to show that it was an individual from the Assinica population which, for whatever reason, made a rather atypical move and found itself in the area east of Eastmain, historically used by the Nottaway population. Given that migratory caribou were present in this same area in December 2008, it is possible that this individual followed a group of caribou moving north and was found in this area as a result.

Casual observations of signs of caribou presence in the study area were compiled by the MFFP in September and November 2013. Two caribou were also observed in mid-July 2014 and three at the end of June 2015 (Map 6-15). The dates of these observations lead to the belief that they were woodland caribou, since migratory caribou are generally not found in this area at that time of year. However, this finding should be qualified, because sometimes migratory caribou in a weakened state or that have suffered injuries do not migrate toward their calving area and remain in their wintering area.[9] It is therefore not certain that signs of presence and casual observations of caribou in the study area were of woodland caribou. Current knowledge therefore indicates that woodland caribou have used the study area very little over the past decade.

Migratory caribou, on the other hand, are likely to frequent the study area in winter, from mid-November to mid-March, in search of food. Telemetric monitoring data provided by the MFFP indicate that, over the past two decades, individuals from the Leaf River population frequented the study area during two periods, December 16, 2013 to March 6, 2014 and December 20, 2015 to February 8, 2016. This activity occurred within a 20 km and wider radius from the centre of the proposed mine. They were primarily concentrated in the northeast portion of the study area, on the periphery of the Opinaca Reservoir.

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7 The migratory caribou hunt has been banned indefinitely in Québec since February 1, 2018.

8 E-mail from Guillaume Szor, Biologist, Direction de la gestion de la faune du Nord-du-Québec, MFFP, April 20, 2018.

9 Personal conversation with Serge Couturier, Biologist, Ph. D.

The aerial survey done in March 2018 by WSP of a 1,600-km^2 portion of the study area did not detect the presence of caribou. It should be noted that during this survey, two Cree participants mentioned that the study area generally had not been frequented by caribou for several years, except a few observations in the Opinaca Reservoir area during periods when migratory caribou usually occupy the area (November to March). Furthermore, the tallyman and his family indicated in April 2018 that caribou are uncommon along the traplines and that, when present, they are generally found in the southern sector of the study area, more than 20 km from the proposed mine.

Habitat conditions of Woodland Caribou

Several authors recognize that, when selecting habitats, woodland caribou prefer peatlands, mature softwood stands with lichens and other sites rich in lichens (Équipe de rétablissement du caribou forestier du Québec, 2013*a*). It is also known that they avoid recently disturbed areas, (Moreau and coll., 2012) although they sometimes occupy regenerating stands that have been harvested or burned, six to 40 years old, especially in spring (Hins and coll., 2009). In summer, woodland caribou usually live in softwood forests over 50 years of age (Courbin and coll., 2009; Hins and coll., 2009; Lantin, 2003), peatlands and on dry barrens (lichen tundra).

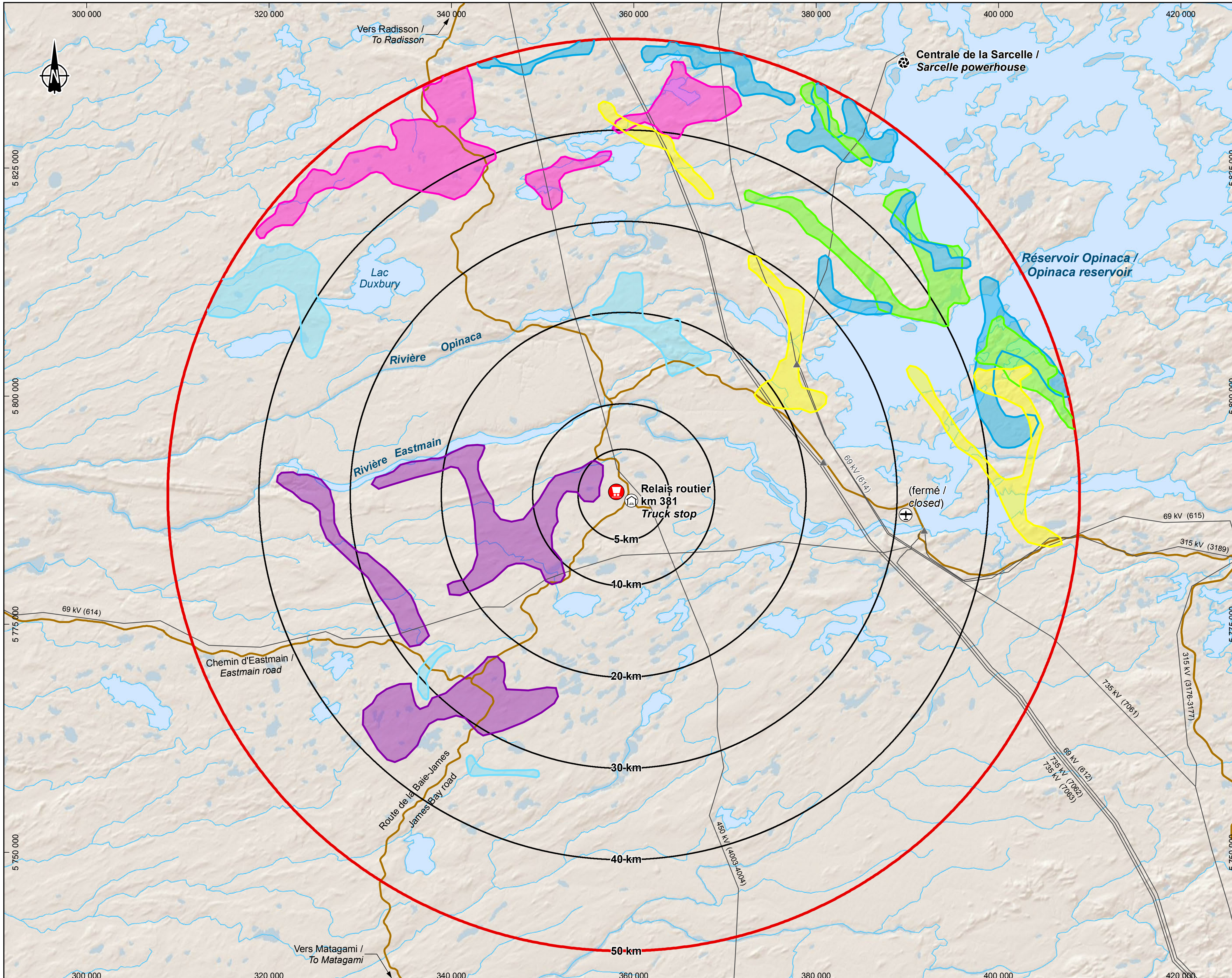
As indicated earlier, the probabilistic approach applied by EC and updated in 2011 (EC, 2011) clearly showed that 70% of the variation recorded in recruitment of woodland caribou populations is explained by a single variable that encompasses the human and natural (forest fire) disturbance rates. Therefore, analysis of the habitat disturbance rate appears to be a relevant indicator to characterize current conditions of the habitat in the study area.

The current habitat disturbance rate was assessed across the study area, i.e., within a 50-km radius from the centre of the proposed mine, representing an area in the range of 7,850 km^2 (Map 6-16). For this simulation, the total human disturbance footprint was determined based on the combined effects of fires that occurred over the past 40 years and various human disturbances in the buffer zone (500 m). This assessment method is based on Environment Canada's demonstration, in which the use of a 500-m buffer zone to map man-made features provided a better representation of the combined effects of heightened predation and avoidance on boreal caribou population trends across the country (EC, 2011). The habitat disturbance rate within a radius 5 km to 50 km from the centre of the proposed mine was assessed to identify the variation at different scales (Table 6-31).

First, there are no forestry activities for industrial purposes in the study area, which preserves it from major human disturbances caused by the harvesting of wood substance and the presence of logging road networks. Human disturbances of the habitat are primarily associated with industrial areas (mines), hydroelectric production, linear structures (roads, power transmission lines) and with some land uses.

Overall, man-made features disturb 7% of the study area. The km 381 truck stop of the James Bay road, near the proposed mine, concentrates human activity and constitutes a significant source of woodland caribou habitat disturbance in this area.

However, the main source of caribou habitat disturbance in the study area is of natural origin. It is associated with large forest fires that have affected the study area over the past 40 years. Fires alone have disturbed caribou habitat in the study area at a rate of 66%. These fire-burn areas overlap with the majority of areas disturbed by man-made features, such that the total percentage of disturbance (natural and human) in the study area is assessed at approximately 68%.



Projet mine de lithium Baie-James / *James Bay Lithium Mine Project*

Zone d'étude de la grande faune / *Large mammal study area*

Caribou /*Caribou*

Localisation du caribou migrateur par période hivernale / *Location of Migratory Caribou in Winter Period*

- Décembre 2007 à avril 2008 / *December 2007 to April 2008*
- Décembre 2009 à février 2010 / *December 2009 to February 2010*
- Décembre 2010 / *December 2010*
- Décembre 2013 à mars 2014 / *December 2013 to March 2014*
- Décembre 2015 à février 2016 / *December 2015 to February 2016*

Caribou forestier / *Woodland Caribou*

- Localisation du caribou forestier (décembre 2008 à mars 2009) / *Location of woodland caribou (December 2008 to March 2009)*

Infrastructures / *Infrastructure*

- Relais routier / *Truck stop*
- Centrale hydroélectrique / *Hydroelectric powerhouse*
- Aéroport / *Airport*
- Route / *Road*
- Poste et ligne de transport d'énergie / *Substation and transmission line*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement /

Environmental Impact Assessment

Occurrence de caribous / *Caribou Occurrence*

Sources :

World Shaded Relief, ESRI, 2018

BDGA, 1 : 1 000 000, RNCan, 2011

Caribou : MFFP, 2017, © Gouvernement du Québec

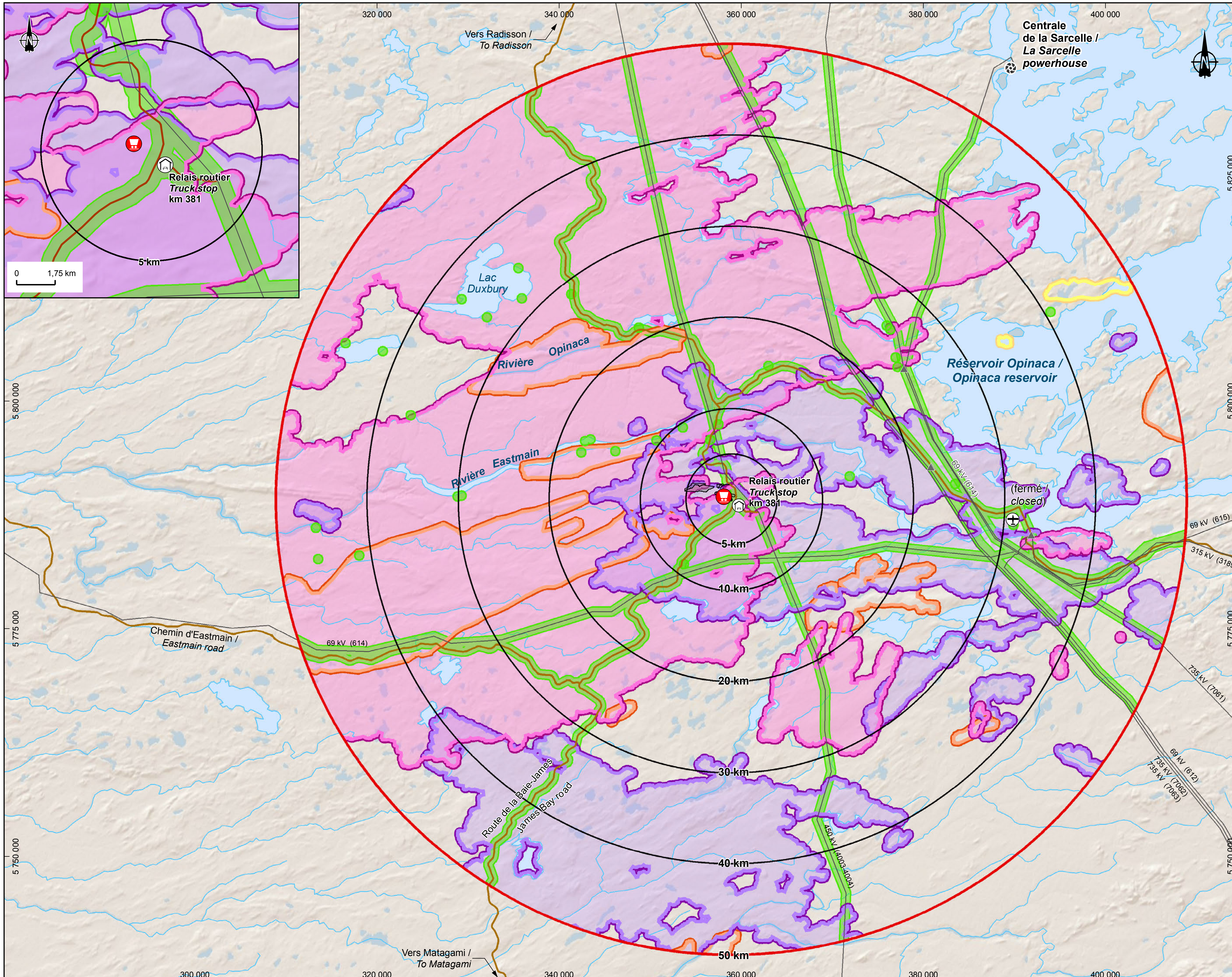
No Ref : 171-02562-00_wspT087_EIE_c6-15_caribou_181012.mxd

0 4,25 8,5 km

UTM 18, NAD83

Carte / *Map* 6-15

wsp



Projet mine de lithium Baie-James / *James Bay Lithium Mine Project*

Zone d'étude de la grande faune/ *Large mammal study area*

Perturbation (500 m) / *Disturbance (500 m)*

Perturbation anthropique / *Anthropogenic disturbance*

Perturbation naturelle (feux de forêt)
Natural Disturbance (forest fire)

1978 à 1980 / *1978 to 1980*

1981 à 1990 / *1981 to 1990*

1991 à 2000
(pas de feux dans la zone d'étude pour cette période) /
1991 to 2000
(No forest fire in the study area during this period)

2001 à 2010 / *2001 to 2010*

2011 à 2016 / *2011 to 2016*

Infrastructures / *Infrastructure*

Relais routier / *Truck stop*

Centrale hydroélectrique / *Hydroelectric powerhouse*

Aéroport / *Airport*

Route / *Road*

Poste et ligne de transport d'énergie / *Substation and transmission line*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Perturbation de l'habitat du caribou forestier /
Woodland Caribou Habitat Disturbance

Sources :
Base cartographique, Cartographic base, Canvec 2017
Feux de forêt / Forest fire : MFFP, 2018

No Ref : 171-02562-00_wspT080_EIE_c6-16_perturbation_181011.mxd

0 4,25 8,5 km
UTM 18, NAD83

Carte / *Map* 6-16

wsp

Table 6-31: Analysis of disturbance rates of Woodland Caribou habitat within a 5- to 50-km radius from the centre of the proposed mine

Distance from centre of the mine (km)	Type of disturbance	Area (ha)	Disturbance (%)
5	**Size of area**	**7,854**	**100%**
	Human	2,013	26%
	Natural	7,052	90%
	Natural and human	7,231	92%
10	**Size of area**	**31,416**	**100%**
	Human	5,235	17%
	Natural	26,545	85%
	Natural and human	27,089	86%
20	**Size of area**	**125,664**	**100%**
	Human	14,403	12%
	Natural	110,831	88%
	Natural and human	112,049	89%
30	**Size of area**	**282,743**	**100%**
	Human	30,320	11%
	Natural	229,500	81%
	Natural and human	232,594	82%
40	**Size of area**	**502,655**	**100%**
	Human	44,386	9%
	Natural	370,337	74%
	Natural and human	376,379	75%
50	**Size of area**	**785,396**	**100%**
	Human	57,874	7%
	Natural	520,181	66%
	Natural and human	531,550	68%

A certain proportion of the burned areas likely have the potential for self-regeneration and can provide conditions suitable for the woodland caribou in the future. However, during the March 2018 aerial survey, the regeneration observed in these areas was characterized as “very poor” (Photos 6-3 and 6-4). This situation can be explained by the fact that a large portion of the territory was subject to successive fires. Young natural forest stands or unproductive land are sensitive to natural regeneration occurrences due to limited seed production and become especially vulnerable under short fire cycles (short interval between two disturbances) (Mansuy, 2013).

The location of the projected mine represents one of the sectors in the study area that is most disturbed by human and natural elements. For example, within a 5-km range from the centre of the mine, approximately 92% of the area is disturbed. Fires have disturbed approximately 90% of this sector while human factors generate 26% of the disturbances. Within a 10 km range from the centre of the mine, 86% of the area is disturbed. Fires cover approximately 85% of the latter while human disturbances are responsible for approximately 17%.

Photo 6-3: Recent fire area – 2011-2016

Photo 6-4: Poor-regeneration fire area – 2001-2010

The relative probability of occurrence of woodland caribou, based on the habitat selection model by Leblond and coll. (2015), provides another indicator to assess the environmental conditions in terms of habitat for the woodland caribou. This indicator was incorporated in the identification of priority areas to create vast protected areas for the woodland caribou. It is noted, however, that although this mathematical model of habitat selection by a group of individuals incorporates many environmental characteristics, it does not necessarily indicate the real distribution of the species in the area. The model also does not consider the real regeneration conditions of burned forest areas over the last decades. The projected mine area generally presents a medium to low relative probability of woodland caribou occurrence (Map 6-17).

Areas providing the highest probability of occurrences are generally residual forest islands formed after forest fires. The habitat available within a 10-km range of the centre of the projected mine is very fragmented. On this matter, EC specifies that to ensure self-sustainability for the local populations, the latter must have access to continuous tracts of undisturbed habitat with the biophysical characteristics needed to meet their needs during their life cycle (EC, 2012). Therefore, due to its high disturbance rate, the study area offers poor habitat conditions for woodland caribou.

MOOSE

The low moose density in Quebec's boreal forest is mainly due to an unproductive habitat. It is during winter that low food availability and quality are the most critical. The moose's typical winter habitat is almost always made up of mixed stands, where the arrangement of the coniferous and deciduous trees provides it with cover in proximity to feeding areas.

Fire, which is a disturbance factor in the region's plant dynamics (CRRNTBJ, 2010), can increase the quantity of browse available. Several years after a fire, regeneration in burn areas containing a large proportion of tree or shrub species, constitute rich feeding habitats (Courtois and coll., 1996; Samsom and coll., 2002). The scarcity of birch, poplar and mixed stands could explain the moose's increased use of old burn areas and river scrubland in the Nord-du-Québec region (Maltais and coll., 1993). However, that large expanses of burn areas have little cover to provide shelter.

The forest species moose seeks out as food sources are white birch and willow in the summer and balsam fir in the winter (Dussault and coll., 2002, 2004; Samsom and coll., 2002). Deciduous mixed forests and in regeneration serving as food sources, interspersed with mature stands offering cover, provide suitable habitats for moose. Mixed forest stands, deciduous forest stands and shrub swamps are scarce in the study area. Scrubland and burns, with or without regeneration, are low-quality environments that are dominant in the landscape of the study area. With regard to the calving period, the preferred habits are lake and watercourse banks, coniferous forest stands and hilltops.

The March 2018 moose survey, initially planned on a 100-km^2 area, was performed instead over a larger area of 1,600 km^2. The environment is largely bare due to forest fires and contains small islands of residual forests primarily concentrated along watercourses. These islands, especially when they contain stems from deciduous or shrub species, are the only areas that provide suitable conditions to meet the moose's cover and nutritional requirements during winter. Several watercourses and lakes are present within the study area. However, the limited availability of mature coniferous forest stands constitutes a deficiency in terms of moose-habitat suitability, namely, as cover during winter.

In light of this situation, the survey method for detecting moose in the 1,600 km^2 area was adjusted by reducing flight speed and altitude over woodlands appearing to provide more suitable conditions for wintering and by carrying out a full coverage above the latter. We can therefore infer that moose wintering areas were detected in the 1,600-km^2 area with an accuracy rate comparable to the 100-km^2 area where moose-specific survey standards were applied. A reasonable effort was made to count and classify the number of animals for all moose tracks observed. When estimating density per 10 km^2, an 80% observation rate was used to estimate the number of individuals.

Table 6-32 provides a summary of the data gathered on moose during the March 2018 field campaign. A total of four individuals (three females and one calf) were sighted in a single wintering area inside the moose-specific survey area (Map 6-18), which corresponds to an estimated density of 0.5 moose/10 km^2. Twenty wintering areas were detected and 34 moose were counted across the 1,600-km^2 survey area. Applying an 80% observation rate to individuals, 43 moose inhabited this area for a density of 0.27 moose/10 km^2. This density is comparable to that reported in the scientific literature.

The moose density in hunting zone 22, which the study area is a part of, is among the lowest in Quebec. It was estimated at 0.26 moose/10 km^2 in 1991 and at 0.31 moose/10 km^2 in 1997. Applying a 3% growth rate from 1991 to 2012, the moose population is estimated at 0.5 moose/10 km^2, or 9,872 individuals (Morin, 2015). In hunting zone 22, an average of 156 moose per year were hunted from 2013 to 2017 (MFFP, 2018). Among these, based on slaughtering data provided by the MFFPD, an average of 15 moose per year were sampled in the large fauna study area.

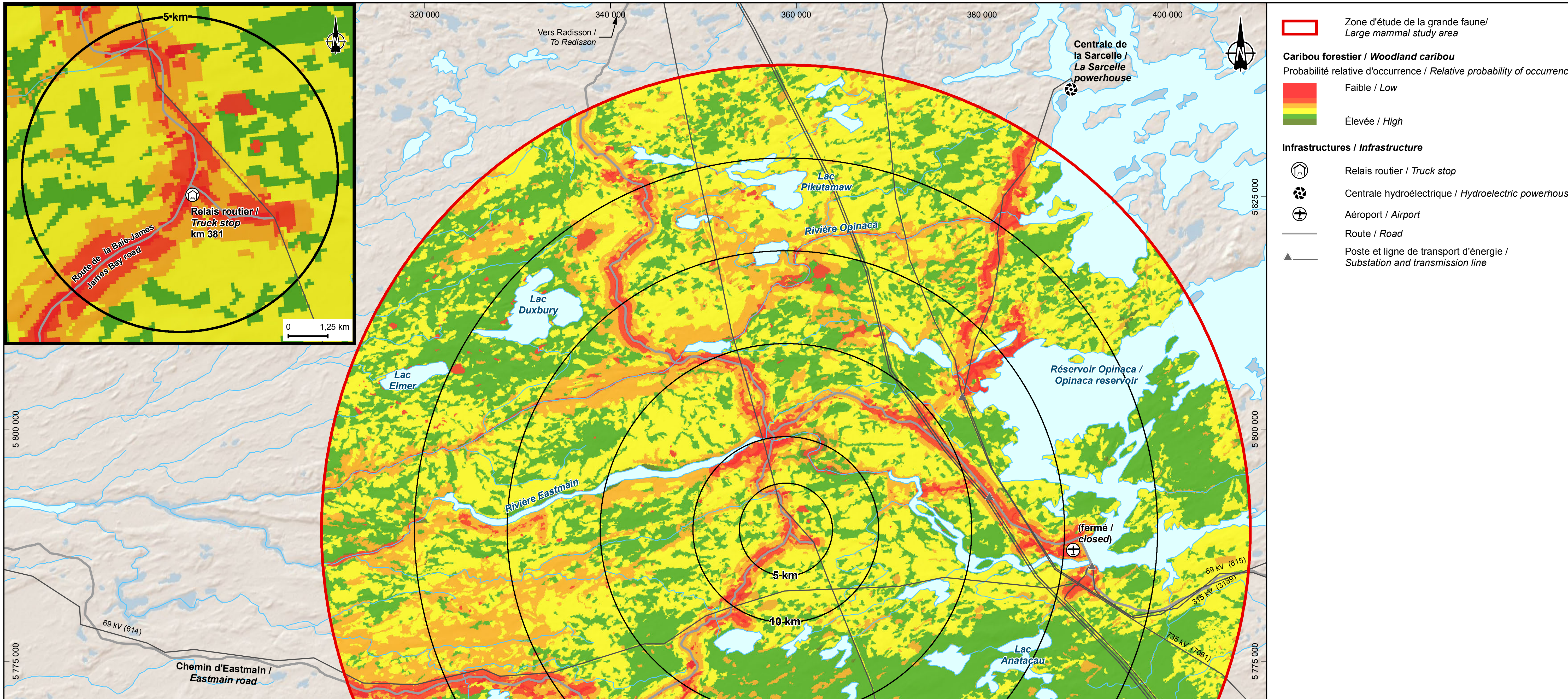
BLACK BEAR

No specific survey of the black bear has been performed in the study area. However, individual bears and signs of their presence were observed during some surveys targeted at other wildlife groups. The black bear is hunted for its meat and fur. In the territory located north of the 50th parallel, however, this practice is for the exclusive use of Aboriginal people. The latter primarily use trapping to capture the animal (Lamontagne and coll., 2006).

Table 6-32: March 2018 moose survey data compilation and density estimate

Moose winter range	Female	Male	Fawn	Undetermined	Number observed	Estimated number based on an 80% visibility rate	Density estimate at 10 km^2
In the 100-km^2 survey area							
M-1	3	0	1		4	5	
Subtotal	**3**	**0**	**1**	**0**	**4**	**5**	0.50
Outside the 100-km^2 survey area							
M-2	-	1	-		1	1	
M-3	1	-	1		2	3	
M-4	1	-	1		2	3	
M-5	1	-	-		1	1	
M-6	1	-	-		1	1	
M-7	-	1	-		1	1	
M-8	3	-	1		4	5	
M-9	1	-	1		1	1	
M-10	1	-	-		1	1	
M-11	2	-	-		2	3	
M-12	1	-	1		2	3	
M-13	-	1	-		1	1	
M-14	-	1	-		1	1	
M-16	-	-	-	2	2	3	
M-17	-	-	-	1	1	1	
M-18	-	1	-		1	1	
M-19	1	-	1		2	3	
M-20	2	1	-		3	4	
M-21	1	-	-		1	1	
Subtotal	**16**	**6**	**6**	**3**	**30**	**38**	**0.25**
Total in the 1,600 km^2 area	**19**	**6**	**7**	**3**	**34**	**43**	**0.27**

In hunting zone 22, the black bear population density was estimated at 0.2 bears/10 km^2 in 2003. This density represents a population of approximately 5,600 bears (Lamontagne and coll., 2006). The study area for large fauna is found in fur-bearing animal management unit (FAMU) 92. In the last five seasons for which data is available (2011-2012 to 2015–2016), a total of five fur pelts were sold (MFFP, 2018).



GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Probabilité relative d'occurrence du caribou forestier / *Woodland Caribou Relative Probability of Occurrence*

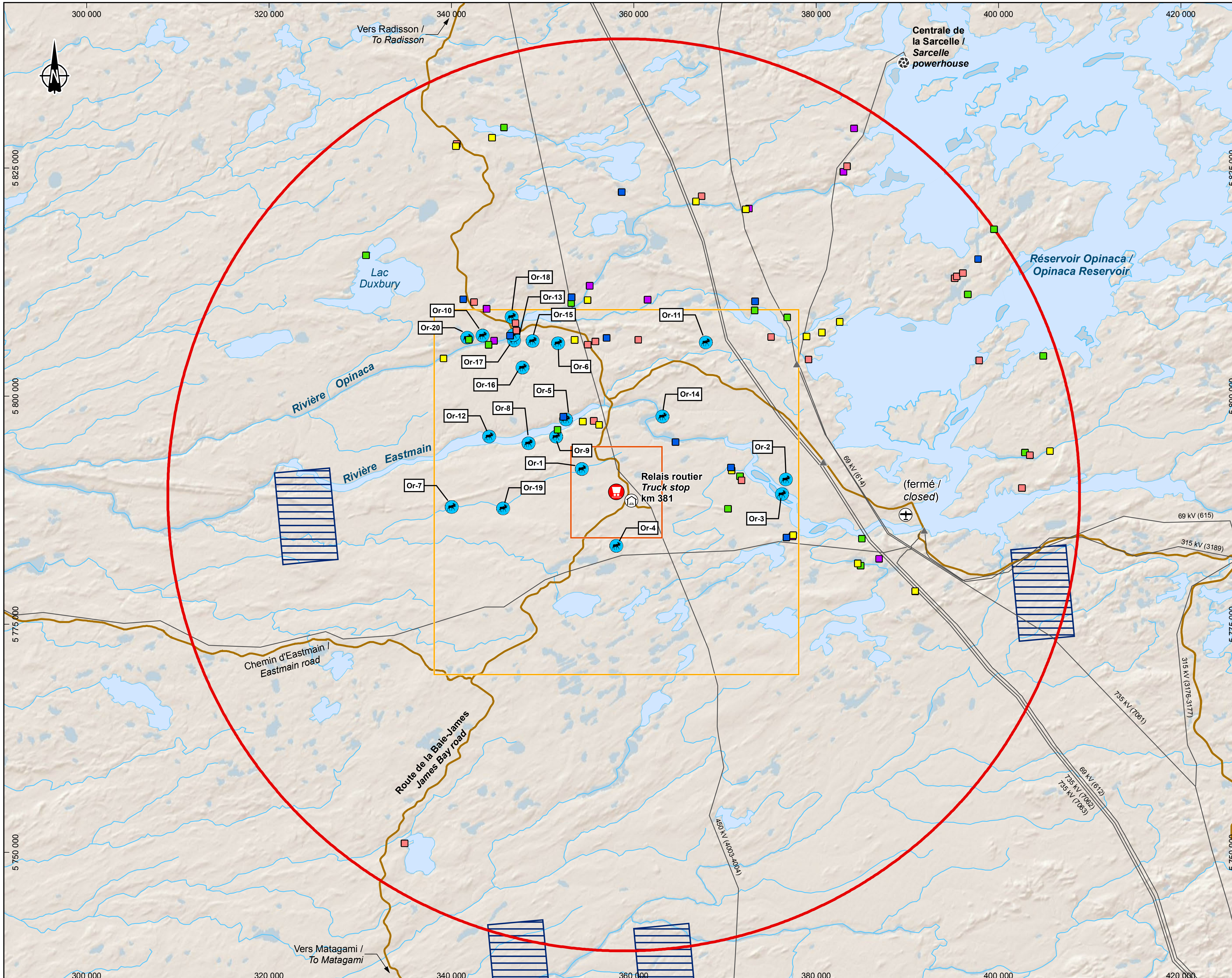
Sources :
BDGA, 1; 1 000 000, 2014
MDDELCC, avril 2015

No Ref : 171-02562-00_wspT062_EIE_c6-17_occu_car_180903.mxd

0 4,25 8,5 km
UTM 18, NAD83

Carte / *Map* 6-17

wsp



Projet mine de lithium Baie-James / *James Bay Lithium Mine Project*

Zone d'étude de la grande faune / *Large mammal study area*

Zone d'inventaire du caribou (1 600 km^2) / *Caribou inventory area (1 600 km^2)*

Zone d'inventaire de l'orignal (100 km^2) / *Moose inventory area (100 km^2)*

Orignal / *Moose*

Site d'inventaire / *Survey site*

Or-2 Numéro du site / *Site number*

Sites d'abattage de l'orignal (MFFP, 2017) / *Moose kill sites (MFFP, 2017)*

- 2013
- 2014
- 2015
- 2016
- 2017

Parcelle d'inventaire de l'orignal (MFFP, 1991) / *Moose survey plot (MFFP, 1991)*

Infrastructures / *Infrastructure*

- Relais routier / *Truck stop*
- Centrale hydroélectrique / *Hydroelectric powerhouse*
- Aéroport / *Airport*
- Route / *Road*
- Poste et ligne de transport d'énergie / *Subtation and transmission line*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement /
Environmental Impact Assessment

Points d'occurrence et sites d'abattage de l'orignal /
Moose Occurrence Points and Kill Sites

Sources :
World Shaded Relief, ESRI, 2018
Base cartographique / Cartographic base, BDGA, 2011
Orignal / Moose : MERN, 2017, © Gouvernement du Québec

No Ref : 171-02562-00_wspT088_EIE_c6-18_orignal_181012.mxd

0 4,25 8,5 km
UTM 18, NAD83

Carte / *Map* 6-18

wsp

In fall, the black bear primarily uses barrens, areas where heath plants are dominant, recent burns and lichen-free peatlands. In spring, it can also be found in hardwood and mixed forests and scrubland, swamps, marshes, watercourses and lakes (CRRNTBJ, 2010; Tecsult Inc., 2005).

In the study area, the availability of food used by black bear is likely determined by the occurrence of wetlands and disturbed habitats. The latter are key to produce berries on which the bear relies to build up its fat reserves (Samson, 1996). Disturbed habitats are primarily represented by habitats undergoing regeneration following two fires. Moreover, Cree users reported that bears visit the remote landfill in search of food, making this a good hunting area for this species. In short, the overall study area represents a potential suitable habitat for black bear.

GREY WOLF

Although the grey wolf (*Canis lupus*) is more often linked to fur-bearing animals than to large mammals, it nevertheless represents one of the main predators of the moose and caribou. During the field inventories performed, namely, the March 2018 aerial moose and caribou survey, no signs of wolf activity were observed in the study area. However, the tallyman mentioned a wolf pack sighting in August 2018 near the km 381 truck stop.

6.3.2.2 SMALL WILDLIFE

Based on available data and distribution ranges presented in the documents consulted (Banfield, 1977; CRRNTBJ, 2010; FAPAQ, 2003; MFFP, 2016; Prescott and Richard, 2004), 20 species from among small terrestrial wildlife potentially occur in the study area. Table 6-33 lists these species.

Table 6-33: List of small terrestrial wildlife species potentially present in the study area

Species*	Scientific name
Long-tailed weasel	*Mustela frenata*
Least weasel	***Mustela nivalis***
Wolverine	***Gulo gulo***
Canadian beaver	*Castor canadensis*
Red squirrel	*Tamiasciurus hudsonicus*
Northern flying squirrel	*Glaucomys sabrinus*
Ermine	*Mustela erminea*
Snowshoe hare	*Lepus americanus*
Grey wolf	*Canis lupus*
River otter	*Lontra canadensis*
Canadian lynx	*Lynx canadensis*
Woodchuck	*Marmota monax*
American marten	*Martes americana*
Striped skunk	*Mephitis mephitis*
Fisher	*Martes pennanti*
American porcupine	*Erethizon dorsatum*
Muskrat	*Ondatra zibethicus*
Red fox	*Vulpes vulpes*
Eastern chipmunk	*Tamias striatus*
American mink	*Mustela vison*
* Species in bold have a special status.	

Sources: Banfield, 1977; CRRNTBJ, 2010; FAPAQ, 2003; MFFP, 2016; Prescott and Richard, 2004.

Among these species, two have a special status:

- the least weasel (*Mustela nivalis*), which is on the list of species likely to be designated as threatened or vulnerable in Quebec (MFFP, 2006a);
- the wolverine (*Gulo gulo*), designated as threatened in Quebec (MFFP, 2006b) and endangered in Canada (Gouvernement du Canada, 2017).

LEAST WEASEL

The least weasel is North America's smallest carnivore. It belongs to the mustelidae family and is related to the ermine (*Neovison erminea*) and to the American mink (*Mustela vison*). In North America, the least weasel lives almost everywhere in Canada and adapts to very diverse habitats. It occupies the tundra or the coniferous forest to the north but prefers, in the more southern areas, open environments such as prairies, wet meadows, swamplands, watercourse banks and brush (MFFP, 2001*a*). In Quebec, though the distribution area is vast, sightings of this species are rare (MFFP, 2001*a*) and abundance poorly known. It is found in the Nord-du-Québec region, but likely in very localized areas. Its presence was namely reported in the Eastmain area (FAPAQ, 2003). A study to identify weasel carcasses trapped by the Cree was conducted by the MRNF's direction régionale du Nord-du-Quebec from 2009 to 2011. During this period, a total of 1,021 weasels were sent to the Aménagement de la faune office in Chibougamau. Of this number, 671 were analyzed and a single specimen, captured near Eastmain, proved to be a least weasel (CRRNTBJ, 2010). This rarity can, however, be explained by its secretive habits and small size (FAPAQ, 2003). No weasel is reported in the 2015–2016 trapping data for UGAF92, which Eastmain and the study area are part of (MFFP, 2016).

WOLVERINE

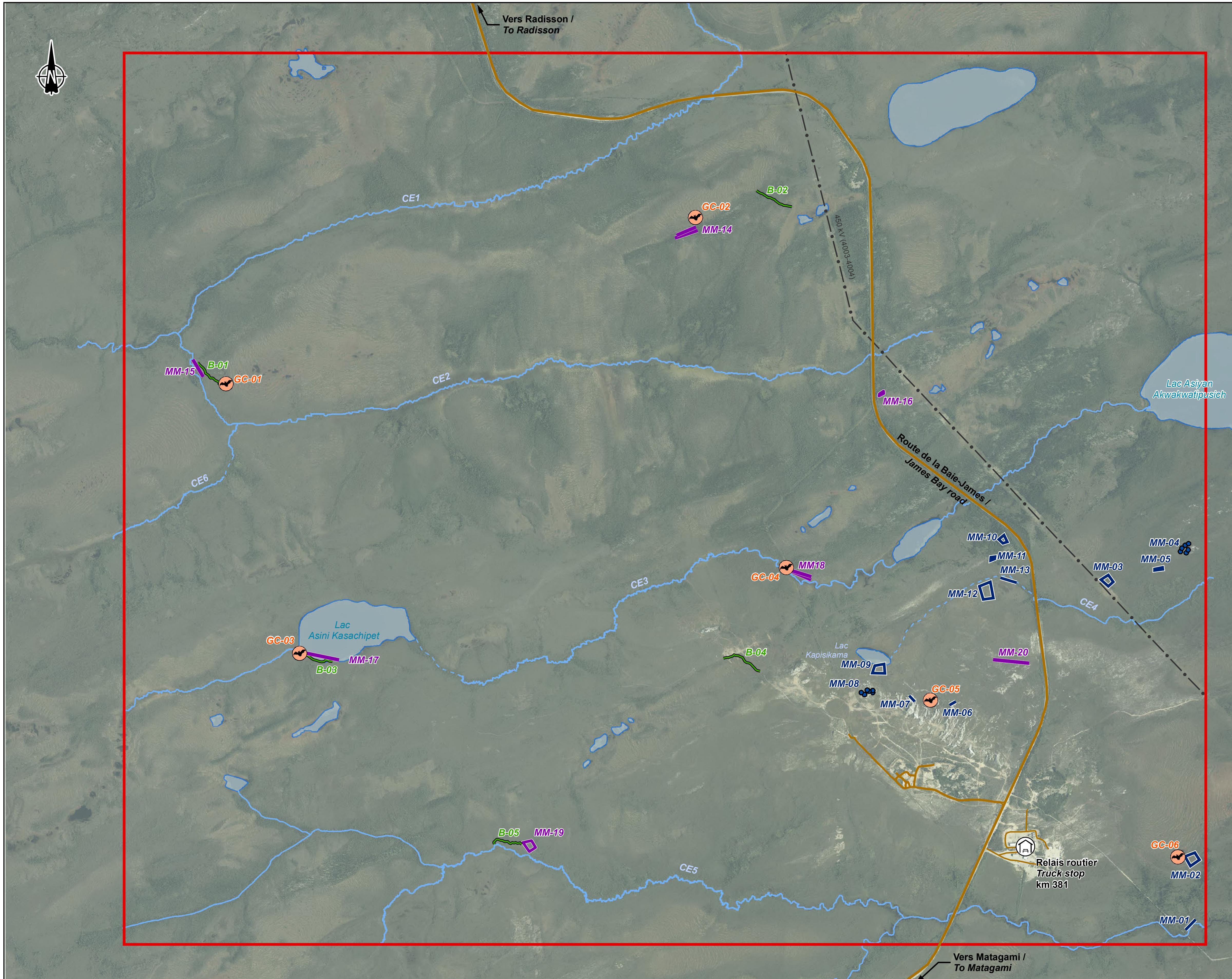
The wolverine is the largest terrestrial member of the mustelidae family (EC, 2016). Though the species is often considered extinct, several recent sightings in the area were reported (FAPAQ, 2002). Its distribution range is mainly confined to the north of the province and it's a very secretive species. The wolverine is a solitary animal and primarily a scavenger, whose survival relies on the availability of abundant food resources. Consequently, the habitat requirements of non-reproductive individuals seem relatively independent of the environment's biophysical attributes, the determining factor being prey availability (EC, 2016). In 2006, a systematic survey over 100,000 km^2 in the Abitibi and James Bay Lowlands natural province identified two potential wolverine track networks some dozen kilometres from La Sarre and Matagami (EC, 2016; Fortin, 2006).

6.3.2.3 *SMALL MAMMALS*

METHODOLOGY

Small mammal inventories were conducted for this project in 2011 and 2017. The methodology used, described in detail in the *Terrestrial wildlife and avifauna baseline study* (*Étude spécialisée sur les faunes terrestre et avienne)* (WSP, 2018*g*), is based on the *Protocole pour les inventaires de micromammifères* (Jutras, 2005) developed at the time by the MRNF. This methodology relies on the use of grill traps set up in typical habitats of the study area. During habitat selection, special attention was paid to the potential presence of the rock vole (*Microtus chrotorrhinus*) and of the southern bog lemming (*Synaptomys cooperi*), two species likely to be designated as threatened or vulnerable in Quebec (MFFP, 2006*a*).

In 2011, 13 trapping sectors were inventoried in the study area's southeast quarter. The traps were set up and monitored during six to nine consecutive days, from September 21–29, 2011. In 2017, seven additional trapping sectors were inventoried to complete the initial coverage of the study area. The traps were set up and monitored during five consecutive days, from September 19–25, 2017. Given the nature, layout and area of habitats targeted in the study area, use of standard trapping grids was sometimes unsuitable, namely, in presence of linear landscape elements (downslopes, watercourses, etc.). Consequently, depending on the shape and area of environments inventoried, a combination of standard grids, half-grids, transects and aggregates was used in this study. The location of the trapping areas is presented on Map 6-19.



Zone d'étude locale / *Local study area*

Inventaires / *Inventory*

(GC-XX) Station d'inventaire acoustique des chiroptères / *Bat listening station*

(B-XX) Bardeau à couleuvres / *Grass-snake shingle*

(MM-XX) Secteur de piégeage des micromammifères (2017) / *Small mammal trapping sector (2017)*

(MM-XX) Secteur de piégeage des micromammifères (2011) / *Small mammal trapping sector (2011)*

Infrastructures / *Infrastructure*

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

Hydrographie / *Hydrography*

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine

Étude d'impact sur l'environnement /
Environmental Impact Assessment

Sites d'inventaire de la faune terrestre / *Terrestrial Fauna Survey Sites*

Sources :
Orthoimage : Galaxy août / august 2017
Inventaire / Inventory : WSP 2017

No Ref : 171-02562-00_wspT073_EIEmb_c6-19_f-terrestre_180903.mxd

0 240 480 m

UTM 18, NAD83

Carte / *Map* 6-19

wsp

RESULTS

2011 Inventory

The trapping effort, calculated in number of trap-nights, represents the trapping pressure exerted on an environment or area. A trapping effort of 5,781 trap-nights was carried out for the overall study area in 2011.

During the survey, 117 specimens, belonging to eight different species, were sampled. Three of these species are insectivores: the cinereous *(Sorex cinereus)*, smoky *(Sorex fumeus)* and pygmy *(Sorex hoyi)* shrews. The five other species belong to the family of rodents: the Gapper's red-backed *(Clethrionomys gapperi)*, meadow *(Microtus pennsylvanicus)* and rock voles *(Microtus chrotorrhinus)*, the eastern heather vole *(Phenacomys ungava)* and the deer mouse *(Peromyscus maniculatus)*. Among these species, only the rock vole is on the list of species likely to be designated as threatened or vulnerable in Quebec (MFFP, 2006*a*).

2017 Inventory

In 2017, trapping efforts including 2,141 trap-nights for additional surveys performed in the study area.

Only nine specimens belonging to two species were sampled during this survey: the cinereous shrew, an insectivore, and the deer mouse, belonging to the rodent family.

Species and habitats

During the 2011 survey, burns were already present in the study area; fewer and not as widespread as in 2017, they formed a mosaic of habitats with the unaffected environments. In these conditions, unaffected habitats represented refuges from which small mammals could recolonize the fire-affected environments (Trottier and coll., 1989). In 2011, a good species diversity was still present in the favourable habitats, but the densities of small mammals observed were already low. Several other fires occurred in the sector over the following years, some of which affected vast areas. Hence, in 2017, most of the study area is characterized by relatively recent burns. The forest fires do not only have short-term impacts like the death and escape of individuals, but also mid- and long-term ones, in cases of intense or recurrent fires, causing the disappearance and/or modification of current habitats (Morris and coll., 2011; Trottier and coll., 1989). Mature forest environments, notably, which are a core element of the habitat of several micromammal species, have virtually disappeared from the study area. Between 2011 and 2017, the number of species surveyed has dropped from eight to two, with a nearly five time lower capture rate.

Rock Vole

The 2011 survey led to the identification of the rock vole, a species likely to be designated threatened or vulnerable in Quebec (MFFP, 2006a). Although its distribution range is widespread across the province, the rock vole remains one of the most rarely seen mammal species in eastern Canada (Prescott and Richard, 2004). As its name indicates, it is closely associated with the presence of rocky outcrops, boulders or rock piles, often in mixed deciduous-coniferous forests near water sources. The MM-07 sector, a forest stand downslope of a rock mound, totally matched the species' habitat requirements. However, the entire rocky outcrop sector was struck by several forest fires since 2011 and the remaining habitat no longer has the characteristics that made it suitable for this species (total loss of forest cover).

However, due to its specific habitat preferences, the rock vole lives in small, isolated colonies throughout its distribution area (Banfield, 1977; Christian and Daniel, 1985; Daniel, 1980; Desrosiers and coll., 2002; Duhamel and Tremblay, 2013; Kirkland and Jannett, 1982; Prescott and Richard, 2004). Moreover, it seems that this species is generally characterized by a low population density (Banfield, 1977; Daniel, 1980; Desrosiers and coll., 2002). These attributes make the rock vole especially vulnerable to habitat disturbance.

Consequently, in light of the extent of the forest fires that affected the study area, the species is unlikely to still occur there.

Southern Bog Lemming

The southern bog lemming is a rodent from the cricetidae family. A significant portion of its distribution range is found in Canada, from Manitoba up to Nova Scotia (Fortin and coll., 2004). In Quebec, its range covers the southern part of the province (Desrosiers and coll., 2002), where it is generally found in low density, although peaks of abundance are occasionally observed (Fortin and Doucet, 2003). It can also be found in peatlands where sphagnum and heath shrubs are most dominant, in grassy marshes and the moist mixed forests surrounding these habitats (Desrosiers and coll., 2002). It also occurs in fields, prairies, and clearings due to forest clearcut, and among rocks where moss is abundant (Desrosiers and coll., 2002).

Although the species was not caught during the 2011 and 2017 surveys, it is potentially found in the area. However, in light of habitat disturbance by forest fires in the study area—notably, the disappearance of most mature forest environments, including around wetlands—this species is unlikely to occur there.

6.3.3 ICHTYOFAUNA

Preliminary sampling campaigns of ichthyofauna were conducted in 2012 and more complete samples were taken in 2017. The *Aquatic habitat baseline study (Étude spécialisée sur l'habitat aquatique*) (WSP, 2018*c*) provides details on the methodology, work and results. This section summarizes the content of the sector study. The ichthyofauna sampling sites (fish and benthos) are illustrated on Map 6-8.

FISH COMMUNITY

2012 INVENTORY

In all, 166 fish from six species were caught during the inventory conducted in 2012 as part of the project. The white sucker was the most abundant species and was found in three lakes and watercourses inventoried in the study area. The yellow perch was caught only in Lake Kapeika; no other species was caught in this lake. The yellow perch were small, a sign of the poor quality of the habitat. Brook trout were caught in creeks CE4 and CE5. Table 6-34 presents a summary of the 2012 catches.

2017 INVENTORY

The inventory strategy used in 2017 was designed to cover the fish habitat of the study area (not covered in 2012) and to obtain a representation of the various types of habitats. The inventory campaign of fish communities and their habitats was conducted from September 7 to September 14, 2017. The results are presented below by lake and watercourse in the study area.

Lake Asiyan Akwakwatipusich

Although an inventory was not conducted in 2017 in Lake Asiyan Akwakwatipusich, some characterization work was carried out. Initially, a drone was used to take video images of the lake and a bathymetry was conducted. The banks of the lake are generally steep and a small section of about 50 metres shows signs of erosion on the north shore. In this location, the bank shows signs of slumping. Flood zones covered with herbaceous plants and shrubs are present in this lake on either side of the mouth of creek CE3 as well as on its eastern side. These zones may be suitable for northern pike spawning. Northern pike was one of the three species caught in this lake in 2012, along with white sucker and lake chub (Table 6-34).

Table 6-34: Data summary for fish caught in 2012

	Lake Asiyan Akwakwatipusich			Lake Kapisikama	Expansion of creek CE3	CE3		CE4		CE5				
Species	CACO	COPL	ESLU	PEFL	CACO	COPL	CUIN	CUIN	SAFO	CACO	COPL	CUIN	ESLU	SAFO
Number	57	5	6	38	4	3	20	5	2	18	2	1	2	3
Average size (TL, cm)	32.9	11.4	44.7	12.1	15.1	10.5	4.1	5.9	9.5	20.7	12.5	4	25.5	20
Standard deviation (cm)	5.4	2.5	11.9	1.7	3.4	1.8	1.1	0.7	0	4.3	0.7	-	14.8	8.7
Maximum size (cm)	46	15	58	15.5	18	12	5.5	7	9.5	35	13	-	36	26
Minimum size (cm)	17	9	23	9	11.5	8.5	1	5	9.5	16	12	-	15	10

TL: Total length.

Species: CACO: white sucker; COPL: lake chub; ESLU; northern pike; PEFL: yellow perch; SAFO: brook trout; CUIN: brook stickleback.

Table 6-35 presents the main morphometric and physicochemical properties of the lake.

Table 6-35: Morphometric and physicochemical properties of Lake Asiyan Akwakwatipusich

Area (ha)	62.6
Perimeter (km)	3.6
Average depth (m)	1.0
Maximum depth (m)	1.0
Date of physicochemical surveys	June 30, 2012
Water temperature (°C)	15.3
Dissolved oxygen (%)	55
Conductivity (µS/cm)	8
pH	6.4
Water transparency (m)	Not available

Lake Asini Kasachipet

The aquatic habitat of Lake Asini Kasachipet is very homogeneous. The substrate of this body of water is dominated by silt. Scattered boulders, often protruding from the surface of the water, are observed. On the bank, sand and pebbles dominate the substrate. The aquatic vegetation consists mainly of large yellow-pond lilies (*Nuphar variegata*). The vegetation on the banks of the lake consists mostly of black spruce (*Epicea mariana*), tamarack (*Larix laricina*), heath as well as herbaceous plants and peat moss.

A fishing effort involving four net-nights and two seine searches was deployed in this lake in 2017. The brook stickleback was the only species caught.

The inventory results show that Lake Asini Kasachipet is not very productive and fish usage is limited since only the brook stickleback seems to frequent this body of water. The outlet of the lake, creek CE3, does not have any apparent outflow, which could limit upstream migration. The shallowness of the lake and its high acidity could explain its limited use by aquatic fauna.

Table 6-36 presents the main morphometric and physicochemical properties of Lake Asini Kasachipet.

Table 6-36: Morphometric and physicochemical properties of Lake Asini Kasachipet

Area (ha)	18.6
Perimeter (km)	1.9
Average depth (m)	0.75
Maximum depth (m)	1.0
Date of physicochemical surveys	September 9, 2017
Water temperature (°C)	10.6
Dissolved oxygen (%)	84
Conductivity (µS/cm)	7
pH	3.7
Water transparency (m)	0.3

Lake Kapisikama

The aquatic habitat of Lake Kapisikama is homogeneous. This lake, which is ringed by a floating bog mat, has a substrate made up exclusively of decomposing organic matter. The aquatic vegetation consists primarily of yellow pond-lilies. On the bank, the vegetation consists of heath, herbaceous plants and peat moss. The lake does not have a direct outlet. Instead, it drains through its surrounding bog and ultimately into creek CE4. Table 6-37 summarizes the morphometric and physicochemical properties of Lake Kapisikama.

Table 6-37: Morphometric and physicochemical properties of Lake Kapisikama

Area (ha)	1.2
Perimeter (km)	0.55
Average depth (m)	2
Maximum depth (m)	3
Date of physicochemical surveys	September 8, 2017
Water temperature (°C)	12.5
Dissolved oxygen (%)	92 (surface) and 77
Conductivity (µS/cm)	9
pH	4.6
Water transparency (m)	0.5

Yellow perch was the only fish species caught in Lake Kapisikama. This species is found at the northern edge of its distribution area (Scott and Crossman, 1973). The population is isolated and individuals are small and low weight, attesting to the poor habitat. Lastly, the results of the 2017 and 2012 catches are comparable. The average size of individuals was slightly larger, 12.1 cm versus 11.27 cm (Table 6-38).

The inventory results show that Lake Kapisikama is not very productive and fish usage is limited. Its isolation, shallowness and high acidity could explain its limited use by aquatic fauna.

Table 6-38: Data summary for fish caught in Lake Kapisikama

Parameter	Yellow perch
Number of catches (n)	81
Average length (TL; cm)	11.27
Standard deviation (cm)	1.49
Minimum (cm)	8
Maximum (cm)	14
TL: Total length	

Unnamed Pond 1

The fish habitat of unnamed pond 1 is comparable to that of Lake Kapisikama. When the inventory was conducted in September 2017, a fishing effort involving experimental gill netting representing one net-night was used in this lake, but no fish were caught.

Table 6-39 summarizes the main information concerning this body of water.

Table 6-39: Morphometric and physicochemical properties of Unnamed Pond 1

Area (ha)	0.6
Perimeter (km)	0.46
Average depth (m)	2
Maximum depth (m)	3
Date of physicochemical surveys	September 12, 2017
Water temperature (°C)	13 to 14
Dissolved oxygen (%)	83 (surface) and 67
Conductivity (µS/cm)	8
pH	4.2
Water transparency (m)	2.5

Creek CE1

Creek CE1 is a permanent stream that flows from the vast bog complex east of James Bay road. This watercourse drains from east to west. Within the study area, this watercourse is very homogeneous. It is a meandering stream with a low flow rate of less than 0.2 m/s. The average width of the flow channel is 2.2 m and that of the littoral (measured at the natural high-water mark – NHWM) is 51 m. Its average depth is one metre. The substrate is dominated by fine particles. The water is highly coloured.

No fish inventory was taken in this watercourse.

Creek CE2

Creek CE2 is a permanent stream, which like creek CE1, flows from a bog located east of James Bay road. This watercourse drains from east to west. Within the study area, this watercourse is very homogeneous. It is a meandering stream with a low flow rate ranging from 0.04 m/s (August) to 0.19 m/s (October). The average width of the flow channel is 2.4 m and that of the littoral (measured at the NHWM) is 63 m. The average depth is more than one metre. The substrate is dominated by fine particles, although larger particles are found (gravel, stone and pebble) in some very specific areas. During the inventory taken in September 2017, the pH was acidic (between 3.5 and 3.8), conductivity varied between 16 and 17 µS/cm and concentrations of dissolved oxygen were low (between 36% and 42%). The water is highly coloured.

The inventories yielded two fish species: the brook trout *(Salvinus fontinalis)* and the lake chub *(Couesius plumbeus)*. The brook trout was found in creek CE2 even though the habitat is not suitable for salmonids (prevalence of fine particles, low current, low concentration of dissolved oxygen and low pH). No adequate spawning area for brook trout was observed in this watercourse. Table 6-40 presents the catch details.

Table 6-40: Data summary for fish caught in Creek CE2

Parameter	Brook trout	Lake chub
Number of catches (n)	6	2
Average length (TL; cm)	17.6	11.5
Standard deviation (cm)	3.9	2.1
Minimum (cm)	14	10
Maximum (cm)	23	14

TL: Total length.

Creek CE3

Creek CE3 is a permanent stream that flows from Lake Asini Kasachipet. This watercourse drains from west to east. Within the study area, it is very homogeneous and runs 6,800 m. For the portion west of James Bay road, it is a meandering stream winding its way through a fen. Flow rates are low, ranging from 0.30 m/s in June, 0.10 m/s in August and 0.27 m/s in October. East of the road, the topography becomes more accentuated, forcing the watercourse into a sequence of small rapids and pools before flowing into Lake Asiyan Akwakwatipusich. The average width of the flow channel is more than 20 m. The littoral width (measured at the NHWM) is 54 m. The average depth is more than one metre. The substrate is dominated by fine particles. During the September 2017 inventories, the pH was acidic (between 4.09 and 4.7), conductivity was between 12 and 13 µS/cm and concentrations of dissolved oxygen ranged from 57% to 82%. The water is highly coloured. Two beaver dams were noted along this body of water.

The fishing efforts in 2017 yielded four species in creek CE3: the brook trout, white sucker, brook stickleback and lake chub (Table 6-41). Furthermore, while the brook stickleback does not appear in the results of the catches made in the expanded CE3, it is likely that the species is present. Fish of this size could not be caught because of the nets used.

Table 6-41: Data summary for fish caught in Creek CE3

Parameter	Brook trout	White sucker	Brook stickleback	Lake chub
Number of catches (n)	2	3	80	4
Average length (TL; cm)	23.5	22.3	4.2	11.9
Standard deviation (cm)	3.5	5.25	0.8	1.0
Minimum (cm)	21	17	3	10.3
Maximum (cm)	26	27.5	6.5	13
TL: Total length				

Creek CE4

Creek CE4 is fed by runoff from the peatlands surrounding Lake Kapisikama. This watercourse starts where a visible flow channel appears, just over 700 m upstream of James Bay road (Map 6-8). The flow runs through vegetation; the flow channel appears and then disappears between tree roots. Within the study area, the watercourse runs 2,600 m. It flows from west to east. The substrate consists of fine particles only and the depth does not exceed 0.3 m. Flow rates are low, about 0.01 m/s. During the September 2017 inventories, the pH was acidic (4.58), conductivity was 21 µS/cm and the concentration of dissolved oxygen was 68%. The water is highly coloured. No beaver dam was noted along this watercourse. After crossing the road, the flow channel becomes permanent. Creek CE4 reaches the outlet of Lake Asiyan Akwakwatipusich outside the study area.

In 2017, an electrofishing effort was conducted in the watercourse section west of James Bay road. The fishing effort was conducted in a 100-metre section of unbarriered sites (Map 6-8). No fish were caught.

Creek CE5

Creek CE5 is a permanent stream that flows from a peatland complex west of the study area (Map 6-8). This watercourse drains from west to east. Within the study area, it is homogeneous and runs 7,000 m. It ultimately flows into the Eastmain River, more than 10 km downstream of the study area. Like the other watercourses described earlier, it is a meandering river that crosses fens. Flow rates are fairly low, ranging from 0.2 m/s in June, 0.05 m/s in August and 0.2 m/s in October. Progressing downstream, the channel and coastline gradually widen. The average width of the flow channel is 4.8 m. The average width of the coastline (measured at the NHWM) is 77 m. The substrate is dominated by fine particles. During the September 2017 inventories, the pH was acidic (5.16), conductivity was 16 µS/cm and the concentration of dissolved oxygen was 63%. The water is highly coloured. Six beaver dams were noted along this watercourse.

During the inventory campaign, a hoop net was set up in this watercourse, resulting in 74 catches. Five fish species were caught: trout perch, white sucker, brook stickleback, lake chub and northern pike (Table 6-42). The lake chub accounted for more than 60% of the catch. The large flood plains dominated by herbaceous vegetation along this watercourse on either side of James Bay road could be used during the spring floods for northern pike spawning.

Table 6-42: Data summary for fish caught in Creek CE5

Parameter	Trout perch	White sucker	Brook stickleback	Northern pike	Lake chub
Number of catches (n)	2	23	3	1	45
Average length (TL; cm)	8.5	17.1	6	34.5	11.9
Standard deviation (cm)	0.7	2.6	0.5	-	1.0
Minimum (cm)	8	11.5	5.5	-	10.3
Maximum (cm)	9	21.5	6.5	-	13
TL: Total length					

6.3.3.1 *BENTHIC COMMUNITY*

Three sampling campaigns of benthic organisms were conducted in 2017: one in July (between the 24th and 31st), a second in September (between the 5th and 14th) and a final one in October (between the 8th and 12th). The locations of the sampling stations are shown on Map 6-8. Benthos samples were collected at depths not exceeding 0.5 m. For stations 1A, 2A and 5B, the substrate was dominated by sand with, in the case of stations 1A and 2A, a large proportion of silt and clay. The substrate of station 3B was made up exclusively of organic matter.

In total, 48 species or taxons were identified in the four stations sampled. In July, three to four taxons or species were identified in stations 1A, 2A and 3B, while 14 were identified for station 5B. In September, between two and five taxons or species were identified in stations 1A, 2A and 3B, while 10 were identified for station 5B. In October, only five species were counted in station 1A while 16 to 19 were counted for the three other stations.

Table 6-43 shows the variation in the abundance per taxon according to the sampling period for the four stations sampled. Insects made up a significant proportion of the benthic community during the three campaigns. The prevalence of bivalves, oligochaeta and acari was similar. In September, the ostracod accounted for almost a third of the organisms, whereas they were less prevalent in July and October.

Table 6-43: Main taxons collected by campaign

Taxon	July (%)	September (%)	October (%)
Bivalves	7	16	11
Oligochaeta	6	10	12
Acari	6	1	1
Ostracod	3	28	12
Insects	78	45	64

Table 6-44 shows the abundance, diversity (Shannon index), richness and tolerance to pollution of the organisms identified by station and sampling campaign. In July and September, station 5B had the most abundant, rich and diversified benthic community. Station 1A had the least abundant benthic community for the three campaigns.

Of the four stations sampled, the benthic community was least abundant, rich and diverse in September and richest in October. Lastly, the tolerance of the identified organisms to pollution was generally high and remained fairly constant during the three campaigns.

Table 6-44: Descriptors of benthic invertebrate communities

	July				September				October			
Station	Abundance	Diversity	Richness	Tolerance	Abundance	Diversity	Richness	Tolerance	Abundance	Diversity	Richness	Tolerance
1A	22	0.76	3	7.6	2	0.69	2	7.0	5	1.61	5	7.4
2A	20	1.39	4	6.0	31	1.22	5	9.1	195	2.00	19	8.2
3B	8	1.39	4	7.0	8	1.04	3	8.5	51	2.43	16	7.6
5B	85	2.59	14	6.0	46	1.94	10	7.6	131	2.07	16	6.8
Average	34	1.5	6	7	22	1.2	5	8	96	2.0	14	8

6.3.4 HERPETOFAUNA

6.3.4.1 METHODOLOGY

The northern edge of the distribution area of most herpetofauna species in Quebec is more southern than the study area, for both amphibians and reptiles. As such, only a few species were relatively common to the latitude of this project, including the American toad *(Anaxyrus americanus)*, spring peeper *(Pseudacris crucifer)* and mink frog (*Lithobates septentrionalis*) among anurans, and the common garter snake *(Thamnophis sirtalis)* among reptiles.

Since no at-risk herpetofauna species were anticipated in the study area, the inventory efforts in their regard consisted of opportunistic searches in potentially suitable habitats. The methodology used for the herpetofauna inventory is described in detail in the *Terrestrial wildlife and avifauna baseline study* (*Étude spécialisée sur les faunes terrestre et avienne)* (WSP, 2018*g*).

An inventory of garter snakes was conducted in suitable habitats throughout the study area, more specifically, buffer strips exposed to the sun, where these animals are likely to seek warmth. This inventory was conducted using the asphalt shingle method and active searching, as recommended by the MFFP (Larochelle and coll., 2015). As such, 126 shingles were installed on July 8 and 9, 2017 and surveyed on five occasions until their removal on September 24 and 25, 2017. These surveys were conducted on sunny days when garter snakes would be most attracted to the shingles. Opportunistic surveys of available shelters (rocks, debris, etc.) were also conducted concurrently with the shingle surveys and other inventory activities. The locations of the shingle transects are illustrated on Map 6-19.

6.3.4.2 RESULTS

Only two anuran specimens, representing two species, were observed or heard during the field trips in 2017. The two species were the American toad *(Anaxyrus americanus)* and the wood frog *(Lithobates sylvaticus).* These two species, as well as the mink frog *(Lithobates. septentrionalis)*, had also been observed during the inventories in 2012. These species are common and widespread in Quebec.

The inventory conducted by the asphalt shingle method and by active searching in suitable habitats did not reveal any specimens in 2017; however, the exuvia of a garter snake was found on the Route du Nord, in a culvert. Based on its known distribution area, only this species was likely to be found in the study area. An opportunistic observation of a specimen was collected during the inventories conducted in 2012. It was a common species widespread in Quebec.

Despite our searches in suitable habitats and during periods favourable for detecting urodeles (salamanders and newts), no specimens of this group were observed.

No turtles or signs of turtle eggs were detected during field trips in the study area.

6.3.5 AVIFAUNA

Bird inventories were conducted in 2017 for this project, including aerial surveys of waterfowl, an inventory of terrestrial-breeding birds and a targeted search of species at risk. These inventories were conducted from June 7 to July 10, 2017. The methodologies used for these inventories are described in detail in the *Terrestrial wildlife and avifauna baseline study* (*Étude spécialisée sur les faunes terrestre et avienne)* (WSP, 2018*g*).

An inventory of terrestrial-breeding birds was also conducted in 2012 in a portion of the study area. However, since the habitats inventoried have changed dramatically due to fire, only the species surveyed was considered and presented in the section titled *Previous Inventories*.

6.3.5.1 WATERFOWL AND AQUATIC BIRDS

METHODOLOGY

The waterfowl and aquatic bird inventories were essentially conducted by a helicopter flyover. The expanded study area for the helicopter survey is illustrated on Map 6-20. The specimens observed on the ground during other field activities were also noted.

The aerial survey was conducted on June 7, 2017 with a view to covering all the bodies of water in the expanded study area (Map 6-20). The surveys were flown at low altitude and at reduced speed, as proposed by the method used by Environment Canada in the *Black Duck Joint Venture* (Bordage and coll., 2003). During this survey, special attention was paid to the presence of birds of prey. Lastly, a request was submitted to the Canadian Wildlife Service (CWS) to check whether data relevant to the project were available in the *Eastern Waterfowl Monitoring Program* database.

RESULTS

The aerial survey revealed just 47 specimens of eight species of waterfowl and aquatic birds (Table 6-45). In addition, an osprey *(Pandion haliaetus)* flying over the Eastmain River was observed.

No notable area of concentration was observed since the few specimens noted were relatively dispersed in the study area. All the specimens observed were adults except for one immature sandhill crane *(Grus canadensis)*. The most abundant species was the Canada goose *(Branta canadensis)* with 19 individuals counted.

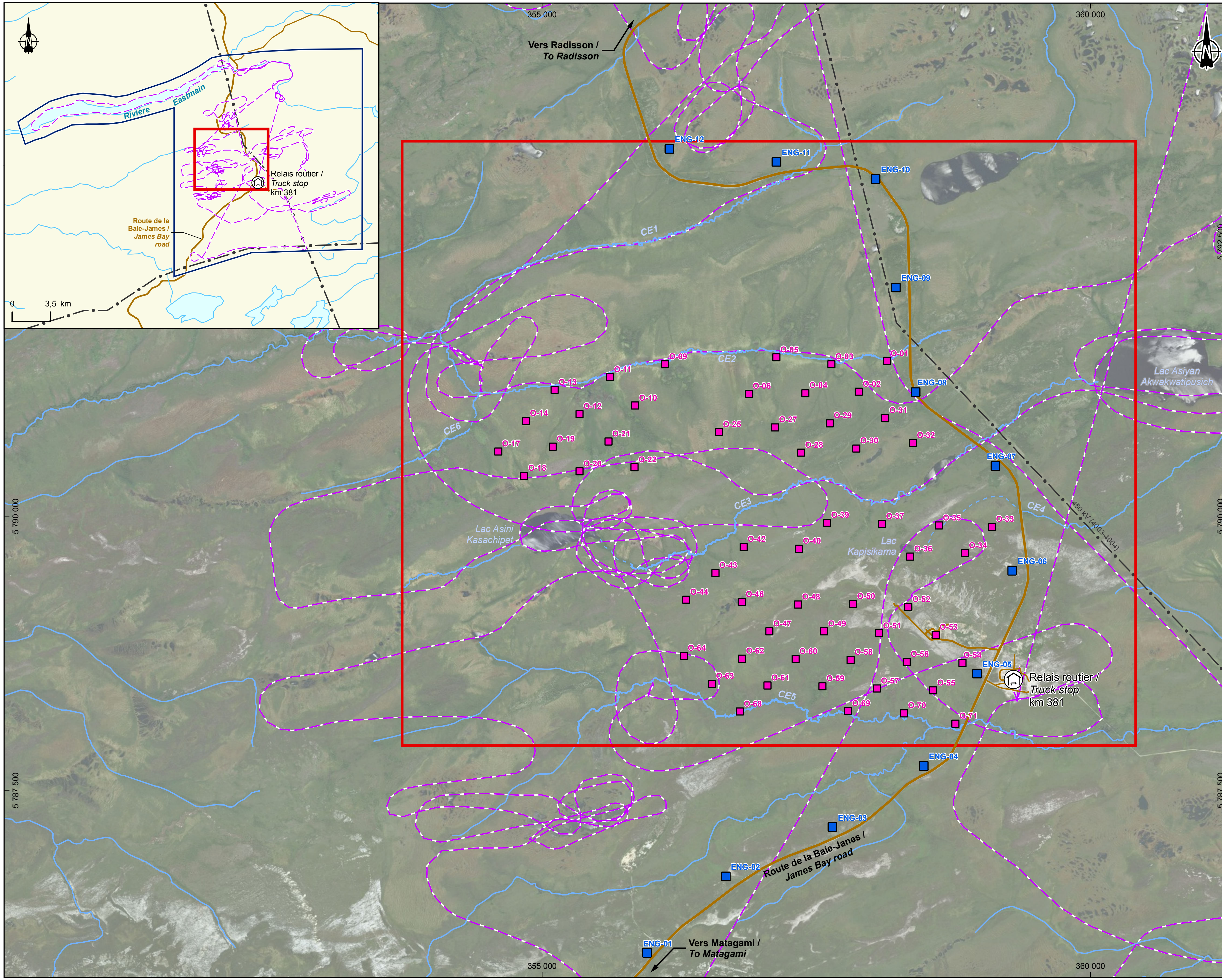
Table 6-45: Results of aerial surveys of waterfowl and aquatic birds – June 2017

Species (n = 8)	Number of specimens	Species (n = 8)	Number of specimens
Canada goose *(Branta canadensis)*	19	Common merganser *(Mergus merganser)*	5
Black duck *(Anas rubripes)*	5	Sandhill crane *(Grus canadensis)*	8
Ring-necked duck *(Aythya collaris)*	1	Surf scoter *(Melanitta perspicillata)*	4
Common goldeneye *(Bucephala clangula)*	1	Green-winged teal *(Anas crecca)*	4

In addition to the waterfowl and aquatic bird specimens counted in the aerial survey, an additional 33 individuals representing six species were noted during the ground survey activities in 2017 (Table 6-46). The most abundant waterfowl and aquatic bird species observed on the ground were Wilson's snipe *(Gallinago delicata)*, the common loon *(Gavia immer)* and the solitary sandpiper *(Tringa solitaria).*

Table 6-46: Results of ground surveys of waterfowl and aquatic birds – June 2017

Species (n = 6)	Number of specimens	Species (n = 6)	Number of specimens
Wilson's snipe *(Gallinago delicata)*	11	Sandhill crane *(Grus canadensis)*	2
Solitary sandpiper *(Tringa solitaria)*	6	Common loon *(Gavia immer)*	7
Greater yellowlegs *(Tringa melanoleuca)*	5	Green-winged teal *(Anas crecca)*	2



Zone d'étude locale / *Local study area*

Zone d'étude pour la sauvagine et les oiseaux aquatiques / *Study area for wildfowl and waterfowl*

Inventaires / *Inventory*

ENG-08 Station d'inventaire nocturne des engoulevents / *Nighthawk listening station*

O-33 Station d'écoute des oiseaux chanteurs / *Songbird listening station*

Inventaire de la sauvagine / *Wildfowl survey*

Hydrographie / Hydrography

CE4 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Infrastructures / *Infrastructure*

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement / *Environmental Impact Assessment*

Sites d'inventaire de la faune avienne / *Avifauna Survey Sites*

Sources :

Image / Image : World Imagery, ESRI

Inventaire / Inventory : WSP 2017

No Ref : 171-02562-00_wspT074_EIEmb_c6-20_f-avienne_180903.mxd

0 350 700 m

UTM 18, NAD83

Carte / *Map* 6-20

wsp

6.3.5.2 *TERRESTRIAL BREEDING BIRDS*

METHODOLOGY

The listening station method was used to survey breeding passerines (Blondel and coll., 1970; EC, 1997, 2007). About 60 stations were set up in the habitats in the local study area (Map 6-20) and each was visited once between July 5 and 10, 2017, inclusively. Given the relative homogeneity of the environments, the stations were divided into three habitat categories: wetlands (31 stations), open habitats (18 stations) and softwood stands (9 stations). A survey using listening stations was also conducted at a preliminary stage of the project, from June 30 to July 4, 2012.

For nighthawks, a nocturnal survey outing, on a clear day, was conducted on July 6, 2017 to take advantage of the species' increased activity periods during the full moon. This survey used ten listening stations along James Bay road (Map 6-20), which were surveyed according to the protocol developed by the Regroupement QuébecOiseaux (Regroupement Québecoiseaux, 2015).

Aside from the field surveys conducted in 2012 and 2017, the Regroupement QuébecOiseaux was asked to provide data from the ÉPOQ (Larivée, 2017) and SOS-POP (SOS-POP, 2018) data bank.

RESULTS

Listening station survey in 2017

Four hundred seventy-two (472) individuals were detected during the listening station survey, representing 32 species of terrestrial breeding birds (Table 6-47). Since the objective of the listening station survey was also to estimate the density of indicated breeding pairs per hectare (IP/ha) in the habitats potentially affected by the project, we established densities for the three categories of habitats studied: wetlands, open habitats and softwood stands. The category with the largest number of species was the wetland habitat with 23 species detected, followed by the open and softwood stand habitats with 16 and 11 species, respectively. The densest category in breeding pairs was found in open habitats, at 7.14 IP/ ha, followed by softwood stands and wetlands, with 6.08 and 4.26 IP/ha, respectively, all species combined (Table 6-47).

Of breeding birds, the dark-eyed junco (*Junco hyemalis*) was most abundant in softwood stand and open habitat stations, with 2.19 and 1.49 IP/ha, respectively. The density of the white-throated sparrow *(Zonotrichia albicollis)* was the same as that of the dark-eyed junco (1.49 IP/ha) in open habitats, while it ranked second, with 1.27 IP/ha, in softwood stands. The white-throated sparrow was also the most abundant species in wetland habitats, with 0.84 IP/ha, followed by the dark-eyed junco with 0.82 IP/ha. In short, these two species are dominant in the three habitat categories studied. They are also the species that showed the greatest consistency from one station to another, followed by the hermit thrush *(Catharus guttatus)* and Lincoln's sparrow *(Melospiza lincolnii).* These are all abundant species common to these latitudes.

Nighthawk survey

There are two types of nighthawk in Quebec: the common nighthawk *(Chordeiles minor)* and the eastern whip-poor-will *(Antrostomus vociferus).* On the evening of the survey, only the common nighthawk was detected, at station Eng-06. Two more were also observed a few times between July 5 and 10, 2017, above the km 381 truck stop. The nighthawk appears on the list of species likely to be designated as threatened or vulnerable in Quebec (MFFP, 2006*a*). It is also considered threatened at the federal level and appears in Schedule 1 to Canada's *Species at Risk Act (*SARA) (Gouvernement du Canada, 2017).

Other opportunistic observations

Six more bird species were sighted during field trips in 2017: Bonaparte's gull *(Chroicocephalus philadelphia),* the hen harrier *(Circus cyaneus),* the sharp-tailed grouse *(Tympanuchus phasianellus),* the Nashville warbler *(Oreothlypis ruficapilla),* the eastern bluebird *(Sialia sialis)* and the northern mockingbird *(Mimus polyglottos).* The last two species were sighted on the edge of the km 381 truck stop. If we include the species detected during the surveys of waterfowl, aquatic birds and terrestrial breeding birds, 53 bird species were detected in the study area in 2017.

Table 6-47: Density of terrestrial breeding birds in habitats surveyed in 2017

Species (n =32)	Density (IP/ha) Wetlands (31 stations)	Open habitats (18 stations)	Softwood stands (9 stations)
Two-barred crossbill *(Loxia leucoptera)*	0.12	-	-
White-crowned sparrow *(Zonotrichia leucophrys)*	-	0.35	-
White-throated sparrow (*Zonotrichia albicollis*)	0.84	1.49	1.27
Song sparrow *(Melospiza melodia)*	0.04	-	-
Le Conte's sparrow[1] (*Ammodramus leconteii)*	-	-	-
Lincoln's sparrow *(Melospiza lincolnii)*	0.35	0.78	0.28
Swamp sparrow *(Melospiza georgiana)*	0.14	-	-
Savannah sparrow *(Passerculus sandwichensis)*	0.31	-	-
Fox sparrow *(Passerella iliaca)*	0.04	0.07	-
American crow *(Corvus brachyrhynchos)*	-	0.07	-
Common raven[1] *(Corvus corax)*	-	-	-
Swainson's thrush *(Catharus ustulatus)*	-	0.07	0.14
Veery *(Catharus fuscescens)*	-	0.04	0.07
Hermit thrush *(Catharus guttatus)*	0.10	0.85	0.85
Tree swallow *(Tachycineta bicolor)*	0.31	-	-
Cedar waxwing *(Bombycilla cedrorum)*	0.06	0.21	-
Dark-eyed junco *(Junco hyemalis)*	0.82	1.49	2.19
American robin *(Turdus migratorius)*	0.18	0.42	0.07
Boreal chickadee[1] *(Poecile hudsonicus)*	-	-	-
Grey jay *(Perisoreus canadensis)*	0.04	0.14	-
Alder flycatcher *(Empidonax alnorum)*	0.04	-	-
Wilson's warbler *(Cardellina pusilla)*	0.10	-	-
Palm warbler *(Setophaga palmarum)*	0.06	0.18	0.71
Yellow-rumped warbler *(Setophaga coronata)*	0.02	-	-
Common yellowthroat *(Geothlypis trichas)*	0.23	0.50	-
Tennessee warbler *(Oreothlypis peregrina)*	-	0.28	-
Black-backed woodpecker *(Picoides arcticus)*	0.04	-	-
Northern flicker *(Colaptes auratus)*	0.14	-	-
Rusty blackbird *(Euphagus carolinus)*	0.08	0.21	0.14
Ruby-crowned kinglet *(Regulus calendula)*	-	-	0.07
Grey jay *(Perisoreus canadensis)*	0.08	-	0.28
Winter wren *(Troglodytes hiemalis)*	0.12	-	-
Number of species	**23**	**16**	**11**
Total density (IP/ha)	**4.26**	**7.14**	**6.08**

1 Too few observations to establish a breeding pair density.

Listening station survey in 2012

The listening station survey conducted in 2012 revealed the presence of 41 species (Table 6-48). The slight differences between the species detected in 2012 and in 2017 may be due to the effect of forest fires in the study area between these two periods.

Table 6-48: Species detected during the 2012 breeding bird survey

Species (n = 41)	Sighted in 2017	Species (n = 41)	Sighted in 2017
Two-barred crossbill *(Loxia leucoptera)*	Yes	Dark-eyed junco (*Junco hyemalis)*	Yes
Wilson's snipe *(Gallinago delicata)*	Yes	American robin (*Turdus migratorius)*	Yes
White-throated sparrow (*Zonotrichia albicollis*)	Yes	Boreal chickadee[1] *(Poecile hudsonicus)*	Yes
Lincoln's sparrow *(Melospiza lincolnii)*	Yes	Grey jay *(Perisoreus canadensis)*	Yes
Swamp sparrow *(Melospiza georgiana)*	Yes	Alder flycatcher *(Empidonax alnorum)*	Yes
Savannah sparrow *(Passerculus sandwichensis)*	Yes	Yellow-bellied flycatcher *(Empidonax flaviventris)*	No
Fox sparrow *(Passerella iliaca)*	Yes	Wilson's warbler *(Cardellina pusilla)*	Yes
American tree sparrow *(Spizella arborea)*	No	Palm warbler *(Setophaga palmarum)*	Yes
Red-tailed hawk *(Buteo jamaicensis)*	No	Yellow-rumped warbler *(Setophaga coronata)*	Yes
American crow *(Corvus brachyrhynchos)*	Yes	Nashville warbler *(Oreothlypis ruficapilla)*	Yes
Common nighthawk *(Chordeiles minor)*	Yes	Northern waterthrush *(Parkesia noveboracensis)*	No
Common starling *(Sturnus vulgaris)*	No	Yellow warbler *(Setophaga petechia)*	No
Merlin *(Falco columbarius)*	No	Common yellowthroat *(Geothlypis trichas)*	Yes
Herring gull *(Larus argentatus)*	No	Black-backed woodpecker *(Picoides arcticus)*	Yes
Common raven[1] *(Corvus corax)*	Yes	American three-toed woodpecker *(Picoides dorsalis)*	No
Brown creeper *(Certhia americana)*	No	Northern flicker *(Colaptes auratus)*	Yes
Hermit thrush *(Catharus guttatus)*	Yes	Common loon *(Gavia immer)*	Yes
Greater yellowlegs *(Tringa melanoleuca)*	Yes	Rusty blackbird *(Euphagus carolinus)*	Yes
Sandhill crane *(Grus canadensis)*	Yes	Ruby-crowned kinglet *(Regulus calendula)*	Yes
Tree swallow *(Tachycineta bicolor)*	Yes	Winter wren *(Troglodytes hiemalis)*	Yes
Cedar waxwing *(Bombycilla cedrorum)*	Yes		

6.3.5.3 *DATA FROM AVAILABLE DATA BANKS*

Although the SOS-POP data bank has no data on the study area, some useful information was found in the ÉPOQ data bank. Data from the *Programme de suivi de la sauvagine de l'Est* do not extend north of 51° 15' N and as such do not cover the study area.

A comprehensive list of bird sightings recorded in the study area was extracted from ÉPOQ data bank (Larivée, 2017). These data cover a period of more than 30 years, from 1981 to 2015 (Table 6-49). Despite the time span covered, only 186 mentions covering 64 species were recorded in the study area. These are divided into five observations in spring, 147 in summer and 34 in the fall. There are no winter observations. In regard to seasonal diversity, five species were observed in spring, 60 in summer and 21 in the fall. Of these species, some were not detected during the 2012 and 2017 surveys for the project, including the northern goshawk (*Accipiter gentilis*) and the bald eagle *(Haliaeetus leucocephalus).*

Table 6-49: Bird sightings by season in the ÉPOQ data bank for the study area – 1981 to 2015

Species[10]	Spring	Summer	Fall
Northern goshawk *(Accipiter gentilis)*		x	
Osprey *(Pandion haliaetus)*	x	x	
Wilson's snipe *(Gallinago delicata)*		x	
Two-barred crossbill *(Loxia leucoptera)*		x	
Red crossbill *(Loxia curvirostra)*		x	
Canada goose *(Branta canadensis)*			x
White-crowned sparrow *(Zonotrichia leucophrys)*		x	x
White-throated sparrow *(Zonotrichia albicollis)*		x	x
Song sparrow *(Melospiza melodia)*		x	
Lincoln’s sparrow *(Melospiza lincolnii)*		x	
Swamp sparrow *(Melospiza georgiana)*		x	
Fox sparrow *(Passerella iliaca)*	x	x	
Hen harrier *(Circus cyaneus)*		x	
Red-tailed hawk *(Buteo jamaicensis)*		x	x
Mallard *(Anas platyrhynchos)*		x	
Spotted sandpiper *(Actitis macularius)*		x	
American kestrel *(Falco sparverius)*		x	
Common nighthawk *(Chordeiles minor)*		x	
Ruffed grouse *(Bonasa umbellus)*	x	x	
Herring gull *(Larus argentatus)*		x	x
Greater yellowlegs *(Tringa melanoleuca)*		x	
Common raven *(Corvus corax)*	x	x	*x*
Common merganser *(Mergus merganser)*		x	x
Great blue heron *(Ardea herodias)*			x
Swainson’s thrush *(Catharus ustulatus)*		x	x
Hermit thrush *(Catharus guttatus)*		x	x
Sandhill crane *(Grus canadensis)*		x	
Hooded merganser *(Lophodytes cucullatus)*		x	x
Tree swallow *(Tachycineta bicolor)*		x	
Cedar waxwing *(Bombycilla cedrorum)*		x	
Dark-eyed junco *(Junco hyemalis)*		x	x
Willow ptarmigan *(Lagopus lagopus)*		x	

10 List produced by Marie-France Julien of Regroupement QuébecOiseaux, on 2018/01/31. Number of sheets: 15. Number of mentions: 186.

Table 6-49: Bird sightings by season in the ÉPOQ data bank for the study area – 1981 to 2015 (cont.)

Species	Spring	Summer	Fall
American robin *(Turdus migratorius)*		x	x
Boreal chickadee *(Poecile hudsonicus)*		x	x
Grey jay *(Perisoreus canadensis)*		x	x
Alder flycatcher *(Empidonax alnorum)*		x	
Bonaparte's gull *(Chroicocephalus philadelphia)*		x	
Wilson's warbler *(Cardellina pusilla)*		x	
Palm warbler *(Setophaga palmarum)*		x	
Yellow-rumped warbler *(Setophaga coronata)*		x	x
Nashville warbler *(Oreothlypis ruficapilla)*		x	
Magnolia warbler *(Setophaga magnolia)*		x	
Northern waterthrush *(Parkesia noveboracensis)*		x	
American redstart *(Setophaga ruticilla)*		x	
Yellow warbler *(Setophaga petechia)*		x	
Common yellowthroat *(Geothlypis trichas)*		x	
Black-and-white warbler *(Mniotilta varia)*		x	
Tennessee warbler *(Oreothlypis peregrina)*		x	
Mourning warbler *(Geothlypis philadelphia)*		x	
Orange-crowned warbler *(Oreothlypis celata)*		x	x
Hairy woodpecker *(Picoides villosus)*	x		
Northern flicker *(Colaptes auratus)*		x	x
Yellow-bellied sapsucker *(Sphyrapicus varius)*		x	
Buff-bellied pipit *(Anthus rubescens)*			x
Common loon *(Gavia immer)*		x	
Bald eagle *(Haliaeetus leucocephalus)*		x	
Ruby-crowned kinglet *(Regulus calendula)*		x	x
Common teal *(Anas crecca)*		x	x
Red-breasted nuthatch *(Sitta canadensis)*		x	
Common tern *(Sterna hirundo)*		x	
Pine siskin *(Spinus pinus)*		x	
Mourning dove *(Zenaida macroura)*		x	
Winter wren *(Troglodytes hiemalis)*		x	
Philadelphia vireo *(Vireo philadelphicus)*		x	

6.3.5.4 *SPECIAL STATUS SPECIES*

Among the bird species surveyed in the study area, there are three species at risk in Quebec or in Canada: the common nighthawk, the rusty blackbird *(Euphagus carolinus)* and the bald eagle. The first one nests in burned over areas, bare habitats and flat roofs (Poulin and coll., 1996), all widely available in the study area. The second frequents swamps, beaver ponds and peatlands (EC, 2014), all of which are still well represented habitats in the study area and the surrounding areas. Both species were detected in 2012 and 2017. As for the bald eagle, whose sighting in 2007 is recorded in the ÉPOQ data bank (Larivée, 2017), suitable habitats for feeding and nesting are available in the study area, although the species was not detected during the 2012 and 2017 surveys.

6.3.6 BATS

Quebec is home to eight bat species, five of which are resident because they remain in our latitude during the winter and three are described as migratory since they overwinter farther south. However, in Quebec, even resident species migrate during the fall season, although for shorter distances than in the case of so-called migratory species.

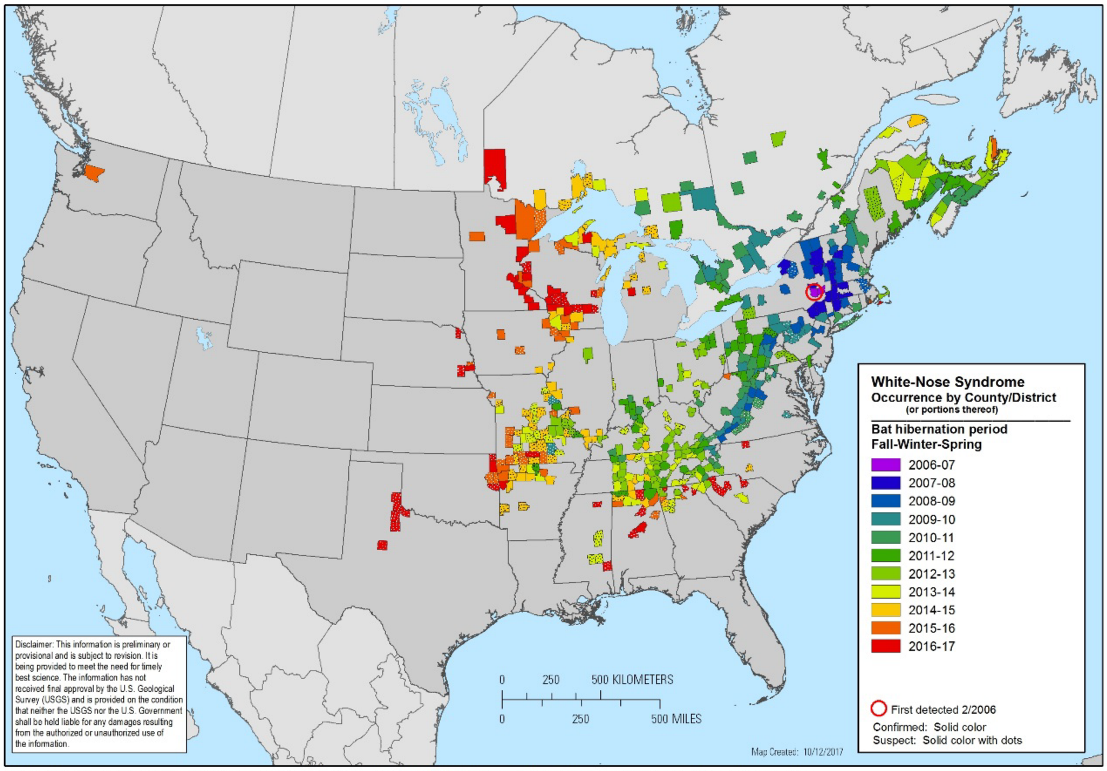
6.3.6.1 *EXISTING DOCUMENTATION*

According to the geographic distribution of the bat species in Québec (Jutras and coll., 2012), established based on data from the CDPNQ, the study area is potentially frequented by five of the eight species: the northern myotis, the little brown myotis, the big brown bat, the hoary bat and the eastern red bat *(Lasiurus borealis).* According to these data, there are no silver-haired bats in the study area: its geographic range stops about 200 kilometres farther south.

Surveys conducted between 2003 and 2009 by the Réseau québécois d'inventaires acoustiques de chauves-souris (Jutras and Vasseur, 2011) at Lac Bourbeau, approximately 300 kilometres southeast of the study area, confirmed the presence of four of these five species. Only the eastern red bat was not listed. The dominant species in the Réseau's surveys are the hoary bat (54.7% of records collected between 2003 and 2009) and bats of the genus *Myotis* (39.6% of records). In addition, a survey conducted as part of the impact study for the Whabouchi project, about 100 kilometres south-east of the study area, identified bats of the genus *Myotis* as well as "the hoary bat [...] and/or the eastern red bat [...]." Moreover, a little brown myotis maternity colony of approximately 300 individuals was recorded in this area, and the Ministère des Ressources naturelles has confirmed that hoary bats have been observed near Lac du Spodumene (Nemaska Lithium, 2013).

In general, little data is available on bats in the northern environment. The northern limit of their distribution is difficult to define (EC, 2015). It is possible that the distribution limit for some species may extend farther north than estimates show. In fact, the data collected by our team on the Côte-Nord and in Labrador indicate that the eastern red bat, the northern long-eared bat and the little brown myotis are found up to the 54th parallel, well beyond their known distribution (Brunet, personal communication). It is not known, however, whether these were resident breeding individuals or merely extralimital observations.

A dramatic increase in bat mortality has been observed since 2006–2007 in abandoned mines and caves in the Northeastern United States. Most of the affected bats showed unique external signs, as some parts of the body, mainly the snout, were covered with a whitish fungal infection, hence the name white-nose syndrome (WNS) (MFFP, 2017*c*). WNS is spreading rapidly and now affects more than 15 states in the Northeastern United States. In Canada, the provinces of Ontario, New Brunswick and Quebec have also been also affected. WNS is therefore a major international issue for bat conservation. It is estimated that more than a million bats have succumbed to this syndrome since its discovery, attesting to the magnitude of this disease (MFFP, 2017*c*). Most North-American bat species may be affected by WNS. However, the little brown myotis, the northern myotis, the big brown bat, the tri-coloured bat (*Perimyotis subflavus*) and the Indiana bat (*Myotis sodalis*, absent in Quebec) have been especially affected in the Northeastern United States and Ontario (MFFP, 2017*c*). The presence of WNS has been confirmed in Nord-du-Québec (Map 6-21). Most of the species affected by WNS are insectivorous and cave dwelling.



Citation: White-nose syndrome occurrence map - by year (2017). Data Last Updated: 10/12/2017. Available at: https://www.whitenosesyndrome.org/resources/map.

Map 6-21: Spread of WNS in North America

In 2014, due to the spread of this disease, the tri-coloured bat, the little brown myotis and the northern myotis were classified as “endangered” in Canada and listed in Schedule 1 to the SARA (Gouvernement du Canada, 2014).

6.3.6.2 *ACOUSTIC MONITORING*

METHODOLOGY

In 2017, a bat survey was conducted in the study area using fixed acoustic monitoring, a technique based on the protocol developed by the MRNF for bat surveys in the context of wind projects (MRNF, 2008). This methodology is used to collect timely information on bat activity using automated monitoring stations.

Six monitoring stations were set up to document the habitats most favourable to the activities of potentially present bat species, more specifically, sites suitable for breeding, foraging or roosting, as well as potential movement or migration corridors. These monitoring stations are shown on Map 6-19. The desired key habitats were associations characterized by the presence of or proximity to two or more of the following:

— open areas;
— mature forests;
— watercourses and bodies of water;
— wetlands.

The stations were set up between July 6 and July 9, 2017 and removed on September 24 and 25, 2017. They were therefore active during the bat breeding season (early June to late July) and the beginning of the migration period (mid-August to mid-October).

The methodology used for this inventory is described in detail in the *Terrestrial wildlife and avifauna baseline study* (*Étude spécialisée sur les faunes terrestre et avienne*) (WSP, 2018*g*).

RESULTS

The acoustic monitoring conducted during the breeding and migration periods in 2017 confirmed the presence of *Myotis* bats as well as two other species, for a total of just 68 passes recorded:

- *Myotis* bats (4.41% of records);
- Big brown bat (*Eptesicus fuscus*) (1.47% of records);
- Hoary bat (*Lasiurus cinereus*) (86.76% of records).

Of the total, 7.35 % of records were undetermined because the calls were too short to enable identification of the species.

These results are consistent with those obtained by the Réseau québécois d'inventaire acoustique de chauves-souris in Abitibi (Jutras and Vasseur, 2011) and the survey conducted for the Wabouchi project (Nemaska Lithium, 2013) concerning the presence of *Myotis* and two other species, as well as for the dominance of the hoary mouse.

However, considering the survey effort (261 night-stations), few passes were recorded for the various bat species.

Most of the species surveyed during this inventory were arboreal (Tremblay and Jutras, 2010): the hoary bat, which is a migratory species, essentially roosts in trees, while *Myotis* bats use trees, buildings and rocky structures (Tremblay and Jutras, 2010). For its part, the big brown bat roosts instead in buildings or rocky structures (Tremblay and Jutras, 2010) but also in mature trees with cavities (woodpecker holes, crevices, etc.) (Willis and coll., 2006). Arboreal bats typically look for large, wide-diameter trees (Tremblay and Jutras, 2010).

Consequently, mature forests are particularly suitable for daytime roosts and breeding sites for the at-risk species surveyed in the study area. We know that bats choose swamps, bogs, beaver ponds, lakes and watercourses as hydration and foraging habitats (Taylor, 2006). Consequently, the association of watercourses, bodies of water and other wetlands with mature forests are generally a key habitat for bats. While the presence of watercourses and/or wetlands characterized each monitoring station, mature forests have almost completely disappeared from the study area due to forest fires in the last decade. This probably explains the low bat presence.

6.3.6.3 *SEARCH FOR HIBERNACULA*

Documentary research was conducted to evaluate the potential presence of bat wintering habitats in the study area and in a one-kilometre surrounding buffer zone. We looked for natural cavities or mine openings potentially suitable for this type of habitat. Various sources were consulted, more specifically, the geomining information system (SIGÉOM) (MERN, 2017), internal databases, photos and videos taken during wildlife surveys and the regional offices of the MERN and MFFP.

An analysis of the documents showed that there are no natural cavities or mine openings in the area (Bellemare and Germain, 1987; Gauthier and coll., 1995; McCann, 2014). According to Christine Lambert of the Direction de la protection de la faune du Nord-du-Québec, the most northern hibernacula in Quebec is found at the Bruneau mine, about 250 km south of the study area.

Hibernation sites must have an appropriate ambient temperature, one that is cold enough to decrease the bat's metabolic rate but warm enough that it doesn't freeze to death. The interior ambient temperature of a mine or cave depends in large part on the average annual temperature of the region. Therefore, the 0°C isotherm, the line connecting all points where the average annual temperature is 0 C, would be the theoretical limit above which it would not be likely to find a hibernaculum since the temperature of cavities or mine openings would be too low for bats. The presence of hibernacula above this theoretical limit must, however, not be excluded since microclimate conditions could explain special cases (Gauthier and coll., 1995). Still, this theoretical limit makes it possible to assess the potential of the study site, which is located about 250 km north of the 0°C isotherm (MDDELCC, 2018*a*).

Consequently, since no natural cavity or mine opening was found in the sector and since the latter is located beyond the theoretical limit described above, we believe that there is no likelihood of bat hibernacula in or around the study area.

6.3.6.4 *SPECIAL STATUS SPECIES*

MYOTIS BAT

Until WNS arrived, the genus *Myotis* was most abundant in Eastern Canada (Broders and coll., 2003; Delorme and Jutras, 2006; Jutras and coll., 2012). In Quebec, this genus includes the little brown myotis, the northern myotis and the eastern small-footed myotis, the latter never having been surveyed in Abitibi.

The little brown myotis and the northern myotis are two of the five resident species in Quebec. They remain in their foraging and breeding habitats until fall (Brunet and coll., 1998; Prescott and Richard, 2004), at which point they move to their wintering habitat, usually in caves or old mine openings (Banfield, 1977; Mc Duff and coll., 2001). In the east part of their distribution area, *Myotis* bat populations have been decimated by WNS. This disease was first detected in Canada in 2010 and to date has caused a 94% overall decline in numbers of known hibernating *Myotis* bats in Nova Scotia, New Brunswick, Ontario and Quebec hibernacula (MFFP, 2017*c*).

The northern myotis is usually found in boreal forests (Broders and coll., 2003; Owen and coll., 2003), while the little brown myotis is found in a greater variety of habitats such as riparian, forest or anthropogenic sites (Prescott and Richard, 2004). In summer, the two species may use both tree structures (natural cavities or those excavated by woodpeckers, cracks under the bark, etc.) and buildings or rock structures as roosts for resting or rearing their young (maternity colonies) (Tremblay and Jutras, 2010).

HOARY BAT

The hoary bat is also a migratory species found in Quebec (MFFP, 2001*b*) and the largest bat species in Canada. It occupies one of the largest distribution areas, from the Atlantic to the Pacific coast, a part of Canada and extending south to the northern part of South America, including Bermuda and the Greater Antilles (MFFP, 2001*b*). Although the hoary bat is even found in spruce domains, it is rare in Quebec. Acoustic monitoring carried out at the end of the 1990s revealed its presence in a few locations in Estrie, Montéregie, Outaouais, Abitibi-Témiscamingue, Mauricie, Nord-du-Québec, Saguenay–Lac-Saint-Jean, Bas-Saint-Laurent, Gaspésie (Charbonneau and coll., 2011; MFFP, 2001*b*) and the Capitale-Nationale region (Charbonneau and Tremblay, 2010). It usually lives in wooded and semi-wooded areas and mainly hunts moths over glades and bodies of water. In summer, it roosts in trees. In fall, it migrates south to the U.S. and the Caribbean to overwinter (MFFP, 2001*b*).

A forest-dwelling species, it goes out late in the night to hunt, rarely comes in contact with humans and is difficult to see. The threats faced by this species are not well documented. Loss of habitat due to a reduction in snag numbers could have a negative impact, as can human disturbance of its wintering habitat in caves and mines. Just as for the silver-haired bat, it may suffer the effects of the fight against forest insect pests (MFFP, 2001*b*). Loss of habitat, WNS and the development of wind energy are also threats that could affect hoary bat populations (Tremblay and Jutras, 2010).

EASTERN RED BAT

Like the previous species, the eastern red bat is a migratory species (MFFP, 2001c). It is found across North America, including southern Canada and as far as the southern part of Central America and Bermuda. In Quebec, the eastern red bat is even found in spruce domains. In summer, it usually roosts during the day by hanging from a tree or bush branch. At night, it hunts insects such as fog-basking beetles, grasshoppers, moths and flies. In early September, eastern red bats migrate as a group to the Southeastern United States and northeastern Mexico. It then hibernates in tree foliage, hollow trees containing old woodpecker holes or under loose bark. It returns to our latitude around the end of May, where the female gives birth to two or three pups between early June and July (Tremblay and Jutras, 2010).

Since it is a species that is rarely seen or identified, its population trend in Quebec is not known (MFFP, 2001*c*). Data compiled since the mid-1990s has confirms its presence in small numbers in all the administrative regions of Quebec (Tremblay and Jutras, 2010). The fight against insect pests could have a negative impact on this bat as can loss of habitat and the development of wind energy (MFFP, 2001*c*; Tremblay and Jutras, 2010).

6.4 SOCIAL ENVIRONMENT

6.4.1 STUDY AREA

The social environment study area aims to generate a relevant record of the current and future activities of the Cree First Nations touched by the project and of other territory users. The study area for this specific project comprises the easternmost part of the RE2 trapline (Map 6-22) and is demarcated to the north and east by the boundaries of the RE2 trapline. To the south, it includes a zone around Lake Amiskw Matawaw which is used by the tallyman's family. And lastly, its western boundary is a little more than 13 kilometres from the project site. This study area, given the type of activities planned during the mine development phase, will make it possible to adequately evaluate the project's potential impact on the territory users' present or planned activities.

The Cree territory users who participated in the 2017–2018 consultation sessions were questioned with regard to the boundaries of the social environment study area. The RE2 trapline tallyman's family explained that they could not respond to such a query, for they were unaware of the project's impacts. Some users of the territory comprising the two adjacent traplines (VC33 and VC35) mentioned that they would have preferred a larger study area including the northern bank of the Eastmain River, which is where their families practise traditional activities. The social environment study area incorporates the local study area used to determine the project's influence on most of the physical and biological environments' respective components. Moreover, the Eastmain River is not considered an environmental component likely to be touched by the project activities. It was thus agreed to keep the boundaries as proposed in this EIA.

Regarding the landscape, the social environment study area takes into account a radius of 7 to 15 kilometres around the project site. Studying the landscape over this particular area allows for understanding the overall landscape and defining its units.

A specific study area was used to assess the archaeological potential. The boundaries of this area, which covers a total of 56.6 km^2, are shown on Map 6-22.

6.4.2 OVERALL CONTEXT

The study area is in the Nord-du-Québec administrative region, a region that includes cities, Northern villages, Cree villages and Indigenous land. The region's territories are subject to distinct administrative management procedures depending on whether they are located north of the 55th parallel (the Kativik Regional Government territory) or south of it (EIJBRG) (Gouvernment du Québec, 2018*a*). The study area is in the EIJBRG territory and more specifically on the Eastmain Cree community's territory (Map 1- 1).

Established in 2014, the EIJBRG is Québec's only regional government. In addition to the 9 Nord-du-Québec Cree communities, it also includes the 4 James Bay communities of Chibougamau, Chapais and Lebel-sur-Quévillon, along with the villages of Matagami and Valcanton, Radisson and Villebois (also in James Bay) (GREIBJ, 2018*a*). Of all these geographical localities, which were part of the Municipality of Baie-James prior to the establishment of the EIJBRG, the two villages closest to the study area are Matagami (278 km) and Chapais (313 km) (insert of Map 1- 1).

The two sites closest to the study area are the Cree villages of Eastmain and Nemaska, which are respectively 100 kilometres and 82.5 kilometres away (Map 1-1). Each community is administered by a band council and the communities as a whole are governed by the Grand Council of the Crees (GCC). Each community has its own representatives from various regional governments and agencies, among them the Cree Nation Government (CNG), the Cree Trappers' Association, the Cree Nation Youth Council and the Cree Hunters and Trappers Income Security Board.

In 2016, the village of Eastmain comprised 200 occupied private lodgings (Statistique Canada, 2017). The village also includes the council's administrative building, a courthouse (Photo 6-5), a fire station, a police station, a medical clinic run by the Cree Board of Health and Social Services of James Bay (CBHSSJB) (Photo 6-6), a wellness centre, a first responder station (Photo 6-7), the Cree Trappers' Association's regional office (Photo 6-8), a school belonging to the Cree School Board (*Wabannutao*), a daycare centre, a community centre (the *Multi-Services Day Center*), a sports centre with a skating rink, a gas station with a mechanic's shop, a hotel and restaurant (Photo 6-9), a bank, a post office, a community radio station, an airport and a general and grocery store (*Northern*). The village also has water and sewer services.

6.4.3 TERRITORY PLANNING AND DEVELOPMENT

Nearly all of the social environment study area considered for the purposes of this project is found on Category III lands, and a zone northwest of this area cuts into Category II lands (Map 6-22). Management and development of the resources on the territory's Category II and Category III lands is jointly ensured by three primary authorities: the CNG, the EIJBRG and the MERN.

Various development agencies are also involved in regional planning, among them the Cree Regional Authority (James Bay) and the SDBJ.

6.4.3.1 CREE NATION GOVERNMENT AND GRAND COUNCIL OF THE CREES (EEYOU ISTCHEE)

In January 2014, by virtue of *An Act respecting the Cree National Government* (R.S.Q., c. G-1.031, previously the *Act Respecting the Cree Regional Authority*, c. A-6.1), the Cree Regional Authority became known as the Cree Nation Government. This authority can exert municipal competence (local or regional county) over some or all Category II lands. The Eeyou Planning Commission (EPC) has been mandated with preparing a regional plan for the use of Category II lands and resources (Secrétariat aux affaires autochtones, 2016). The CNG represents the Crees as required under the JBNQA in areas such as the environment, the hunting, fishing and trapping regime, and economic and community development (GCC, 2011; Hydro-Québec, 2004). The CNG's headquarters are in Nemaska.

Photo 6-5: Eastmain courthouse

Photo 6-6: **Cree Board of Health and Social Services of James Bay**

Photo 6-7: **First responder station**

Photo 6-8: Cree Trappers' Association regional office

Photo 6-9: Eneyaauhkaat Lodge

The GCC's mandate is two-fold, consisting of defending the interests of the Québec Cree nation at the provincial, national and international levels, and of overseeing the implementation of the JBNQA (of which it is a signatory). The GCC's Board of Directors is made up of a chairman and vice-chairman, elected by popular vote, as well as the chiefs of each of the nine Cree communities, and one other person from each community. In 2003, Washaw Sibi, the members of which had yet to form a Cree community, was named as the 10th Cree nation by the General Assembly of the Grand Council of the Crees; and although their chief and an elected representative have a voice at the Grand Council, the community's status is not officially recognized by the government (GCC, 2011; Washaw Sibi-Eeyou, not dated).

The CNG and GCC are two separate legal entities, but have a similar composition and are managed as a single organization by the Cree Nation (GCC, 2011).

6.4.3.2 *EEYOU ISTCHEE JAMES BAY REGIONAL GOVERNMENT*

The EIJBRG adopted the urban planning regulations that had come into force under the prior Municipality of Baie-James. These regulations notably earmarked the various uses of the different parts of the Category III lands. The territory being studied straddles zones 52-02-R and 52-03-C of zoning regulation no. 79 (GREIBJ, 2018*b*). The planned mining infrastructure is in zone 52-03-C, whose main businesses are vehicle sales and services, accommodations and food services. Other types of uses are also authorized in this sector: resource development, industrial activities (trade, services and industries with a moderate impact, public utility equipment), leisure/recreation (parks and green spaces; intensive and extensive use) and public/institutional uses. Mining activities are thus permitted.

Regarding zone 52-02-R, the primary activity is resource development. Other authorized uses include vacation spots (scattered), industrial activities (public utility equipment), leisure/recreation (parks and green spaces; intensive and extensive use; hunting and fishing lodges), public and institutional uses and conservation activities.

6.4.3.3 *MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES NATURELLES*

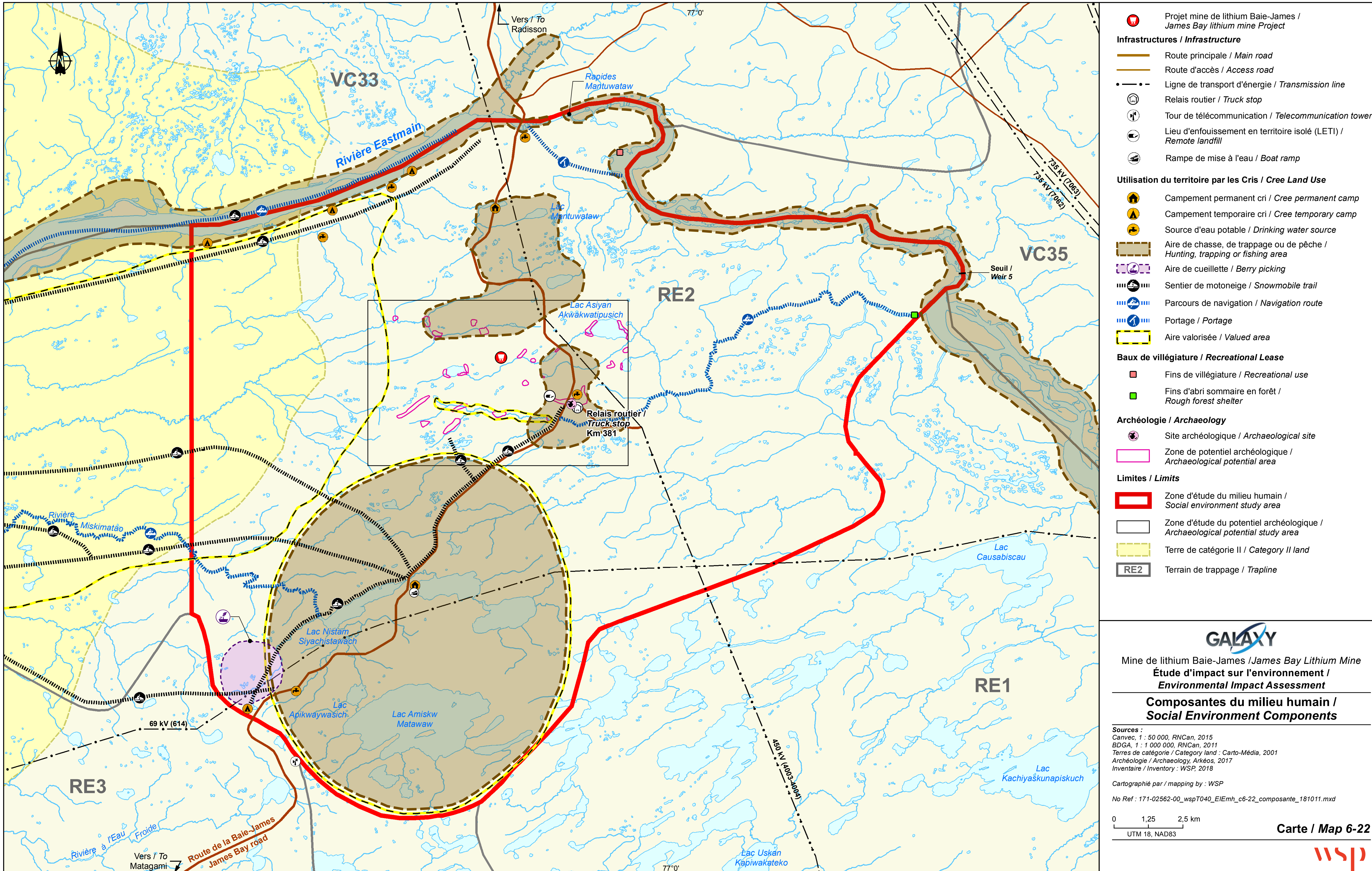
The MERN has the goal of managing and ensuring the sustainable development of Québec's energy and mineral resources as well as its overall territory (MERN, 2018). It is involved in the territory's development and resource management for this very purpose. Public land use plans (PLUPs) and the Regional Plan for Public Land are the MERN's two primary tools for the management and development of public land.

Determining the best use of the public land involves establishing the government's main orientations in terms of public land protection and development. The Regional Plan for Public Land, in turn, seeks to identify, in conjunction with regional stakeholders, principles and conditions for ensuring a harmonious use of public land.

As per the MERN, there are currently no PLUPs or Regional Plans for Public Land in force for the Nord-du-Québec region.

6.4.3.4 *CREE REGIONAL AUTHORITY (JAMES BAY)*

The CRE (Conférence régionale des élus de la Baie-James) was the Québec government's main contact for regional development matters. At present, in the Nord-du-Québec administrative region, the tasks of a CRE (regional council of elected representatives) are split between the Cree Regional Authority (James Bay), the CNG, the EIJBRG and the Kativik Regional Government. The Cree Regional Authority notably has the mandate of promoting cooperation among the regional partners. The following people sit on its Board of Directors: the mayors of Chapais, Chibougamau, Lebel-sur-Quévillon and Matagami, four members from the municipal councils of each of these cities (chosen by their respective councils), and the heads of the local councils of the villages of Radisson, Valcanton and Villebois (ARBJ, 2018).



Vers / To Radisson
77°0'
VC33
Rivière Eastmain
Rapides Mantuwataw
Lac Mantuwataw
Lac Asiyan Akwâkwatipusich
RE2
VC35
Seuil / Weir 5
735 kV (7063)
735 kV (7062)
Relais routier / Truck stop Km 381
Rivière Miskimatao
Lac Nistam Siyachistawach
Lac Apikwaywasich
Lac Amiskw Matawaw
Lac Causabiscau
RE1
69 kV (614)
450 kV (4003-4004)
RE3
Lac Kachiyaskunapiskuch
Rivière à l'Eau Froide
Vers / To Matagami
Route de la Baie-James
James Bay road
Lac Uskan Kapiwakateko
77°0'
Projet mine de lithium Baie-James / James Bay lithium mine Project
Infrastructures / Infrastructure
Route principale / Main road
Route d'accès / Access road
Ligne de transport d'énergie / Transmission line
Relais routier / Truck stop
Tour de télécommunication / Telecommunication tower
Lieu d'enfouissement en territoire isolé (LETI) / Remote landfill
Rampe de mise à l'eau / Boat ramp
Utilisation du territoire par les Cris / Cree Land Use
Campement permanent cri / Cree permanent camp
Campement temporaire cri / Cree temporary camp
Source d'eau potable / Drinking water source
Aire de chasse, de trappage ou de pêche / Hunting, trapping or fishing area
Aire de cueillette / Berry picking
Sentier de motoneige / Snowmobile trail
Parcours de navigation / Navigation route
Portage / Portage
Aire valorisée / Valued area
Baux de villégiature / Recreational Lease
Fins de villégiature / Recreational use
Fins d'abri sommaire en forêt / Rough forest shelter
Archéologie / Archaeology
Site archéologique / Archaeological site
Zone de potentiel archéologique / Archaeological potential area
Limites / Limits
Zone d'étude du milieu humain / Social environment study area
Zone d'étude du potentiel archéologique / Archaeological potential study area
Terre de catégorie II / Category II land
RE2 Terrain de trappage / Trapline
GALAXY
Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement / Environmental Impact Assessment
Composantes du milieu humain / Social Environment Components
Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Terres de catégorie / Category land : Carto-Média, 2001
Archéologie / Archaeology, Arkéos, 2017
Inventaire / Inventory : WSP, 2018
Cartographié par / mapping by : WSP
No Ref : 171-02562-00_wspT040_EIEmh_c6-22_composante_181011.mxd
0 1,25 2,5 km
UTM 18, NAD83
Carte / Map 6-22

The five-year James Bay development plan (*Plan quinquennal jamésien de développement 2015-2020* (ARBJ, 2015) recommends nine orientations, 20 action items and 20 development objectives. The objectives notably include financial support for innovative and feasible projects that involve rare earths. Other objectives involve (to varying degrees) the James Bay Lithium Mine project. These are:

- reducing the percentage of workers in the natural resources sector who are obliged to commute;
- increasing the number of companies with a policy promoting the hiring of James Bay workers;
- increasing the number of new training programs adapted to the employment sector;
- increasing the number of women following study programs in non-traditional occupations;
- implementing measures to facilitate the transportation of merchandise throughout the Nord-du-Québec region;
- increasing the number of active entrepreneurs in the James Bay territory.

The Cree Regional Authority has entered into framework agreements and special agreements with the Québec government regarding the key principles of the regional development strategy. One such special agreement concerns the Table jamésienne de concertation minière. This body's mission revolves around supporting and upholding the mining industry's sustainable development in the James Bay territory while also promoting significant socioeconomic spin-offs for territory residents (ARBJ, 2018).

6.4.3.5 *SOCIÉTÉ DE DÉVELOPPEMENT DE LA BAIE-JAMES*

Created by the Québec government in 1971, the SDBJ has the mission of promoting the sustainable economic development, natural resource development and long-term development of the hydroelectric resources managed by Hydro-Québec on the James Bay territory (SDBJ, 2017).

The SDBJ is active in two sectors, namely economic development and services. Its economic development role mainly consists of identifying, attracting and supporting business projects through a special investment fund. Its activities in the services sector focus on managing transportation infrastructure on behalf of Hydro-Québec and the Ministère des Transports, de la Mobilité durable et de l'Électrification des transports (MTMDET). Over time, the SDBJ's expertise and regional presence have resulted in its being awarded mandates for the management of over 50% of the regional road network, an airport and two airfields (SDBJ, 2017). The SDBJ is notably responsible for maintenance of the James Bay road, which crosses the study area and administration of the Km 381 truck stop, located east of the mining project.

6.4.4 *REGIONAL AND LOCAL ECONOMY AND POPULATION*

This section addresses the socioeconomic situation of the EIJB territory compared to the Nord-du-Québec region and the province as a whole. For each theme, data is first provided for the Cree communities, then for the EIJB communities.

6.4.4.1 *POPULATION*

CREE COMMUNITIES

In 2016, the nine Cree communities comprising the Eeyou Istchee James Bay (EIBJ) territory represented were home to 17,141 residents, compared to 12,629 in 2001 (Table 6-50). In 2016, in fact, the Crees represented over one third (38.5%) of the population of the Nord-du-Québec region. Eastmain, the Cree community touched by this project, consisted of 866 people in 2016, which placed it in seventh position (from a demographic standpoint) among the Cree communities on the EIJB territory. The percentage change in the community's population between 2001 and 2016 was 41.3%, which is higher than that of other Cree communities on the EIJB territory.

Table 6-50: Population of Cree communities, Nord-du-Québec and Québec – 2001, 2006, 2011 and 2016

Territory	Population (individuals) 2001	2006	2011	2016	Variation 2001–2016 (%)
Chisasibi	3,467	3,972	4,484	4,872	40.5
Eastmain	613	650	767	866	41.3
Mistissini	2,597	2,897	3,427	3,523	35.7
Nemaska	566	642	712	760	34.3
Oujé-Bougoumou	553	606	725	737	33.3
Waskaganish	1,699	1,864	2,206	2,196	29.3
Waswanipi	1,261	1,473	1,777	1,759	39.5
Wemindji	1,095	1,215	1,378	1,444	31.9
Whapmagoostui	778	812	874	984	26.5
Cree communities*	**12,629**	**14,131**	**16,350**	**17,141**	**35.7**
Nord-du-Québec	**38,757**	**39,817**	**42,579**	**44,561**	**15.0**
Québec	**7,237,479**	**7,546,131**	**7,903,001**	**8,164,361**	**12.8**

* Population living in Cree communities (Indigenous and non-Indigenous).

Sources: Statistics Canada 2007, 2012 and 2017.

It should be noted that the population residing in EIBJ Cree communities is very young (Table 6-51). In 2016, close to one third (31.4%) of the Cree population was aged 14 and under (Figure 6-4). This proportion was close to twice that recorded in Québec (16.3%), and stood at 27.5% for Nord-du-Québec, also a high figure. In the Eastmain Cree community, this age group (0–14) had a proportion of 34.1%, higher than the average of the population aged under 15 in the EIBJ territory. Conversely, in the same period, the 65-and-over age group was less well represented in the EIBJ (5.5%) and Nord-du-Québec (7.7%) communities than in the whole of Québec (18.3%).

Table 6-51: Age-group distribution of the population in Cree communities, Nord-du-Québec and Québec – 2016

Territory	Population by age group: 0–14 Number	0–14 %	15–54 Number	15–54 %	55–64 Number	55–64 %	65 and over Number	65 and over %	Total Number	Total %
Cree communities	5,385	31.4	9,670	56.4	1,175	6.9	940	5.5	17,170	100
Nord-du-Québec	12,270	27.5	24,520	55.0	4,325	9.7	3,445	7.7	44,560	100
Québec	1,333,260	16.3	4,136,760	50.7	1,199,145	14.7	1,495,195	18.3	8,164,360	100

Note: All data in this table have been subjected to random rounding to a multiple of 5 by Statistics Canada. Since totals were rounded separately, they do not necessarily match the sum of the rounded figures.

Source: Statistics Canada, 2017.

For the 2015-2016 year, inter-regional net migration in EIBJ was almost nil, standing at -0.21%, representing the loss of 34 persons. During this period, these persons moved mainly to the Outaouais, Laurentides and Centre-du-Québec regions (ISQ, 2017*a*).

According to the Institut de la statistique du Québec (ISQ), the population of Cree communities should continue its demographic growth over the coming years. Between 2011 and 2036, it should increase by 41.1% to reach a total of 23,320 persons. In comparison, the population of Nord-du-Québec and Québec should increase respectively by 25% and 17.3% over the same period (ISQ, 2014*a*). In regard to households, between 2011 and 2036, their number should increase by close to 68% in Cree communities, compared with 34% for Nord-du-Québec and 20.6% for Québec (ISQ, 2014*b*).

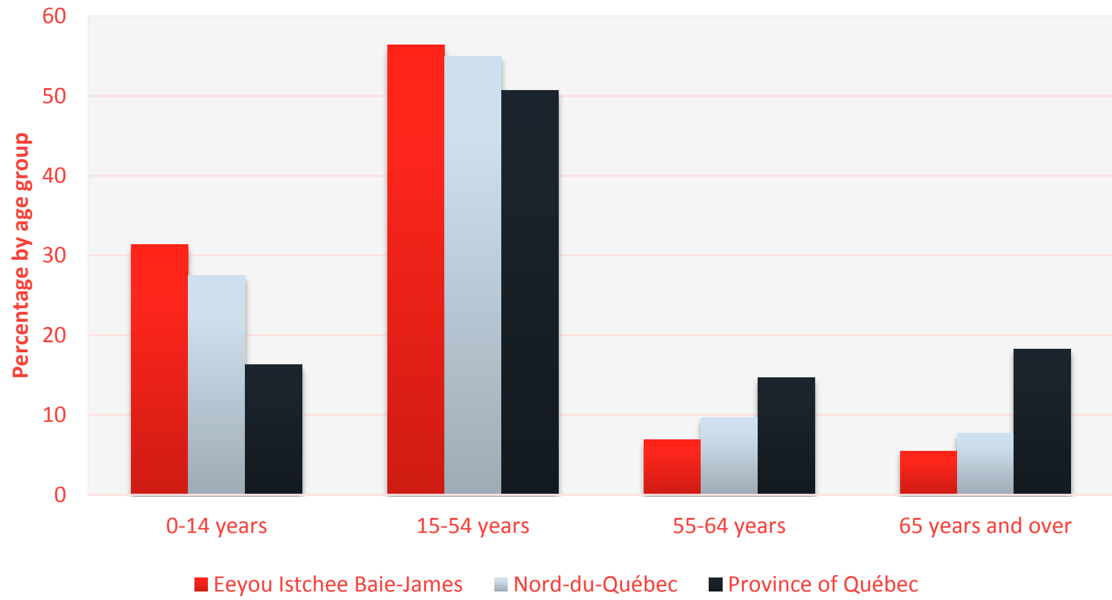


Figure 6-4: Population distribution by major age groups in Cree communities, Nord–du-Québec and Québec – 2016

Source: Statistics Canada, 2017.

JAMES BAY COMMUNITIES

In 2016, the population of James Bay communities was 14,232 persons. Chibougamau was the largest population centre with 7,504 persons, and Lebel-sur-Quévillon, with a population of 2,187, was in second place (Table 6-52). Unlike that of Cree communities, the population of James Bay communities is shrinking. Between 2001 and 2016, James Bay communities lost 12.8% of their population.

Table 6-52: Population of James Bay communities, Nord-du-Québec and Québec – 2001, 2006, 2011 and 2016

Territory	Population (individuals)				Variation (%)
	2001	2006	2011	2016	2001–2016
Chapais	1,795	1,630	1,610	1,499	-16.5
Chibougamau	7,922	7,563	7,541	7,504	-5.3
Lebel-sur-Quévillon	3,236	2,729	2,159	2,187	-32.4
Matagami	1,939	1,555	1,526	1,453	-25.1
Villages	1,422	1,394	1,303	1,589	11.7
James Bay communities	**16,314**	**14,871**	**14,139**	**14,232**	**-12.8**
Nord-du-Québec	**38,757**	**39,817**	**42,579**	**44,561**	**15.0**
Québec	**7,237,479**	**7,546,131**	**7,903,001**	**8,164,361**	**12.8**

Sources: Statistics Canada 2007, 2012 and 2017.

A reading of the population data from the 2016 census shows that the James Bay population has an age-group distribution similar to that of Québec, although it has a smaller proportion of persons aged 65 and over, and slightly higher proportions of the three other age groups (Table 6-53). The James Bay population differs, however, from that of Nord-du-Québec, since the latter is influenced by the high level of young people among the Cree population. Also, the average age of the James Bay population in 2016 was 40.4 years, compared with 32.4 for the Nord-du-Québec region and 41.9 for Québec (ISQ, 2017*b*, 2017*c*).

Table 6-53: Age-group distribution of the population of James Bay communities, Nord-du-Québec and of Québec – 2016

	Population by age group									
	0–14		15–54		55–64		65 and over		Total	
Territory	Number	%	Number	%	Number	%	Number	%	Number	%
James Bay communities	2,470	17.4	7,460	52.4	2,280	16.0	2,020	14.2	14,230	100
Nord-du-Québec	12,270	27.5	24,520	55.0	4,325	9.7	3,445	7.7	44,560	100
Québec	1,333,260	16.3	4,136,760	50.7	1,199,145	14.7	1,495,195	18.3	8,164,360	100

Note: All data in this table have been subjected to random rounding to a multiple of 5 by Statistics Canada. Since totals were rounded separately, they do not necessarily match the sum of the rounded figures. In addition, because of rounding, totals do not always equal 100%.

Sources: Statistics Canada (2017)

Regarding migration, inter-regional net migration involving the James Bay population shows a loss of 232 persons for the years 2015–2016. Most of these people went to the Saguenay–Lac-Saint-Jean, Abitibi-Témiscamingue and Montérégie regions (ISQ, 2017*a*).

According to the ISQ, the demographic decline of the James Bay population should continue between 2011 and 2036. By 2036, the James Bay population should have declined by 6.1% since 2011, to number 13,412 people. In contrast, the population of Nord-du-Québec and Québec should increase by 25% and 17.3% respectively between 2011 and 2036 (ISQ, 2014*a*). The number of James Bay households should diminish by 0.6% between 2011 and 2036 (ISQ, 2014*b*).

6.4.4.2 *EDUCATION LEVELS*

CREE COMMUNITIES

In 2011, there were 4,810 Cree aged 15 and over who held at least one secondary-education diploma, amounting to 44.2% of the population of Cree communities, as against 77.8% in Québec (Table 6-54). In 2016, the number had risen to 5,715 Cree, or 48.7% of the population, compared with 80.1% for Québec. Thus, although the graduation rate increased by 4.5 percentage points between 2011 and 2016, the education level of the Cree population remains distinctly lower than the level for Québec.

Moreover, Cree student participation in postsecondary studies is low. Among other things, this translates into a 2016 university degree rate (all cycles taken together) that is lower in Cree communities (8.8%) than in the population of Québec (24.1%). However, the number of university graduates rose from 818 in 2011 to 1,030 in 2016. The greatest increase since 2011 has been seen in college studies, where the variation rate is 26.3%, followed by vocational training with a rate of 19.5%.

According to the JBCSB, in 2015, there were 638 students enrolled in postsecondary education, as against 438 in 2010. Of the 638 students in 2015, 468 were studying at a CEGEP, 120 at a university and 50 at another training centre. Of these 638 students, 16 were from the Eastmain community (CSB, 2016).

Table 6-54: Highest level of education attained by the population aged 15 and over in Cree communities and in Québec – 2011 and 2016

Level of education	2011			2016			Variation 2011–2016	
	Cree communities		Québec	Cree communities		Québec	Cree communities	Québec
	Number	%	%	Number	%	%	%	%
No high-school diploma	6,080	55.8	22.2	6,015	51.3	19.9	-1.1	-7.9
High-school diploma or some postsecondary studies	1,200	11.0	21.7	1,340	11.4	21.5	11.7	1.6
Diploma or certificate from a trade school (vocational training)	1,515	13.9	16.2	1,810	15.4	16.9	19.5	6.8
Collegiate diploma or certificate or some university studies	1,215	11.2	16.6	1,535	13.1	17.6	26.3	8.3
University diploma, certificate or degree	880	8.1	23.3	1,030	8.8	24.1	17.0	5.9
Total	**10,890**	**100**	**100**	**11,730**	**100**	**100**	**-**	**-**

Note: All data in this table have been subjected to random rounding to a multiple of 5 by Statistics Canada. Since totals were rounded separately, they do not necessarily match the sum of the rounded figures. In addition, because of rounding, totals do not always equal 100%.

Sources: Statistics Canada (2012 and 2017).

JAMES BAY COMMUNITIES

In 2016, the level of education was lower in James Bay communities than in the rest of Québec. In total, 73% of residents aged 15 and over had at least one secondary-level diploma, compared with 80.1% for Québec. The discrepancy is greater at the university level. Only 1,360 James Bay residents (12.1%) had a university education (all cycles taken together), that is, less than half the proportion in the Québec population (24.1%). However, it should be noted that graduation rates have been increasing since 2011 (Table 6-55). Among James Bay graduates, most hold a vocational diploma, both in 2011 (23.5%) and in 2016 (26.9%).

Regarding high-school graduation among James Bay residents, available data show that in 2010 the rate stood at 56.9% after five years of schooling and 69.7% after seven years (MELS, 2008, 2011).

The CFPBJ, in Chibougamau, has two other points of service, one at Lebel-sur-Quévillon and the other at Matagami. It offers a set of study programs in a number of sectors, particularly in the mining sector. Programs offered are determined in collaboration with the Commission de la Construction du Québec, the Agence de santé régionale or Emploi-Québec in order to ensure that they meet the region’s needs for labour. CFPBJ programs of interest to the mining industry are the following: Diamond Drilling, Drilling and Blasting, Ore Extraction, and Operation of Ore-Processing Machines (CFPBJ, 2017). The CFPBJ also works in concert with mining companies to adapt its training programs to their situation and needs. Thanks to this collaboration, field training periods are organized on partner mining sites, enabling students to learn in their future working environment (Sonia Caron, CFBJ, telephone interview, February 2018).

Table 6-55: Highest level of education attained by the population aged 15 and over in James Bay communities and in Québec – 2011 and 2016

Level of education	2011 James Bay communities Number	2011 James Bay communities %	2011 Québec %	2016 James Bay communities Number	2016 James Bay communities %	2016 Québec %	Variation 2011–2016 James Bay communities %	Variation 2011–2016 Québec %
Without high-school diploma	3,220	31.6	22.2	3,025	27.0	19.9	-6.1	-7.9
High-school diploma or some postsecondary studies	1,775	17.4	21.7	1,995	17.8	21.5	12.4	1.6
Diploma or certificate from a trade school (vocational training)	2,395	23.5	16.2	3,015	26.9	16.9	25.9	6.8
Collegiate diploma or certificate or some university studies	1,530	15.0	16.6	1,805	16.1	17.6	18.0	8.3
University diploma, certificate or degree	1,255	12.3	23.3	1,360	12.1	24.1	8.4	5.9
Total	**10,175**	**100**	**100**	**11,195**	**100**	**100**	-	-

Notes: 2011 data do not include the population of Matagami aged 15 and over. Data from the National Household Survey were removed for reasons of data quality or confidentiality.
All data in this table have been subjected to random rounding to a multiple of 5 by Statistics Canada. Since totals were rounded separately, they do not necessarily match the sum of the rounded figures. In addition, because of rounding, totals do not always equal 100%.

Sources: Statistics Canada (2012 and 2017).

6.4.4.3 *INCOME*

CREE COMMUNITIES

Disposable Income Per Capita

In 2015, disposable income per capita in Cree communities was $23,256, which is $3,202 more than the figure in 2011 (Table 6-56). Although the income levels are lower than what is seen regionally and provincially, the increase between 2011 and 2015 was greater for the Cree than for the Nord-du-Québec region ($2,784) and for Québec as a whole ($2,464) (ISQ, 2017*d* and *e*). Per capita disposable income consists of employment income and government transfers, such as Employment Insurance, Old Age Security, Social Assistance and Québec Pension Plan benefits, minus taxes and other contributions.

Table 6-56: Disposable income per capita, income of workers from 25 to 64 (2011–2015) and couple-family median income in Cree communities, Nord-du-Québec and Québec – 2011-2014

	Income ($)					
	Disposable per capita		Employees from 25 to 64 years old		Median for couple-families	
Territory	2011	2015	2011	2015	2010	2014
Cree Communities	20,054	23,256	34,461	40,173	74,044	83,890
Nord-du-Québec	21,301	24,085	36,483	42,054	76,314	80,080
Québec	24,393	26,857	36,729	39,332	66,311	68,570

Sources: ISQ (2017d, e, f, g, h) and ISQ (2014c).

The proportion of per capita income from government transfers for the Cree in 2015 was higher than that of Nord-du-Québec and Québec as a whole (ISQ, 2017*d* and *e*).

Income of Employees Aged 25 to 64

In 2015, median employment income for workers from 25 to 64 years old in Cree communities was $40,173 (Table 6-56). Since 2011, income for this group of workers has increased to $34,461 for a 16.6% rise. By comparison, income for employees between 25 and 64 years old in Québec was $39,332 in 2015 (ISQ, 2014*c*, 2017*f*).

Median Family Income

Median after-tax income of couple-families in Cree communities increased from $74,044 in 2010 to $83,890 in 2014, an increase of 13.3% in four years (Table 6-56). The increase is more than double that of Nord-du-Québec (4.9%) and nearly four times higher than Québec as a whole (3.4%). In 2014, the median income of Cree families was higher than the level in Nord-du-Québec ($80,080) (ISQ, 2017*g* and *h*).

The Income Security Program for Cree Hunters and Trappers

In 1976, the JBNQA established the Cree Hunters and Trappers Income Security Program (ISP) to encourage the Cree, by providing income support, to continue their traditional hunting, fishing or trapping activities. For the 2016–2017 period, the participation rate across the entire IBIS territory was 13.9%, representing a slight decrease compared to 15.2% in 2015–2016 and 15.7%. in 2014–2015. The rate is also lower than the 2009–2010 rate of 14.9%. In Eastmain, the percentage of ISP participants rose to 9% in 2016–17, an increase of 1.4% from the 2009–2010 rate. There were 73 people (59 adults and 14 children, equal to 43 family units) from Eastmain enrolled in ISP in 2016–17. Note that ISP provided average incomes of nearly $17,000 per claimant (i.e., family unit) in 2016–17 (OSRCPC, 2010 and 2018).

JAMES BAY COMMUNITIES

Disposable Income Per Capita

Per capita disposable income in James Bay communities was $29,189 in 2015, up $3,219 from 2011 (Table 6-57) (ISQ, 2017*d*). This income is higher than Québec as a whole ($26,857) and the Nord-du-Québec region ($24,085) (ISQ, 2017*e*).

Table 6-57: Disposable income per capita, income of workers from 25 to 64 (2011–2015) and couple-family median income in the James Bay communities, Nord-du-Québec and Québec (2011–2014)

	Income ($)					
	Disposable per capita		Employees from 25 to 64 years old		Median for families consisting of one couple	
Territory	2011	2015	2011	2015	2010	2014
James Bay Communities	25,970	29,189	41,579	49,016	75,073	78,830
Nord-du-Québec	21,301	24,085	36,483	42,054	76,314	80,080
Québec	24,393	26,857	36,729	39,332	66,311	68,570

Sources: ISQ (2017d, e, f, g, h) and ISQ (2014c).

Income of Employees Aged 25 to 64

In 2015, the median employment income of James Bay workers from 25 to 64 years old was $49,016. The income for this group of workers is increasing, with a growth rate of 15.2% for the period 2011–2015. Note that between 2011 and 2015, the Québec population's median employment income increased by 7.1%, from $36,729 to $39,332 (ISQ, 2014*c*, 2017*f*).

Median Family Income

A James Bay family's median after-tax income increased from $75,050 in 2010 to $78,830 in 2014, an increase of 5.0% in four years. This increase is lower than that in Nord-du-Québec (5.8%), but higher than the provincial rate

(3.2%). A James Bay couple-family median after-tax income is slightly lower ($75,073 in 2010 vs. $78,830 in 2014) than the region's for the same period ($76,314 in 2010 vs. $80,080 in 2014) (ISQ, 2017*h* and *g*).

6.4.4.4 *LABOUR MARKET*

From 2012 to 2016, the participation rate for the Côte-Nord–Nord-du-Québec region increased from 61.0% to 64.2% while the employment rate gained more than two percentage points, ranging from 56.4% to 58.8%.[11,12] The unemployment rate dropped from 2015 to 2016, from 9.8% to 8.7%, after an increase in 2014–2015.[13]

Note that the Côte-Nord–Nord-du-Québec region ranks first among the regions that had the highest employment growth from 2015 to 2016. The growth rate was 6.7% compared to 0.2% for Québec as a whole (ISQ, 2017*i*).

CREE COMMUNITIES

The Cree labour force, 15 years old and over, reached 7,665 people for all Cree communities in 2016. The participation rate for all Cree communities was 67.7% with almost identical rates for men (68.5%) and women (67.0%). The participation rate was 73.0% for Eastmain (420 working people). Participation rates of men and women for Eastmain in 2016 differed by 1.1 percentage points (72.2% for men and 73.3% for women).

Of the working population, the employed represented 6,445 people for all communities (employment rate 57.8%), including 385 in Eastmain. According to Statistics Canada, the number of employed women was generally higher than men.

In 2016, there were 1,225 unemployed people in all Cree communities, with an unemployment rate of 15.0%. More men than women were unemployed (785 versus 425). In Eastmain, the number of unemployed was 40, with an unemployment rate of 9.5% (Statistique Canada, 2017).

JAMES BAY COMMUNITIES

In 2016, the unemployment rate for the entire James Bay communities population was 9.0%, higher than Québec (7.2%) (Statistics Canada, 2017). The rate is higher for men (10.1%) than for women (6.9%). The situation is partly due to problems in the forestry industry, a sector employing mainly men. However, participation and employment rates, 66.7% and 61.0% respectively, were higher than those in the rest of Québec (60.5% and 56.7%). According to ISQ data, in 2015, the James Bay population included 6,208 workers from 25 to 64 years old (ISQ, 2017j).

In the first half of 2013, among the 45 occupations in demand in the Nord-du-Québec region, six were associated with the mining sector: underground production and development miners, mining and quarrying supervisors, work site and industrial mechanics, geology and mineralogy technicians and technologists, mining engineers and geologists (Emploi-Québec, 2017).

6.4.4.5 *STRUCTURE OF THE ECONOMY*

CREE COMMUNITIES

The structure of the Cree economy is mainly based on the tertiary sector, particularly band councils and school and health institutions. However, traditional hunting, fishing and trapping remains important to Cree communities.

In 2016, almost two thirds (62.8%) of the Cree labour force with experience worked in the following categories: business, finance and administration, sales and services, education, law and social services, community and government services.[14] The trade, transportation and machinery categories accounted for 13.7% of the experienced labour force, 2.6 percentage points lower than in 2011. Occupations in the primary sector accounted for 4.6% of the EIBJ workforce in 2016, compared with 1.6% in Québec. The processing, manufacturing and utilities sectors accounted for only 0.9% of the experienced labour force in 2016, compared to 4.9% for Québec (Statistique Canada, 2017).

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11 The participation rate is the working population as a percentage of the total population 15 years old and over.

12 The employment rate (also called the employment-population ratio) reflects the number of people working relative to the population 15 years old and over.

13 The unemployment rate represents the number of unemployed in relation to the working population.

14 Individuals 15 years old and over who were employed or unemployed during the week prior to Census Day, and last worked for a salary or by contract in 2005 or 2006.

The Council of the Cree Nation of Eastmain employed about 75 people in 2011. It is divided into eight departments: Administration and Human Resources, Public Works, Public Safety (Public Safety and Fire Protection), Public Health which includes First Responders and "Healing" Departments, Special Projects, Department of Culture, Youth, Sports and Recreation, Housing and the Police (Première Nation d'Eastmain, 2011).

Economic activities in Eastmain are primarily related to these sectors: services, restaurants, transportation (including airport management), construction (three companies), trapping and to a lesser extent, trade as well as outfitter sectors (AADNC, 2011). Wabannutao Eeyou Economic Development Corporation's (WEDC) mandate is to foster the development of businesses in the community. It also manages a variety of businesses including a hotel, restaurant, cell phone service store, amusement centre, construction company, gas station and mechanical workshop (Craig William, WEDC, ind. interview, June 2018).

JAMES BAY COMMUNITIES

When it comes to the economy, James Bay communities are largely dependent on the energy, mining and forestry sectors. The economic structure of the James Bay communities remained relatively identical from 2006 to 2011. Jobs in management, business, finance and administration, science and sales and services accounted for 56.7% of the experienced labour force (15 years old and over in 2006) and for 59.7% in 2011. However, in 2016, the same sectors experienced a significant drop to 44.9%. Trades, transportation and machinery jobs accounted for about 21% of the experienced labour force in 2006 and 2011. A decrease to 18.5% is evident in 2016. Elsewhere, jobs in the primary sector experienced significant growth in 2016 (7.1%) compared to 2006 (5.9%) and 2011 (3.2%). The experienced labour force in the primary sector remains larger in proportion than in the rest of Québec (1.6%).

Machinery rental makes up a large part of business for construction companies in James Bay communities. Construction and transportation contracts derive mainly from mining and forestry companies, but really took off during Eastmain-1 and Eastmain-1-A–Sarcelle–Rupert hydroelectric projects. In contrast, residential construction is slowing down due to population declines (CREBJ, not dated).

6.4.4.6 *DEVELOPMENT PROJECTS*

The EIBJ territory is currently under the scrutiny of several mining companies for exploration or extraction. Eastmain Resources has a project to explore a gold deposit just over 80 kilometres east of the James Bay Lithium Mine project. The Whabouchi mining project by Nemaska Lithium completed its environmental assessment and is currently at the pre-construction phase; it is located more than 100 kilometres southeast of the James Bay Lithium Mine project and will mine a spodumene deposit. The Rose lithium-tantalum mining project by Critical Elements Corporation is located 60 kilometres southeast of this project and is currently undergoing an environmental assessment. The project will also require the relocation of a 315-kV electrical transmission line and the construction of a substation.

In addition, a James Bay road repair program, set up by the SDBJ, has been underway since 2015. The road will be resurfaced up to kilometre 381. Past this distance, culvert changes are planned. The reconstruction project extends to the Cree community of Chisasibi. The work will include the reconstruction of the upper road bed, the replacement of several existing culverts and bridges, tree removal along the road, and sign upgrades. The reconstruction program will cost $265 million and will end in 2021. Most of the investment will be from 2018 to 2021. The James Bay road reconstruction between kilometres 320 and 381 is scheduled for 2020.

Locally, the Eastmain community, like all other Cree communities, faces a housing problem due to aging, overcrowding and poorly-built residential infrastructure (GCC, 2011). Thus, according to an Eastmain First Nation Council representative, an additional 40 homes would be needed to meet the demand for housing in the community. The waiting list has 32 names and 30 lots are available in the community for residential construction. The Eastmain First Nation undertakes the construction of approximately one house a year. It also plans to construct a multiple-dwelling structure in 2019 (Mark Tivnan, Eastmain Cree First Nation, ind. interview, July 2018).

During the 2017–2018 consultations, some Cree users of the territory also mentioned that they had recently started the commercial harvest of wild mushrooms in the social environment study area. In addition, a very preliminary outfitters project was mentioned.

6.4.5 QUALITY OF LIFE AND WELL-BEING

According to the World Health Organization, health is defined as: "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". This vision of health is characterized by a search for balance between individuals and their environment, such as will optimize their well-being. In this context, health results from a constant interaction between individuals and their environment, with a range of dimensions determining their state of health. These dimensions are called determinants of health, which are the factors, within the population and/or at the individual level, that will change or improve health, depending on their state (INSPQ, 2014).

For the Cree, this "complete state of well-being" is known as *miyupimaatisiiun*, and is not only the result of determinants of health, but also the product of a balance among several social, economic and environmental factors (nature, diet and social balance). This vision of health as a multidimensional and interdependent totality is a holistic vision of health (INSPQ, 2014).

According to the GCC, the Cree population groups that could potentially be concerned by the development of projects on EIJB territory are as follows:

- workers employed on the projects;
- workers employed by businesses offering services and supplies to the projects;
- the spouse(s), children and families of workers;
- users of the territory near the projects;
- the communities whose territory is affected by the projects;
- local health and social services;
- the Cree Nation;
- other populations (GCC, 2011).

A brief overview of the primary determinants of health among the Cree that could be affected by the project is presented in the sections that follow.

6.4.5.1 LIFESTYLE

In 2003, the Cree Board of Health and Social Services of James Bay (CBHSSJB) conducted a health survey of the Cree in collaboration with the INSPQ (CBHSSJB and INSPQ, 2008).

According to this study, the five main long-term health problems reported by the Cree in 2003 were hypertension, allergies other than food, diabetes, back pain and migraines. Nearly 60% of the Cree population aged 12 years or older indicated they were affected by one of these problems. A 22% proportion of respondents said they *sometimes or often* limited their daily activities due to a health problem.

Also, according to the survey, over half of Cree adults (51%) were obese and a third (33%) overweight. Furthermore, in the year prior to the survey (2003), just over a quarter (27%) of the adult population had experienced food insecurity. This situation was associated primarily with inadequate income.

According to the INSPQ, official statistics corroborate the perceptions the Cree have of their health. The mortality rate from respiratory disease is very high among the Cree, as are the rates of renal cancer, diabetes and hypertension (INSPQ, 2006).

However, there are some positive aspects in terms of the health situation. Looking at work-related diseases, we see that Cree workers experience high daily stress less often, and their incidence of occupational injuries is lower. Furthermore, the Cree walk more to get to work or school, and very few are physically inactive.

A 2013 report on the state of health of the people of nine Cree communities, *Overview of the Health of the Population of Region 18*, provides a new overview (CBHSSJB, 2013). Data on life expectancy and infant mortality for the Eeyouch (James Bay Cree) approach those for Québec and are much better than those recorded for several other Indigenous groups.

However, the prevalence of diabetes is increasingly problematic. In 1983, diabetes afflicted 2.4% of Eeyouch people; in 2011, more than one Eeyouch adult in five was afflicted. In 2009, the rate was already 3.3 times that for Québec. However, positive changes are noted, and more people are becoming active, engaging in an ever-widening range of activities (CBHSSJB, 2013).

6.4.5.2 SOCIAL ENVIRONMENT

SOCIAL ISSUES

Social issues that come up repeatedly in the literature and in consultation meetings held for the James Bay Lithium Mine project revolve primarily around alcohol abuse, theft and vandalism associated with young people, the use of illegal drugs, child neglect and domestic violence.

The general data indicate alcohol consumption in Cree communities to be a relatively recent social problem. The available data indicate that the proportion of people who had consumed alcohol (at least once in the year prior to the survey) increased between 1991 and 2003, rising from 49% to 53%, while that of people who had never consumed alcohol dropped considerably during this same period, falling from 23% to 14%. Likewise, the proportion of adults in Cree communities who consume alcohol at least occasionally rose from 35% in the 1980s to 49% in 2001. This proportion remains below average when compared with other regions of Canada. According to the CBHSSJB, young Cree are now more exposed to alcohol than previous generations were, since access routes (the road, airport, etc.) have contributed to the increased availability of alcoholic beverages (CBHSSJB, 2005).

The causes of excessive consumption are many. Some point to socioeconomic problems such as idleness, the rapid transition from one way of life to another, lack of income, and frustrated aspirations as underlying causes of the high demand for alcohol, and likely for drugs (INRS, 1998). It appears that abusive alcohol consumption and the associated social issues are tied to the same types of variables in Indigenous communities as among non-Indigenous people. These variables include the person’s age, their degree of social integration in the community, social policies, the legal context, and so on; it is the particular combination of these factors that creates the specific problems and their increased prevalence among Indigenous people (May, 1996).

Furthermore, based on several studies done of First Nations, gambling is a veritable “scourge” among Indigenous people. The effects of gambling are much more evident in the context of poverty in which many Indigenous people find themselves, and compound other serious social problems. The problem is particularly acute in urban settings (INSPQ, 2010).

SENSE OF BELONGING AND SOCIAL COHESION

There are different definitions of a sense of social connectedness. A majority of researchers agree that it involves a dimension of acceptance (feeling of being understood and respected) and of intimacy, attachment and proximity with other people (Richer and Vallerand, 1998). Furthermore, social cohesion can generally be defined as the result of processes (socialization, participation, interaction, etc.) by which individuals share values and standards of conduct, which provide a sense of belonging to the group. This cohesion leads individuals to trust others and to share resources. It therefore involves living as a group, a sense of sharing, of common good and participation in civil society (Helly, 1999). It is often associated with the level of mutual aid, traditions and language spoken.

The Cree in the EIJB territory show a strong sense of belonging to their community. In 2003, 82% of Cree experienced a sense of belonging (qualified as “somewhat strong” or “very strong”). This proportion is significantly higher than that found among French-speaking Quebecers (56%) (CBHSSJB and INSPQ, 2008). This sense of belonging is equally developed among young and older people. The near absence of immigration seen in the EIJB territory may contribute to the strong general sense of belonging: population growth in the territory is the result of a combination of high fertility and rising life expectancy (INSPQ, 2006).

Social cohesion in Cree communities is higher than that seen in Québec overall. In 2001, a third (32.3%) of Cree aged 15 years or older cared for the elderly without compensation, compared with 17.7% of Québecers. This proportion is similar for both men and women. Despite the changes experienced in the Cree Nation in recent years, it remains very attached to traditional activities and to use of the Cree language, which may contribute to the social cohesion of the Cree nation. Indeed, in 2003, a very high proportion (89%) of Cree spoke mainly Cree at home. Furthermore, most Cree can carry on a conversation in English and some also speak French (CBHSSJB and INSPQ, 2008).

TRADITIONAL LIFESTYLE

With the development of numerous major projects in the EIJB territory since the 1970s, the culture and identity of the James Bay Cree have been under significant pressure, characterized by several changes related to contemporary life. As development of projects in the EIJB territory is pursued, the GCC expects that Indigenous communities will be increasingly exposed to non-Indigenous people. Development of the territory must therefore go forward with respect for the traditions and culture of First Nations, meaning efforts to heighten awareness must be put in place so that non-Indigenous people are more enlightened and familiar (GCC, 2011).

Furthermore, the GCC has identified passing on Cree culture to young people as a priority in order to preserve the language, knowledge, traditions and abilities of elders. The Cree nation has several organizations that aim to preserve and promote Cree culture and identity: the Department of Traditional Pursuits, Cree Regional Authority (CRA), Aanischauuukamikw Cultural Institute, Cree Native Arts and Crafts Association, and the local cultural coordinator present in each community (GCC, 2011).

6.4.5.3 *HEALTH AND SOCIAL SERVICES*

The CBHSSJB, in partnership with the Ministère de la Santé et des Services sociaux du Québec (MSSS), manages and organizes health and social services in the nine communities of the Cree Territory of James Bay (MSSS Administrative Region 18) (CBHSSJB, 2012). It is also responsible for promoting the health and well-being of the Cree (INSPQ, 2014).

The CBHSSJB manages all establishments providing health and social services in the region. Establishments under its responsibility are the regional hospital in Chisasibi and the (CMCs), located in each of the nine Cree communities. The CMCs provide general medical services, home care, dental care and social services. The Chisasibi Hospital has 29 beds, 17 of which are used for active care. A hemodialysis unit has nine beds (CBHSSJB, 2012).

During the meeting with CBHSSJB Eastman representatives, the latter presented several problems the organization is currently facing in responding to the needs of the population. Difficulties with nurse recruitment, and the availability of only one ambulance, were mentioned.

6.4.6 *USE OF TERRITORY*

6.4.6.1 *CURRENT USE OF LAND AND RESOURCES FOR TRADITIONAL PURPOSES*

The EIJB territory has nine Cree communities. The only community found in the project study area is the Eastmain community.

Since the creation of beaver reserves in the 1930s, the Cree territory is divided in traplines. Each trapline is under the responsibility of a tallyman who, each year, supervises the dividing of the resources to use and areas to preserve to ensure renewal of the species sampled.

The territory of the Eastmain community includes 15 traplines. The planned mining infrastructure is located on the RE2 trapline occupying 5.8% of the Eastmain community's total trapping territory of 15,668 km^2. No other trapline is concerned by the current study, although during the consultations, users frequenting nearby traplines (VC33 and VC35) also deemed they could be impacted by the project (Map 6-22). Users generally agree that it is difficult to delimit the size of the study area for consideration, since they are unaware of the extent of the mine's impacts (such as noise, dust, contaminants and odours) on the trapline.

The principal activities carried out on the traplines are hunting, fishing and trapping of fur-bearing animals. They take place year-round, according to specific practices and timetables. Frequenting the trapline is also considered a revitalizing and curative activity for users.

Note that fur-bearing animal captures by Cree trappers are documented yearly by the Cree Trapper's Association. In 2015–2016, the main species collected and documented for the Eastmain community are, in rank of importance and including number of specimens: marten (55), beaver (47), moose (20), black bear (14), (12), muskrat (12), lynx (12), fox (various species) (7), and otter (6) (CTA, 2016).

The RE2 trapline is located 25 kilometres east of the village of Eastmain and spans 90 kilometres. It is bordered to the north by the Eastmain River. The study area, located in the trapline's eastern section, covers nearly half of its area. This is the most frequented section since it is crossed, from north to south, by the James Bay road. The km 381 truck stop and two transmission lines are in this part of the trapline.

The 2013 forest fire affected a large part of the trapline, leading to a decrease in its use and in the resources collected on the land. However, with renewed plant growth and the return of resources, users are gradually getting back to their normal activities, which they expect to continue in the future.

The territory considered for the project and its vicinity is currently frequented by family members of the RE2 trapline tallyman, mainly to hunt moose and goose, to fish and trap, and to gather berries and other plants. Brian Weapenicappo has been the RE2 trapline licensee since he replaced his uncle Clarence Mayappo as tallyman in 2014. Several members of his extended family are occasional or regular trapline users.

Two permanent encampments are found in the study area, along the James Bay road. One of these, built in 2016 and located 7 kilometres northwest of the project site, includes a single camp. The second encampment, less than 10 kilometres south of the project site, includes four camps and a tipi. These camps are the users' main camps and may be frequented year-round: in spring, mainly during goose hunting; in autumn, during moose hunting; on weekends or holidays, for fishing and the other activities. Trapping activities usually are usually done in fall and winter. Winter is also a good time for hunting or snaring small wild game (such as ptarmigan or hare) and for hunting moose. Users of these camps are also ISP recipients, which means they spend at least four months per year on the land.

Some temporary encampment sites are also present along the Eastmain River. Tents can be set up there, when needed, mainly during moose hunting or for fishing.

Moose hunting is carried out in the study area, but there are few sites specific to this activity since the moose population is scattered across the territory. However, the Eastmain River (in the study area) and James Bay road remain especially frequented for this activity.

Fishing is mainly practised on two lakes in the study area's southern portion. The intersection of the James Bay road and Eastmain River (in the study area's northern part) is also well frequented for fishing activities. Sturgeon, pike, walleye and whitefish are fished there. The community has plans for a sturgeon spawning ground enhancement project in the vicinity. This would limit fishing on this site for the time needed to ensure its sustainability.

Various locations in the study area are frequented for goose hunting, primarily east of the James Bay road. This activity is practised near watercourses, namely, on former borrow pits that have become attractive to the geese, at certain lake outlets and at stream crossings along the James Bay road. Close to a dozen of these different sites were identified in the study area's social environment (grouped per sector on Map 6-22). In spring, users often spend close to one month goose hunting on the trapline with family members. In fall, hunting is carried out more sporadically, generating less interest or family gatherings. The tallyman has plans for a goose hunting pond project on the Eastmain River (close to the sturgeon spawning ground community project). The increasing number of hunters on the trapline calls for the need to develop new hunting areas.

Users mentioned that the study area, and more specifically the sector around the Km 381 truck stop, has always been a great place for beaver trapping. However, few beavers were trapped recently since the resource needs to regenerate following the 2013 forest fire. The same is true of the other trapping sectors on the trapline. The trapline's western part, that includes the study area's western part, is considered a beaver conservation zone, where the population can regenerate before it moves elsewhere on the trapline. Users rarely frequent this sector.

Another sector appreciated for its wealth of resources is in the southern part of the study area, within a radius of 5 kilometres around the main camp and its lakes. This sector is regularly frequented on a year-round basis.

The gathering of blueberries and medicinal plants (and even of mushrooms within a community business project) is carried out in various locations, namely, where access is facilitated by the James Bay road.

When staying at their main camp, users primarily get their water supply from the km 381 truck stop. Other water sources are used by those travelling elsewhere on the territory. Four other sources were identified in the study area: three close to the Eastmain River and one in the southern part of the trapline.

In fact, the food collected on the territory, mainly in the study area for RE2 trapline users, is expected to regain its importance since the lull imposed by the forest fire. According to some users, a large part of their food comes from what they gather on the trapline, and when they stay there, this is their main food source. Traditional food is also brought back into the community and shared, mostly during celebrations such as birthdays or feasts. Generally, some users mentioned they consumed less traditional food since the forest fire and some said they had to turn to other traplines to supply themselves. Therefore, traditional food consumption was estimated at about once a week. The quantity of these foods depends on hunting success and activities per season. For example, goose is consumed more often in spring, moose in fall, and fish in summer and fall.

In addition to using the James Bay road and several short access roads linked to it (and mainly travelled by quad), travelling in the study area is mainly done by snowmobile. Thinning of the trapline by the 2013 forest fire facilitated travelling everywhere on the territory, without the need for snowmobile trails. Nevertheless, the low food quantities since the fire implies a decrease, purely temporary, in travelling.

In addition to the Eastmain River, which is frequently navigated along the northern limits of the study area, two waterways allow for long canoe trips, notably for trapping activities. These are possible from the James Bay road up to the Eastmain River; either to the west on the Miskimatao River or to the east by the CE5 stream. However, few such trips were made in recent years.

Lastly, in addition to the family members of the RE2 trapline tallyman, several other Eastmain members, or even from other Cree communities (and some non-Indigenous) fish or hunt moose near the Eastman River bridge or along the James Bay road.

Note that the users of VC33 (outside the study area, along the north edge) and VC35 (outside the study area, along the northeastern edge) traplines, use the section of the Eastmain River bordering the study area for fishing, moose hunting, goose hunting and beaver trapping. The other parts of their traplines they frequent are much further away from the study area.

6.4.6.2 *MINING ACTIVITY*

Galaxy owns 52 map-designated claims in the study area. The spatial distribution of the claims is partly consistent with the projected mining infrastructure site as shown on Map 2-1. Besides the claims belonging to other owners, no other mining title is present in the study area.

6.4.6.3 *VACATIONS AND RECREATIONAL ACTIVITIES*

There are two MERN vacation lot leases in the study area along the Eastmain River. One of these leases, issued for a cottage, is approximately 4 kilometres east of the James Bay road. The second lease, issued for a rustic shelter, is located 13.5 kilometres east of the James Bay road (Map 6-22).

The section of the study area located in Category III is included in hunting and fishing zone 22, which spans a vast territory from Mistissini in the south to Whapmagoostui in the north, and from James Bay in the west to the Caniapiscau in the east, excluding Category I and II lands. In this area, hunters must abide by the hunting rules that apply in the area. According to MFFP data, a total of 156 moose were killed in this hunting zone in 2017 (MFFP, 2018). Concerning fishing, some restrictions apply for Category II lands and on fishing methods used, and certain fish species are for exclusive use by Indigenous peoples (MFFP, 2017*d*).

Furthermore, Québec is divided in 96 fur-bearing animal management units (FAMU). The FAMU 92 is affected by the study area. It has the same boundaries are the territory belonging to the Eastmain Cree community. It corresponds to an area where trapping is for the exclusive use of Indigenous peoples as per the *Regulation respecting beaver reserves* (R.R.Q., 1981, c. C-61, r. 31) and *Act Respecting Hunting and Fishing Rights in the James Bay and New Québec Territories* (CQLR, chapter D-13.1) (MFFP, 2016*a*). Recent data on trapping is unavailable for the FAMU 92 (MFFP, 2016*b*).

During consultations, Indigenous users of the territory mentioned that hunting and fishing are practised by some non-Indigenous in the study area, mostly at the junction of the James Bay road and Eastmain River.

According to the Fédération des pourvoiries du Québec, there is no outfitting business in the study area (FPQ, not dated).

The Fédération québécoise du canot et du kayak does not list any canoeable route in the study area (FQCK, 2005). Note that a boat launch ramp is installed near the James Bay road, at Nistam Siyachistawach Lake.

6.4.6.4 QUARRIES, SANDPITS AND CONTAMINATED SOILS

None of the sites in the study area are listed in the *Répertoire des dépôts de sols et résidus industriels* or the *Répertoire des terrains contaminés* (MDDELCC, 2018*b* and *c*).

According to Phase I of the EAS carried out in the project's sector, two quarries were operated at an unknown date prior to October 1982, one on the site of the current remote landfill and/or close to it, and another north of the km 381 truck stop (Appendix B).

6.4.7 INFRASTRUCTURE

6.4.7.1 ROADS

The main roadway in the social environment, the James Bay road crosses the study area from south to north for 30.8 kilometres. This road, originally built to provide access to the hydropower project sites in the 1970s, spans 620 kilometres, crosses the EIJB territory and is an extension of Route 109 (Tourisme Baie-James, 2012). The road begins at Matagami and ends at Radisson. Other than some mostly seasonal hunting or fishing camps, there is no populated area along or near the James Bay road.

The James Bay road has not been a provincial highway since 2002 and is now administered by the SDBJ. Many Indigenous communities, including Eastmain, Waskaganish, Wemindji and Chisasibi, can be reached by this road, which is also used by their members. Two forks in the road, one at kilometre 275 (North Road) and another at kilometre 544 (Trans-Taiga Road), lead, respectively, to the municipality of Chibougamau and to the Caniapiscau reservoir.

There are two secondary roads in the study area: one southeast of the project area, giving access to the 4003–4004 circuit corridor and the other along the pegmatite hill to the south and ending at the remote landfill.

The Sûreté du Québec ensures road safety on the James Bay road except for areas under the jurisdiction of Cree communities, which are under the responsibility of the Cree police force.

According to SDBJ data, 56,139 vehicles used James Bay road in 2014 and 55,532 vehicles in 2017, for a daily average of 150 vehicles.

As mentioned in section 6.4.4.6, major repairs are currently underway on the James Bay road. Work on the stretch between kilometres 320 and 381 is planned for 2020.

6.4.7.2 AIRPORTS

There is no airport in the project area. The airfields closest to the project site are the airports located at the Eastmain River (97 km), Nemiscau (88 km) and the Éléonore mine (85 km), which is near the Opinaca Reservoir (Map 1-1).

6.4.7.3 POWER LINES

There are two power lines near the social environment study area. From north to south, the 4003-4004 circuit (450 kV) crosses the study area where it cuts through the James Bay road in three places. The 614 (69 kV) circuit crosses the study area from east to west at its southern part. Neither of these two power lines crosses the planned mining infrastructure (Map 6-22).

6.4.7.4 TELECOMMUNICATIONS

Most of the EIJB territory is served by Hydro-Québec's telecommunications network via a microwave link and a regional fibre-optic network owned by Eeyou Communications Network, a not-for-profit telecommunications corporation that provides broadband carrier services for the Cree communities and municipalities of the James Bay region (RCE, 2017). There is no telecommunications infrastructure in the study area. The closest infrastructure is south of the study area, between the James Bay road and Amiskw Matawaw Lake (Map 6-22).

6.4.7.5 *KM 381 TRUCK STOP AND REMOTE LANDFILL*

There is a km 381 truck stop in the study area at km 381 of the James Bay road. It offers lodging, food services, meeting room rental and mechanical troubleshooting (SDBJ, 2017). A convenience store, a laundry room, a cafeteria, a motel, two garages and a gas station are also part of this complex located on Block 27 of the Eastmain River watershed, a 100-hectare site owned by the SDBJ since 1994. Drinking water is supplied by two artesian wells on the west side of the site. Its buildings and other infrastructure are shown on Map 6-23.

There is a remote landfill near the proposed pit, linked to the activities of the km 381 truck stop. This remote landfill was authorized on July 18, 2006 by the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP). However, the site has been used for waste management since December 5, 1983. Before that, it served as a quarry. Until 2011, the waste brought to this site was buried in trenches and later incinerated in containers. A lease was issued to the SDBJ by the MRNF in 2012 (Raymond Thibault, SDBJ, meeting, 2017, and Alain Coulombe, SDBJ, interview, 2018). The phase I environmental site assessment, shown in Appendix B, provides greater detail on this remote landfill.

6.4.8 LANDSCAPE

6.4.8.1 *COMPONENT TYPES*

The landscape inventory and analysis method used in this project is based on Hydro-Québec's landscape study method for transmission and distribution lines and station projects (Hydro-Québec, 1992) and the MTMDET's visual assessment method for transport infrastructure integration (MTQ, 1986).

The description of the landscape is based on data from inventories of the biophysical and social environments conducted in 2011, 2017 and 2018, as well as on information gathered from various documents such as aerial photos and maps. Field visits were made to inventory the landscape (topography, plants, land use, visual fields).

REGIONAL LANDSCAPE

At the regional level, the project site is in the northern part of the "natural province" of the James Bay Lowlands. This province consists of an immense peat plain which, to the east of Waskaganish, becomes more fragmented due to an increased presence of scattered bodies of water and rocky mounds. The lower reaches of several large rivers (including the Eastmain, Nottaway, Broadback and Rupert) form the largest part of the hydric network while a dense but poor drainage system crosses the plain. Many ponds but few lakes are found around the bogs.

Two Cree villages, Waskaganish and Eastmain, are home to most of this province's population. These villages are located near James Bay on the banks of the Rupert River and Eastmain River respectively.

LANDSCAPE IN THE STUDY AREA

The James Bay road forms the backbone of the study area from north to south over an approximate distance of 31 kilometres. Most of the traditional activity sites (camps and hunting, fishing and trapping areas) as well as a rest area and secondary roads are connected to it. There are several snowmobile trails that converge on the larger lakes in the southern portion of the study area (Map 6-24).

A natural mosaic characterizes most of the landscape in the study area following a complex pattern generally oriented east-west. This mosaic is composed of various types of plant communities, burns from past years, rocky outcrops and bare soil. The plant communities are very diverse and include terrestrial vegetation (scrubland, woodland, spruce stands, pine stands) and wet growth (shrubby, wooded or open peatland). The woody vegetation is about 10 m high in this region.

The topography of the study area is divided into three distinct parts. The incised valley of the Eastmain River borders the northern limit of the area with an elevation of 175 m to 200 m, while a plateau dominates the landscape to the south with an elevation of 225 m to 250 m. There is a large plain between the valley and the plateau, at an elevation ranging from 175 m to 225 m. It occupies the largest part of the study area. The plain and the plateau are dotted with hills characterized by rocky outcrops. These hills can reach an elevation of about 240 m on the plain and about 280 m on the plateau.

Infrastructures du relais routier / *Truck Stop Infrastructure*

- Puits d'eau potable / *Potable water well*
- 1 Caféteria et centre administratif / *Cafeteria and administrative office*
- 2 Garage d'entretien / *Maintenance garage*
- 3 Poste à essence / *Fuel station*
- 4 Buanderie / *Laundry*
- 5 Logement des employés / *Employee residence*
- 6 Motel / *Motel*
- 7 Maison SDBJ / *SDBJ house*
- 8 Maison Hydro-Québec / *Hydro-Quebec house*
- 9 Dôme pour sable et sel de voirie / *Road sand and salt dome*
- 10 Entrepôts / *Warehouse*
- 11 Génératrices / *Generators*
- 12 Carothèque de Galaxy / *Galaxy's core racks*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Relais routier du km 381 / *Km 381 Truck Stop*

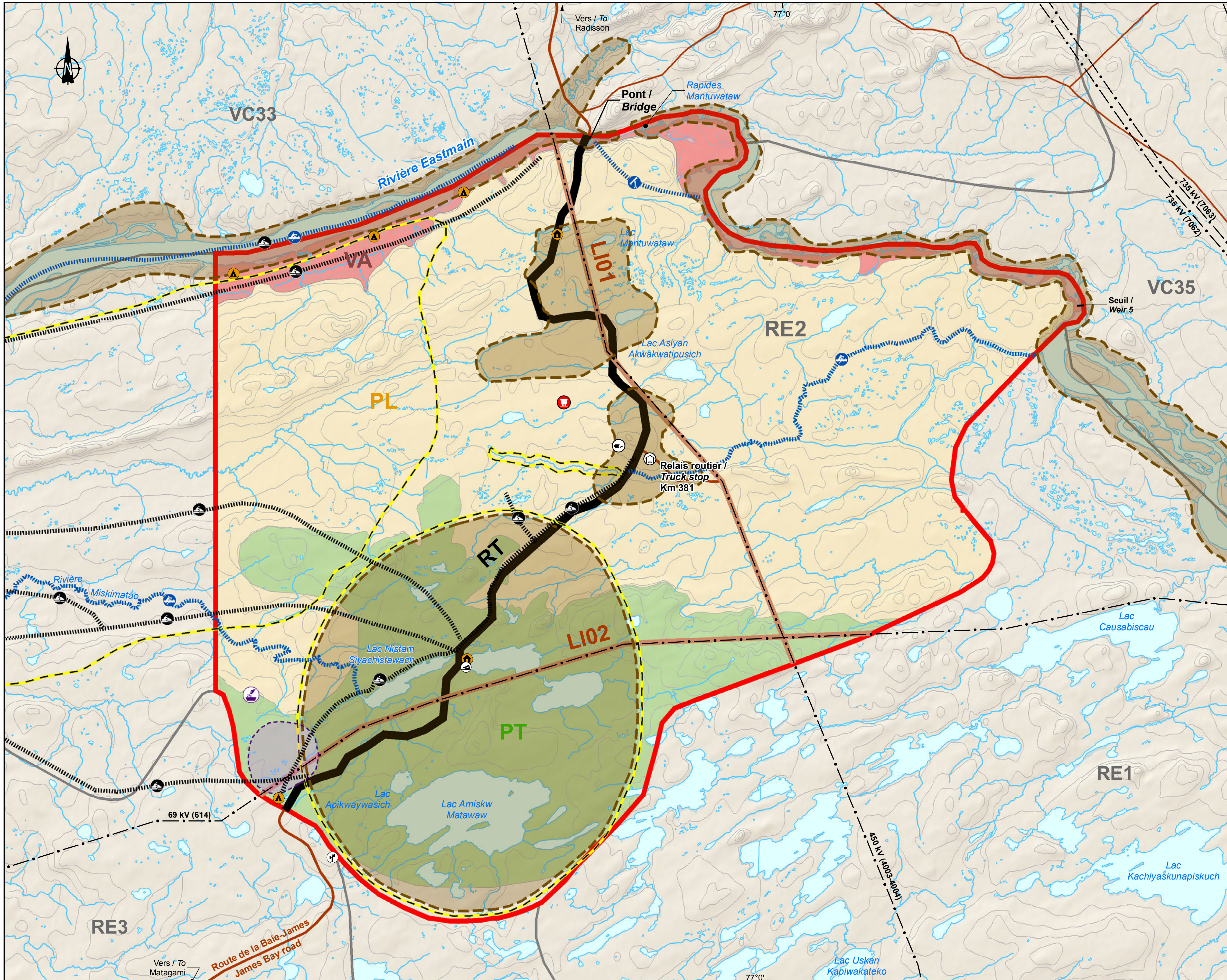
Sources :
Image Galaxy, 2017

No Ref : 171-02562-00_wspT156_EIEmh_c6-23_relais_routier_180903.mxd

0 20 40 m
UTM 18, NAD83

Carte / *Map* 6-23

wsp



Projet mine de lithium Baie-James / *James Bay lithium mine Project*

Unités de paysage / *Landscape Unit*

- Vallée (VA) / *Valley (VA)*
- Plaine (PN) / *Plain (PN)*
- Plateau (PT) / *Plateau (PT)*
- Ligne de transport d'énergie (LI) / *Transmission line (LI)*
- Route de la Baie-James (RT) / *James Bay road (RT)*

Utilisation du territoire par les Cris / *Cree Land Use*

- Campement permanent cri / *Cree permanent camp*
- Campement temporaire cri / *Cree temporary camp*
- Aire de chasse, de trappage ou de pêche / *Hunting, trapping or fishing area*
- Aire de cueillette / *Berry picking*
- Sentier de motoneige / *Snowmobile trail*
- Parcours de navigation / *Navigation route*
- Portage / *Portage*
- Aire valorisée / *Valued area*

Infrastructures / *Infrastructure*

- Route principale / *Main road*
- Route d'accès / *Access road*
- Ligne de transport d'énergie / *Transmission line*
- Relais routier / *Truck stop*
- Tour de télécommunication / *Telecommunication tower*
- Lieu d'enfouissement en territoire isolé (LETI) / *Remote landfill*
- Rampe de mise à l'eau / *Boat ramp*

Limites / *Limits*

- Zone d'étude du milieu humain / *Area of study of the human environment*
- RE2 Terrain de trappage / *Trapline*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Unités de paysage /
Landscape Units

Sources :
MNT, ESRI, 2014
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Inventaire / Inventory, WSP, 2018

Cartographié par / mapping by : WSP

No Ref : 171-02562-00_wspT149_EIEmh_c6-24_paysage_181011.mxd

0 1,25 2,5 km
UTM 18, NAD83

Carte / *Map 6-24*

wsp

A network of lakes and rivers of different sizes forms the natural fabric of the landscape. The largest lakes are clustered south of the study area in the plateau area, while smaller lakes are scattered to the northeast, on the plain.

The landscape in the study area alternates between open views (bodies of water, open peatland, rocky outcrops, bare soil), no views (blocked by the landscape or by dense groups of coniferous trees) and partial views (burned areas with burned trees still standing, deciduous trees in winter). The hills are natural visual landmarks in the study area, while power transmission towers and the James Bay road are anthropogenic visual landmarks.

The landscape in the study area is used for traditional activities or for transit (more specifically, via the James Bay road). Cree camp users, as well as hunters, fishers, trappers and visitors to the rest area are considered temporary fixed observers. Users of the territory travelling on the James Bay road, snowmobile trails and navigable bodies of water and watercourses are the main moving observers.

The landscape in the study area is not legally protected.

6.4.8.2 *LANDSCAPE UNITS*

The identification and analysis of landscape units make it possible to grasp the challenges of the study area both on a visual and human scale. A landscape unit is a separate and homogeneous section of territory characterized by a cluster of similar visual elements. The study area was thus divided into five types of landscape units taking into account the homogeneity of the permanent elements and visual characteristics. These units were defined mainly by the topography and land use, the components least sensitive to the effects of wildfires. The five types of landscape units in the study area are:

- valley;
- plain;
- plateau;
- power line;
- road.

Tables 6-58 to 6-62 describe these landscape units based on the following components:

- limits and specific land use;
- routes;
- land use elements or elements of recognized aesthetic interest;
- topography;
- hydrography;
- vegetation;
- spatial organization;
- observers (within the unit);
- visual field;
- view quality and visual points of view.

VIEW QUALITY AND VISUAL POINTS OF VIEW. VALLEY LANDSCAPE UNIT

The valley landscape unit includes the Eastmain River. It is visually isolated from the study area by its incised position (Map 6-24 and Photo 6-10). The unit is used for hunting, fishing and its sources of drinking water.

Table 6-58: Valley landscape unit

Component	Description
Limits and specific land use	• The valley landscape is located north of the study area and is mainly formed of the lower Eastmain River, its banks, the Mantuwataw Rapids and Weir #5 farther upstream.
Routes or transport routes	• The river is a shipping route with a portage path in the vicinity of the Mantuwataw Rapids. • The James Bay road crosses the valley for approximately 50 m. From this road, a service road runs west along the river valley. The James Bay road bridge straddles the river below the Mantuwataw Rapids. • A power line straddles the river downstream of the bridge. • A snowmobile trail runs along part of the river valley.
Land use elements	• Three temporary Cree camps on the south shore of the Eastmain River, downstream of the Mantuwataw Rapids. • Two wildlife areas used for hunting, fishing or trapping as well as one spawning area and one valued area.
Topography	• Somewhat incised compared to the adjacent territories, the valley is at an elevation of 150 m to 175 m.
Hydrography	• Several small bodies of water flow into the Eastmain River, which flows into James Bay about 90 km to the west.
Vegetation	• The unit is characterized by woody vegetation and burns.
Spatial organization	• The Eastmain River is the backbone of the valley and is a geographical landmark in the study area. The towers of a power line and the James Bay road bridge are the unit's notable landmarks.
Unit observers (within the unit)	• Users of temporary Cree camps, hunters and fishers (temporary fixed observers). • Transiting users on the Eastmain River, the James Bay road and snowmobile trails (mobile observers).
Visual field	• The typical visual field is limited where the river valley is concerned. It is deep in the direction of the river and open views are limited by the topography or woody vegetation.
View quality and visual points of view	• The view quality of the valley is based on its natural appearance. • Except for the James Bay road bridge, the valley is visually isolated from the study area.

Photo 6-10: Valley landscape unit, view from an elevated rocky outcrop

PLAIN LANDSCAPE UNIT

This landscape unit forms a vast plain that encompasses the project site. The plain is dotted with some elevated rocky outcrops, small hills and power transmission equipment that is visible from afar (Map 6-24 and Photo 6-11). The unit is used for traditional activities and for transit.

Table 6-59: Plain landscape unit

Component	Description
Limits and specific land use	• The plain landscape unit runs between the Eastmain River to the north and an elevated plateau to the south. Most of the unit is characterized by a natural mosaic and includes the project site.
Routes or transport routes	• The James Bay road crosses the unit for about 16 km. Some service roads run west and east from the James Bay road. • Two snowmobile trails. • Two long navigable watercourses between Eastmain River, upstream of Weir #5 and the vicinity of the project site, as well as the Miskimatao River, which meets up with the Eastmain River. • A power line crosses the unit for approximately 17 km.
Land use elements	• One permanent Cree camp near the James Bay road. • Three wildlife areas used for hunting, fishing or trapping and three valued areas.
Topography	• The unit is at an elevation ranging from 175 m to 225 m. • Several hills stand out from the plain forming an elongated pattern. Some reach an elevation of 240 m.
Hydrography	• Meandering streams drain the plain, which contains several small scattered bodies of water.
Vegetation	• The plain vegetation (woodland, scrubland, spruce stands, pine stands, burns and peatland) creates alternating visually open, filtered or closed spaces. Vegetation at the project site and nearby areas has been altered mainly due to successive forest fires. North of the site, however, there is peatland (open, shrubby or forested) and some patches of coniferous trees near the James Bay road that were not affected by the fires.
Spatial organization	• Aside from the James Bay road, the spatial organization is dependent on a large, barely perceptible grid. Hills, elevated rocky outcrops, power transmission equipment and the James Bay road form visual landmarks.
Unit observers (within the unit)	• Users of the permanent Cree camp, hunters, fishermen and trappers (temporary fixed observers). • Transiting users use the James Bay road, snowmobile trails and bodies of water and watercourses (moving observers).
Visual field	• The unit has highly variable visual fields. Where there are trees, the visual field is limited in depth and opening, and the views are closed. Where there are rocky outcrops, bare soil, open peatland or bodies of water, the visual field is open, as are the views. Where there are burns, the visual field is reduced and the views are filtered.
View quality and visual points of view	• The visual quality of the unit is based on its natural appearance. • The depth of the views depends on the height and density of the vegetation, which is highly variable. • The elevated rock outcrops are visible from afar and offer panoramic views. The James Bay road offers views towards the unit.

Photo 6-11: Plain landscape unit, view from an elevated rocky outcrop on the plain

PLATEAU LANDSCAPE UNIT

The plateau landscape unit dominates the study area in height and its topography is a little more pronounced than that of the plain. The plateau contains the largest lakes and some hills (Map 6-24 and Photo 6-12). The unit is used for traditional activities and for transit.

Table 6-60: Plateau landscape unit

Component	Description
Limits and specific land use	• The plateau landscape unit forms the southern part of the study area. Most of the unit is characterized by a natural mosaic.
Routes or transport routes	• The James Bay road crosses the unit for about 13 km. Some service roads run eastward from the James Bay road. • Several snowmobile trails converging on Lake Nistam Siyachistawach. • The Miskimatao River between Eastmain River and Nistam Siyachistawach Lake. • A power line crosses the unit for approximately 20 km.
Land use elements	• One permanent Cree camp near Lake Nistam Siyachistawach. • One wildlife area used for hunting, fishing or trapping and one valued area.
Topography	• The unit is at an elevation ranging from 225 m to 250 m. • Several hills stand out from the plateau forming an elongated pattern. Some reach an elevation of 280 m.
Hydrography	• The watercourses are rather straight and there are several large lakes.
Vegetation	• The vegetation (woodland, scrubland, spruce stands, pine stands, burns and peatland) creates alternating visually open, filtered or closed spaces.
Spatial organization	• Aside from the James Bay road, the spatial organization is dependent on a large, barely perceptible grid. Hills, elevated rocky outcrops, power transmission equipment and the James Bay road form visual landmarks.

Table 6-60: Plateau landscape unit (cont.)

Component	Description
Unit observers (within the unit)	• Users of the permanent Cree camp, hunters, fishermen and trappers (temporary fixed observers). • Transiting users use the James Bay road, snowmobile trails and bodies of water and watercourses (moving observers).
Visual field	• The unit has highly variable visual fields. Where there are trees, the visual field is limited in depth and opening, and the views are closed. Where there are rocky outcrops, bare soil, open peatland or bodies of water, the visual field is open, as are the views. Where there are burns, the visual field is reduced and the views are filtered.
View quality and visual points of view	• The visual quality of the unit is based on its natural appearance. • The depth of the views depends on the height and density of the vegetation, which is highly variable. • The elevated rock outcrops are visible from afar and offer panoramic views. The James Bay road offers views towards the unit.

Photo 6-12: Plateau landscape unit, view from an elevated rocky outcrop on the plain towards the plateau

POWER LINE LANDSCAPE UNITS

The power line landscape units (LI01 and LI02) are long corridors that cross the landscape in the study area. (Map 6-24 and Photo 6-13). The controlled vegetation and power transmission equipment in these corridors contrast with the surrounding natural landscape. The towers are important visual landmarks of the landscape in the study area.

Table 6-61: Power line landscape units

Component	Description
Limits and specific land use	• Landscape units LI01 and LI02 include power transmission equipment and cut across the James Bay road in some places. The towers rise well above the treetops. Controlled vegetation under the equipment forms a corridor about 55 m wide. • The LI01 power line landscape unit crosses the study area along a north/south axis for about 20 km. It is usually east of the James Bay road. Unit LI02 crosses the study area along an east-west axis for approximately 20 km and runs perpendicular to that of the James Bay road.
Routes or transport routes	• Each unit is accessible by a secondary road via the James Bay road and controlled vegetation allows access to the equipment.
Land use elements	• Unit LI02 cuts across one wildlife area and a large valued area. • Unit LI01 cuts across three wildlife areas.
Topography	• The units follow the terrain while avoiding the highest hill peaks.
Hydrography	• The units straddle many watercourses.
Vegetation	• Vegetation is cut regularly and is generally lower than adjacent natural vegetation.
Spatial organization	• The spatial organization of the units is governed by the routes of the power lines. • The part of the power transmission structures that extends beyond the treetops creates landmarks in the landscape.
Unit observers (within the unit)	• The main observers are mobile.
Visual field	• The visual field is generally deep but limited in opening due to the presence of trees on both sides of the lines.
View quality and visual points of view	• The visual quality of the units is based on the plant diversity created by the maintenance of the rights-of-way and the deep views.

Photo 6-13: Power line landscape unit, view from the Eastmain River valley towards the power transmission equipment

ROAD LANDSCAPE UNIT

This unit consists of a stretch of the James Bay road and its surroundings, including diverse vegetation and a rest area (Map 6-24 and Photo 6-14, 6-15). The James Bay road is the backbone from which the James Bay landscape has generally been viewed and experienced since 1970, at least by non-Indigenous people. Its path follows the natural terrain and offers views of the region from certain stretches.

Table 6-62: Road landscape unit

Component	Description
Limits and specific land use	• The road landscape unit includes a stretch of approximately 31 km of the James Bay road and its surroundings (30 m wide on both sides of the road). It crosses the study area from north to southwest following a sometimes winding path. It includes a truck stop at km 381 of the 620 km James Bay road. The rest area is an important geographical landmark for travellers and its buildings are the largest in the study area. There are also abandoned borrow pits whose tracks fade with natural revegetation.
Routes or transport routes	• Some service roads are attached to the James Bay road and lead to different activity areas.
Land use elements	• The road is near the permanent Cree camps in the study area. It cuts across most of the wildlife areas and crosses a large valued area.
Topography	• The road follows the topography of its receiving environment while being elevated by at least 1 m because of its sizeable infrastructure.
Hydrography	• The road drains into ditches.
Vegetation	• The roadside is typically vegetated. Vegetation cover has colonized the road shoulders, which consist of a fine granular material. Vegetation in the surrounding area and on the shoulders is highly varied, like that of the entire study area. However, it often has more trees than the surrounding natural environment.
Spatial organization	• The spatial organization of the units is governed by the fairly winding path of the road. • Where present, woody vegetation forms a visual screen. • The visual landmarks of the road are located in adjacent landscape units (elevated rock outcrops, hills, towers).
Unit observers (within the unit)	• The main observers of the unit are mobile and are the users of the James Bay road.
Visual field	• The visual field is more or less deep in the centre of the road, depending on how winding it is, and its opening is limited or filtered by vegetation.
View quality and visual points of view	• The visual quality of the road is based on its natural appearance and deep views. The deepest views are from the high points of the road and where there is no woody vegetation. • The diversity of the visual framing of the James Bay road helps heighten perception of the landscape.

Photo 6-14: Road landscape unit

Photo 6-15: Road landscape unit

6.4.9 HERITAGE AND ARCHAEOLOGY

6.4.9.1 NATURAL HERITAGE

In December 2002, the Québec government adopted the *Natural Heritage Conservation Act* (NHCA) in order to contribute to the objective of safeguarding the character, diversity and integrity of Québec's natural heritage. In this Act, "protected area" means:

> *"A geographically defined expanse of land or water established under a legal and administrative framework designed specifically to ensure the protection and maintenance of biological diversity and of related natural and cultural resources."*

The project study area does not have any protected areas. A 453,900-hectare biodiversity reserve is planned north of the Eastmain community, on a piece of land that cuts across the Wemindji community's land, over 60 kilometres north of the mining site (Gouvernement du Québec, 2010).

6.4.9.2 ARCHAEOLOGY

As part of the James Bay Lithium Mine project, a study was conducted to evaluate the archaeological potential in the study area, shown on Map 6-22 (Arkéos inc., 2018). The following text outlines this study.

The findings of the study were as follows:

- Hydrographic and topographic features may have made Indigenous groups interested in using the study area. The study area straddles two secondary watersheds that flow more or less parallel to the Eastmain River in opposite directions. These watersheds would have been good alternatives to bypass a section of the Eastmain River that has rapids. Otherwise, resource mining in the area could have favoured its use, particularly concerning the attraction that wetland wildlife may hold.
- An archaeological inventory was conducted for the 450-kV power line that runs through the study area. Two nearby areas were visited, the crossings of the Eastmain River and the Pontax River. This inventory did not make it possible to update the archaeological site.
- However, ancient human presence in the study area is evidenced by both the toponymy and the existence of at least one archaeological site (FbGg-1) east of the hill where the pit will be built (about 400 m). This site is near the Km 381 truck stop.
- In total, 27 areas with prehistoric archaeological potential have been targeted within the study area. These sites are those that are most likely to contain remains attesting to a human presence from prehistoric time up to the twentieth century. These areas of archaeological potential are shown on Map 6-22.

7 IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS

7.1 IMPACT ASSESSMENT METHOD

The general approach used to identify, analyze and mitigate environmental impacts (or improve them when these are positive) relies on a sound knowledge of the project and the receiving environment, on the experience acquired during the construction, operation or follow-up of similar projects. The approach covers the following elements:

- Knowledge of the project allows us to identify sources of impact based on the technical properties of the structures to be built and work to achieve (construction phase), operation modes (operation phase) and rehabilitation work (rehabilitation phase), when necessary, in addition to the activities and timelines associated with the various phases.
- Description of the environment (physical, biological and human) allows us to understand the project's environmental and social context and identify its most sensitive components.
- The consultation of stakeholders affected by the project allows us to survey their expectations and concerns, in addition to gaining a thorough knowledge of the environment, which leads to, considering the knowledge acquired on the receiving environment, an identification of the major issues linked to the project.
- Experience acquired during the execution of past projects provides information on the nature and intensity of impacts associated to this type of project, and on the effectiveness of the mitigation, improvement and compensation measures normally used.
- Concurrently, these different types of knowledge automatically mitigate the number and magnitude of the impacts likely to occur, since the project is subject to an optimization process at its planning stage.

Note that differences in views between experts and the population concerned by the project can arise at the impact assessment stage. The following sections report these differences, among other things, when these were observed.

7.1.1 KEY ELEMENTS

7.1.1.1 SOURCES OF IMPACT

The sources of impact represent project components likely to have effect on the environment. We can distinguish them, based on whether they are linked to the construction, operation or rehabilitation phase. The construction phase will not only include mining complex construction activities (infrastructure), but also preliminary activities required to mine the deposit (clearing, stripping of overburden and surface waste rock, etc.). The sources of impact also take into account the presence and functioning of the project's infrastructure, throughout its operation and also during rehabilitation work to ensure site closure according to regulations established.

Some sources of impact are negative while others are positive. Table 7-1 presents the sources of impact related to the project.

7.1.1.2 ENVIRONMENTAL COMPONENTS

Identifying the environmental components, using inventories from the study area, will serve to draw up of a list of elements from the physical, biological and social environments likely to be affected by one or several sources of impact related to the project. These components are presented in Table 7-2.

Table 7-1: Project impact sources

Construction phase	
Site preparation and infrastructure construction	Stripping of natural soils, clearing, excavation and grading work, work in aquatic environment. Presence of site trailers and construction of temporary or permanent infrastructure (buildings, storage areas, access roads, mining infrastructure foundations, construction of buildings and of road for ore transport, etc.).
Water management	Management of runoff or other on the site during construction work.
Hazardous and waste materials management	Handling, management of hazardous and waste materials to eliminate, recycle or reuse. Also, management of accidental spilling of hazardous waste related to overall activities.
Transportation and traffic	All transport on the site, refuelling, local traffic. Also, use of equipment (bulldozers, drills, excavators, etc.) required on the site.
Economic development and presence of workers	Hiring of labour and presence of workers at the mine, purchase of goods and materials and granting of contracts for various services.
Operation phase	
Presence and operation of the pit	Process plant feed material and waste rock drilling, blasting and extraction activities.
Other infrastructure and equipment in operation	Concentrator, garage for mechanical maintenance, administrative offices, water treatment plant, explosive storage facility, worker camp, dikes, generators, etc.
Management of process plant feed material, overburden and waste rock	Storage of process plant feed material, overburden and waste rock in accumulation areas intended for that purpose, and ongoing site rehabilitation when possible.
Water management	Dewatering of the pit, management of water at the plant, on the mining site and toward a natural environment (final effluent).
Hazardous and waste materials management	Handling, management of hazardous and waste materials to eliminate, recycle or reuse. Also, management of accidental spilling of hazardous waste related to overall activities.
Transportation and traffic	All transport on the site, refuelling, local traffic and transporting of spodumene concentrate to Matagami, and use of heavy equipment on the site (bulldozers, drills, excavators, etc.).
Economic development and presence of workers	Hiring of workforce and presence of workers at the mine, purchase of goods, services and materials for mining operations.
Rehabilitation phase	
Infrastructure dismantling	Work linked to the dismantling of plant and related facilities.
Pit rehabilitation	Flooding and securing of the pit.
Water management	Water intake and wastewater treatment, if necessary and rehabilitation of site, etc.
Hazardous and waste materials management	Handling, management of hazardous and waste materials to eliminate, recycle or reuse. Also, management of accidental spilling of hazardous waste related to overall activities and soil decontamination work if necessary.
Transportation and traffic	All transport on the site, refuelling, local traffic and transporting of spodumene concentrate to Matagami, as well as use of heavy equipment on the site (bulldozers, drills, excavators, etc.).
Economic development and presence of workers	Hiring of workforce for site rehabilitation and purchases required for completion of the work.

Table 7-2: Identification of environmental components of project

Physical environment		
Soil		Physicochemical and stratigraphic properties of surface deposits and vulnerability of soil to erosion and contamination and their stability.
Water	Hydrogeology	Natural gravity flow (water table) or induced (draining or pumping) of groundwater.
	Hydrological regime	Movement and renewal of surface water, watercourse hydrology and hydraulics.
	Water and sediments	Physicochemical properties of surface water, groundwater and sediments and their vulnerability to contamination.
Air	Atmosphere	Physicochemical properties of air, including dust concentration and GHG emissions.
	Artificial light at night	Ambient night-time lighting level
	Ambient noise	Ambient noise level properties.
	Vibrations and overpressure	Air pressures and velocity of ground vibrations during blasting.
Biological environment		
Vegetation and wetlands		Land plant groups, hydrous environments, including species at risk from the study area.
Fauna	Large fauna	Moose, caribou, bears and their habitats.
	Small fauna and herpetofauna	Small land mammals and their habitats, including species at risk and species trapped by the Cree. All amphibians and reptiles.
	Ichthyofauna	Fish populations and their habitats.
	Avifauna	All bird species and their habitats, including species at risk.
	Bats	All chiroptera species (bats) and their habitats, including species at risk.
Social environment		
Current use of land and resources for traditional purposes		Traditional hunting, fishing, trapping and gathering activities by Indigenous people.
Infrastructure		James Bay road, km 381 truck stop and SDBJ.
Perception of physical environment		Air and water quality, ambient noise, night-time lighting, vibrations and overpressure.
Quality of life		Lifestyle, social environment and health-care services.
Local and regional economy		Jobs and businesses.
Heritage and archaeology		Natural heritage (protected areas), areas of archaeological potential and incidental findings.
Landscape		Landscape units and visual integrity.

7.1.2 ANTICIPATED IMPACTS OF PROJECT

Project impacts are determined using a grid that establishes links between sources of impact and environmental components. The exercise allows us to identify the environmental components likely to be affected by the facilities or activities planned.

Environmental protection measures integrated from the moment of project design are considered in determining potential impacts. The grid on impact interrelationships is presented in Table 7-3. Each box in the grid shows the project component from which the potential impact can occur on an environmental component.

7.1.3 IMPACT ASSESSMENT

Impact assessment consists in determining, during the various stages of the project, the significance of the anticipated impacts on the physical, biological and social environment. This assessment considers measures incorporated at project design, in addition to applicable mitigation and improvement measures, and focuses on impacts that persist following application of these measures, that is, residual impacts.

Three criteria are analyzed to measure the significance of the impact:

- Intensity of impact;
- Extent of impact;
- Duration of impact.

Details of the assessment criteria will follow.

INTENSITY OF IMPACT

Intensity of impact indicates the severity of disturbance on the environmental component studied.

This analysis considers the environmental component’s properties (namely its sensitivity and resilience in the face of change) as well as its enhancement. The value associated with the environmental component considers its ecosystemic (only biological environment) and/or socio-economical role, as well as, the value assigned to it by the stakeholders consulted.

The environmental components which are subject to legal or regulatory protection, for which the protection is subject to a consensus or which play an essential role in their environment (ecosystem, sociocultural or economic environments, etc.) are considered as highly valuable. On the contrary, environmental components that fail to generate interest and whose conservation and protection are of little concern to the environment are considered as invaluable.

There are three levels of impact intensity:

- **High intensity**: the impact endangers the environmental integrity of the component or substantially or irreversibly changes the component or its use.
- **Moderate intensity**: the impact leads to a reduction in the quality or use of the component but does not compromise its environmental integrity.
- **Low intensity**: the impact imperceptibly destroys or changes the quality, use or integrity of the component in the environment.

Concerning the landscape, impact intensity is based on level of absorption and insertion of the project’s equipment and structures in its environment.

EXTENT OF IMPACT

Extent of impact is based on the size of the territory or proportion of inhabitants affected. Extent can be regional, local or isolated:

- **Regional extent**: the impact affects the entire study area (or area larger than the study area) or a large proportion of its population.
- **Local extent**: the impact affects a limited portion of the study area or of its population.
- **Isolated extent**: the impact affects a small area or a few individuals in the study area.

Concerning the landscape, extent of impact is related to the observers’ level of perception of the equipment and structures in the landscape.

Table 7-3: Grid on anticipated impact interrelationships

			Construction phase					Operation phase							Rehabilitation phase					
			Site preparation and infrastructure construction	Water management	Hazardous and waste materials management	Transportation and traffic	Economic development and presence of workers	Presence and operation of the pit	Other infrastructure in operation	Management of economic material, overburden and waste rock	Water management	Hazardous and waste materials management	Transportation and traffic	Economic development and presence of workers	Dismantling of infrastructures	Rehabilitation of the pit	Water management	Hazardous and waste materials management	Transportation and traffic	Economic development and presence of workers
Environmental components	Physical environment	Soil	—		—					—		—			—			—		
		Hydrogeology	—	—				—	—	—	—				—	—	—			
		Hydrological regime	—	—				—	—	—	—				—	—	—			
		Water and sediments	—	—	—	—		—	—	—	—	—	—		—	—	—	—	—	
		Atmosphere	—		—	—		—	—	—		—	—		—	—		—	—	
		Artificial light at night	—			—		—	—	—			—		—				—	
		Ambient noise	—			—		—	—	—			—		—	—			—	
		Vibrations and overpressure	—					—												
	Biological environment	Vegetation and wetlands	—		—	—		—		—		—	—		+				—	
		Large fauna	—		—	—	—	—	—	—			—	—	—				—	—
		Small fauna and herpetofauna	—	—	—	—		—	—	—		—	—		—		—	—	—	
		Ichthyofauna	—	—	—	—		—			—	—			—		—		—	
		Avifauna	—			—		—	—	—	—		—		—				—	
		Bats	—			—		—	—	—			—		—				—	
	Social environment	Use of land and resources for traditional purposes	—			—	—	—	—	—	—		—	—	—				—	—
		Infrastructure				—	+						—	+					—	+
		Perception of physical environment	—	—		—		—	—	—	—		—		—	—	—		—	
		Quality of life	—			—	+	—	—	—			—	+	—	—			—	+
		Local and regional economy					+							+						+
		Heritage and archaeology	—					—		—										
		Landscape	—			—		—	—	—			—		—	—			—	

Note — indicates a negative impact and + a positive impact.

DURATION OF IMPACT

Duration of impact refers to the period of time for which the impact of the project will affect the environment. These criteria include intermittence. Impact duration can be long, moderate or short:

- **Long-term**: the impact persists on a continuous or discontinuous basis during the entire project duration. This is often a permanent and irreversible impact.
- **Moderate-term**: the impact is felt temporarily (on a continuous or discontinuous basis) during the entire construction phase, or during certain periods during project operation or rehabilitation.
- **Short-term**: the impact is felt temporarily (on a continuous or discontinuous basis) only for the duration of the construction phase, or at specific, limited periods during project operation or rehabilitation.

For the landscape component, duration indicators are the same as those used for the other components.

MITIGATION, IMPROVEMENT AND COMPENSATION MEASURES

Note that the sound integration of the project in its environment is favoured as of the planning and design stage, thanks to the implementation of criteria or optimizations aimed at protecting the environment.

Therefore, mitigation measures aim to limit the negative impacts of the project on the environment, while improvement measures instead increase the positive impacts. As for compensation measures, these are implemented to compensate the loss or permanent disturbance of some environmental components.

The different measures are identified during the impact assessment exercise for each of the environmental components and allow for a more accurate assessment of the significance of the impacts.

An impact can either be positive or negative. However, only the significance of a negative impact is assessed. This significance is based on intensity, extent and duration of the disturbance. On completion of the assessment, significance is qualified as minor, moderate or major. If the assessment concludes to a significance less than minor, the impact is qualified as negligible.

ASSESSING IMPACT SIGNIFICANCE

As mentioned previously, significance of impact is the result of an overall judgment on the effect of a source of impact on an environmental component, **following application of the mitigation or improvement measures.**

Impact significance incorporates criteria linked to intensity, extent and duration and can be major, moderate or minor, as shown in Table 7-4. The impact significance rating grid is symmetrical since it includes the same amount of impacts of major significance as it does of minor significance (7 in each case) and 13 possibilities of moderate significance impacts.

For the landscape, although intensity and extent indicators differ from the other components, the same impact significance rating grid is used.

Moreover, when certain physical components fall within a regulatory framework, the latter is into account during impact analysis, although it disregards the notions of intensity, duration and extent. For example, the ambient noise impact analysis is based on Instructions Note 98-01 (MDDEP, 2006). Nonetheless, depending on the receiving environment, assessment criteria used to establish the significance of an impact will not be considered uniquely. In the end, the analysis is based on the same method as the one presented above.

Note that for some of the Cree having participated in consultation activities on intensity, extent and duration, the impact assessment differs and hence, significance could be greater for them. To respond to the concerns and worries of the Eastmain population, mitigation or improvement measures have been planned, including several environmental follow-ups to study component trends and assess the efficacy of the measures, as well as, communication methods to keep stakeholders informed of the results of these follow-ups. Furthermore, Galaxy remains open to reviewing the mitigation measures implemented and to adjusting them throughout the life of the project to adequately address the concerns of the stakeholders.

Table 7-4: Impact significance rating grid

Intensity	Extent*	Duration	Significance
High	Regional	Long	Major
		Moderate	Major
		Short	Major
	Local	Long	Major
		Moderate	High
		Short	Moderate
	Isolated	Long	Major
		Moderate	Moderate
		Short	Moderate
Moderate	Regional	Long	Major
		Moderate	Moderate
		Short	Moderate
	Local	Long	Moderate
		Moderate	Moderate
		Short	Moderate
	Isolated	Long	Moderate
		Moderate	Moderate
		Short	Minor
Low	Regional	Long	Moderate
		Moderate	Moderate
		Short	Minor
	Local	Long	Moderate
		Moderate	Minor
		Short	Minor
	Isolated	Long	Minor
		Moderate	Minor
		Short	Minor

* For the landscape, the regional extent corresponds to a large area, the local extent corresponds to a limited area and the point extent to a small area.

PRESENTATION OF RESULTS

For each environmental component identified and for each phase of the project, if applicable, the analysis and assessment of anticipated impacts are presented as follows:

— Source(s) of impact.
— Mitigation measure(s).
— Description of impact.
— Assessment of impact, if the impact is of a negative type.

For ease of reading, the mitigation measures for each project component are identified by a distinct code. The definitions of these mitigation measures can be found in Table 7-5, preceding the impact analysis. The same mitigation measure codes will be used in the impact analysis and assessment exercise (Table 7-5). Lastly, a summary of the impacts is presented at the end of the chapter. The results of the impact significance for each phase of the project are presented.

Table 7-5: List of applicable mitigation measures

Code	Description
Profile and ground surface	
SUR 01	Mark out the boundaries of the planned earthworks, restrict the areas of deforestation and soil stripping as well as cutting areas to the footprint of the required infrastructure (road, pits, stockpiles, basin, etc.).
SUR 02	Mark out access, paths and work areas before undertaking work, and prohibit parking and movement of machinery and vehicles outside of those areas.
SUR 03	Rehabilitate creek banks disturbed by the work as early as possible to minimize erosion and sedimentation. If it is impossible to permanently stabilize disturbed surfaces before winter, implement temporary protection measures.
SUR 04	In watercourse crossing areas, perform deforestation work immediately before construction to minimize erosion.
NOR 01	Restore work areas and stockpiles by levelling surfaces, covering them with natural soils, scarifying or seeding them to support revegetation. Stabilize reworked areas, embankment slopes, overburden stockpiles, etc., as work progresses. Reference: D019 for rehabilitation phase
Soil, water, and sediment quality	
QUA 01	Ensure that enough emergency kits for the recovery of petroleum products and chemicals are available in sensitive locations.
QUA 02	Through frequent inspections, ensure that machinery is in good working order (clean with no contaminant leaks) and that fuel and lubricant tanks are perfectly sealed. Any discovered leaks require immediate repairs to the tank in question.
QUA 03	The usual precautions should be taken during maintenance (draining, greasing, etc.) and refuelling of machinery on site to avoid any accidental spills. Maintenance is to be permitted only in authorized locations intended for that purpose (garage, mechanical workshop); refuelling is to take place in specifically designated areas.
QUA 04	In the case of temporary storage of contaminated excavated material, take all the necessary actions to preserve the integrity of the surrounding soil and water and ensure the safety of workers (put piles on a sealed or impermeable surface, cover piles, restrict access to these piles, etc.).
QUA 05	Restore the waste rock stockpile on a continuous basis to reduce the transport of suspended solids (revegetation) and to limit the leaching of materials and, if necessary, their soil infiltration.
QUA 06	Establish a well system on the periphery of the mining infrastructure to measure the drawdown and the rise of the water table in the sector of the pit.
QUA 07	Carry out development work likely to alter the water quality of watercourses outside the snowmelt period (April 15 to June 15).
QUA 08	Limit the transport of fine particles in the water environment beyond the immediate work area by an effective means (sediment traps, sediment barriers, turbidity curtain, etc.).
QUA 09	Build a temporary bridge for machinery if crossing a watercourse is required. Set up bridging or an ice-bridge when building a trail across a watercourse or fish habitat (ref. NOR 05).

Table 7-5: List of applicable mitigation measures (cont.)

Code	Description
Soil, water, and sediment quality (cont.)	
QUA 10	Equip all fixed equipment containing oils and/or fuel (lighting tower, generator, crusher, sifter, etc.) located less than 60 m from a watercourse or body of water with a leakproof recovery system. Equipment must be equipped with absorbents for quick and effective response in the event of an accidental spill.
QUA 11	Temporary facilities (e.g. construction site trailer, access road, storage areas, waste site) must be located more than 60 m from a watercourse.
QUA 12	Any vehicle and machinery maintenance is prohibited outside the designated areas.
QUA 13	Refuel vessels according to the Transport Canada Safe Boating Guide
NOR 02	Manage excavation waste according to their degree of contamination and in accordance with the requirements of the *Soil Protection and Rehabilitation of Contaminated Sites Policy*. Reference: Q-2, r. 37 – *Land Protection and Rehabilitation Regulation*: Schedules I and II and Response Guide – Soil Protection and Contaminated Sites Rehabilitation: Table 5 – Soil recovery methods authorized in Québec
NOR 03	Dispose of contaminated excavation waste beyond criterion C (except for those contaminated with hydrocarbons) in the pile, and failing that, transport them to another site authorized by the MDDELCC. Evidence of disposal in such a site must be provided. Reference: Q-2, r. 18 – *Regulation respecting the burial of contaminated soils*: Schedule I and Guide – Soil Protection and Contaminated Sites Rehabilitation: Schedule 5 – Excavated soil management grid; Section 6.4.3.1 List of authorized treatment facilities
NOR 04	Dispose of surplus or unusable excavation waste (clay, silt, gravel, rock) with due care and in accordance with the *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains* and D019 to ensure adequate separation from water environments.
NOR 05	Install culverts or crossing structures designed to maintain the free flow of water (and the free passage of fish). The construction of bridges or the installation of culverts shall not reduce the width of the watercourse by more than 20%, as measured from the natural high-water mark. The base of the lower culvert shall be driven below the natural bed of the watercourse at a depth of not less than 15 cm or 10% of the height of the structure and its ends shall extend beyond the base of the embankment by not more than 30 cm and be adequately stabilized. Reference: *Regulation respecting standards of forest management for forests in the domain of the State*
NOR 06	Install a minimum of three observation wells in the selected locations around the stockpile to verify groundwater quality upstream and downstream. Reference: D019, section 2.3.2.1
NOR 07	Surround mining infrastructure pits so that drainage and runoff are transported to a basin and then treated as needed before being released into the environment. In addition, runoff outside activity areas shall be captured by drainage pits, built around the components of the mine site to prevent these waters from encountering sources of contamination (dilution prohibited). Reference: D019, section 2.1.5
NOR 08	Before discharging effluent water, ensure it will be done in accordance with the standards. Reference: *Metal and Diamond Mining Effluent Regulations,* sec. 4 and Schedule 4 and D019, section 2.1.1.1

Table 7-5: List of applicable mitigation measures (cont.)

Code	Description
Soil, water, and sediment quality (cont.)	
NOR 09	In the event of an accidental spill, stop the leak as soon as it is spotted, contain the product and recover it using suitable equipment (absorbent sheets, flanges, drain covers, etc.). Immediately notify the Minister Excavate contaminated soil, place it in a sealed container and dispose of it in accordance with the hazardous materials management program. Advocate for quicker interventions to prevent deep infiltration. Reference: *Environment Quality Act*, Sec. 21 and *Regulation respecting hazardous materials*, Sec. 9
NOR 10	Set aside overburden and segregate the topsoil for reuse when redeveloping disturbed areas. Reference: D019, section 2.6
Atmosphere	
AIR 01	Regularly water roads, work areas, and stockpiles by moistening them to prevent resuspension and dust emission.
AIR 02	Avoid unnecessary engine idling to reduce noise and disturbances from exhaust gas, smoke, dust, or any other contaminants likely to come from the machinery.
AIR 03	Limit the vehicle speed on the various sites as well as for mine operations.
AIR 04	Instead of burning, proceed as much as possible with chipping tree removal residue and clear brush at the work site and then spread.
AIR 05	Optimize stripping according to the real needs of the operation so as not to overexpose unused stripped surfaces in relation to wind erosion and/or to restrict, as needed, access to these surfaces if they are not used during long periods of time.
NOR 11	Ensure that vehicle and machinery exhaust systems are in good condition and function optimally to minimize contaminant emissions into the air, and ensure that the same is true for dust control systems for equipment and machines that are equipped. Reference: *Clean Air Regulation*, Sec.6
Artificial light at night	
LUM 01	Restrict the emission of light toward the sky using fixtures that produce a simple and uniform lighting that would meet the real lighting needs with a luminous flux that would be directed toward the surface to be illuminated;
LUM 02	Limit the period and duration of the use of the lights at night.
LUM 03	Install fixed lights to avoid light spilling out of the spaces to be illuminated and pay attention to the orientation of portable lights and lighting from mobile sources.
Ambient noise	
SON 01	Ensure that motorized equipment (trucks, loaders, bulldozers, backhoes, etc.) are equipped with efficient silencers and are in good condition.
NOR 12	The reference noise level of a fixed source associated with a mining activity shall be assessed in accordance with the requirements of Instruction Note 98-01. Reference: D019, section 2.4.1

Table 7-5: List of applicable mitigation measures (cont.)

Code	Description
Vibrations and overpressure	
VIB 01	Notify all employees and the public about the blasting schedule.
VIB 02	For blasting activities, maintain a maximum of four holes exploding in 8 ms to ensure compliance with the vibration criteria of D019.
VIB 03	To limit overpressure, perform blasting activities in the absence of thermal inversion and carrier wind, when activities will be carried out within 800 m of the km 381 truck stop.
VIB 04	Use blasting mats and a collar height of at least 5 m when the blasting will be carried out within 500 m of the km 381 truck stop and the James Bay road, to limit rock projections.
NOR 13	Comply with the maximum distances and loads during blasting to adhere to the criteria of D019 and the threshold guidelines regarding the use of explosives in or near Canadian fisheries waters. Reference: D019, section 2.4.2 and Fisheries Act, para. 35(2) and Guidelines for the use of explosives in or near Canadian fisheries waters, p. 6, paragraphs 8 and 9.
Vegetation and wetlands	
VEG 01	Carry out tree clearing to direct their fall into the areas to be cleared. Do not leave any logging residues in watercourses and areas not affected by the work.
VEG 02	Choose native plant species suitable for mine site rehabilitation and appropriate to the hardiness zone.
VEG 03	To prevent the introduction of invasive alien species, clean the excavation machinery or vessels before using them on site.
VEG 04	Recover tree species with commercial value, enrich other types of wood by chipping them and using them to condition soil.
VEG 05	Relocate the population of *carex sterilis*, a plant species likely to be designated as threatened or vulnerable, to another habitat favourable for its survival.
VEG 06	Verify the potential introduction or not of invasive alien plant species annually and quickly eradicate, wherever possible, any new occurrences of invasive alien plant species observed.
VEG 07	Make a clay berm all along the stripped areas to prevent the drainage of peatlands on the periphery of infrastructure.
NOR 14	Maintain a riparian protection area of 10 to 15 m, depending on the side slope, around wetlands, watercourses, and waterbodies. Reference: Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains, Sec. 3.1 and 3.2
NOR 15	Develop a compensation project for the loss of wetlands or water. Reference: *Act respecting compensation measures for the carrying out of projects affecting wetlands or bodies of water*, Sec. 2

Table 7-5: List of applicable mitigation measures (cont.)

Code	Description
Fauna	
FAU 01	Perform work in the water outside the different breeding periods of the species present, from September 15 to December 1, inclusively.
FAU 02	Deforestation activities between June 1 and July 31 are prohibited to limit impacts on fauna.
FAU 03	Identify and report areas with the highest risk of collision with large mammals through adequate signage.
FAU 04	Prior to the demolishing a building or other facility, carry out an inspection (concealed spaces) to verify its possible use as maternity or dwelling place by bats. Where appropriate, protective measures will be taken to ensure the survival of bats.
FAU 05	Ensure workers are aware that it is important not to feed animals and not to leave food lying around so as not to attract wildlife near work areas.
NOR 16	Develop a compensation project for the loss of fish habitat. Reference: *Act respecting the conservation and development of wildlife*, Chapter IV.1; Lignes directrices pour la conservation des habitats fauniques; *Fisheries Act*, Sec. 35(2)b and *Metal and Diamond Mining Effluent Regulations*, Sec. 27.1 (if deposit of deleterious substances into fish habitat)
Use of land for traditional purposes	
UTT 01	Ensure workers are aware of traditional practices of Indigenous communities and activities of Indigenous users of the territory.
UTT 02	Establish and maintain a communication plan to inform the public, users, and municipal authorities about the start and progress of work.
UTT 03	Conduct beaver dam inspections at regular intervals to identify any changes to the CE2 water level and flow, and notify the community of these changes.
UTT 04	Prohibit hunting and recreational fishing for workers at the mine site.
Infrastructure	
CIR 01	Establish a traffic management plan, including the addition of signage.
CIR 02	Secure the sites at risk.
CIR 03	Maintain at all times public routes free of any obstruction of debris, waste, dirt, sediment, etc.
CIR 04	Establish, together with the Tallyman, an area closed to traditional activities for security purposes.
Perception of physical environment	
PER 01	Make monitoring and environment quality monitoring reports available.
Quality of life	
VIE 01	Establish an ongoing dialogue with the public through an internal community relations group and communication program.
VIE 02	Establish and implement a code of ethics for workers.

Table 7-5: List of applicable mitigation measures (cont.)

Code	Description
Quality of life (cont.)	
VIE 03	Prohibit alcohol consumption in the worker camp at the site.
VIE 04	Offer healthy and balanced menus (low in sugar and trans fat) in the worker camp's cafeteria.
VIE 05	Establish with the representatives of the Cree community an annual calendar of the main traditional activities and set time slots for production stoppages based on their participation in these activities.
VIE 06	Prohibit all forms of video lottery at the site.
Local and regional economy	
ELR 01	Establish a regional purchasing policy that would prioritize local and regional companies in the competitive bidding process where the skill and price are competitive.
ELR 02	Offer training programs to fill mine positions.
ELR 03	Prioritize hiring local workers.
ELR 04	Develop a memorandum of understanding and partnership agreement for Indigenous participation in the project.
ELR 05	Implement mechanisms to integrate workers, particularly for members of Indigenous communities (information sessions, human resources representatives, employee assistance program, etc.).
ELR 06	Establish a communication plan to announce to local stakeholders the positions to be filled at the mine.
ELR 07	Regularly update forecasts regarding the duration of operations and announce in advance the closure of the mine.
ELR 08	Develop an Employee Assistance Program to provide closure transition support (e.g. reclassification assistance committee for workers).
Heritage and archaeology	
ARC 01	Ensure workers are aware of the obligations regarding fortuitous archaeological discoveries.
NOR 17	Report to the officials of the various building sites any fortuitous discovery and halt work at the location of the discovery until it can be fully assessed. Officials must notify the Minister of it without delay. Obtain formal authorization from these officials before resuming work. Reference: *Cultural Heritage Act*, Sec. 74
NOR 18	Assess any archaeological site discovered to determine the extent of work required (e.g. excavation) to protect archaeological discoveries. Reference: *Cultural Heritage Act*, Sec. 76
NOR 19	Obtain an archaeological research permit to conduct any excavations or surveys of the property or archaeological sites. Reference: *Cultural Heritage Act*, Sec. 68
Landscape	
PAY 01	Model the top of the waste rock stockpile to round it and integrate it into the landscape.

7.2 IMPACTS ON THE PHYSICAL ENVIRONMENT

7.2.1 SOILS

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Hazardous and waste materials management.

MITIGATION MEASURES

Mitigation measures SUR 01 to SUR 04, QUA 01 to QUA 04, QUA 08 to QUA 13 should be applied, as well as standards NOR 02 to NOR 04, and NOR 09 described in Table 7-5.

DESCRIPTION OF IMPACT

In the site preparation stage, erosion occurs during deforestation, grubbing, grading, development, fill/excavated material operations, as well as during the construction of watercourse crossing structures. Soil erosion and sediment transport are greatly influenced by soil conditions, slope, and precipitation patterns.

In relation to the contamination risks identified during the ESA – phase I, the study revealed that residual materials (paper, plastic, metal, wood, fabric) were observed at the remote landfill. However, the remote landfill sector is located outside planned works and in this sense, the risks of soil contamination by contact with the remote landfill soils are unlikely or non-existent.

Risks of soil contamination are also possible, mainly because of the potential leak of petroleum products or accidental spills from equipment. The impact of a potential spill would be, among other things, based on the volume of contaminants spilled, the uniqueness (spill) or the repetition (leak) of the problem. In the event of a spill, the actions provided for in the emergency action plan will be implemented quickly, which will help to limit the extent of the contamination. These measures focus on prevention by regularly checking equipment and adding emergency devices that will allow for a quick response in case of an accident. In addition, in the event of a spill, the emergency plan will be quickly implemented, which will reduce the extent of contamination and prevent the contamination of groundwater. Losses or spills of hydrocarbons or other products are generally one-time events and accidental.

Moreover, environmental surveillance activities are especially important in the prevention and effectiveness response in case of a spill, and some preventative measures will also reduce the risk of major spills, like the implementation of double-walled tanks.

IMPACT ASSESSMENT

For all the reasons mentioned above, the intensity of this impact is considered low since soil quality is not likely to change. The extent is considered local given that soil contamination or erosion would occur in an area confined to the incident site or areas of the site in operation. The duration is short since it will be possible to immediately respond to decontaminate the site quickly or dispose of contaminated soil in a short time. For soil erosion, its duration is also short because it may occur during the entire construction period. The extent of the impact on the soil during the construction phase is considered **minor**.

OPERATION PHASE

SOURCES OF IMPACT

- Management of economic material, unconsolidated deposits, and waste rock.
- Hazardous and waste materials management.

MITIGATION MEASURES

Mitigation measures SUR 01 and SUR 02, QUA 01 to QUA 05, QUA 10, QUA 12 should be applied, as well as standards NOR 02 to NOR 04, NOR 09 and NOR 10 described in Table 7-5.

DESCRIPTION OF IMPACT

The risks of soil contamination in case of accidental spills are the same as during the construction phase. In addition, since the hydrocarbon tanks will be above ground, the risk of a leak going unnoticed for a relatively long time is unlikely. Also, as with the construction phase, environmental monitoring activities will prevent the anticipated impacts.

As for issues relating to erosion, since the the slope of the waste rock stockpile will be restored continuously, the consequences of sediment and erosion transport will be reduced.

IMPACT ASSESSMENT

The application of mitigation measures will minimize the potential impacts on the soil during the operation phase. Overall, the intensity of this impact is considered low. Its extent is local since sediment erosion and transport may occur at any mine site. The duration is medium since the impact may occur during the life of the mine, a period of approximately 20 years. Overall, the significance of the impact on the soils during the operation phase is considered **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructures.
- Hazardous and waste materials management.

MITIGATION MEASURES

In the rehabilitation phase, mitigation measures SUR 02, QUA 01 to QUA 04, QUA 07, QUA 08, QUA 12 and standards NOR 01 to NOR 04 and NOR 10 in Table 7-5 must be met.

DESCRIPTION OF IMPACT

Overall, the impact of activities during the rehabilitation phase will be approximately the same as that of the construction phase, until the site is completely restored.

As the rehabilitation materializes, hazardous materials not required will be removed from the site, recovered and returned to suppliers, sold to a third-party or disposed of by firms authorized to manage these materials. The aboveground tanks will be removed from the site and the soils beneath these will be characterized. In case of contamination, they will be handled in accordance with the laws and regulations in force. The footprints of the rock storage area and those supporting the infrastructure will be characterized, and if the soil meets the quality criteria, they will be left in place. If not, they will be excavated and handled in situ or even transported to an authorized contaminated soil treatment site.

The dismantling of infrastructures can also contribute to soil erosion (scarification of roads, dike retreat, etc.).

Finally, to avoid leaving an environmental legacy behind, the rehabilitation plan provides that the entire site will be characterized to determine whether the soil is contaminated, as per the criteria set by the MDDELCC. If so, it will be handled in accordance with the laws and regulations in force.

IMPACT ASSESSMENT

The application of mitigation measures will minimize the potential impacts on soil contamination and erosion. As a result, the intensity of the contamination phenomena is considered low. Its extent is local and could occur throughout the mine site. The duration will be short since the impact will only be felt during the closure phase. The significance of the impact on the soil during the rehabilitation phase is considered **minor**.

POST-REHABILITATION PHASE

Once the site has been restored, the impacts will be non-existent, since no mining activity likely to alter the soil quality will be taking place.

7.2.2 HYDROGEOLOGY

CONSTRUCTION PHASE

SOURCES OF IMPACT

— Site preparation and infrastructure construction.
— Water management.

MITIGATION MEASURES

Standard mitigation measures SUR 01 and SUR 02 will be applied to reduce the project's impact on hydrogeology. These mitigation measures consist mainly in minimizing the increase in runoff, as this change may affect the seepage rate and, to a lesser degree, the local flow regime. The following measures will also be applied: QUA 01 to QUA 04, QUA 10 and QUA 11.

DESCRIPTION OF IMPACT

During soil excavation to develop or install various infrastructure, the surface water seepage regime will be altered. It may be limited or higher depending on the type of development. Also, if the groundwater body is reached during excavation, the water will have to be pumped out, thereby altering groundwater flow locally.

IMPACT ASSESSMENT

During the construction phase, the intensity of the impact is deemed low given that minor changes to the flow regime will be noted. The mitigation measures to be applied will reduce the anticipated impacts. The extent is limited since the impacts will be felt near the work areas. The duration will be short because groundwater flow will rebalance once the work is completed. In short, the significance of the residual impact on the groundwater flow regime will be **minor**.

OPERATION PHASE

SOURCES OF IMPACT

During the operation phase, activities likely to affect the groundwater flow regime are essentially the following:

— Presence and operation of the pit;

- Other infrastructure in operation;
- Management of economic material, overburden and waste rock; and
- Water management.

MITIGATION MEASURES

The QUA 06 measure will be applied to monitor anticipated changes in the local flow regime, and the drawdown and rise of the water table. In addition, NOR 06 provides that a network of monitoring wells will be established on the periphery of the mining infrastructure.

DESCRIPTION OF IMPACT

Pumping activities required for pit dewatering will lead to changes in the groundwater flow regime, particularly near the pit, and may alter the recharge and resurgence rates in some watercourses near the site. During the various operation phases, the groundwater level in the pit will be maintained through pumping near the bottom of the pit. The groundwater piezometric surface will therefore be gradually lowered to allow for dry operations.

A lowering of the water table in the bedrock and in unconsolidated deposits will therefore be observed around the pit. The effects of dewatering activities on the groundwater flow regime are controlled by hydrogeological features, that is, the hydraulic properties of geological formations, and the link between them and the surface water system. These features are particularly complex in hydrogeological systems with fissured rock environments, like those found on the site. That is why digital modelling is customary in such cases to represent the hydrogeological system and assess the potential impacts of dewatering activities.

Hydrogeological modelling was conducted to assess the impact of pit operation on the surrounding environment (water table drawdown) and to estimate the volume of water pumped when the pit is in the final operation stage. According to the modelling results, the anticipated groundwater drawdown will be at a maximum near the pit, decreasing as the distance from the pit increases. Details of the modelling work are provided in the specialised study (WSP, 2018*a*).

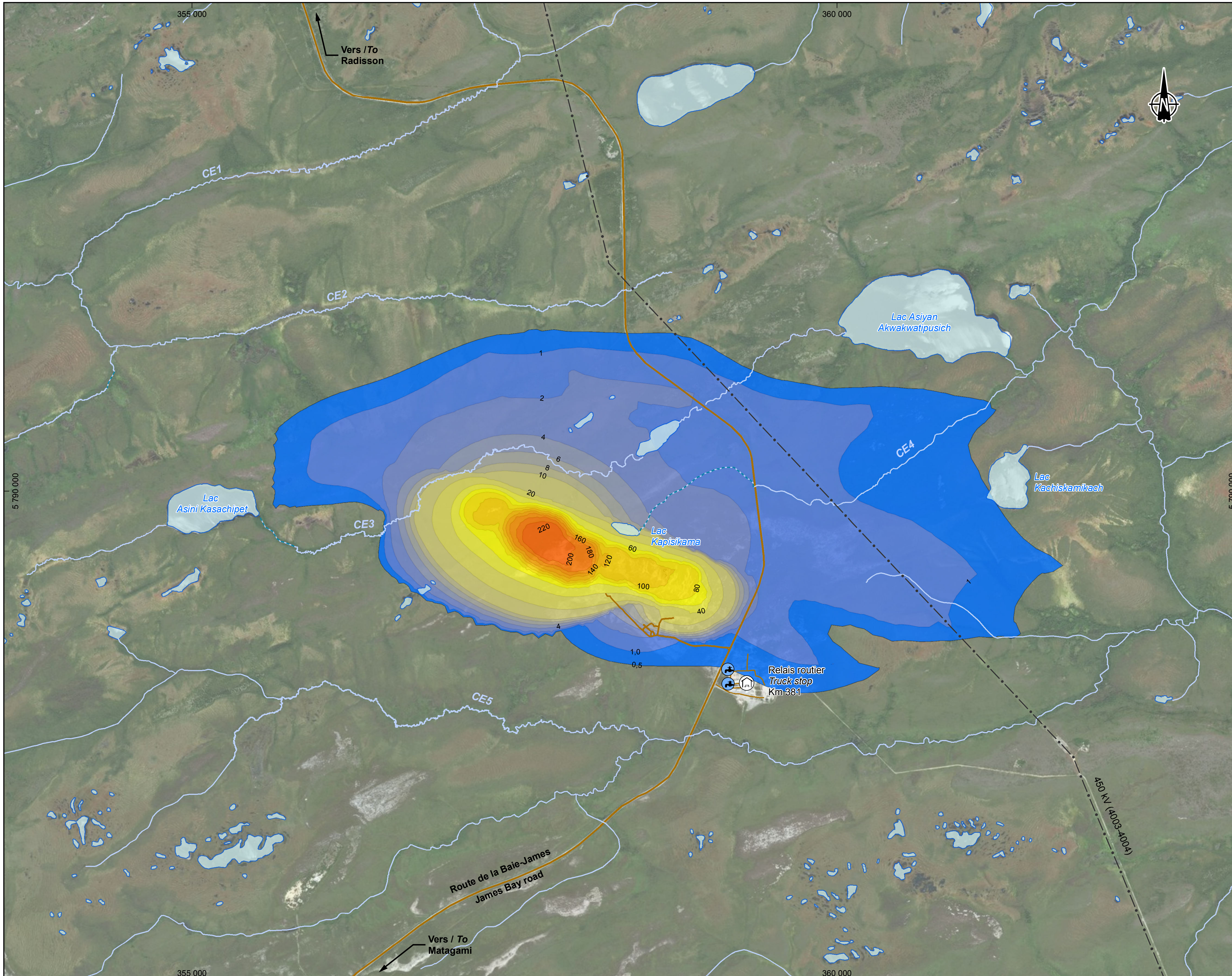
The results indicate that the dewatering flows at the end of operation would be 1,800 m^3/day. When operation wraps up, the water table drawdown is expected to be virtually nil at approximately 500 m from the pit in surface deposits. For the bedrock aquifer, the radius of influence of the dewatering would be close to 2 km in the northeast sector. In the south and west (including the km 381 truck stop sector), the drawdown is expected to be less, at around 500 m from the pit walls. In the bedrock, the drawdown is limited by the unit with low permeability.

The only groundwater user listed in the sector is located approximately 700 m from the pit boundary (potable water wells at the km 381 truck stop), that is, at the edge of the potential water table drawdown area. The impact on the wells should therefore be negligible. In addition, the water table drawdown area will be developed gradually as the pit develops. There will therefore be enough time to gather geotechnical and piezometric data with a monitoring system in place, which will make it possible to foresee potential problems and take corrective action where necessary.

The results also show that the impact on lakes and watercourses would involve reduced base flow between 1.5 and 52%, meaning a decrease in average flow between 0.01 and 1.5%. Groundwater contribution to the base flow of watercourse CE4 would become very low.

Lake Kapisikama, located less than 200 m from the pit, will be impacted and will no longer be supplied by groundwater. The four-fold reduction in the surface area of the watershed of this lake will also decrease surface water inflow. The lack of groundwater contribution and the reduced surface water inflow will cause the lake's water level to drop.

Lastly, a higher volume of material on stockpiles and water volumes in the various watersheds will alter the flow conditions in these sectors by increasing the hydraulic head locally.



Rabattement / ***Drawdown***

- 0,5 m (Faible / *Low*)
- 1 m
- 2 m
- 4 m
- 6 m
- 8 m
- 10 m
- 20 m
- 40 m
- 60 m
- 80 m
- 100 m
- 120 m
- 140 m
- 160 m
- 180 m
- 200 m
- 220 m
- 240 m (Élevé / *High*)

Infrastructures / ***Infrastructure***

- Route principale / *Main road*
- Route d'accès / *Access road*
- Ligne de transport d'énergie / *Transmission line*
- Relais routier / *Truck stop*
- Source d'eau potable / *Drinking water source*

Hydrographie / ***Hydrography***

- CE3 Numéro de cours d'eau / *Stream number*
- Cours d'eau permanent / *Permanent stream*
- Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Rabattement du niveau d'eau dans l'aquifère rocheux, dénoyage final /
Water Level Drawdown in the Bedrock Aquifer, Final Dewatering

Sources :
Orthoimage : World Imagery (ESRI, 2018)
Rabattement / Drawdown, WSP 2018

No Ref : 171-02562-00_wspT157_EIE_c7-1_rabat_180904.mxd

0 300 600 m
UTM 18, NAD83

Carte / *Map* 7-1

wsp

IMPACT ASSESSMENT

During the operation phase, changes in the flow regime are related to pit operation. The intensity is deemed moderate given that a significant water table drawdown is planned around the pit. The extent of the impact is deemed local because the changes to the groundwater flow regime will occur within a radius of up to 1.7 km around the pit. The duration of the impact will be long because the flow regime will be altered throughout the operation phase. In short, the significance of the residual impact on hydrogeology is deemed **moderate**.

REHABILITATION PHASE

SOURCES OF IMPACT

— Dismantling of infrastructures.
— Pit rehabilitation.
— Water management.

MITIGATION MEASURES

No additional mitigation measures are planned during the rehabilitation phase other than monitoring of the drawdown and rise of the water table (QUA 06). A network of wells established on the periphery of the mining infrastructure will be kept and studied after operations end.

DESCRIPTION OF IMPACT

Stopping pit dewatering activities at the end of the project will cause the groundwater level to rise back to its initial position. The final rise in the groundwater level will depend on the conditions of equilibrium for the formation of a lake inside the pit. The groundwater flow regime is expected to essentially return to its original state once the pit is filled.

The impacts noted during the operation phase are similar for the rehabilitation phase as concerns the waste rock stockpile. The piezometric level will begin to recover as soon as mining operations end. In the post-operation phase, waste rock will drain slowly under the effects of gravity to reach a new permanent equilibrium. The length of the recovery period will depend on hydrogeological conditions.

IMPACT ASSESSMENT

During the rehabilitation phase, the intensity is considered moderate because groundwater will continue to accumulate in the pit. The extent is deemed local because the effect will be felt within a radius of up to 1.7 km around the pit. Its duration is estimated to be long because it will take a number of years for the rock formation to return to a state of equilibrium. In short, based on the assessed impacts, the significance of the impact on hydrogeology is deemed **moderate**.

POST-REHABILITATION PHASE

Stopping pumping activities will have a positive effect on hydrogeology in the post-rehabilitation phase, allowing a new natural equilibrium to be gradually reached in the environment. The pit is expected to fill up in 120 to 170 years.

7.2.3 HYDROLOGICAL REGIME

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Water management.

MITIGATION MEASURES

Mitigation measures SUR 01, SUR 03, SUR 04, QUA 07, QUA 09 and QUA 11 will have to be applied in order to limit the impact on the hydrological regime in the study area during the construction phase, along with standards NOR 01, NOR 05, NOR 07, NOR 14 and NOR 15, described in Table 7-5.

DESCRIPTION OF IMPACT

The development of surfaces (deforestation, excavation, topsoil stripping, backfilling, grading of surfaces, etc.) for the construction of various mining facilities and infrastructure, and the construction of drainage ditches and watercourse crossing structures will likely alter the natural flow of surface water locally. Moreover, soil compaction could limit water seepage into the soil, thus promoting increased surface runoff.

IMPACT ASSESSMENT

Since small areas relative to the total watershed surface (approximately 5%) will be affected by the construction work, and considering the planned mitigation measures, only minor changes to the hydrological regime are anticipated. The intensity of the impact is therefore considered low. It will be limited in scope since it will be in a small area where construction will take place, and its duration will be short since it will be limited to the construction phase. The significance of the impact on the hydrological regime during the construction phase is therefore **minor**.

OPERATION PHASE

SOURCES OF IMPACT

- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, overburden and waste rock.
- Water management.

MITIGATION MEASURES

Mitigation measures SUR 01, QUA 05 and UTT 03 will have to be applied to limit the impact on the hydrological regime in the study area during the operation phase, along with standards NOR 01, NOR 05, NOR 07, NOR 08 and NOR 14, described in Table 7-5.

DESCRIPTION OF IMPACT

During the operation phase, all contact water on the mining site will be collected by a network of ditches and pumping stations, directed to a retention basin and then pumped out into effluent located on creek CE2 after passing through the WTP. However, runoff from the overburden stockpiles is considered clean and will be drained by a network of ditches and discharged into creek CE3. Map 7-2 shows the location of proposed infrastructure as well as the delineation of watersheds in the study area under the projected conditions, while Table 7-6 shows the project's impact on the areas of the watersheds under study.

The watershed of creek CE1 is unaffected by the project. Considering natural runoff only, the watershed of creek CE2 is 22% smaller; however, since it will be receiving the main mining effluent, its total surface area will increase by 20%. The watersheds of creeks CE3, CE4 and CE5 will be cut down in size slightly by the pit, which will reduce their surface areas by 6%, 9% and 1%, respectively. The watershed of creek CE6 will be partially encroached by the waste rock stockpile and will decrease by 20%.

A comparison with points located further downstream of the watercourses reveals that the impacts are mitigated because the surface area of the northern part (at the junction of CE1, CE2 and CE6) is increased by 6%, whereas the tributary surface area of the southern part (CE3, CE4 and CE5) is reduced by 2%.

Table 7-6: Impact of the project on watersheds in the study area

Body of water	Size (km^2)		Difference (%)
	Current state	Future state	
Northern part	**19.81**	**20.95**	**+6**
CE1	7.63	7.63	0
CE2	9.07	10.84	+20
• Natural – outside project footprint	9.07	7.11	-22
• Project infrastructure	-	3.73	-
CE6	3.11	2.47	-20
Southern part	**48.76**	**47.62**	**-2**
CE3	10.33	9.71	-6
• Natural – outside project footprint	10.33	9.16	-11
• Project infrastructure	-	0.55	-
CE4	3.03	2.76	-9
CE5	27.01	26.76	-1

Typical flows under future conditions were estimated using the same methodology as the one for flows under current conditions, described in the hydrological technical study *(Étude spécialisée sur l'hydrologie*) (WSP, 2018*b*). Additions to these natural flows include the expected effluent discharge rate into creek CE2 and the influence of the water table drawdown through pumping around the pit. It should be noted that due to the very flat and marshy (peat bog) nature of the watersheds studied, uncertainty remains about the evaluation of typical flows and impacts on them. The values should therefore be considered with caution. No water extraction from the watercourses will occur for the purposes of the project.

According to information from the Project Definition Document (Primero, 2018), the average effluent discharge rate at the end of the operation phase will be around 0.20 m^3/s from June to October, inclusively. During summer low flow, a minimum flow of around 0.18 m^3/s is expected. There will be no discharge in the winter months (November to May). During the melt period, a flow of 0.35 m^3/s was considered for effluent, the maximum capacity of the WTP. These effluent flow values consider flow from pit dewatering.

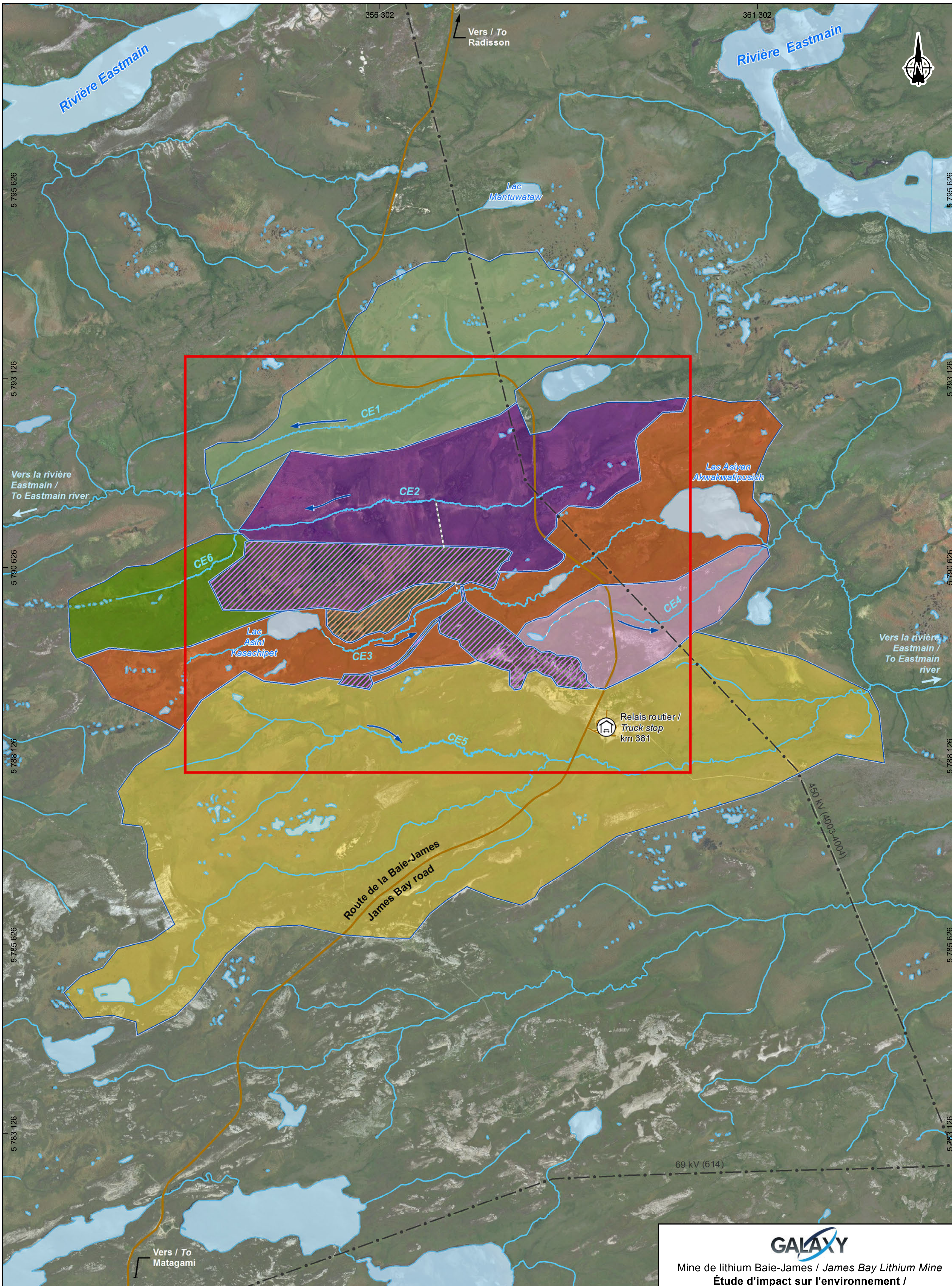
According to the findings of the hydrogeological study (WSP, 2018*a*), dewatering the pit will have an small impact and low-water flows in the upstream portion of creeks CE3, CE4 and CE5 (upstream of James Bay road) and to a lesser extent in creek CE2 (section 7.2.2). Creek CE1, further from the pit, should not be impacted.

Table 7-7 shows an estimate of the impacts on the typical flows of watercourses in the study area. For creek CE2, substantial increases are anticipated in summer low flows (a ten-fold increase from 16 L/s to 190 L/s) and in average flows during the summer (up to close to 80%) due to the presence of mining effluent. In contrast, average monthly winter flows and winter low flows are around 23% lower. Flood flows are higher for the weakest recurrences (+29% for the 2-year flood), but slightly lower for the strongest (-3% for the 100-year flood). For CE6, all typical flows are around 20% lower.

Table 7-7: Impact of the project on typical flows of watercourses in the study area

		Impacts (%)							
		CE1	CE2	CE6	Northern part	CE3	CE4	CE5	Southern part
Low-water flows	$Q_{2,7}$ annual	0%	-23%	-20%	-14%	-23%	-62%	-2%	-10%
	$Q_{10,7}$ annual		-23%	-20%	-14%				
	$Q_{5,30}$ annual		-23%	-20%	-14%				
	$Q_{2,7}$ summer		+462%	-20%	+208%				
	$Q_{10,7}$ summer		+1073%	-20%	+488%				
	$Q_{5,30}$ summer		+489%	-20%	+221%				
Average monthly flows	January	0%	-22%	-20%	-13%	-7%	-11%	-1%	-3%
	February		-22%	-20%	-13%				
	March		-22%	-20%	-13%				
	April		-22%	-20%	-13%				
	May		-22%	-20%	-13%				
	June		+47%	-20%	+18%				
	July		+79%	-20%	+33%				
	August		+75%	-20%	+31%				
	September		+77%	-20%	+32%				
	October		+65%	-20%	+26%				
	November		-22%	-20%	-13%				
	December		-22%	-20%	-13%				
	Annual		+27%	-20%	+9%				
Flood flows	2 years	0%	+29%	-19%	+8%	-8%	-9%	-1%	-4%
	10 years		+7%	-19%	-1%				
	25 years		+2%	-19%	-3%				
	50 years		-1%	-19%	-4%				
	100 years		-3%	-19%	-5%				

In the southern part, all typical flows are expected to decrease in all watercourses. For CE3, the decrease is 23% for low-water flows, 7% for average flows and 8% for flood flows. For CE4, affected by pit dewatering, the decrease is more than 60% for low-water flows, 11% for average flows and 9% for flood flows. Lastly, only a slight decrease of 1 to 2% in typical flows is expected for CE5. Although the percentage change may seem very large, given the order of magnitude of the flows involved (approximately 0.01 m^3/s to 0.3 m^3/s), the values are nonetheless low.



Zone d'étude locale / *Local study area*

Hydrographie / *Hydrography*

Limite de bassin versant / *Watershed limit*

Bassin versant 1 / *Watershed 1*

Bassin versant 2 / *Watershed 2*

Ruissellement sur le site vers l'effluent CE2 / *Site runoff to CE2 effluent*

Bassin versant 3 / *Watershed 3*

Ruissellement sur la halde de mort-terrain vers l'effluent CE3 / *Runoff from overburden stockpile to CE3 effluent*

Bassin versant 4 / *Watershed 4*

Bassin versant 5 / *Watershed 5*

Bassin versant 6 / *Watershed 6*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

CE3 Numéro du cours d'eau / *Stream number*

Sens d'écoulement de l'eau / *Direction of water flow*

Effluent minier / *Mine effluent*

Infrastructures / Infrastructure

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement /
Environmental Impact Assessment

Bassins versants aux conditions projetées / *Future Watershed Limits*

Sources :
Image, Bing Maps Aerial
Inventaire / Inventory, WSP 2018

No Ref : 171-02562-00_wspT147_EIE_c7-2_BV_projetes_180904.mxd

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Carte / *Map 7-2*

wsp

The impact on water levels in creeks CE2, CE3 and CE4 was assessed using one-dimensional hydraulic modelling with HCE-RAS software. The methodology used to build and calibrate the model, and to run the simulations, is detailed in the specialized study on hydrology (WSP, 2018*b*), which also contains a map of the model domain.

It should be noted that since the local watercourse slope is very gentle and the floodplain is closely connected to the low-flow channel, a change in flow entails a very small water level change in these watercourses. It therefore appears that, due to the presence of natural log jams or beaver dams, the control sections are the main factor influencing water levels in the study area, which limits the project's impacts on those levels. The simulations that were run represent the current state of the watercourse as surveyed in 2017 and 2018. However, these conditions could change if the controls move, disappear or are altered.

Table 7-8 shows the project's impacts on the water levels of watercourses in the study area. For creek CE2, no significant impact is expected upstream of the mining effluent discharge point. Downstream, water levels are expected to rise 10 to 26 cm during summer low flow due to the presence of effluent. During winter low flow, however, the impact is negligible. The average monthly flows are slightly higher in the summer and lower in the winter. Flood levels are higher for the weakest recurrences (+4 cm to +8 cm for the 2-year flood) and less so when the recurrence increases, even decreasing slightly for the 100-year flood downstream of the watercourse. For creek CE3, the simulations that were run show negligible impacts downstream of the mining effluent. Upstream of this point, a slight decrease in water levels is expected: 1 cm for low-water levels, around 5 to 7 cm for 100-year flood levels, and around 1 to 4 cm for average levels. For creek CE4, the impact was assessed solely downstream of James Bay road, with an observed decrease of 1 to 9 cm in all typical levels.

Table 7-8: Impact of the project on watercourse levels in the study area

<table>
<tr><th colspan="2" rowspan="2">Simulated conditions</th><th rowspan="2">Northern part</th><th colspan="2">Southern part</th></tr>
<tr><th>CE3</th><th>CE4</th></tr>
<tr><td rowspan="2">Low-water flows</td><td>Summer</td><td>from +10 cm to +26 cm, depending on the sections</td><td>-1 cm upstream from the effluent</td><td rowspan="2">from -9 cm upstream from the junction with creek CE3
to -1 cm upstream of the junction with creek CE3</td></tr>
<tr><td>Winter</td><td>≈ 0 cm</td><td>≈ 0 cm</td></tr>
<tr><td rowspan="2">Average monthly flows</td><td>June to October</td><td>from +2 cm at the level of the effluent
to +8 cm at the junction with CE6</td><td>-4 cm upstream from the effluent</td><td rowspan="2">from -4 cm upstream with the junction with creek CE3
to -1 cm upstream from the junction with creek CE3</td></tr>
<tr><td>November to May</td><td>from -1 cm at the level of the effluent
to -4 cm at the junction with CE6</td><td>from -1 cm to -3 cm upstream from the effluent (depending on the months)</td></tr>
<tr><td rowspan="2">Flood flows</td><td>2 years</td><td>from +8 cm at the level of the effluent
to +4 cm at the junction with CE6</td><td>-5 cm upstream from the effluent</td><td>from -5 cm upstream from the junction with creek CE3
to -2 cm upstream from the junction with creek CE3</td></tr>
<tr><td>100 years</td><td>from +5 cm at the level of the effluent
to -3 cm at the junction with CE6</td><td>-7 cm upstream from the effluent</td><td>from -4 cm upstream with the junction with creek CE3
to -1 cm upstream from the junction with creek CE3</td></tr>
<tr><td colspan="5">Notes: Impacts are negligible when the variation is approximately 0 cm (≈ 0 cm). For this reason, results for the northern part are presented from the effluent site on creek CE2. For the southern part, the impacts are negligible upstream from the effluent on creek CE3.</td></tr>
</table>

Given the increases in flow expected in creek CE2, attention was paid to the impact on velocities in the low-flow channel. In some sections, we note a slight reduction in velocities due to the local effects of controls. However, we see an increase in velocities in the creek overall. Consequently, for a two-year flood, there is an estimated increase in the range of 75% immediately upstream from the effluent (from 0.04 m/s to 0.07 m/s), to 25% at the level of the junction with CE6 (from 0.12 m/s to 0.15 m/s). For the 100-year flood, the increase is more limited, ranging from 33% at the level of the effluent (from 0.09 to 0.12 m/s) to 17% at the level of CE6 (from 0.17 to 0.2 m/s). With an average summer flow, the increase is in the range of 200% (from 0.02 m/s to 0.07 m/s). Nonetheless, it should be noted that, despite this high-percentage increase, the order of magnitude of velocities remains very low, never exceeding 0.4 m/s for each scenario simulated – which is explained by the very gentle slope of the watercourse and the large flood plains connected to the low-flow channel. The increase in velocities therefore should not cause erosion in the watercourse, nor any major morphological changes.

In recent years, several studies have been done in Québec to determine the probable impacts of climate change in different regions (URSTM, 2017). Table 7-9 summarizes the climate changes predicted in these studies.

Table 7-9: Climate change outlook to 2050 in James Bay

Indicator	1981–2010 average	Outlook to 2050
Average winter temperature (December to February, °C)	-18.46	-13.3
Annual minimum temperature (°C)	-38.96	-29
Frost-free days (number)	150	179
Annual precipitation (liquid and solid, mm)	835	946
Annual precipitation of 99th centile (extremes, mm)	19	23
Accumulation of precipitation during extreme events (mm)	220	290
Days with accumulation of precipitaion > 10 mm (number)	6	8
Average summer temperature (June to August, °C)	12.96	16.15
Maximum annual temperature (°C)	27.88	31.39

Source: URSTM, 2017.

According to this study, in the James Bay outlook to 2050, a minimum, average and maximum increase in temperature is anticipated, slightly more marked in winter than summer, along with an increase in the number of frost-free days. Furthermore, total annual precipitation is expected to increase (liquid and solid). However, in winter, this increased precipitation will be compensated by the rise in temperature that will reduce the maximum snowcover. The thaw season should start earlier than at present, and the floods produced by snow melt could also occur earlier, with slightly lower maximum flows. Last, extreme precipitation events could be more frequent and greater in intensity.

IMPACT ASSESSMENT

The impact assessment was conducted considering the most critical configuration, as well as the overall footprint of the project, dewatering flows from the pit and effluent discharge into CE2. The impact was evaluated in terms of the contributory area for the six watercourses of the study area, characteristic flows and water levels. Although changes will occur in the watersheds of the study area that will lead to significant changes in characteristic flows of the watercourses, the impact on the water levels and velocities of the watercourses remains moderate due to the land configuration (very flat and marshy with many controls). The intensity of the impact on the hydrological regime of the watercourses of the study area is therefore considered to be moderate. Its extent is considered local, since not all of the watercourses in the study area will be impacted, and for those that are, the effect on water levels and velocities becomes negligible at the boundary of the study area. The duration is long, since the impacts will occur during all phases of operation. The significance of the impact on the hydrological regime during the operation phase is therefore **moderate**.

REHABILITATION AND POST-REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructures.
- Pit rehabilitation.
- Water management.

MITIGATION MEASURES

Mitigation measures SUR 03, QUA 07, QUA 09 and QUA 11 will have to be applied in order to limit the impact on the hydrological regime in the study area during the rehabilitation phase, along with standard NOR 01, described in Table 7-5.

DESCRIPTION OF IMPACT

The rehabilitation phase involves decommissioning and returning the site to its original condition (backfilling, grading of surfaces, revegetation, securing of the site, temporary works and structures, etc.). During this phase, the dismantling of facilities could change the natural flow of surface water, such as the removal of roads and pumping stations for runoff.

Once rehabilitation of the site is complete, the infrastructure for water management on the site will be dismantled (retention pond, WTP, effluent), which will make it possible for creeks CE2 and CE6 to return to their original watersheds in terms of area. The suppression of mining effluent will make it possible for creek CE2 to return to a natural flow regime. The presence of the revegetated waste rock stockpile (steep slope) will nonetheless have a permanent impact on the topography of these watersheds, formerly very flat and marshy, resulting in greater reactivity to precipitation. The pit will be progressively filled with water from natural precipitation, to create a lake with an outflow toward creek CE3. The watershed of creeks CE4 and CE5 therefore will be encroached permanently by 9% and 1%, respectively (Table 7-6). The watershed of creek CE3 will increase permanently with the addition of the lake resulting from flooding of the pit. Nonetheless, no flooding is foreseen in the first 100 years, the time over which the pit will fill. Decommissioning of the network of collection ditches at the foot of the overburden stockpiles will also allow the watershed to return to a natural drainage scheme closer to the original pattern.

IMPACT ASSESSMENT

Since the areas affected will be as large as during operations, changes are expected to the hydrological regime. The intensity of the impact is therefore considered moderate. Its extent will be local, since the impacts will occur within the local study area and its duration long, since the change will be permanent. The significance of the impact on the hydrological regime during the rehabilitation phase is therefore **moderate.**

7.2.4 WATER AND SEDIMENTS

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Water management.
- Hazardous and waste materials management.
- Transportation and traffic.

MITIGATION MEASURES

Standard mitigation measures QUA 01 to QUA 04, QUA 08 to QUA 13, NOR 02 to NOR 04, NOR 07 to NOR 09 will be applied to reduce the impact of the project on water quality and sediments. These measures are presented in Table 7-5. Measures SUR 01 to SUR 04 will also help to monitor the impacts on the quality of water and sediments.

DESCRIPTION OF IMPACT

During the construction phase, road transport, transporting of heavy machinery, use of refuelling sites and temporary storage or handling of hazardous and waste materials will constitute potential sources of accidental spills that could contaminate the water and sediments. However, the risk of accidental spills is reduced by the application of mitigation measures. These measures will be aimed on prevention thanks to a regular monitoring of the equipment and the addition of emergency devices that allow for prompt response in the event of an accident. An accidental spill, if it occurs, will saturate the soils with contaminants at the spill site. If a significant volume is released, a portion of the product that has not adhered will migrate down into the groundwater table or toward the surface water, leaving a floating or sinking pure phase, depending on the liquid, and partly dissolving in the water. Therefore, it will be important to take swift action in the event of an accidental spill and recover the contaminated soils.

Contaminated groundwater will flow as per the local hydrogeological network. The impact of a potential spill will be, among other things, based on the volume of contaminants spilled, the uniqueness (spill) or the repetition (leak) of the problem and aquifer vulnerability at the spill site. Risk of a major spill at the site will be close to zero and the significance of the impact even lower since the volumes of potential spills linked to machinery will be limited. In addition, in the event of a spill, the cleaning and reporting procedure or emergency plan will be implemented, which will reduce the extent of the contamination and prevent contamination of the groundwater.

Moreover, access roads and routes will have to be maintained to ensure the safety of the workers. Use of ice melters to ensure the safety of routes during winter, could increase the salt concentration in surrounding soil and affect the quality of water and sediments. Seepage of surface water into the soil could carry a portion of these ice melters toward the groundwater table. Groundwater salinity could increase beneath the access roads in places where aquifer is most vulnerable. Considering that ice melters are rarely used and considering the dilution, dispersion and retention phenomena, a significant increase in groundwater salinity is highly unlikely. The ice melter used will be approved by the MTMDET and MDDELCC.

IMPACT ASSESSMENT

During the construction phase, the intensity is low, whether for risks linked to spills, or those linked to petroleum products or other hazardous materials. The mitigation measures to be applied will efficiently reduce the anticipated impacts. The extent is local given that the contamination would occur in an area confined to work site. Its duration is rated as short since it is limited to the period of construction. In short, the significance of the impact is **minor**.

OPERATION PHASE

SOURCES OF IMPACT

- Presence and operation of the pit.
- Other infrastructures in operation.
- Management of economic material, overburden and waste rock.
- Water management.
- Hazardous and waste materials management.
- Transportation and traffic.

MITIGATION MEASURES

Standard mitigation measures QUA 01 to QUA 06, QUA 12, NOR 02 to NOR 04, NOR 06 to NOR 09 will be applied to reduce the impact of the project on the quality of water and sediments. These measures are presented in Table 7-5.

DESCRIPTION OF IMPACT

Use and maintenance of the machinery during the operation phase could affect the quality of water and sediments. Development of the sites designated for the project's different infrastructure and the site's normal operations will require the use of vehicles, equipment and heavy machinery. Use, maintenance and transporting of this equipment will emit certain substances into the environment. Potential of leaks or accidental spills during use will increase the risk of contamination of water and sediments by hydrocarbons or other contaminants. The petroleum product storage area and mechanic's shop pose an additional risk. Consequently, leaks at these installations could generate a contamination of the water and sediments. Nevertheless, the impact of these leaks would usually be limited if quickly detected and managed.

The waste rock stockpile could be a source of impact according to the geochemical properties of waste rock and tailings. Therefore, during operation, runoff percolates through the stockpile and could leach some metals. As presented in Section 4.7.1, waste rock is "low risk" under D019. In addition, according to this same directive, waste rock from all lithologic units would be considered leachable, at varying degrees. Results from tests on tailings, when compared to D019 criteria, reveal that all tailing samples were also considered to be "low risk". Pit dewatering water could also contain metals. The latter will be pumped and directed into the site's main water retention basin.

It is possible, yet unlikely, that the water contaminated with metal will reach the bedrock aquifer. However, the presence of an impermeable layer, clay or other, in the area around the stockpile would limit the risk of contamination. Moreover, all runoff will be recovered by way of a peripheral ditch system, which will limit water seepage toward the underlying aquifer.

Runoff from overburden stockpiles will be captured and directed to a retention basin where the particulate matter will stabilize. Analysis performed on unconsolidated deposits revealed that little metals leached from the materials (below the applicable criteria). Therefore, the water will be returned to the environment without any additional processing.

Dry maintenance activities pose little risk in terms of groundwater contamination. The pumps will be electric and the response time in the event of a hazardous product spill is so rapid, impacts associated to a potential contamination are considered "zero".

A WTP will be in operation on the site from June to October. The water that was in contact with pit walls and waste rock, and then returned into the natural environment, will undergo treatment beforehand. The MDMER authorizes effluents if the pH is between 6 and 9.5, if the concentration ranges in the effluent do not exceed the authorized limits, and if the effluent has proven to be non-toxic. In addition, the effluent must comply with the criteria of D019 and the EDOs which will be specifically established for the project. Therefore, while in compliance to EDO standards, negative impacts on water quality will be limited. The quality of the surface water and groundwater will be monitored in real time throughout the mining operations. The details of the program are presented in Chapter 10.

IMPACT ASSESSMENT

During the operation phase, intensity is low because the protection measures implemented to prevent spills and the migration of contaminated water toward the natural environment will be sufficiently effective. Extent is local since several bodies of water in the study area are affected by the project. During operation, the impact is felt on a discontinuous basis, therefore the duration is moderate. The significance of the residual impact on water and sediments is considered **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructures.
- Pit rehabilitation.
- Water management.
- Hazardous and waste materials management.
- Transportation and traffic.

MITIGATION MEASURES

Standard mitigation measures QUA 01 to QUA 04, QUA 07, QUA 08, QUA 10 to QUA 12, SUR 03, NOR 01 to NOR 04, NOR 09 to NOR 10 will be applied to reduce the impact of the project on the quality of water and sediments. These measures are presented in Table 7-5.

DESCRIPTION OF IMPACT

During the rehabilitation phase, general decommissioning activities, management of hazardous and waste materials, water management and transport could have a negative affect the quality of water and sediments. Therefore, the impacts described in the construction phase also apply to the rehabilitation phase.

Moreover, the impacts are like those in the operation phase in regard to the waste rock stockpile, main retention basin and its WTP treatment prior to its return in the receiving environment, since water infrastructure will remain in place in spite of site rehabilitation, and this, until the effluent meets D019 requirements.

IMPACT ASSESSMENT

Similarly to during the construction period, negative impacts linked to the risks of contamination of groundwater by accidental spill and the spreading of ice melters in the winter are expected during the rehabilitation phase. Moreover, impacts are like those in the operation phase in regard to the waste rock stockpile since infrastructure will remain in place in spite of site rehabilitation. The mitigation measures that will be applied will efficiently reduce the anticipated impacts and hence, the intensity is low. The extent is local since the work will be confined within the limits of the local study area. The duration is short since site rehabilitation will be conducted over a one-year period. The significance of the impact on the quality of water and sediments is therefore considered to be **minor**.

POST-REHABILITATION PHASE

During the post-rehabilitation phase, the pit will gradually fill up with water. Due to reduced groundwater inflow, the pit lake recharge will mainly come from precipitations. The quality of the pit lake water could deteriorate since part of the water from precipitations will be exposed to the rock walls.

In addition, post-rehabilitation activities will recreate surface runoff conditions similar to initial conditions. The groundwater flow regime is expected to essentially return to its original state. The pit lake will have an outflow toward creek CE3. When the infrastructure for water management on the site is dismantled, the surface water’s physicochemical nature will return to its initial condition.

7.2.5 ATMOSPHERE

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Hazardous and waste materials management.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures AIR 01 to AIR 05 and standard NOR 11 described in Table 7-5 will be applied.

DESCRIPTION OF IMPACT

During the construction phase, contaminant emissions in the air related to the project are primarily linked to truck traffic, unloading of materials, soil stripping and the deployment of equipment (WSP, 2018*c*). Deterioration of air quality can have effects on the health of the fauna and flora through deposition and on human health through inhalation. The extent of the effects depends on amount of contaminants emitted into the atmosphere and duration of exposure to contaminants.

The results of the modelling survey on human sensitive receptors identified, reveal that the standards of the *Clean Air Regulation* (CAR) and Canadian Ambient Air Quality Standards (CAAQS) for gaseous compounds and total particulate matter are met (WSP, 2018*c*). The modelling survey therefore shows that the deterioration of the quality of the atmosphere by gaseous compounds and total particulate matter will be confined to the site and its immediate environment and will not affect the primary users. The combined effects on human health, fauna and flora are therefore negligible.

In addition, in regard to GHG emissions, it was calculated that the project's construction activities will emit 24,969 tCO_2eq (Appendix E), from heating the camp (56%), mobile equipment (33%), and use of generators (9%), which represents a fraction of the emissions in the Canadian heavy industry category (less than 0.03%).

IMPACT ASSESSMENT

The impact of the dust and other disturbances on the quality of the atmosphere during construction is considered low intensity based on the remoteness of the planned activities versus the nearest sensitive receptors. Nevertheless, certain disturbances (dustfall, for example) may be felt in some sections of the study area, conferring a local extent to this impact. In addition, the sectors in question can vary depending on the day, based on weather conditions since the disturbances will necessarily be dependent on the winds. The duration of this impact is short since it is limited to the period of construction. The impact on the quality of the atmosphere during the construction phase is therefore considered to be of **minor** significance.

OPERATION PHASE

SOURCES OF IMPACT

- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, overburden and waste rock.
- Hazardous and waste materials management.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures AIR 01 to AIR 05 and the NOR 11 standard described in Table 7-5 will be applied.

DESCRIPTION OF IMPACT

The impact associated to an increase in particles and metals in the air during the operation phase, was determined by an air dispersion modelling survey of contaminants for Year 9 of operation and by considering daily extraction and transport of a maximum of 42.3 kt of material from the pit (15.4 Mt per year). Periodically scheduled activities (expansion of the dikes and stockpile), were also considered. The detailed results during the operation phase are presented in the air dispersion modelling study (WSP, 2018*c*). The scenario was developed such as to represent the worst conditions during operation, or, maximal operation at the same time as site expansion activities.

The study concludes to the modelling of occasional exceedances of the total particle standards from the *Clean Air Regulation*, at the limit of the application of standards and criteria, as identified as 300 m away from operations. Exceedances are mainly found east of the pit. Map 7-3 illustrates the isocontours of the maximum concentrations modelled for all of the years. However, for all sensitive receptors, no exceedance from the standard is expected. Furthermore, for all metals and gaseous compounds, the maximum concentrations meet standards and criteria, and this, both at the limit of application and at sensitive receptors.

Crystalline silica is the only modelled substance for which we note criteria exceedances (one-hour and yearly). Exceedances are infrequent for the one-hour criterion. In fact, results modelled to the 99th percentile reveal compliance to the criterion both at the limit of application and at sensitive receptors. For the yearly criterion, the only inhabited sensitive receptor exhibiting an exceedance is the km 381 truck stop. Concentrations modelled at other inhabited receptors such as the Cree camps nearby the site, are all below the limit value.

During the operation phase, several activities such as road transport, traffic, operating of machinery, and propane use, are likely sources of gaseous contaminants, including GHG emissions. GHG emissions linked to mining activities were estimated annually and for the entire project duration (Appendix E). The estimation is based on Galaxy’s data for the different mining activities and considers direct and indirect sources.

During operation, the direct annual GHG emissions from the project are estimated at approximately 61.2 kt CO_2eq. GHG emissions from mining activities calculated according to the 1-1 and 1-10 equations of QC1.3 in the *Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere* are 16.9 kt CO_2eq. These include diesel consumption for fixed equipment, propane use for heating of the site, and explosives. In regard to transport activities on the site, equations 27-1 and 27-02 from the same section of the RMRCECA served to estimate the annual value at 44.3 kt CO_2eq. During operation of the mine, annual GHG emissions will represent 0.07% of the total emissions in Canada's heavy industry in 2020.

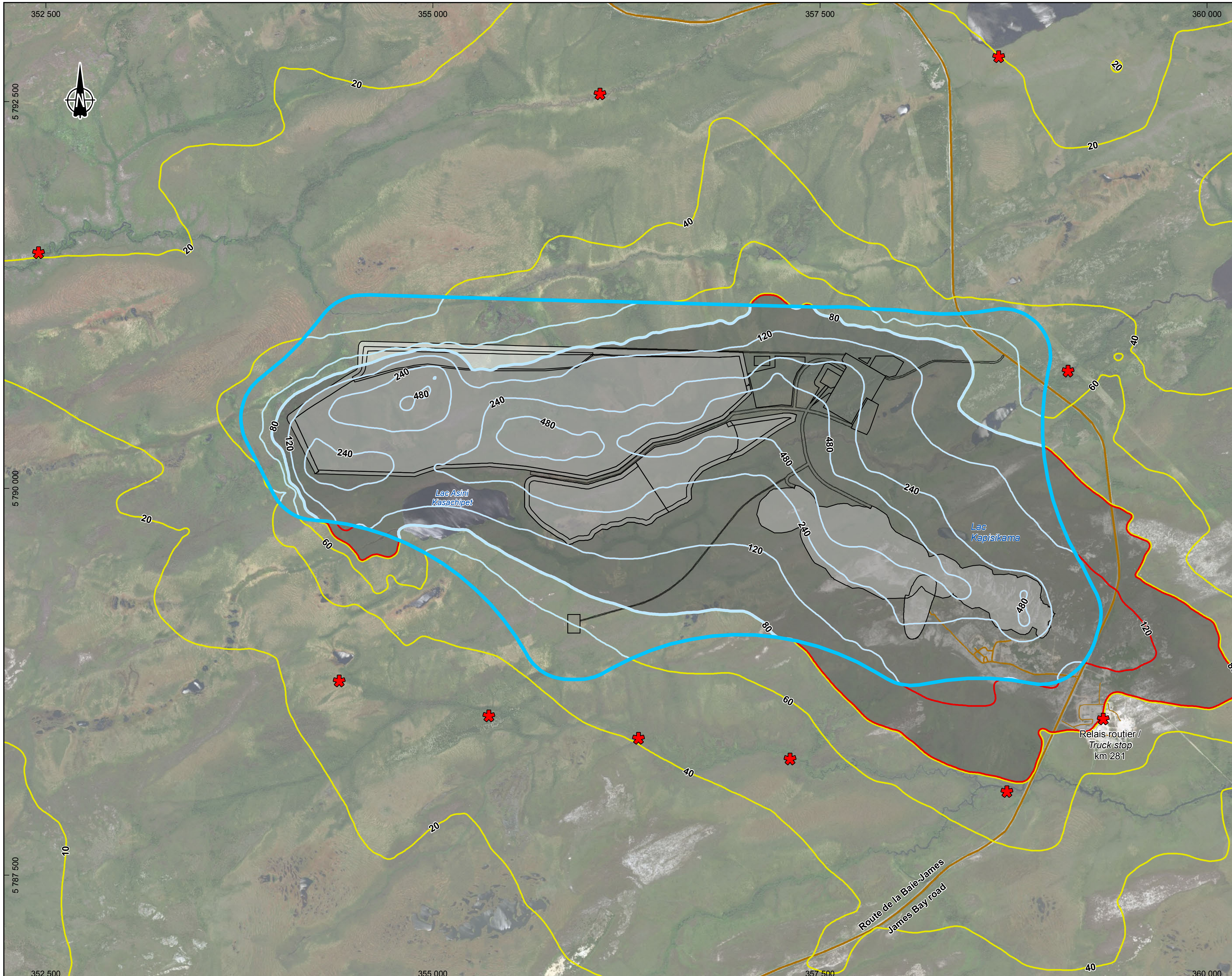
IMPACT ASSESSMENT

The intensity of the impact on the quality of atmosphere during the operation phase is considered to be low intensity because standards for sensitive receptors are met. The extent of this impact is local since the impacts are felt nearby the mining activities, within the local study area. Lastly, the duration of this impact is considered to be moderate and will continue to be felt throughout the years the mining site will operate. In short, the impact of the project on the quality of the atmosphere is considered of **minor** significance.

REHABILITATION PHASE

SOURCES OF IMPACT

— Dismantling of infrastructures.
— Pit rehabilitation.
— Hazardous and waste materials management.
— Transportation and traffic.



Modélisation de la dispersion atmosphérique / *Air Dispersion Modelling* (µg/m³)

- Supérieure à la valeur limite / *Above the limit*
- Inférieure à la valeur limite / *Below the limit* (considérant la concentration initiale / *when considering background level*)
- Hors domaine d'application / *Outside of the application domain*
- Récepteurs sensibles / *Sensitive receptor*
- Limite d'application des normes et critères / *Norms and criteria application limit*

Valeur limite / *Limit value* : 120 µg/m³
Concentration initiale / *Background level* : 40 µg/m³

Composantes du projet / *Project Component*

- Infrastructures minières / *Mining infrastructure*

Infrastructures / *Infrastructure*

- Route principale / *Main road*
- Route d'accès / *Access road*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine

Étude d'impact sur l'environnement

Environmental Impact Assessment

Concentrations maximales de particules totales modélisées sur une période de 24 heures – Scénario d'exploitation / *Maximum Modelled Total Particulate Matter Concentration for a 24 hour period – Operation Scenario*

Source :
Orthoimage : World Imagery
No Ref : 171-02562-00_wspT183_EIE_c7-3_air_181015.mxd

Échelle : 1 : 25 000
0 250 500 m
UTM fuseau 18, NAD83

Carte / *Map* 7-3

wsp

MITIGATION MEASURES

Mitigation measures AIR 01 to AIR 03 along with the NOR 11 standard described in Table 7-5 will be applied.

DESCRIPTION OF IMPACT

The impact on the quality of the atmosphere during the mine rehabilitation phase is linked to the same activities as in the construction phase, although the latter are less likely to emit dust; yet, as for the other project phases, the standards, in both the periphery of the site and overall scope of application, will be met. Therefore no exceedance is expected at sensitive receptors identified.

IMPACT ASSESSMENT

The impact of the dust and other disturbances linked to the quality of air during the rehabilitation phase is considered to be low intensity due to the significant reduction in industrial activities. The extent is local since it could spread all over the mining site and its periphery. In regard in the anticipated negative impacts, its duration is short because the rehabilitation work will be completed within a few years. The impact on the quality of the atmosphere during the rehabilitation phase is therefore considered to be of **minor** significance.

POST-REHABILITATION PHASE

Once the site has been restored, impacts will be non-existent, since no mining activities that would affect the quality of the atmosphere will be taking place.

7.2.6 ARTIFICIAL LIGHT AT NIGHT

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures LUM 01 to LUM 03 (Table 7-5) will be implemented to minimize the project's impact on artificial light at night.

DESCRIPTION OF IMPACT

Activities that involve fixed or mobile lighting during the construction phase could result in the emission of artificial nocturnal light into the sky and work site limits, which are likely to disturb nocturnal landscapes and have an impact on the biological and social environments on the periphery. Light levels from these facilities and the use of mobile equipment have not been modelled, since this is a temporary situation and the sources will emit very little light compared with developments in the operation phase.

IMPACT ASSESSMENT

The intensity is considered low. The extent is considered localized, since artificial nocturnal light emitted during the construction phase will affect a small area in the study area. The duration is short. The significance of the impact during the construction phase is considered **minor**.

OPERATION PHASE

SOURCES OF IMPACT

- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, unconsolidated deposits, and waste rock.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures LUM 01 to LUM 03 (Table 7-5) will be implemented to minimize the project's impact on artificial light at night.

DESCRIPTION OF IMPACT

To accurately assess the impact that future facilities will have on artificial nocturnal light, a photometric modelling of the light levels was carried out using AGI32 lighting analysis software, version 18.3 (AGI32 Light Analyst, Illumination Engineering Software). The methods and the complete results of this modelling are presented in Appendix H.

The addition of new nocturnal light sources related to the project's facilities will locally alter the sky brightness conditions. The results of light to the sky show a low-intensity light level. The average calculated at 100 m above the tallest building in winter is 0.2 lux for the entire local study area. The light points in the sky are concentrated above the administrative and industrial area (maximum level reached 8.3 lux), stockpiles (approximately 6 lux), and to a lesser extent above the pit (approximately 1 lux), since the light is found under the present elevation of the soil around the pegmatite mound. Road-related lighting also projects low light onto the sky (approximately 0.5 lux). These changes in the brightness of the sky will locally alter the environmental area, which is currently representative of a sector that is slightly impacted by the brightness (C1) toward an area characteristic of a low-brightness sector (C2). On the other hand, the additional supply of light should not be sufficient to alter the environmental area attributed to the truck stop, which is already C2 because of the lighting already present at the site.

Expected changes in the brightness of the sky will have very little effect on the sky glow. The effects will only be visible near lit areas. The change will be barely perceptible on all other sensitive receptors in the study area, including permanent Cree campsites. Local alterations in the brightness of the sky will have very little effect on the uses of the territory (traditional or otherwise) on the periphery for facilities planned for the mine's operation.

The addition of new nocturnal light sources in connection with the facilities required by the project will not result in the emission of light trespass. The modelisation results show that light levels at 1.5 m from the ground at limits of the local study area will be zero. The light is only concentrated at the edge of the lit areas. Therefore, no impact of a light trespass source is expected on the quality of life for humans, their uses of the territory (traditional or otherwise), on the periphery of facilities planned for the mine's operation.

Side views were modelled using two sensitive receptors, the km 381 truck stop and the permanent Cree camp to the south. The results of the visual side simulation show that at the km 381 truck stop, the light emitted by future facilities will not be directly visible due to the area's rugged topography, which limits the direct view into the site. On the other hand, a slight sky glow will be perceptible in the sky, which will locally impact the quality of the nocturnal landscape in the area. The same observation can be made at the permanent Cree camp. The glow will be more visible in the presence of clouds, this is the artificial nocturnal light emitted by ground facilities, which has the effect of increasing the visibility of sky glows in addition to reducing the brightness of the sky.

In the context of the project, the environmental effects of artificial nocturnal light on the biological environment are considered insignificant due to the low level of light generated to the sky and the absence of light trespass at the limits of the local study area.

IMPACT ASSESSMENT

During the operation phase, the probable residual impacts of the project on artificial light at night mainly affect the social environment. Effects on the biological environment will be minor due to the low level of light generated to the sky and the absence of artificial light at the limits of the local study area. Therefore, the expected impacts are more specifically assessed on the brightness of the sky and nocturnal landscapes. The impact intensity on artificial light at night is considered low, since the brightness of the sky and quality of the nocturnal landscapes will be slightly altered, and it is unlikely that these changes affect users of the area. The extent is considered local considering that the impact will be concentrated on the site itself and a few hundred metres around. The duration is medium, since the impact will only be felt during the operation phase and is not permanent. The significance of the impact during the operation phase is considered **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

— Dismantling of infrastructures.
— Transportation and traffic.

MITIGATION MEASURES

Mitigation measures LUM 01 to LUM 03 (Table 7-5) will be implemented to minimize the project’s impact on artificial light at night.

DESCRIPTION OF IMPACT

The activities mentioned above that involve fixed or mobile lighting during the rehabilitation phase could temporarily result in the emission of artificial nocturnal light into the sky and work site limits, which is likely to disturb nocturnal landscapes and have an impact on biological and social environments on the periphery. The light levels from these facilities and the use of mobile equipment have not been modelled, since this is a temporary situation and the sources will emit very little light compared to the facilities that will be present during the operation phase, in the same place.

IMPACT ASSESSMENT

During the rehabilitation phase, the facilities that will be lit and the use of equipment and machinery that will require lighting for operations and worker safety will be temporary and emit very little artificial nocturnal light. The intensity is considered low. The extent is considered local, since the artificial nocturnal light emitted during the rehabilitation phase will affect a small area in the local study area. The duration is short. The significance of the impact during the rehabilitation phase is considered **minor**.

POST-REHABILITATION PHASE

As the activities on the site will be completed during the post-rehabilitation phase, no impact is anticipated on artificial light at night.

7.2.7 AMBIENT NOISE

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measure SON 01 and NOR 12 described in Table 7-5 will be applied.

DESCRIPTION OF IMPACT

A simulation during the construction phase was set up during the busiest periods in terms of equipment and noisy work simultaneously. The scenario includes the development activities required to develop the mine site when there will be the most trucks at the site. Dikes and stockpile will be under construction, and the quarry will be in operation. At this stage of the project, the construction methods and details (number, type of equipment, etc.) are not exactly known. Hypotheses were necessary to be able to establish the most likely scenarios to occur on the same day.

The noise criteria for the daytime period are based on a 12-hour period. It was considered in the model that the work would only be done during the day (between 7 a.m. and 6 p.m.), a 10-hour period. Galaxy does not foresee any problems in complying with the noise standard of 55 dBA between 7:00 a.m. and 7:00 p.m.

IMPACT ASSESSMENT

The impact intensity is considered low since the sound impacts assessed during the construction phase comply with the MDDELCC criteria for construction sites. The extent is considered local considering that the impact will be felt on the periphery of the mine site, including the km 381 truck stop. Its duration is short and it will spread over the entire construction. The significance of the impact on the ambient noise during the construction phase is therefore considered **minor**.

OPERATION PHASE

SOURCES OF IMPACT

- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, unconsolidated deposits, and waste rock.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures SON 01 and NOR 12 described in Table 7-5 will be applied.

DESCRIPTION OF IMPACT

To assess the extent to which noise may be detrimental to well-being, sound criteria have been established within D019. This directive indicates average hourly sound levels for the diurnal and nocturnal periods that should not be exceeded. These values are based on the prescriptions of Instruction Note 98-01 on noise of the MDDELCC, according to the uses permitted by a municipal zoning by-law. The project falls within zone IV (non-sensitive area) and the applicable noise criteria are 70 dBA at night, except for the Cree camp and the km 381 truck stop, and 55 dBA during the day or residual noise, if higher. For those two other sites, the criteria are 55 dBA at night and 50 dBA during the day.

A simulation of sound propagation to assess the project's noise emissions with tailwinds was conducted in year 9 of the operation, the year when the production level would be the highest. Map 7-4 presents the iso-contours of noise as modelled during the operations. The detailed results of this modelling are presented in a separate study (WSP, 2018*d*). The most restrictive noise level to be met is that generated during the nocturnal period and it is set at 50 dBa ($L_{Aeq\ 1h}$). Considering all of the mine's emission sources, its maximum sound impact for the nearest sensitive receptor is assessed at 42 dBa (km 381 truck stop).

IMPACT ASSESSMENT

The impact intensity during the operation phase is considered low, since the sound impact is in accordance with the limit of 50 dBA at night, even in tailwind conditions, considering all sources of noise are simultaneously active. The extent of this impact is local because it will encompass the entire mining site as well as a zone of influence on the periphery of it. This impact will be of short duration and intermittent, occurring during the operation period, approximately 20 years. Overall, this impact is considered of **minor** importance.

REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructures.
- Pit rehabilitation.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures SON 01 and NOR 12 described in Table 7-5 will be applied.

DESCRIPTION OF IMPACT

As with the construction phase, the rehabilitation methods and details (number, type of equipment, etc.) are not exactly known. The results modelled during the construction phase are in accordance with the standards, and the work required during rehabilitation is similar to that during construction.

IMPACT ASSESSMENT

The impact intensity is considered low since sound impacts during the rehabilitation phase will be in accordance with D019. The extent is considered local given that the impact will be felt on the periphery of the mine site. Its duration is short, since all of the activities in the rehabilitation phase will take place over a period of one year. The significance of the impact on the ambient noise during the rehabilitation phase is therefore considered **minor**.

POST-REHABILITATION PHASE

As there will be no more activity at the site during the post-rehabilitation phase, there will be no impact on the ambient noise.

7.2.8 VIBRATIONS AND OVERPRESSURE

CONSTRUCTION PHASE

SOURCE OF IMPACT

- Site preparation and infrastructure construction.

MITIGATION MEASURES

Mitigation measures VIB 01 to VIB 04 and NOR 13, described in Table 7-5, will be applied.

DESCRIPTION OF IMPACT

Blasting is planned during the construction phase for the quarry construction. These activities will cause vibration and air overpressures.

IMPACT ASSESSMENT

The intensity of the impact is considered low, since the activities during construction will be marginal. Its extent is considered local given that vibration and air overpressures could be experienced in the periphery of the quarry. Its duration is short, since the impact will be felt intermittently, during blasting. The significance of the impact of vibration and air overpressures during the construction phase is therefore considered **minor**.

OPERATION PHASE

SOURCE OF IMPACT

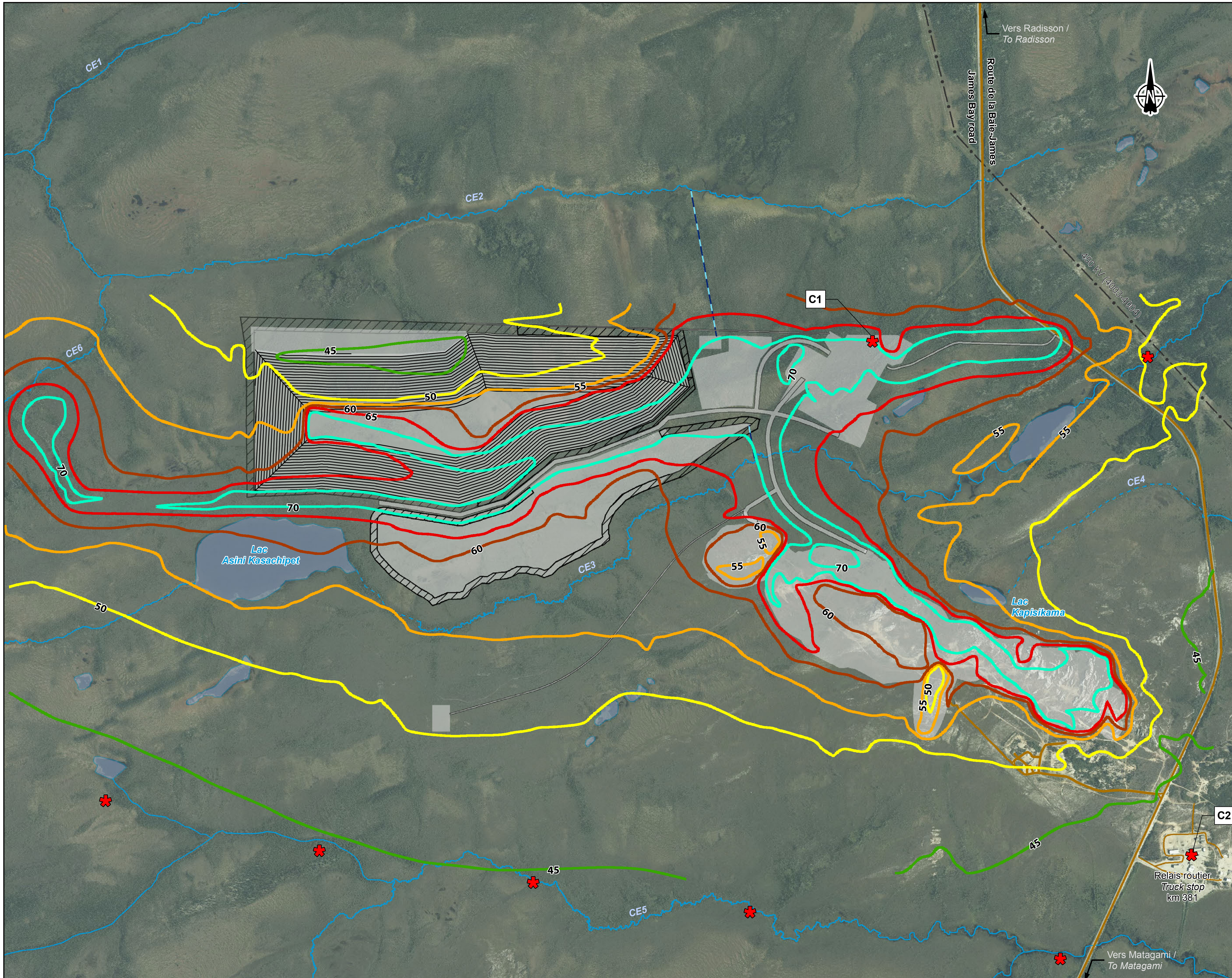
- Presence and operation of the pit.

MITIGATION MEASURES

Mitigation measures VIB 01 to VIB 04 and NOR 13, described in Table 7-5 will be applied.

DESCRIPTION OF IMPACT

The impact assessment was carried out considering the use of a load of 185 kg of explosives per hole 152 mm in diameter, an explosive density of 1.2 t / m^3 and a solid packing collar height of 3 m. The vibration criterion of D019 for structures and sensitive human areas is 12.7 mm/s. Assuming a maximum of four holes exploding in 8 ms, the threshold is respected for the nearest structures, which are the km 381 truck stop (10.2 mm/s), the industrial sector (9.3 mm/s) and the worker camp (4.4 mm/s). For fish, the criteria established in the *Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters* (Wright and Hopky, 1998) is a pressure of 100 kPa in their swim bladder. This pressure is reached at a distance of 137 m from the detonation, assuming the same parameters indicated above. Since the minimum distance between the pit and the watercourse will be 165 m (creek CE3), the detonations will be compliant. As indicated in the specialized study on the aquatic habitat (WSP, 2018*e*), there are no spawning grounds or potential spawning sites in creek CE3. However, creek CE5 has a potential to have spawning ground. The criterion is 13 mm/s in a spawning ground during the period when eggs are incubating. A vibration level of 3.9 mm/s is calculated in the pit location closest to creek CE5 (945 m), which is compliant.



Récepteur sensible / *Sensitive recepteur*

Courbes isophoniques (Nuit - 12 h L_{Aeq}) /
Isophone Contour (Night - 12 h L_{Aeq})

- 45 dBa
- 50 dBa
- 55 dBa
- 60 dBa
- 65 dBa
- 70 dBa

Composantes du projet / *Project Component*

Route / *Road*

Infrastructure minière / *Mining Infrastructure*

Infrastructures / *Infrastructure*

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Hydrographie / *Hydrography*

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Niveaux sonores modélisés -
Phase d'exploitation - L_{Aeq1h} /
Modeled Noise Levels –
Operation Phase – L_{Aeq1h}

Sources :
Orthoimage : Galaxy, août / august 2017
Données du projet / Project data : Galaxy, 2018
Fosse, carrière et entreposage des explosifs /
Pit, quarry and explosives magasine : Mining Plus, 2018
Secteur administratif et industriel et aire de minerai /
Administrative and industrial sector and ROM pad : Primero, 2018

No Ref : 171-02562-00_wspT185_EIE_c7-4_bruit_181015.mxd

0 175 350 m
UTM 18, NAD83

Carte / *Map 7-4*

wsp

Regarding air overpressures, the criterion of D019 is 128 dB for sensitive populated areas. The air overpressure calculation is 122 dB for the km 381 truck stop and 117 dB at the worker camp. The calculations assumed the absence of temperature inversions and tailwinds. These parameters could therefore increase the values by 10 dB, under certain conditions. As a result, mitigation measure VIB 03 will make it possible to maintain the thresholds within adequate levels. Furthermore, flying rock during blasting will be minimized by using blasting mats and a stuffing collar at least 5 m high when done in sensitive sectors.

IMPACT ASSESSMENT

The intensity of the impact is considered low, since the level of vibration and air overpressures assessed during the operation phase comply with the criteria of D019 and Fisheries and Oceans Canada. Its extent is considered local given that vibration and air overpressures may be experienced on the periphery of the mining site, at the km 381 truck stop and along the James Bay road. The duration will be short, since the impact will be felt intermittently, at the time of blasts. The significance of the impact of vibration and air overpressures during the construction phase is therefore considered **minor**.

REHABILITATION PHASE

Does not apply, since there will be no activity that could generate vibration and air overpressures during rehabilitation work.

POST-REHABILITATION PHASE

Does not apply since there will be no more activity on the site.

7.3 IMPACTS ON THE BIOLOGICAL ENVIRONMENT

7.3.1 VEGETATION AND WETLANDS

CONSTRUCTION AND OPERATION PHASES

SOURCES OF IMPACT

— Site preparation and infrastructure construction.
— Presence and operation of the pit.
— Management of economic material, overburden and waste rock.
— Transportation and traffic.
— Hazardous and waste materials management.

MITIGATION MEASURES AND COMPENSATION

Mitigation measures VEG 01 to VEG 07, SUR 01 to SUR 04, QUA 01 to QUA 05, QUA 10 to QUA 12 should be applied, as well as standards NOR 02 to NOR 04, NOR 10 and NOR 15, described in Table 7-5.

To make up for inevitable losses of wetlands, a compensation program will be developed to comply with MDDELCC requirements (NOR 15). This program will be prepared and presented to the MDDELCC with the application for work authorization.

DESCRIPTION OF IMPACT

The anticipated impacts on vegetation are primarily related to the destruction and modification of natural habitats. These impacts will be caused by the deforestation and excavation necessary to prepare the site and by the construction of temporary or permanent infrastructure. It is important to note that the construction of waste rock and overburden stockpiles as well as expansion of the pit will take place continuously during the operation phase. To provide an overview of the area of natural environments that will be affected by the construction of all infrastructure, it was considered relevant to merge the construction and operation phases in describing the impact.

The work required for future development of mining infrastructure will result in the transformation of roughly 95 ha of terrestrial environment and 302 ha of wetlands. Note that optimization of the project has made it possible to completely avoid encroaching on hydrous environments. Table 7-10 lists the area of natural environments affected for all project infrastructure, by type of grouping observed in the study area. These affected areas also include those stripped around infrastructure, consisting of a 35 m protection zone, to shield them from possible forest fires. The initial condition of these environments prior to activities is generally non-degraded.

In addition to areas directly affected by work, the development of the site and projected infrastructure will have an indirect impact on plant communities preserved. On the one hand, work will fragment ecosystems and could lead to changes in plant communities bordering infrastructure. On the other, the establishment infrastructure will isolate some wetlands areas and change the drainage pattern on the work site. Under these conditions, some wetlands could be subject to more or less significant changes, in particular partial dewatering in the periphery of drainage ditches. Note that building of a small clay berm along stripped areas will reduce the effect of this indirect impact. Monitoring of vegetation on the periphery of infrastructure during the first years will allow better evaluation of this anticipated impact. Details are presented in Chapter 10. A list of these indirect losses is also provided in Table 7-11.

Efforts to optimize the project have made it possible to preserve one of the two communities of *carex sterilis* found in the study area, a plant species likely to be designated threatened or vulnerable. For the second community that could not be avoided, relocation to another suitable habitat is planned. Given the scarcity of information on the ecology and distribution of this plant, this relocation aimed at limiting the impact on the species should be considered experimental, and details of the transplantation method will be included in the compensation program.

Besides direct encroachment on land, other sources of impact could affect vegetation and wetlands. The management of hazardous and waste materials could lead to accidental spills of hydrocarbons into the environment, mainly associated with refuelling or breakdown of machinery. Appropriate work practices will be put in place to prevent accidental spills, and should they occur, the contaminated soil will be managed in a manner consistent with existing regulations. Recycling and recovery of non-hazardous waste materials will be promoted during the construction phase. Therefore, environmental risks associated with spills are low and, if they do occur, will be limited to the work site.

Last, machinery transportation and traffic on the work site could accidentally introduce or propagate invasive non-native plant species within the territory. The rather rigorous climatic conditions in the study area will nonetheless limit the growth potential of some invasive species present mainly in the south of the province. Mitigation measures are planned to reduce the risks of introduction and propagation during construction and operation activities.

IMPACT ASSESSMENT

The application of mitigation measures will minimize the potential impacts on vegetation and wetlands. Nonetheless, despite these mitigation measures and the reduction of impacts through project optimization, the area of environments affected will be relatively significant, and the population of one species likely to be designated threatened or vulnerable cannot be avoided. For these reasons, this impact is considered moderate. However, it is important to note that its extent is local, since deforestation will affect only the mine site. The duration is medium since the impact may occur during the life of the mine, a period of approximately 20 years. Overall, the significance of the impact on vegetation and wetlands during the construction and operation phases is considered **moderate**.

REHABILITATION PHASE

SOURCE OF IMPACT

- Transportation and traffic.
- Decommissioning of infrastructures.

Table 7-10: Area of terrestrial environments and wetlands directly affected by type of project infrastructure

Type of infrastructure	Rocky outcrop (ha)	Human (ha)	Scrubland (ha)	Burns (ha)	Black spruce stand with lichen (ha)	Shrub peatland (ha)	Wooded peatland (ha)	Open peatland (ha)	**Total per infrastructure (ha)**
Quarry	0.00	0.00	4.44	0.00	0.00	0.00	0.00	0.21	**4.65**
Waste rock stockpile	0.00	0.00	14.60	3.69	1.31	52.98	52.66	83.74	**208.97**
Overburden stockpile	0.00	0.00	6.80	0.00	0.39	6.94	9.46	31.69	**55.27**
Pit	30.44	0.00	17.08	0.00	0.00	0.00	0.45	21.57	**69.55**
Dry storage area	0.00	0.00	0.00	0.00	1.28	0.48	5.23	1.47	**8.46**
ROM pad	0.00	0.00	0.00	0.00	1.03	0.00	0.85	1.01	**2.89**
Pumping stations	0.00	0.00	0.00	0.00	0.00	0.00	0.86	0.08	**0.95**
Administrative and industrial area	0.00	0.00	0.00	0.00	6.11	2.04	9.45	0.00	**17.60**
Explosives magazine	0.00	0.00	0.00	0.14	0.00	0.00	0.08	2.52	**2.74**
Water treatment plant	0.00	0.00	0.00	0.00	0.00	0.39	1.50	0.00	**1.88**
Roads	0.00	0.04	3.00	0.06	4.25	2.93	5.37	8.32	**23.97**
Total per environment	**30.44**	**0.04**	**45.92**	**3.89**	**14.36**[1]	**65.75**[1]	**85.92**[1]	**150.61**	**396.93**

Note: The sum of columns and lines may vary due to rounding of areas.

Table 7-11: Area of terrestrial environments and wetlands directly and indirectly affected

Natural environment	Total area of the local study area (ha)	Area directly affected (ha)	Area indirectly affected[1] (ha)
Terrestrial environment	**617.54**	**94.65**	**15.20**
Rocky outcrop	53.55	30.44	3.02
Human	43.52	0.04	0.16
Scrubland	244.21	45.92	6.46
Burns	161.65	3.89	1.11
Black spruce stand with lichen	114.61	14.36	4.45
Wetland	**2,720.69**	**302.28**	**49.80**
Shrub peatland	722.16	65.75	8.92
Wooded peatland	786.72	85.92	12.97
Open peatland	1,211.81	150.61	27.91
Other environments within the local study area that are not affected by the project	350.24	0	0
Subtotal	**3,338.47[2]**	**396.93**	**65.00**

1 Includes isolated waste environments as well as a 25 m buffer zone applied on either side of infrastructure.
2 Natural environments made up a total of 3,688.47 ha in the study area. Some types of natural environments inventoried will not be affected by the project.

MITIGATION MEASURES

Mitigation measures VEG 02, VEG 3 and VEG 06, QUA 01 to QUA 04, QUA 10 to QUA 12 will have to be applied, as well as standards NOR 02 to NOR 4 and NOR 10 as well as NOR 01 and NOR 04, described in Table 7-5 will be applied during the rehabilitation phase.

DESCRIPTION OF IMPACT

During this phase, rehabilitation of the site, including revegetation of various infrastructure, is planned. In summary, stockpiles and other stripped surfaces will be revegetated to stabilize the site and allow a full return of vegetation as quickly as possible. The clay berms will be removed to allow new connectivity among restored environments and surrounding natural environments.

Transportation and traffic will continue to be a potential vector for the introduction and propagation of invasive alien plant species. The application of mitigation measures will nonetheless reduce this risk to a negligible level.

IMPACT ASSESSMENT

The impact on vegetation during the closure phase is positive overall. As a result, an impact assessment is not required.

POST-REHABILITATION PHASE

After rehabilitation of the site, impacts will be nonexistent, since no mining activities likely to alter the quality of vegetation and wetlands will take place.

7.3.2 LARGE FAUNA

CONSTRUCTION AND OPERATION PHASES

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, overburden and waste rock.
- Transportation and traffic.
- Hazardous and waste materials management.
- Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures SUR 01 to SUR 04 should minimize the areas affected, i.e. the footprint of required infrastructure (road, pits, stockpiles, basin, etc.). Overall, measures FAU 03 and FAU 05, SON 01, CIR 01 to CIR 03, and LUM 01 to LUM 03 will help reduce disturbance of these species.

DESCRIPTION OF IMPACT

Two species of large mammals are likely to frequent the project zone: the moose (*Alces alces americana*) and the black bear (*Ursus americanus*). In regard to caribou, the study area is located in overlapping ranges of the Assinica population of woodland and migratory caribou of the Leaf River population (Couturier and coll., 2004). Woodland caribou are listed as a threatened species in Canada under the *Species at Risk Act*. They are also designated as vulnerable in Québec under the *Act respecting threatened or vulnerable species*. Since caribou, and more specifically woodland caribou, are a sensitive component of the natural environment, the study area for large fauna was defined primarily with this species in mind. However, no caribou were observed during the field survey, and data from radio collars did not show the mine area to be frequented by this species. Furthermore, subsequent forest fires have destroyed the vegetation. Return of this vegetation, and consequently of caribou habitat, is likely to take longer than the duration of the project.

Moose, a common species in southern Québec, are very rare in the sector, with an estimated density of 0.5 moose/10 km^2 (Morin, 2015). As concerns black bears, the population density was estimated to be 0.2 bears/10 km^2 in 2003 (Lamontagne and coll., 2006). However, disturbed environments, well represented by those undergoing regeneration following three fires, offer good habitat potential for black bears in the study area. Despite the low density of large fauna species likely to frequent the study area, the project will result in a loss of approximately 94.65 ha of land vegetation and 302.28 ha of wetlands during site preparation, and the construction and operation phases.

During site preparation and the construction and operation phases, accidental deaths of large fauna specimens could occur occasionally due to collisions with vehicles. To minimize this risk, areas with the highest risk of collision with large fauna will be identified through adequate signage. Besides deaths resulting directly from transportation and traffic during preparation work, construction and operation, some activities are likely to change the natural behaviour of large fauna and cause them to avoid affected areas, or in the case of black bears, to attract them, due to food resources or household waste.

Movements of large fauna within the project footprint or near its periphery could also be altered by artificial lighting, noise, dust and vibration during blasting, and by human presence. To reduce these potential impacts, in particular, motorized equipment will be outfitted with high-performance mufflers in good condition to minimize noise disturbance. Furthermore, workers will be made aware of the importance of not feeding animals or leaving food lying about so as not to attract wildlife, especially bears, near work areas.

Last, despite the potential presence of caribou in the study area or near the project footprint, current knowledge indicates that the species has used the study area very little over the past decade, be they woodland or migratory caribou. As a result, this sensitive component does not appear threatened by construction or operation activities, and therefore no impact on caribou is anticipated.

IMPACT ASSESSMENT

For all sources of impact identified during preparation, construction and operation, application of the mitigation measures proposed will help reduce the intensity, extent, duration and significance of the residual impact on bears and moose. The intensity of the impact is therefore considered low. Its extent is local, since the impacts considered will be limited essentially to the mine site. The duration is considered medium, since the impact will extend over the life of the mine, a period of approximately 20 years. Overall, the significance of the impact on large fauna during the construction phase is therefore considered **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

— Decommissioning of infrastructures.
— Transportation and traffic.
— Economic development and presence of workers.

MITIGATION MEASURES

As in the site preparation, infrastructure construction and operation phases, mitigation measures FAU 03 and FAU 05, SON 01, CIR 01 to CIR 03, and LUM 01 to LUM 03 should minimize the immediate impact of rehabilitation work on large fauna while limiting the footprint of infrastructure to be decommissioned and restored (pits, stockpiles, basin, etc.).

DESCRIPTION OF IMPACT

In light of the work involved, the impact of activities during the rehabilitation phase will be essentially the same as during the construction and operation phases. Therefore, some activities associated with rehabilitation work (artificial lighting, noise, dust, risk of spills, human presence, etc.) are likely to alter the natural behaviour of large fauna and their movements. Several preventive measures will nonetheless be implemented to minimize the impacts of rehabilitation work on large fauna.

IMPACT ASSESSMENT

For all sources of impact identified during rehabilitation, application of the mitigation measures proposed will help reduce the intensity, extent, duration and significance of the residual impact on large fauna. The intensity of the residual impact is therefore considered low. Its extent is local, since the impacts considered will be limited essentially to the mine site. The duration is considered short, since the impact will span the period of rehabilitation work. Overall, the significance of the impact during the operation phase is considered **minor**.

POST-REHABILITATION PHASE

To the extent that restored habitats could be used quickly by the species generally associated with them, the side benefits of rehabilitation work potentially will be high for large fauna. This hypothesis is all the more plausible given that the estimated diversity and density of these species, prior to implementation of the project, was relatively low in the study area.

7.3.3 SMALL FAUNA AND HERPETOFAUNA

CONSTRUCTION AND OPERATION PHASES

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, overburden and waste rock.
- Water management.
- Transportation and traffic.
- Hazardous and waste materials management.

MITIGATION MEASURES

Mitigation measures SUR 01 to SUR 04, QUA 01 to QUA 05, QUA 07 to QUA 13, AIR 01, AIR 02, LUM 01 to LUM 03, SON 01, VEG 01, VEG 02, FAU 02 and FAU 05 will have to be applied, as well as standards NOR 02 to NOR 05, NOR 08, NOR 09 and NOR 14, described in Table 7-5.

DESCRIPTION OF IMPACT

The construction and operation phases of the project are considered together, insofar as the nature of impacts on fauna will be essentially the same during these two phases. Indeed, outside of preparation and construction work, the pit and stockpiles will be created continuously during operation.

The different species of small fauna and herpetofauna whose presence was confirmed or is possible in the study area frequent a wide variety of terrestrial, wetland and aquatic habitats. During the site preparation step, and then the operation phase, the project will result in an overall loss of land and wetland habitats suitable for small fauna and herpetofauna of roughly 397 ha, 94.65 ha of which will be land vegetation and 302.28 ha wetlands. These are total final impacts that have been taken into consideration.

For most small fauna species, the movement of individuals whose home range overlaps the infrastructure footprint will increase, at least temporarily, the density on the periphery of the study area, where similar habitats exist.

For small mammals and herpetofauna, whose ability to move is lower, it is probable that the development and construction work will lead to the death of individuals. These deaths should nonetheless be compensated rapidly by annual recruitment, given the high fertility that generally characterizes these fauna components. Species that prefer open areas will be better able to compensate for deaths in the areas cleared within the project footprint.

Potential impacts are also anticipated on water management. Several species of herpetofauna, as well as some small fauna, such as beavers, muskrats and river otters, live in wetlands or in water during one or more phases of their development. As a result, activities of the construction phase that change local hydrology, transport particulates or otherwise alter wetlands or aquatic environments could have an impact on these species. Several preventive measures will nonetheless be implemented to minimize impacts on wetlands and aquatic environments.

Risks of contamination of natural environments are also possible, mainly because of potential leakage of petroleum products or accidental spills from equipment. The impact of a potential spill will depend on, among other things, the volume of contaminants released, and whether the problem is a one-time incident (spill) or repeated (leak). In the event of a spill, the measures provided for in the emergency action plan will be implemented quickly, which will help to limit the extent of the contamination and prevent contamination of groundwater. Losses or spills of other products are generally one-time chance occurrences. The environmental monitoring activities will facilitate prevention and increase the effectiveness of intervention in the event of a spill. Some preventive measures will also reduce the risks of a major spill, such as the use of double-walled tanks.

Indirect impacts will also be associated with the disturbance of several species of small fauna and herpetofauna. In particular, disturbance will be caused by the heightened night-time noise and lighting, and by increased dust and vibration during blasting. The effects will be felt mainly by species with small home ranges. Species that are more mobile will likely adapt their home ranges, when possible, by avoiding the work area footprint and/or by moving to favourable habitats located nearby.

The effect of noise can be negative on certain mammals (Shannon and coll., 2015). In general, noise and human presence will temporarily limit the use of the work area and periphery by wildlife (avoidance). Feeding, reproduction and raising of young will also be disturbed for some species, depending on the period when these activities occur. The effects will be felt mainly by species with small home ranges. Motorized equipment will be outfitted with high-performance mufflers in good condition to minimize noise disturbance.

Several species, including the vast majority of anurans, are nocturnal, and more night-time lighting could have negative effects (disturbance of behaviour and circadian rhythm, increased risk of predation, avoidance, etc.). Nonetheless, some species are also predators, and the artificial lighting could, in these cases, heighten their feeding success. More light could also affect their behaviour and reproduction, which could have negative effects on the survival of these species. Furthermore, anurans are virtually immobile, for the most part, and depend on their respective habitats, wetlands in particular. It is therefore very difficult for these species to move and change habitats following an increase in night-time lighting. This dependence on their habitat could compromise the survival of these species in the presence of artificial light. However, several mitigation measures, related to the extent, duration and type of lighting will be implemented to reduce this impact.

There will also be a risk of collision due to traffic on the construction site. Some small fauna species, such as foxes, could be attracted by food resources or household waste. To minimize this risk, workers will be made aware of the importance of not feeding animals or leaving food lying about so as not to attract wildlife, especially bears, near work areas.

The array of impacts expected on small fauna and herpetofauna will be minimal due to the low population densities found in the study area during the 2017 field survey. Despite the potential presence of some species with a special status in the study area or near the project footprint, none appear to be significantly affected by the construction and operation activities.

IMPACT ASSESSMENT

The application of mitigation measures will minimize the potential impacts on small fauna and herpetofauna during the construction and operation phases. Overall, the intensity of this residual impact is considered low. Its extent is local, since the impacts considered will be limited to the mine site. The duration is medium, since the impact may occur during the life of the mine, a period of approximately 20 years. Therefore, the residual impact on small fauna and herpetofauna during the construction and operation phases is considered **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

— Decommissioning of infrastructures.
— Water management.
— Hazardous and waste materials management.
— Transportation and traffic.

MITIGATION MEASURES

The mitigation measures SUR 02, SUR 03, QUA 01 to QUA 04, QUA 07 to QUA 13, AIR 01, AIR 02, LUM 01 to LUM 03, SON 01, VEG 02, FAU 01 and FAU 05 will have to be applied along with standards NOR 01 to NOR 05, NOR 08, NOR 09 and NOR 14, recorded in Table 7-5.

DESCRIPTION OF IMPACT

The impact of activities during rehabilitation will be essentially the same as that during the construction and operation phases, except that there will be no loss of habitat. Therefore, the risks of alteration of aquatic environments (hydrology, particulates) or of contamination of natural environments (leaks or spills) will be present, although minimized by the mitigation measures put in place. Indirect impacts will also be associated with the disturbance of some species of small fauna and herpetofauna (noise, lights, human presence), as will risks of collision associated with traffic on the site.

The impacts expected on small fauna and herpetofauna during the rehabilitation phase will be less significant than for most species, whose densities were already very low during the field surveys done in 2017 and which will tend to avoid areas where human activities will be concentrated in the preceding phases.

IMPACT ASSESSMENT

Application of mitigation measures will minimize the potential impacts on small fauna and herpetofauna. As a result, the intensity of this residual impact is considered low. As a result, the extent is local, since the impacts considered will be limited to the mine site. The duration will be short, since they will only be felt during the rehabilitation phase. Overall, the significance of the impact on small fauna and herpetofauna during the rehabilitation phase is therefore considered **minor**.

POST-REHABILITATION PHASE

After rehabilitation of the site, positive impacts on small fauna and herpetofauna are expected, since new natural habitats will be available.

7.3.4 ICHTHYOFAUNA

CONSTRUCTION PHASE

SOURCES OF IMPACT

— Site preparation and infrastructure construction.
— Water management.
— Hazardous and waste materials management.
— Transportation and traffic.

MITIGATION MEASURES

Mitigation measures SUR 01, SUR 03, SUR 04, QUA 01 to QUA 04 and QUA 07 to QUA 13 will have to be applied to limit the impact on ichthyofauna in the study area as well as standards NOR 02 to NOR 05, NOR 09, NOR 13 to NOR 16, described in Table 7-5.

DESCRIPTION OF IMPACT

During the construction phase, site preparation and infrastructure construction, water management, hazardous and waste materials management, transportation and traffic could have a negative effect on ichthyofauna.

Construction and site preparation activities, as well as circulation of machinery near watercourses and bodies of water, are likely to result in increased suspended solids in the water. Application of the aforementioned measures will limit this increase.

In addition, during the work, there will be a risk of accidental spills of petroleum hydrocarbons associated with use of the machinery. These risks are mainly related to refueling or breakdown of the machinery. Despite the implementation of preventive measures, there will still be a risk of accidental spills during construction but it will be low with application of the measures. Such a spill, if it occurred, would contaminate the soil at the spill site. At this time, the actions defined in the emergency response plan would be implemented. If a significant volume is released, a portion of the product that has not adhered to the soil particles could migrate through surface runoff to water bodies and courses. Appropriate work practices will be put in place to prevent accidental spills, and should they occur, the contaminated soil will be managed in a manner consistent with existing regulations. The magnitude of the effect will depend on the nature of the product and its concentration. Environmental risks associated with spills are low and, if they do occur, will be limited to the work site.

In addition, culverts will be installed in accordance with standard NOR 05 and outside the periods defined by FAU 01; there will therefore be no permanent effect on this component. The progressive construction of dikes, road ditches and water retention basins is likely to alter the natural flow in the environment. Consequently, the fish habitat could undergo some changes.

IMPACT ASSESSMENT

Since only small areas will be affected by the construction work, and in light of the planned mitigation measures, only minor changes to the hydrological regime are anticipated. The intensity of the impact is therefore considered low. The extent will be site-specific since it will be in a small area where the construction work will be carried out near water and the duration will be short term as it will occur only during the construction phase. The significance of the impact on the hydrological regime during the construction phase is therefore **minor**.

OPERATION PHASE

SOURCES OF IMPACT

— Presence and operation of the pit.
— Water management.
— Hazardous and waste materials management.

MITIGATION MEASURES

Mitigation measures SUR 01, SUR 03, SUR 04, QUA 01 to QUA 04 and QUA 06 to QUA 13 will have to be applied to limit the impact on ichthyofauna in the study area as well as standards NOR 02 to NOR 09 and NOR 13 to NOR 16, described in Table 7-5.

DESCRIPTION OF IMPACT

During the operation phase, the presence of the pit, water management, and hazardous and waste materials management could have a negative effect on ichthyofauna. Throughout the operation of the mine, it will be necessary to accumulate contact water in a retention basin. The clear majority of this water will be pumped into creek CE2 after passing through the WTP. The final effluent will at minimum meet the criteria established by D019, the REMMMD and the EDOs. A second mine effluent will be on creek CE3, where runoff from the overburden stockpile will be captured and returned to the watershed.

As presented in sections 7.2.2 and 7.2.3, changes to the watersheds, flows and levels are anticipated. The lowering of the water table due to pit dewatering will affect the watercourses in the study area. Table 7-12 summarizes the anticipated changes for bodies of water and watercourses and their potential consequences on fish and fish habitat.

In addition, there is a risk of accidental spills of petroleum hydrocarbons associated with machinery use. Such a spill, if it occurred, would contaminate the soil at the spill site. At that time, the actions defined in the emergency response plan would be implemented. If a significant volume is released, a portion of the product that has not adhered to the soil particles could migrate through surface runoff to water bodies and courses. The magnitude of the effect will depend on the nature of the product and its concentration. Environmental risks have been addressed in the emergency response plan, and procedures will be established to minimize the extent.

Table 7-12: Project impact on water courses and bodies of water in the study area

Creeks / Bodies of water	Source of impact	Anticipated impact on the water environment	Effect on fish and their habitat
Lake Kapisikama	Decrease in watershed size and water table drawdown due to pit dewatering	Gradual drying up of the lake	Loss of 12,220 m^2 of fish habitat.
CE1	No impact	N/A	N/A
CE2	Presence of mining effluent and decrease in natural flow on a part of the watershed	<u>Summer</u> Increased flows Increase in average and low water levels <u>Flood</u> Increased flow Increase in level Increase in velocity <u>Winter</u> Decrease in average monthly and low flow Imperceptible effect on levels	No anticipated change in habitat functions. Increases in velocity should not cause erosion or morphological changes in the watercourse.
CE3	Presence of mining effluent and decrease in natural flow on a part of the watershed	Decrease in average low and flood flows Slight decrease in levels between Lake Asini Kasachipet and the effluent, which dissipates at the mining effluent	No anticipated change in habitat functions. Despite an expected decrease in flows (average and low) on a segment, these changes will result in only a slight decrease in levels.
CE4	Decrease in watershed size and water table drawdown due to pit dewatering	Decrease in all flows, substantial for low flow (60%) Downstream of James Bay road, a decrease (-9 cm) in low water levels over the first 350 m. This decrease gradually dissipates after 1,500 m.	The decrease in level could lead to a loss of fish habitat during low water levels. However, due to the shape of the channel (U-shape), this decrease should cause only a small reduction in limited space.
CE5	Decrease in watershed size	Small decrease in flows producing imperceptible changes in level	No anticipated change in habitat functions.
CE6	Decrease in watershed size	Decrease in flows (20%)	Despite an expected decrease in flows, these changes will result in only a slight local decrease in levels. No anticipated change in habitat functions.
Note: Only the downstream portion of the James Bay road culvert is considered a fish habitat on creek CE4.			

Kapisikama Lake will gradually dry out as the pit expands. This lake has a population of yellow perch. A fish habitat compensation plan will be developed (NOR 16) to address this impact.

IMPACT ASSESSMENT

In the operation phase, the impact on ichthyofauna is associated with changes in water quality, the drawdown of the water table, the encroachment of the infrastructure on the watercourse watersheds and the water returned to the environment from mining effluent. The intensity is considered low since the impact is not significant after application of the mitigation measures and dissipates quickly in the environment. The extent of the impact is considered local since it is felt in various sectors of the study area. The duration of the impact is medium term as the changes will be felt throughout the operation phase. In short, the significance of the residual impact on ichthyofauna is considered **minor**.

REHABILITATION AND POST-REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructures.
- Water management.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures SUR 02 to SUR 04, QUA 01 to QUA 04 and QUA 07 to QUA 13 will have to be applied to limit the impact on ichthyofauna in the study area as well as standards NOR 01 to NOR 09, described in Table 7-5.

DESCRIPTION OF IMPACT

The rehabilitation phase involves decommissioning and returning the site to its original condition. During this phase, the dismantling of facilities and circulation of machinery near bodies of water and watercourses may alter the natural flow of surface waters from time to time. Removal of the roads and pumping stations may have the same effect on runoff, leading to an increase in suspended solids in the water. Application of the aforementioned measures will limit this increase.

As in the other project phases, there is a risk of accidental spills of petroleum hydrocarbons associated with use of the machinery. As previously indicated, corrective actions and the proposed mitigation measures will limit the impact of such a spill.

Once the site is restored, the water management infrastructure will be dismantled on site (retention basin, WTP, effluent), allowing creeks CE2 and CE6 to return to their original watersheds in terms of surface area. The removal of the mine effluent will make it possible for creek CE2 to return to a natural flow regime. The pit will progressively fill with water from natural precipitation, creating a lake with an outflow toward creek CE3. There will therefore be permanent encroachment of the CE4 and CE5 watersheds. The CE3 watershed will permanently increase with the addition of the lake resulting from the pit flooding. However, no overflow is foreseen in the first 100 years, time needed to fill the pit. Decommissioning of the collection ditches at the foot of the overburden stockpiles will also allow the watershed to return to a natural drainage scheme closer to the original pattern.

IMPACT ASSESSMENT

Since the affected areas are small compared to the surface, the changes at close-out will be permanent. The intensity of the impact will be low, the extent will be limited and the duration will be long. The significance of the impact on ichthyofauna during the rehabilitation/post-rehabilitation phase is therefore **minor**.

7.3.5 AVIFAUNA

CONSTRUCTION AND OPERATION PHASES

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, overburden and waste rock.
- Water management.
- Transportation and traffic.

MITIGATION MEASURES

Some construction and infrastructure operations, in particular deforestation and soil stripping, are likely to affect birds. Mitigation measures SUR 01, SUR 02, SUR 03 and SUR 04 will help minimize the areas affected. During breeding season, measures FAU 02, SON 01 and LUM 01 to LUM 03 will help reduce the risk of incidental take of birds, their eggs and their nests. Protective measures QUA 05, QUA 08, QUA 09, NOR 07 to NOR 09, NOR 13, NOR 14 and VEG 01 will help mitigate the potential effects of the work on waterfowl and other aquatic or shore birds. Finally, mitigation measures LUM 01 to LUM 03 will reduce the effect of lights on nocturnal migrants. The mitigation measures are described in Table 7-5.

DESCRIPTION OF IMPACT

Avifauna frequents a wide variety of terrestrial wetland and aquatic habitats in the study area. At the site preparation stage and during construction and operation, certain activities will contribute to a loss of approximately 397 ha of terrestrial and wetland habitats, i.e. 94.65 ha of terrestrial vegetation and 302.28 ha of wetlands, despite the proposed mitigation measures.

Site preparation, construction and operation activities could lead to incidental bird mortality through incidental take, i.e. injuring, killing or disturbing birds or destroying or disturbing their nests or eggs, especially during deforestation work. In addition to harming birds, nests or eggs, incidental take can have long-term consequences for bird populations due to the cumulative effect of many incidents. There will also be a risk of collision due to traffic on the construction sites.

In addition to the mortality that may result directly or indirectly from the preparation, construction and operation of the mine, these activities are likely to change the natural behaviour of birds and cause them to move to the periphery of the affected areas. Thus, for most of the bird species, the movement of individuals whose home range overlaps or borders the infrastructure right-of-way could increase, at least temporarily, densities on the periphery of the study area, where similar habitats exist. Despite the loss of natural environments, stripped soil, pit walls and stockpiles may be used by species that nest in open areas.

Birds within or near the project footprint could be disturbed by the artificial lighting. In particular, some nocturnal bird species may be negatively affected (e.g. disturbance in circadian rhythm and behaviour, increased risk of predation, avoidance). This artificial lighting could also cause nocturnal migrants to deviate from their flight path. In summer, however, some predatory species may benefit from this lighting to improve their feeding success. Mitigation measures addressing the extent, duration and type of lighting will be implemented to reduce this impact.

Noise, dust and vibration during blasting could also disturb some birds during breeding season, especially songbirds, which will have to adapt to changes in the sound environment. Motorized equipment will be outfitted with high-performance mufflers in good condition to minimize noise disturbance.

Potential impacts are also anticipated on water management. Several species of avifauna frequent aquatic or riparian environments during one or more phases of their development. Consequently, activities that alter the hydrology of watercourses, contribute to the migration of fine particulate matter or otherwise alter aquatic or wetland environments will affect these species. Various preventive measures will nevertheless be implemented to minimize the impact of the project on aquatic and wetland environments.

Finally, despite the potential presence of special status species in the study area or near the project footprint, none appear to be directly affected by the construction and operation of the mine. It should also be noted that the expected impact on avifauna in general will be lessened given the relatively low diversity and density of birds observed in the study area during the 2017 surveys. As well, all the previously proposed mitigation measures will help to significantly mitigate the project's impact on avifauna.

IMPACT ASSESSMENT

For all sources of identified effects on birds during construction and operation, the application of the proposed mitigation measures will help reduce the intensity, extent, duration and significance of the impact. The intensity of the impact is therefore considered low. Its extent is local since the impact will essentially be limited to the mine site. The duration is considered medium term, since the impact will extend over the life of the mine, a period of approximately 20 years. Overall, the significance of the impact during the construction and operation phases is considered **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructures.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures SUR 01, SUR 02, SUR 03 and NOR 01 should minimize the impact of the rehabilitation work, while limiting it to the infrastructure to be dismantled and restored (pits, stockpiles, basin, etc.). Measures FAU 02, SON 01 and LUM 01 to LUM 03 will also help reduce the risk of incidental take of birds, their eggs and their nests. Measures QUA 07, QUA 08, NOR 14 and VEG 01 will help mitigate the potential effects of the work on waterfowl and other aquatic or shore birds. The mitigation measures are described in Table 7-5.

DESCRIPTION OF IMPACT

Considering the work involved, the impact of rehabilitation activities will be essentially the same as during construction and operation. Thus, some of the activities associated with rehabilitation work (artificial lighting, noise, dust, risk of spills, etc.) are likely to disturb the natural behaviour of birds and temporarily cause them to move to the periphery of the affected areas. Various preventive measures will nevertheless be implemented to minimize the impact of the rehabilitation work on the terrestrial, wetland and aquatic environments.

IMPACT ASSESSMENT

For all sources of identified impacts during rehabilitation, the application of the proposed mitigation measures will help reduce the intensity, extent, duration and impact of the residual impact on birds. The intensity of the residual impact is therefore considered low. Its extent is local since the impact will essentially be limited to the mine site. The duration is considered short term since the impact will be limited to the duration of the rehabilitation work. Overall, the significance of the impact during the rehabilitation phase is considered **minor**.

POST-REHABILITATION PHASE

Since restored habitats can quickly be used by the species generally associated with them, we consider that the expected benefits of the rehabilitation work could be high for birds. This assumption is all the more plausible since bird diversity and density before the project were relatively low in the study area.

7.3.6 BATS

CONSTRUCTION AND OPERATION PHASES

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Presence and operation of the pit.
- Management of economic material, overburden and waste rock.
- Other infrastructure in operation.
- Transportation and traffic.

MITIGATION MEASURES

In order to minimize the residual impact of the sources identified during the construction and operation phases, mitigation measures SUR 01, SUR 02, AIR 02, SON 01, VEG 02, FAU 02 and FAU 04 as well as standards NOR 07 to NOR 09 and NOR 13, described in Table 7-5, will be applied.

DESCRIPTION OF IMPACT

The surveys identified three species of arboreal bats in the study area (Tremblay and Jutras, 2010). As mentioned earlier (section 6.3.1), the study site has been greatly affected by several forest fires in the recent past. Consequently, there is little or no tree stratum in several parts of the study area (rocky outcrops, scrubland, alder, burns, stripped zones, open peatlands and treed peatland). Still, the wooded peatland and spruce-lichen stands show some potential for daytime roosts. However, it is limited due to the small diameter of the black spruce. Consequently, deforestation and other activities related to the construction of work and storage areas will result in a direct and indirect loss of 117.7 ha of habitat for these two types of environments.

According to the recovery strategy for the little brown myotis, northern myotis and tricoloured bat (EC, 2015), loss of habitat is one of the biggest threats, second only to white-nose syndrome, which has largely decimated these species in Québec. This loss of habitat could cause bat mortality if arboreal bats are present during deforestation activities. However, considering the mitigation measures applied and the sparse population observed during the 2017 survey, this risk is minimal.

Wetlands are usually considered key habitats to meet the food needs of bats as they typically contain a large quantity of prey (Grindal and coll., 1999). In all, 302.28 ha of wetlands will be directly affected by the project. The loss of these sites could lead to increased movement to alternative feeding sites. However, it should be mentioned that peatland, which makes up all of the affected wetlands, is generally not the preferred feeding sites of bats. Free water surfaces are not common in wetlands and their acidity is not conducive to the production of large quantities of insects.

Changes in the habitat structure could also affect the bats' use of the environment. However, this impact is more difficult to characterize and quantify since numerous factors are involved and their effects vary by species. For example, forest fragmentation can lead to the creation of linear features that will be used by certain species (EC, 2015). Bats generally use linear forest structures to guide their movements (Grindal and Brigham, 1998; Henderson and Broders, 2008). Forest edges along the cuts, as well as road rights-of-way and other linear features are therefore potential corridors for movement. The effects of habitat fragmentation appear to vary by species and by the nature and extent of the fragmentation itself (Ethier and Fahrig, 2011; Segers and Broders, 2014). It is, however, clear that changes to the habitat structure could change the use of the area by bats.

Activities that cause noise, vibration and dust, such as earthwork, excavation, transportation and construction, could disturb the local bat population. Since bats use echolocation during their movements and to catch prey, anthropogenic noise, particularly at high frequencies, could interfere with these activities. The impact of this type of disturbance varies by species since each one uses its own echolocation frequency range (Bunkley and coll., 2015). The noise generated by road traffic covering a frequency band of up to 50 kHz but mostly between 1Hz and 20 kHz (Schaub and coll., 2008) will probably cause more disturbance in species using relatively low echolocation frequencies. For this project, the species using such frequencies are the hoary bat and the big brown bat. In terms of daytime roosts, noise could also affect the bats by disturbing their sleep. Consequently, in the vicinity of the infrastructure, the quality of roosts for local populations may decrease and sites may even disappear, causing individuals to move to similar habitats in the surrounding area.

Similarly, vibrations caused by certain activities close to key habitats such as maternity colonies could lead to reduced reproductive success, causing the bats to leave the area in search of other sites (EC, 2015; McCracken, 2011). That said, no maternity colonies were found on the project site and the likelihood of their presence is low. This is because, depending on the species, bat maternity colonies are found in large-diameter snags, buildings or rock faces. In light of the forest fires and nature of the plant communities present in the project footprint, few snags are suitable for maternity colonies. And although there are rock faces in some sectors, they are rarely frequented by bats and are therefore unlikely to be used to form maternity colonies. The construction of new buildings could, depending on their configuration and accessibility for bats, result in the creation of roosts (daytime, hibernacula or maternity).

Since bats are nocturnal, they are more likely to be disturbed by artificial light (Stone and coll., 2015). In particular, it seems that the presence of artificial light would disturb the movements of some species (Stone and coll., 2009) and could lead them to less than optimal flight paths. These alternative flight paths could require them to expend more energy and make them more vulnerable to predators (Stone and coll., 2015). However, it is difficult to assess the real effect for this project as the impact of a change in flight path varies depending on the surrounding environment. Some bat species such as the big brown bat and bats of the genus Myotis often use artificial light sources for feeding purposes, as they attract a large number of flying insects (Rydell, 1992; Stone and coll., 2015).

In short, since the current environment is not favourable to these animals (greatly disturbed by forest fires) and the low population density observed during the 2017 surveys, the residual impact of the mine construction and operation will be minimized.

IMPACT ASSESSMENT

In light of the mitigation measures, the generally unfavourable environment for bats and their presence in small numbers, the residual impact of the project during construction and operation is considered low, even considering the special status of the horary bat and bats of the genus *Myotis.* Since the effects of the project are largely confined to the mine site, the scope of the impact is considered local. The duration of the impact is considered medium term as most of the issues will only be present during the mine's useful life. Consequently, the significance of the residual impact on bats during the construction and operation phases is considered **minor.**

REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructures.
- Transportation and traffic.

MITIGATION MEASURES

In order to minimize the residual impact of the project during the rehabilitation phase, mitigation measures SUR 02, AIR 02, SON 01, VEG 02 and FAU 04, described in Table 7-5, will be applied.

DESCRIPTION OF IMPACT

Unlike the construction and operation phases, no loss of natural habitat will occur during the rehabilitation phase. When mining projects are involved, loss of habitat usually has the greatest impact on bats. Similar to the construction and operation phases, disturbances associated with vibrations, noise and light will occur during this phase. However, the application of mitigation measures will minimize their impact.

That said, there is a possibility that the buildings erected during the mine activities will be used as roosts by bats (day and/or maternity and/or hibernacula) For this reason, before demolishing any building or facility, an inspection will be conducted to check whether the site is being used by bats (FAU 04). If necessary, steps will be taken to minimize the impact of any such demolition. Consequently, the demolition of buildings will have no residual impact.

IMPACT ASSESSMENT

For the same reasons as for the construction and operation phases, the intensity of the project's impact during the rehabilitation phase is considered low as no loss of habitat is anticipated. The scope of the impact is local since the effects will only be felt at the mine site. The duration of this impact will be short term as it will not continue past this phase. Hence, the significance of the impact on bats during the rehabilitation phase is **minor**.

POST-REHABILITATION PHASE

Over time, the impact of the project during this phase will be positive for bats as they are expected to return to new natural habitats.

7.4 IMPACT ON THE SOCIAL ENVIRONMENT

7.4.1 CURRENT USE OF LAND AND RESOURCES FOR TRADITIONAL PURPOSES

CONSTRUCTION PHASE

SOURCES OF IMPACT

— Site preparation and infrastructure construction.
— Transportation and traffic.
— Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures UTT 01 to UTT 03, CIR 01, CIR 02 and CIR 04 will have to be applied, as well as disturbance reduction measures AIR 01 to AIR 05, SON 01, LUM 01 to LUM 03, and VIB 01 to VIB 04. These are described in Table 7-5.

DESCRIPTION OF IMPACT

The traditional activities of Cree users on the territory in the study area could be disrupted during the construction phase. Consultations with users revealed that various animal species are hunted in the study area, particularly moose and waterfowl. Fishing, trapping (beavers, bears) and snaring (hare, etc.) are also carried out and could be affected by the species' temporary avoidance or abandonment of the area.

The construction could also prevent such traditional activities as berry picking and beaver trapping on portions of the territory where the mining infrastructure will be located although other areas far from the project's sphere of influence are also conducive to these activities on the RE2 trapline. The tranquility of the area, especially the Cree camps located close to the mining site itself, could also be affected by mine construction activities. Users accustomed to carrying out traditional activities in the projected infrastructure sector could find their safety compromised by the site's new vocation.

To allow them to adapt their practices to these new conditions, land users will be informed before the work begins and of its progress. Galaxy will ensure that construction workers are made aware of the Crees' traditional way of life and their practices on the territory. Disturbances associated with increased traffic on the James Bay road will be mitigated by a traffic management plan that will include the installation of signage indicating the site and requiring compliance with speed limits. In addition, for security reasons, prior to the start of work, an exclusion zone for traditional activities will also be established near the mine site, in collaboration with the RE2 trapline Tallyman. Lastly, the at-risk developments on the site will be secured.

IMPACT ASSESSMENT

For all the reasons mentioned above, the intensity of this impact is considered moderate since the project will cause disturbances on the territory despite the mitigation measures planned to reduce the potential negative effects. The extent of the expected residual effects is local since the effects are likely to be felt by land users who frequent the study area, i.e. the RE2 trapline tallyman's family. The duration will be short term. Hence, the significance of the impact on land use during the construction phase is considered **moderate**.

OPERATION PHASE

SOURCES OF IMPACT

- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, overburden and waste rock.
- Water management.
- Transportation and traffic.
- Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures UTT01 to UTT04, CIR01, CIR02 and CIR04 will have to be applied as well as disturbance reduction measures AIR 01 to AIR 05, SON 01, LUM 01 to LUM 03, and VIB 01 to VIB 04. These are described in Table 7-5.

DESCRIPTION OF IMPACT

Traffic on the road network, noise, vibration and mine activities could disturb some wildlife species of interest near the mine site and road infrastructure, causing them to move to quieter sectors. Hunters and trappers may therefore have to change their practices and move as well.

The peacefulness of the area, particularly at the Cree camps close to the mine site, could diminish because of the operations, as could the Crees' sense of safety when engaging in traditional activities in the sector. In addition, as mentioned during the 2017-2018 consultation, their perception of the quality and taste of the wildlife hunted on the land near the mine could be affected, leading them to lose interest in this portion of their trapline (Chapter 5).

As for the construction phase, hunting and fishing will be prohibited for workers at the Galaxy worker' camp.

It should be noted that the employment or business income of Cree workers associated with the project could be partly allocated to the practice of traditional activities such as hunting, fishing and trapping. During the Eastmain-1-A–Rupert project, it was found that the increase in income among the Cree population was used to pay for the costs associated with more stays in the territory (Hydro-Québec Production, 2015). Consequently, for the

Cree communities, the project could lead to increased land use and the practice of traditional activities for Cree workers hired at the mine.

IMPACT ASSESSMENT

The application of mitigation measures will minimize the potential impact on land use during the operation phase. Overall, the intensity of this impact is considered moderate. The extent of the expected residual effects is local since the effects are likely to be felt by Cree land users who frequent the study area, i.e. the family of the RE2 trapline tallyman. The duration is medium-term since the impact may persist throughout the operation phase. Overall, the significance of the impact on land use during the operation phase is considered **moderate**.

REHABILITATION PHASE

SOURCES OF IMPACT

— Dismantling of infrastructures.
— Water management.
— Transportation and traffic.
— Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures UTT01 to UTT04, CIR01, CIR02 and CIR04 will have to be applied as well as disturbance reduction measures AIR 01 to AIR 05, SON 01, LUM 01 to LUM 03, and VIB 01 to VIB 04. These are described in Table 7-5.

DESCRIPTION OF IMPACT

The effects of mine rehabilitation activities will be similar to those of the construction and operation phases but the duration will be shorter: temporary disruption of Cree users' traditional activities, peacefulness of the site, diminished sense of safety.

IMPACT ASSESSMENT

The application of mitigation measures will minimize the potential impact on land use during the rehabilitation phase. Consequently, the intensity is considered low. Its scope is local since it affects Cree land users in the study area. The duration will be short term as the impact will only be felt during the rehabilitation phase. The significance of the impact on land use during the rehabilitation phase is considered **minor**.

POST-REHABILITATION PHASE

Following revegetation of the waste rock stockpile and other rehabilitation activities, it is reasonable to believe that during the post-rehabilitation phase, part of the land affected by the mine will be reused and re-appropriated for traditional activities. It should be noted, however, that the Cree users interviewed during the consultations remain skeptical in this regard since they believe it will not be possible to reuse the restored site because of potential contamination (Chapter 5). Galaxy is committed to restoring its mine site in accordance with MERN requirements, which aim to see sites restored to a satisfactory state, including limiting the production and propagation of contaminants likely to harm the receiving environment, eliminating unacceptable risks to health and ensuring the safety of people (MERN, 2017). Communication will continue, as will environmental monitoring. The impact of the project on current use of land and resources for traditional purposes in the post-rehabilitation phase is considered **positive**.

7.4.2 INFRASTRUCTURE

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Transportation and traffic.
- Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures CIR 01 to CIR04 and VIB 01, along with standard NOR 13 must be applied. They are set out in Table 7-5.

IMPACT

The anticipated impact on infrastructure include potential impact on the James Bay road linked to workers' travel and transporting machinery and heavy vehicle traffic during construction. This 620-km road is the main road in the study area, and was originally designed to withstand regular traffic from heavy vehicles. It is maintained by the SDBJ. According to consultations held with the SDBJ, the road has been worn down somewhat since its construction; however, a rehabilitation program to remedy the situation is scheduled for 2020. Certain mitigation measures will therefore be implemented by the SDBJ in connection with this scheduled rebuilt, primarily to reduce the impact on traffic. It will be critical to establish good communication between the SDBJ and Galaxy in order to prevent potential inconveniences to road users.

As a result of the James Bay road's capacity to withstand heavy vehicle traffic, the anticipated travel of heavy vehicles for the project during the construction phase is unlikely to result in damage or premature deterioration of the road. Furthermore, Galaxy commits to maintaining the public traffic lanes free of obstacles, broken objects, waste, dirt, sediment, etc. at all times. It is estimated that during the 18-month construction phase, the work will generate 1,800 trips over the James Bay road. These trips will be in addition to the 55,500 trips counted on this road for the year in 2017, which represents a 2.2% increase.

As stipulated in Section 6-4, there is a rest stop located in the study area: the km 381 truck stop. Like the James Bay road, the km 381 truck stop is part of the SDBJ's assets. Since it offers services such as lodging, restaurants, meeting room rental, mechanical services and laundry services, the km 381 truck stop may very well see an increase in business during the construction period. It is also expected that certain mining services (primarily emergency medical services) will be provided in conjunction with the km 381 truck stop services; however, an agreement has yet to be signed.

On a different note, during consultations held in 2017-2018, SDBJ expressed the fact that it was concerned with the capacity of the remote landfill located 190 m from the anticipated pit. It is unsure that the landfill will be able to handle the quantity of waste generated with the increased km 381 truck stop use. This remote landfill has been in use for 35 years, and is still in operation. It only receives waste from the km 381 truck stop; the volume varies according to use. However, as stipulated in Chapter 4, the waste produced by the mine will not be treated at the remote landfill and the anticipated increase in traffic at the km 381 truck stop should not have a negative impact on this landfill. Moreover, to prevent safety issues, Galaxy will secure the SDBJ's remote landfill by erecting a fence around it. Consequently, there is no anticipated impact on this infrastructure.

IMPACT ASSESSMENT

The remaining residual impact on infrastructure primarily pertains to the increase in travel on the James Bay road during construction. This intensity of this impact is deemed to be low, since the increase will be minor (2.2%). The extent will be regional, since it will be felt over the portion of the James Bay road from km 381 to Matagami. The duration will be short, limited to the construction phase. The significance of the impact on the infrastructure during the construction phase is considered to be **minor**.

OPERATION PHASE

SOURCES OF IMPACT

- Transportation and traffic.
- Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures AIR 03, VIB 01 to VIB 04, and CIR 01 to CIR 04 must be applied, in addition to NOR 13. They are set out in Table 7-5.

IMPACT

Given that the James Bay road is an important roadway, that it was designed to withstand regular heavy vehicle traffic, and that SDBJ will have performed road rehabilitation work prior to the start of mine operations, project vehicle traffic during the operation phase is unlikely to result in damage or premature deterioration of the said road.

During each week of the operation phase, the James Bay road will sustain: 154 truck trips for mine production transport, 35 truck trips for procurement, as well as three bus trips (six one-way trips) to transport workers between the Eastmain airport and mine site. This means that, to the 55,500 trips recorded in 2017 on the James Bay road, 10,100 trips will be added, representing an 18.2% increase. It should be noted that the 3% annual increase corresponds to very short bus trips (approximately 20 km) between the Eastmain access road and worker camp. Furthermore, these trips will be spread out during daytime hours, for the most part.

However, this increase in traffic will require a change in James Bay road users' habits: they will need to be doubly careful since they will share the road with more vehicles, many of which will be heavy vehicles. That being said, with the mitigation measures that will be implemented, drivers should be able to quickly adapt to the additional traffic that will be generated.

Despite a smaller number of workers during the operation phase, the km 381 truck stop will still experience a higher usage rate than before the mining project began, which in turn will make the services offered even more profitable. In fact, a large number of contractors and subcontractors who have short-term assignments at the mining site would be able to stay at the km 381 truck stop.

IMPACT ASSESSMENT

The residual impact on the infrastructure during the operation phase more specifically pertains to the increase in traffic on the James Bay road. Overall, the intensity of this impact is deemed to be quite low, since the volume of traffic generated by the mining activities will be spread out over the entire day, and night travel will be infrequent. The extent is regional, since it will be felt over the entire James Bay road from km 381 to Matagami. The duration is short since, within a few years, James Bay road users will be accustomed to the mine and will have adapted to the new traffic volume. Globally, the significance of the impact on the infrastructure during the operation phase is considered to be **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

- Transportation and traffic.
- Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures CIR 01 to CIR 04 must be applied. They are set out in Table 7-5.

IMPACT

During the rehabilitation phase, which will be spread out over time, approximately 1,800 trips will be taken on the James Bay road. These trips will be marginal, since the discontinuation of the mining activities will result in a global decrease in the number of trips. Furthermore, customer traffic at the km 381 truck stop will be similar to that observed during the construction phase due to the number of workers present. The resulting economic benefits will have a positive impact.

IMPACT ASSESSMENT

Just as with the construction and operation phases, the residual impact on infrastructure during the rehabilitation phase primarily pertains to traffic on the James Bay road, between km 381 and Matagami. The intensity is considered to be low, given the decrease in traffic that will occur as compared to the conditions during the operation phase. Its scope is regional and duration will be short, since the impact will only be felt during the rehabilitation phase. Thus, the significance of the impact on the infrastructure during the rehabilitation phase is considered to be **minor**.

POST-REHABILITATION PHASE

Once the site has been restored, impacts will be non-existent, since no mining activities that would affect the infrastructure will be taking place.

7.4.3 PERCEPTION OF PHYSICAL ENVIRONMENT

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Water management.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures PER 01, UTT 02, CIR 04 and VIE 01 must be applied, as well as the measures intended to decrease atmospheric emissions (AIR 01 to AIR 05), noise (SON 01), water contamination (QUA 01 to QUA 05, QUA 07 to QUA 13), night-time lighting (LUM 01 to LUM 03), vibrations and air overpressure (VIB 01), as well as all relevant standards (NOR 2 to NOR 5, NOR 9, NOR 11, NOR 13 and NOR 14). These are set out in Table 7-5.

IMPACT

Activities associated with the construction phase will result in various disturbances that could potentially affect the quality of the atmospheric environment, lighting and noise, underground and surface water, as well as vibrations felt by Cree who use the areas surrounding the mine, km 381 truck stop workers and visitors, even if the regulatory requirements are met. It should be noted that before construction begins, territory users will be informed of when it will start and of its progress. Furthermore, an area closed to traditional activities near the mining site will be established in collaboration with the Tallyman, thereby limiting the use of this sector.

Since the site is in an isolated area, the current air quality in the area studied is very good. During the construction phase, activities to prepare the site and to build infrastructure will change the air properties since there will be an increased suspension of particulate matter in the air. However, results of the air dispersion modelling study show that the standard will be met at the sensitive receptors.

Regarding ambient noise, the only current anthropogenic contributors in the local study area are the James Bay road and the km 381 truck stop. During construction, the standards set out will be met. The noise modelling survey produced demonstrates that noise levels during operations (under the worst operating conditions) will be compliant (WSP, 2018*d*). The construction activities planned will be smaller in scale than those simulated. Thus, noise levels will increase, but will still be acceptable.

Because of its remote location, sources of vibrations in the study area are nearly non-existent. Vibrations may occur during construction in conjunction with quarry operations. However, blasting operations will be less significant than during the operations phase. Currently, it is expected that vibration thresholds at the km 381 truck stop will be acceptable, as well as the other sensitive areas surrounding the pit. These elements confirm that activities of a lesser scale will also be acceptable. However, some may still feel vibrations when blasting occurs.

In the study area, the only current artificial lighting at night comes from the km 381 truck stop. It emits very little light and the effect it has on the night sky fades quickly as you drive away from it. Some changes are expected since artificial lighting will be added to Galaxy's facilities during construction.

During the consulting activities that took place from 2017-2018, SDBJ's representative expressed a concern that the mining activities, from the start of construction through the end of rehabilitation, may affect the km 381 truck stop's drinking water supply, sourced from artesian wells on its property. It should also be noted that Cree territory users also draw their drinking water from the same location when they stay at their camps. There are two drinking water sources in this location. Construction activities are not likely to affect the drinking water supply at the km 381 truck stop.

As for surface water, current conditions measured in the study area are representative of natural environments, even though they have quite high acidity levels and contain certain metals due to the presence of peatlands, the nature of the rock and unconsolidated deposits. At the sampling stations inventoried, the surface water is generally unaffected by human activity. No change to the surface water quality is anticipated during construction. The risks of accidental spills remain, but Galaxy's emergency response plan allows for those to be dealt with quickly, if such an event were to occur.

The tranquility of the area, especially the Cree camps located around the mining site itself, could also be affected by mine construction activities. People who are used to performing traditional activities in the projected infrastructure sector could find their safety compromised by the site's new use. However, the Cree territory users and workers at the km 381 truck stop will be able to view the survey and environmental monitoring reports that will monitor the status of the situation in terms of water, air, noise and soil. Furthermore, beginning with the construction phase and throughout the entire project period, mechanisms will be put in place so that worrisome situations can be reported to and handled by Galaxy.

IMPACT ASSESSMENT

The intensity of this impact is deemed to be low due to the activities specific to the construction phase, which will produce less disturbance. Furthermore, the mitigation measures will decrease the potential negative effects. The scope of the expected residual effects is deemed to be very limited, since they will likely only be felt by Cree territory users who access certain specific sectors around the mining site, as well as the dozen or so workers and visitors at the km 381 truck stop. The duration is short. Thus, the significance of the impact on the perception of the physical environment during the construction phase is considered to be **minor**.

OPERATION PHASE

SOURCES OF IMPACT

- Presence and operation of the pit.
- Other infrastructure in operation.

- Management of economic material, overburden and waste rock.
- Water management.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures PER 01, UTT 02, CIR 04 and VIE 01 must be applied, as well as the measures intended to decrease atmospheric emissions (AIR 01 to AIR 05), noise (SON 01), water contamination (QUA 01 to QUA 05, QUA 07 to QUA 13), night-time lighting (LUM 01 to LUM 03), vibrations and air overpressure (VIB 01 to VIB 04), as well as all relevant standards (NOR 2 to NOR 9, and NOR 11 to NOR 14). These are set out in Table 7-5.

IMPACT

During operations, the activities are likely to result in more disturbances than during the construction phase, affecting the quality of the atmospheric environment, lighting and noise, underground and surface water, as well as vibrations felt by Cree who use the areas surrounding the mine, km 381 truck stop workers and visitors. As stipulated for the construction phase, the number of Cree territory users in the mining sector will be decreased with establishment of an area closed to traditional activities.

The impacts described for the construction phase are similar to those for the operation phase. Thus, air quality will be altered by mining operations since an increase in suspended particulate matter will change the air properties. However, results of the air dispersion modelling survey show that the standard will be met at the sensitive receptors. As for noise, the modelling survey demonstrates that noise levels during operations (under the worst operating conditions) will be compliant (WSP, 2018*d*). Thus, noise levels will increase, but will still be acceptable.

Because of its remote location, sources of vibration in the study area are nearly non-existent. Vibrations will occur when blasting takes place in the pit. The vibration thresholds at the km 381 truck stop and other sensitive areas surrounding the pit will be acceptable. When the values calculated were close to the limits, mitigation measures were added to ensure the thresholds were not exceeded. However, some may still feel vibrations when blasting occurs.

In the study area, the only current artificial lighting at night comes from the km 381 truck stop. However, some changes are anticipated since artificial lighting will be added to Galaxy's permanent facilities, in addition to that needed for operations.

As previously indicated, SDBJ had expressed a concern that mining activities may affect the km 381 truck stop's drinking water supply. The specialized hydrogeology report demonstrated that groundwater lowering associated with the pit will be minimal where the wells are located (WSP, 2018*a*). In that respect, Galaxy has agreed to monitor the groundwater levels and verify the results of the hydrogeological modelling.

According to the INSPQ, the issues of water quality, quantity and access are the Cree's primary concerns (INSPQ, 2014). These concerns were also voiced during consultation activities (Chapter 5). To that end, the watercourses in the study area were subjected to chemical analyses (water and sediments) within the context of a specialized study on aquatic habitat (WSP, 2018*e*). The watercourses in question run from east to west, toward the Eastmain River. They hydrographic system in the local study area represents a very low percentage of the Eastmain River's watershed (0.1% total). During operations, run-off water from the entire site will be captured and channelled to water retention basins. This water will then undergo WTP treatment, if necessary, before it is discharged into the environment. Under future conditions, water quality will be ensured by means of a monitoring program. Furthermore, D019, MDMER and EDO requirements will also be met.

As is the case during the construction phase, the tranquility of the premises, especially in the Cree camps located around the mining site itself, could also be affected by mine activities. People who are used to performing traditional activities in the projected infrastructure sector could find their safety compromised by the site's new use. The communication measures implemented during the construction phase will continue throughout the operation phase; the survey and environmental monitoring reports will also be available during this period. For safety purposes, the area closed to traditional activities that is established in collaboration with the Tallyman during the construction phase will be maintained.

IMPACT ASSESSMENT

During the operation phase, the intensity of this impact is deemed to be moderate since activities specific to this phase will feature a higher number of sources of disturbance. That being said, the mitigation measures will decrease the potential negative effects. The scope of the expected residual effects is deemed to be very limited, since they will likely only be felt by Cree territory users who access specific sectors around the mining site, as well as the dozen or so workers and visitors at the km 381 truck stop. The duration is short since the impacts will not be continuously felt. Thus, the significance of the impact on the risks of disturbance during the construction phase is considered to be **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

— Dismantling of infrastructures.
— Water management.
— Transportation and traffic.
— Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures PER 01, UTT 02, CIR 04 and VIE 01 must be applied, as well as the measures intended to decrease atmospheric emissions (AIR 01 to AIR 03), noise (SON 01), water contamination (QUA 01 to QUA 05, QUA 07 to QUA 13), night-time lighting (LUM 01 to LUM 03), and all relevant standards (NOR 1 to NOR 9, NOR 11, NOR 12 and NOR 14). These are set out in Table 7-5.

IMPACT

During the rehabilitation phase, the risks of disturbance will be, for all intents and purposes, the same as for the construction phase.

IMPACT ASSESSMENT

Application of the mitigation measures will minimize the potential impacts on the risks of disturbances during the rehabilitation phase. As a result, the intensity is considered to be low. Its scope is deemed to be occasional, since it pertains to Cree territory users in the sector surrounding the mine, as well as the km 381 truck stop workers and customers. Its duration will be short, since the impact will only be felt during the rehabilitation phase. The significance of the impact on territory use during the rehabilitation phase is considered to be **minor**.

POST-REHABILITATION PHASE

The negative perception associated with the site remains, is one element that was brought out during the consultation activities that took place within the Eastmain community in 2017-2018. The concerns pertain to possible contamination of the lakes and watercourses surrounding the mine, the effect on resources (fish, wildlife, plants or other natural resources) used for traditional purposes, as well as its effect on human health. Some people are also worried about the potential effects on future generations. The potential impacts on the perception of the physical environment during the post-rehabilitation phase are negative. All in all, implementation of the rehabilitation plan complies with MERN requirements, and the monitoring program arising out of those should help to minimize this impact.

7.4.4 QUALITY OF LIFE

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Transportation and traffic.
- Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures UTT 01, CIR 01, and VIE01 to VIE06 must be applied. They are set out in Table 7-5.

IMPACT

One fear often mentioned by stakeholders met during public consultation activities was of seeing community values that are very important to the Cree (mutual assistance, support, etc.) disappear or diminish to give way to individualism. They also fear the same for traditional activities (e.g.: hunting); some Eastmain community members are afraid interest will decrease.

Therefore, the feeling of loss or damage to the Cree cultural identity is one of the project's expected impacts on the quality of life. Use of the territory for traditional purposes is more than just the Cree's livelihood. It provides their identity, and translates into a deep feeling of belonging to the land. It's where their collective and individual memories reside, where important events like births and deaths took place, and where legends and beliefs are ingrained. In this respect, preparation of the land and construction of the infrastructure could affect certain Cree community members and contribute to the feeling that their traditional way of life and cultural identity are progressively slipping away.

The increased transport precipitated by the construction activities could also lead to James Bay road users' feeling less safe and the perception of an increased risk of accidents, a concern that was primarily raised by women and territory users during consultations held in June 2018. Road safety on the James Bay road is ensured by Sûreté du Québec. The police stations in the cities of Matagami and Radisson provide these services. Furthermore, Galaxy will establish a traffic management plan to minimize inconveniences associated with the increased road traffic.

In addition, difficulties with integrating the Cree workers into the working environment could be experienced during the construction phase; there is also the risk of tension between them and the construction contractors' non-Cree workers. Experience gleaned from other projects on the EIJB territory, most notably that experienced by workers at the Troilus mine, brought to light the challenges that come with integrating Cree workers into the working environment. This population is faced with having to adapt to issues relating to language, management, work schedules and cultural habits (Roquet, 2008).

The project will also intensify relationships between members of the Eastmain communities and the construction contractors' non-Cree workers. In certain projects, the situation led to tensions stemming from cultural and contextual misunderstandings, not to mention prevailing prejudices that exist between the two groups. Galaxy will develop a code of ethics for its workers, and the construction contractors' workers will also need to follow it. The population will be able to share their comments and concerns with Galaxy at any time through an internal community relations department.

Lastly, health and social service providers met during the consultation activities shared their concerns regarding the pressure that the Eastmain community's health services may feel, due to accidents that could occur during construction. An emergency medical service for project workers will be set up as soon as construction begins. An agreement is currently being developed with the SDBJ to see that this service is offered in conjunction with the existing services at the km 381 truck stop. Thus, no additional pressure will be placed on the Cree community's health system.

IMPACT ASSESSMENT

Application of the mitigation measures will minimize the potential impacts on the quality of life during the construction phase. Overall, the intensity of this impact is deemed to be low, since it is recognized that difficulties will not be felt as strongly at the start of the project as they will during operation. Its scope is regional, since it affects all Cree mine workers, as well as Eastmain's Cree communities. Lastly, the duration of the impact is short. Globally speaking, the significance of the impact on the quality of life during the construction phase is considered to be **minor**.

OPERATION PHASE

SOURCES OF IMPACT

— Presence and operation of the pit.
— Other infrastructure in operation.
— Management of economic material, overburden and waste rock.
— Transportation and traffic.
— Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures UTT01, CIR01, VIE01 to VIE06, ELR 07 and ELR 08 must be applied. They are set out in Table 7-5.

IMPACT

The impacts described for the construction phase, such as the feeling of loss and damage to the Cree cultural identity, the James Bay road users' increased feeling of being unsafe, and difficulties from integrating Cree workers into the working environment, could also be felt during the operation phase.

Galaxy will continue to implement mechanisms for integrating workers since it was demonstrated that the tensions felt were the biggest issue within the context of long-term employment (operation phase), as workers are together for a longer period of time. Non-Cree workers will be sensitized to the Cree communities' traditional practices. Thus, within the context of more long-term relationships, problematic interethnic relationships could deteriorate over time. However, the relatively long duration of the employment, provided that the relationships are good, constitutes an opportunity to bring the two groups of workers closer together.

The studies led by Hydro-Québec within the context of the Eastmain-1-A–Sarcelle–Rupert project demonstrated that the implementation of appropriate measures such as discussions, culture awareness programs and institution of a respectful work climate favours integrating the workers into the working environment (Hydro-Québec and SDBJ, 2009; Roquet, 2008).

These studies also brought to light that separation from family is the primary job difficulty that Cree workers mentioned. The extended absence of the Cree workers, who will be living at the mine's worker' camp, could also have negative repercussions on their family lives and cause marital problems (Roquet, 2008). Furthermore, during consultations with the CBHSSJB and the Cree School Board, concerns were raised regarding the elderly who will be left alone in the community due to the Cree workers' extended absence. Galaxy will attempt to alleviate this concern by offering workers flexible schedules, most particularly by allowing them to take leave for family reasons. Furthermore, in order to allow Cree workers to maintain their cultural traditions, Galaxy will establish an annual schedule of the main traditional activities before the construction phase, and will schedule its production shutdowns according to their participation in these activities.

In addition, another anticipated impact raised by those interviewed during public consultation activities was the possible increase in social problems, such as alcohol and drug consumption or compulsive gambling, among Cree workers or in Cree communities. It would seem, however, that the connection between employment and drug and alcohol abuse is not a given. In fact, abusive consumption is associated with less regular employment and lower income, while moderate consumption is correlated with better income (French and Zarkin, 1995). As a general rule, regular employment is also a key determinant of health, both physical and mental, and is associated with better lifestyle choices (Thériault and Gill, 2007). Nevertheless, for people who already abuse drugs and alcohol, an increase in income could facilitate access. In order to prevent developing or increasing these types of social issues, Galaxy will prohibit consumption of alcohol at the worker' camp, and prohibit all types of video gambling on-site.

Lastly, other significant discrepancies have been observed with regard to the health condition of the Crees and of Indigenous peoples in general, as compared to the rest of the Québec population. These discrepancies are especially pronounced in terms of life expectancy, intentional and unintentional trauma, the prevalence of many chronic illnesses (e.g.: diabetes, obesity, hypertension) and infectious illnesses, as well as psychological distress (Secrétariat aux affaires autochtones, 2018). In this regard, Galaxy will propose measures to encourage healthy lifestyle habits such as healthy and balanced meals at the worker' camp site, low in sugar and trans fats.

One of the possible negative effects associated with getting a well-paying job at the mine is excessive debt in Cree households. The income could facilitate access to credit for purchasing items. Case studies have shown that this issue was observed in several communities (El Kreshi, 2009). Galaxy will work with the Cree workers to help educate them on smart money management.

Another anticipated impact is improving the workers' and certain community households' quality of life. The project will provide jobs for people from various socioeconomic groups within the Cree population, such as specialized and non-specialized workers, adults and youth alike. In all, 360 workers will need to be hired to meet the mine's requirements. It is also important to emphasize that the jobs offered during the operation phase will be full-time and long-term. Income from these jobs along with contracts that Cree businesses are awarded will contribute to improving the quality of life for Cree workers' and a large part of the Cree communities' population.

Lastly, the potential increase in the Cree households' income could also have a positive effect on the Cree population's health. It is a known fact that income level is one of the most significant determining factors of health. The Public Health Agency of Canada indicates in its second report on Canadians' health that as the level of income rises, Canadians are known to be less ill, have a longer life expectancy and better overall health (ASPC, 2013).

The end of the operation phase will lead to a gradual decrease in the number of workers. This downturn in workforce requirements could result in a decrease in income for some, and for others, job loss or change. Some employees may have more difficulty finding a job with the same salary level that they had at the mine. Worry associated with having to draw unemployment and loss of employment could lead to behavioural and health problems for affected workers and their families. Some of the health problems that occur could include an increase in alcohol and drug abuse. Through its communication program, Galaxy will notify their workers, ahead of time, of when they expect work to end, so that they can prepare themselves. Galaxy will also offer an Employee Assistance Program to provide closure transition support (worker reclassification assistance committee).

IMPACT ASSESSMENT

Application of the mitigation measures will minimize the potential impacts on the quality of life during the operation phase. Overall, the intensity of this impact is considered moderate. Its scope is regional, since the impact will be felt by Cree workers and the EIJB's Cree communities. The duration is medium since the impact may occur during the life of the mine, a period of approximately 20 years. The significance of the impact on the quality of life during the operation phase is considered to be **minor**.

REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructures.
- Pit rehabilitation.
- Transportation and traffic.
- Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures UTT01, CIR01, and VIE01 to VIE06 must be applied. They are set out in Table 7-5.

IMPACT

During the rehabilitation phase, there will be more or less the same number of jobs available at the mining site as there were for the construction phase. Just as for the operation phase, the impacts on quality life – primarily integration and social problems – will continue to be felt during the rehabilitation phase.

However, this phase will be characterized by substantial income and significant monetary gains. The type of work planned for the rehabilitation phase, however, primarily pertains to earthwork and landscaping, which generally requires hiring local suppliers. Thus, the rehabilitation phase of the project should have a beneficial impact on the region in terms of labour and purchasing goods, services and materials. Cree workers and suppliers will be able to maintain good levels of income during this period, which will in turn help them to maintain a good quality of life.

IMPACT ASSESSMENT

Application of the mitigation measures will minimize the potential impacts on the quality of life. The intensity is considered to be low, since the operation phase will have resolved the most concerning issues. Its scope is regional, since it affects all Cree mine workers, as well as the EIJB’s Cree communities. It will be of short duration, as the impact will only be felt during the rehabilitation phase. Thus, the significance of the impact on the quality of life during the rehabilitation phase is considered to be **minor**.

POST-REHABILITATION PHASE

Site closure will allow a portion of the territory affected by the mine to be re-used and re-appropriated. These activities will have a positive effect since they will mitigate the negative effects associated with the sense of loss felt with presence of the mine’s remains and changes made to the territory.

7.4.5 LOCAL AND REGIONAL ECONOMY

CONSTRUCTION PHASE

SOURCE OF IMPACT

— Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures ERL01 to ERL06 must be applied. They are set out in Table 7-5.

IMPACT

Mine construction could have significant economic benefits for Cree and James Bay businesses (increase in local demand for goods and services). In fact, numerous services necessary at each construction stage may be able to be subcontracted to local or regional businesses. Furthermore, the construction phase needs may provide opportunities for joint ventures.

The project represents presently an investment of more than approximately $507 million. Of that amount, purchases within Québec could total approximately $406 million during the construction phase. Area socioeconomic stakeholders that were met emphasized the importance of the project’s economic benefits for the Cree and James Bay communities, most particularly in terms of benefits for the businesses. It is also important to highlight the additional revenue this project will generate for the Grand Council of the Crees and the Eastmain community.

Numerous bonification measures have been proposed to favour awarding contracts to local and regional businesses, most specifically through a purchasing policy that gives highest priority in requests for proposals to local and regional businesses, as well as an agreement and partnership protocol for Cree participation (for royalties and jobs). Business opportunities associated with mine construction will have a positive impact on maintaining and developing Cree businesses and on EIJB communities' economies.

The mine's construction expenses will also contribute to job creation, most notably for EIJB's communities and more specifically, the Eastmains community. Work will be spread out over an 18-month period and will require up to 300 workers. It should be highlighted that many Cree and James Bay workers acquired good experience in the construction industry, primarily within the framework of Hydro-Québec's Eastmain-1 and Eastmain-1-A–Sarcelle–Rupert projects.

Many improvement measures have been proposed to favour hiring Cree workers and reducing job obstacles or constraints (worker integration mechanisms such as information sessions and a Cree job consultant, etc.), most specifically through the Impact and Benefit Agreement (IBA) developed with the Eastmain community.

Furthermore, participation in mine construction will empower EIJB community members to improve their job skills, employability and qualifications. Experience acquired during the construction phase will be helpful to those who, when construction is complete, wish to find a new job on the job market. Furthermore, job prospects, not only at this mine but in other mining extraction projects in the region, could entice some of the youth to sign up for training or pursue their education toward a career or trade.

Several measures have been proposed with the goal of allowing Eastmain community members to acquire the skills necessary for the jobs offered during the construction period. In that regard, Galaxy will offer training programs to fill the mine's positions. Lastly, one of the project's positive effects on businesses and the workforce is associated with the development and enhancement of local and regional expertise.

IMPACT ASSESSMENT

For all of the aforementioned reasons, the project impact associated with the local and regional economy during the construction phase is deemed to be **positive**.

OPERATION PHASE

SOURCE OF IMPACT

— Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures ERL01 to ERL08 must be applied. They are set out in Table 7-5.

IMPACT

The project will generate economic benefits in the Cree community during the operation phase. Annual operating expenses will be approximately $134 million. Not only could the mine's activities help with business development for existing local companies, they could also help create new businesses to meet the mining company's needs for goods and services (such as professional services, equipment, repair services, etc.).

Furthermore, we should recall that with getting jobs at the mine and having contracts awarded to EIJB businesses, we can speculate that the active Cree population's income will increase, which would lead to an increase in individuals' personal spending and ultimately stimulate the communities' economies. Business opportunities associated with mine operation will have a positive impact on maintaining and developing Cree businesses and on EIJB communities' economies.

Mine operation should result in the creation of 360 new jobs during the operation phase, not to mention many other indirect jobs, for about 15 to 20 years; at least a portion of these jobs could be filled by members of Cree communities. For those who do get a job at the mine, it would be safe to speculate that their quality of life, and that of their families, will improve. When local workers participate in the project, it will have a positive impact on the EIJB communities' job market.

Participation in mine operation will empower many EIJB community members to improve their job skills, employability and qualifications. Experience acquired during the construction phase will be helpful to those who, when operations end, wish to find a new job on the job market.

Job prospects, not only at this mine but in other mining extraction projects in the region, could entice some of the youth to sign up for training or pursue their education toward a career or trade. Cree who have worked at the mine, and have acquired new professional and social skills, will be able to act as new positive role models and encourage youth to pursue their education. One of the positive effects that the project will have on the labour force is associated with the employability of community workers, as well as the development and enhancement of local and regional expertise.

Since the labour pool in the Eastmain community is limited, the project could place a strain on human resources, which would represent an obstacle for other employers in this community in terms of recruiting and/or retaining personnel. It is also possible that businesses and services would need to adjust their salaries and social benefits in an effort to prevent their staff members from leaving. In fact, the appeal of good job conditions could lead to Cree businesses losing their employees to the mine. People will see the opportunity to increase their income and thus improve their quality of life.

Toward the end of the operation phase, an assistance program will be provided to help support employees during the transition to closure (worker reclassification assistance). Furthermore, as highlighted, Galaxy will regularly update forecasts regarding the length of operation and announce the end of mine operation ahead of time, in order decrease expectations and prepare workers.

IMPACT ASSESSMENT

Just as with the construction phase, the project impact associated with the local and regional economy during the rehabilitation phase remains **positive**.

REHABILITATION PHASE

SOURCE OF IMPACT

— Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures ERL01, and ELR03 to ERL06 must be applied. They are set out in Table 7-5.

IMPACT

During the rehabilitation phase, mining activities will decrease considerably compared to the operation phase. However, some businesses may still be awarded contracts associated with the rehabilitation activities, most notably work to dismantle the infrastructure and restore/redevelop the land.

Within the context of its rehabilitation activities, Galaxy will continue to favour awarding contracts from requests for proposals to businesses within the region – primarily Cree – when skills and price are competitive. Mine rehabilitation will also have an impact on jobs because it will require workers to be hired. Galaxy will prioritize hiring workers from the region for site requalification.

IMPACT ASSESSMENT

As with the construction and operation phases, the project impact associated with the local and regional economy during the rehabilitation phase remains **positive**.

POST-REHABILITATION PHASE

During the post-rehabilitation phase, activities at the mine will have ceased. Thus, apart from monitoring at the site, no other activities will likely have any impact on the economy.

7.4.6 HERITAGE AND ARCHAEOLOGY

DURING THE CONSTRUCTION PHASE

SOURCE OF IMPACT

— Land preparation and infrastructure construction.

MITIGATION MEASURES

Mitigation measure ARC01, as well as standards NOR17 to NOR19 must be applied. They are indicated in Table 7-5.

DESCRIPTION OF THE IMPACT

During the construction phase, the operations likely to impact historical, cultural and archaeological heritage are connected to land preparation and infrastructure construction. Remember that there are no protected areas in the study area and because of this, natural heritage is not considered in the current component.

Several construction activities, like topsoil removal and land preparation, are likely to expose archaeological or historic ruins. An archaeological potential study was conducted to determine the areas of interest related to the remains associated with the ancient human presence. To date, a prehistoric archaeological site associated with Amerindian occupation is currently known due to an incidental discovery at the (FbGg-1) km 381 truck stop located on the eastern edge of the mound selected for mining development. In addition, 27 areas of archaeological potential have been identified in the archaeology study area. The likelihood of finding ruins of archaeological or historical interest therefore exists.

IMPACT ASSESSMENT

Due to its legal protection under the *Cultural Heritage Act*, and because of the importance it holds for First Nations, this component is important for the community. The degree of severity of this impact is considered low because of the mitigation measures that will be implemented, which among other things will allow the site to be documented before construction. The extent of the impact will be minimal since it would be experienced only on a few sites with remains. The duration of the impact will be long. The importance of the impact on heritage and archaeology during the construction phase is **minor**.

OPERATION PHASE

SOURCES OF IMPACT

— Presence and pit mining.

— Management of economic material, overburden and waste rock.

MITIGATION MEASURES

Mitigation measure ARC01, as well as standards NOR17 to NOR19 must be applied. They are indicated in Table 7-5.

DESCRIPTION OF THE IMPACT

During the operation phase, the activities likely to impact historical, cultural and archaeological heritage are related to presence and pit mining, as well as the management of the economic material, the unconsolidated deposits and waste rock. Just like during the construction phase, Galaxy will make workers aware of their obligations over incidental archaeological discoveries and will apply the guidelines.

IMPACT ASSESSMENT

Just like during the construction phase, the degree of severity of this impact is considered low because of the mitigation measures that will be implemented, which among other things will allow the site to be documented before construction. The extent of the impact will be minimal since it wouldn't be experienced at many sites with remains and the duration will be long. The importance of the impact on heritage and archaeology during the construction phase is **minor**.

REHABILITATION PHASE

Since rehabilitation work will not open new areas, there is no impact on heritage and archaeology.

POST-REHABILITATION PHASE

After the site rehabilitation, impacts will be non-existent since there will not be mining operations likely to modify the heritage and archaeology.

7.4.7 LANDSCAPE

DURING THE CONSTRUCTION PHASE

SOURCE OF IMPACT

— Land preparation and infrastructure construction.
— Transport and traffic.

MITIGATION MEASURES

Measures SUR 01 to SUR 04, AIR 01, AIR 03 and AIR 05 must be applied. They are indicated in Table 7-5.

DESCRIPTION OF THE IMPACT

The anticipated impact on the landscape is mostly related to the transformation of the character of the landscape and changing the observer's visual range. The impact is caused by land preparation and infrastructure construction work. During the construction phase, operations will alter the natural character of a large swath of the project site's landscape. Transportation and dust generated by construction work will cover the project site during land preparation.

IMPACT ASSESSMENT

The application of mitigation measures to control the footprint of the work will minimize the potential impact on the landscape and the visual range during construction phases. The severity of impact is considered low. The extent is local since the impact on the visual range will be limited to the local study area. The duration of the impact is short because of the length of the construction period. Overall, the severity of the impact on the landscape during the construction phase is considered **minor**.

OPERATION PHASE

SOURCE OF IMPACT

- Presence and mining the pit.
- Management of economic material, overburden and waste rock.
- Other installations in operation.
- Transport and traffic.

MITIGATION MEASURES

Measures SUR 01 to SUR 04, AIR 01, AIR 03 and AIR 05 must be applied. They are indicated in Table 7-5.

DESCRIPTION OF THE IMPACT

In the operation phase, the addition of the pit and rock stockpiles will transform the nature of the landscape significantly and on a large scale. Transportation and the dust created will be concentrated between the pit, rock stockpiles and buildings. The highest projected building will overshadow the site by at least 18.5 m. Its roof height will reach the same level as the top of the plain's tallest hills.

The pit and waste rock stockpiles will be deployed for the entire phase. Deployment of the pit will result in the removal of much of an elevated rocky outcrop. After the first few years, operations will be on the pit floor, several metres below ground level. The rock wall, south of the pit and facing north, will look out over the area like the elevated rocky outcrop that the pit will have replaced. The waste rock stockpile will have a height of 100 m at its tallest point (300 m high). Its round-topped hills will dominate the landscape. The unconsolidated deposit stockpile and the topsoil stockpile will be connected along the southern edge of the waste rock stockpile. The unconsolidated deposit stockpile will be 40 m high and the topsoil stockpile will be 18 m tall. The ROM pad will be approximately 17 m tall.

The upper part of the buildings, the southern rock wall and the waste rock stockpiles will characterize the landscape and will become visual landmarks. From several observation points, the tree line or topography may obscure all or part of the project components. However, note that depending on the dynamics of forest fires, existing vegetation can change and the visual integration of the installations can be altered accordingly.

The character of the landscape is essentially based on natural components. The installations and industrial aspect of the project contrasts with the landscape's natural appearance. However, the planned buildings will be similar to the ones at the km 381 truck stop nearby, and the rock stockpiles, except the waste rock stockpile, will be similar to the hills in the landscape. The waste rock stockpile will dominate the landscape and its tall round top will create a new focal point in the landscape.

Observer groups in the study area are temporary fixed and mobile ones. There are no permanent residents in the study area. Note that the visual range of observers located in the valley area will not be altered due to the topography restricting the view of the project site.

Buildings will be located at a minimum distance of 5 km from permanent Cree camps and more than 2 km from the km 381 truck stop. Standing in a clear foreground, the visual range of temporary fixed observers staying in the area will be altered at the intermediate plane (from 0.5 km to 3 km distance) and in the background (from more than 3 km away) by the projected buildings. They will also be located at a minimum distance of 0.5 km from wildlife areas (except for a wildlife area east of the planned buildings) and at more than 2 km north of a protected area. Standing in a clear foreground, the visual range of temporary fixed observers visiting wildlife and protected areas will be altered in the middle range and in the background by the projected buildings. In the case of the wildlife area located to the east of the buildings, and standing in a clear foreground, visual range will be altered in the foreground (from 0 km to 0.5 km distance).

The south wall of the projected pit will be located at a minimum distance of 6 km from permanent Cree camps and will not be visible from the km 381 truck stop. Standing in a clear foreground, the visual range of temporary fixed observers staying in the area will be changed in the background by the south wall of the projected pit.

The waste rock stockpiles will be located at a minimum distance of 5 km from permanent Cree camps and more than 2.5 km from the km 381 truck stop. Standing in a clear foreground, and because of the relative height of the waste rock stockpile, the visual range of the temporary fixed observers staying in the area will be significantly altered in the middle range and in the background by the rock stockpiles. Also, the waste rock stockpile will be located at a distance of at least 0.5 km from wildlife areas (except for a wildlife area north of the proposed waste rock stockpile) and at more than 0.9 km from a protected area. Standing in a clear foreground, and because of the relative height of the waste rock stockpile, the visual range of the temporary fixed observers visiting the area will be significantly altered in the middle range and in the background by the rock stockpiles. In the particular case of the wildlife area located north of the waste rock stockpile, and in the presence of open areas, visual range will be significantly modified in the foreground.

Travellers on the James Bay road make up the large group of observers. In general, buildings will be located at a minimum distance of 0.5 km from the road, the south wall of the pit at about 0.28 km and the rock stockpiles more than 1.4 km. Standing on the west side of the road, the visual range is significant at the road axis and its opening is limited. This visual range configuration is more typical from the project site and to the north. Thus, the visual range of mobile observers will be little or not altered by project components and operations that extend beyond treetops or ground elevation. Note that only the visual range of mobile observers travelling south to the project site may be affected by the south wall of the pit. Typically, the visual range will be changed very little or not at all. However, standing in a clear foreground, visual range will be changed in the middle and in the background by the wall that will exceed the treetops or ground elevation.

In some places, the road’s twists and turns, as well as high elevation from the project site, provide for significant views of project components more than 3 km away. The visual range of mobile observers will be altered by the project components in the background. Furthermore, the visual range of snowmobile trail and waterway users is typically significant at the main roadway and its opening is limited or obstructed by the terrain or tree growth. The visual range of these mobile observers will be little changed by the project components. The visual range of boaters on large water bodies prized for fishing, located more than 8 km from the project site and slightly concealed, have their view limited by the topography. The visual range of these mobile observers will be changed little or not at all in the background by taller sections of project components.

Note that the seamless integration of the project into its surroundings has been considered since the planning and design stage. The facilities built will be set back from the James Bay road and a natural buffer zone will be maintained between the highway and the infrastructure. This area includes vegetation and an elevated rock outcrop that will preserve the visual setting of the road at the project site.

The waste rock stockpile volume is relatively large. It will rise at least 50 m above the landscape’s hilltops, and will be the project component that can modify area observers’ visual range from observation points that have open, framed or partially obscured views of the site. However, note that rock stockpiles will only be able to change the visual range of observers from the moment they become visible beyond ground elevation or existing vegetation, which is destined to change quickly due to forest fires. A theoretical map is shown on Map 7-5.

Figures 7-1 to 7-3 show from three points of view the effect of the project components on the observers’ visual range at the end of operations. Specifically, they show the anticipated deployment of all the project components to the last year, before site rehabilitation or the implementation of mitigation measures planned for the rehabilitation phase. Thus, photos make it possible to evaluate the most important effects of the project on the landscape and on the visual range of the observers by comparing the current and future states of the site.

IMPACT ASSESSMENT

Considering the harmonious project integration from the planning and design stage, as well as the deployment of mitigation measures to manage the construction work’s footprint and revegetating the slopes of the waste rock stockpile will minimize the potential impact on the landscape during the extraction phase. The presence of the rock stockpiles and the pit will profoundly transform the character of the natural landscape. The severity of the impact is considered medium. The extent is local since the visual range impact will typically be limited from the medium range to the background. The duration of the impact is long because of the permanency of the waste rock stockpile in the landscape. Overall, the severity of the impact on the landscape is **medium**.

REHABILITATION PHASE

SOURCES OF IMPACT

- Infrastructures dismantlement.
- Pit rehabilitation.
- Transport and traffic.

MITIGATION MEASURES

Measures SUR 02, AIR 01, AIR 03 and PAY 01 must be applied, as well as standard NOR 01. They are indicated in Table 7-5.

DESCRIPTION OF THE IMPACT

During this phase, equipment dismantlement, pit rehabilitation, reshaping the top of the waste rock stockpile and site revegetation will progressively reduce the site's industrial nature and help restore the landscape to its original natural state. These operations will improve the visual appeal of the site and its components at a scale equal to the natural landscape and mitigate the effects on an observer's visual range. The transportation required to conduct the work will be temporary.

IMPACT ASSESSMENT

The application of mitigation measures to monitor the work will minimize the potential impact on the landscape and the visual range during the rehabilitation phases. The severity of impact is considered low. The extent is local since the impact on the visual range will be limited to the local study area. The duration of the impact is short because of the length of the rehabilitation period. Overall, the severity of impact on the landscape during the construction phase is considered **minor**.

POST-REHABILITATION PHASE

After the rehabilitation of the site, the revegetated rock stockpiles and the rehabilitated pit will remain to the trained eye a testament to the industrial past of the site's landscape. The impact on the landscape and on the observer's visual range is generally a positive one. Consequently, an impact assessment is not required.

7.5 ASSESSMENT OF THE ANTICIPATED IMPACTS

An assessment of the project's anticipated residual impacts is summarized in Table 7-13 presented in the following pages.

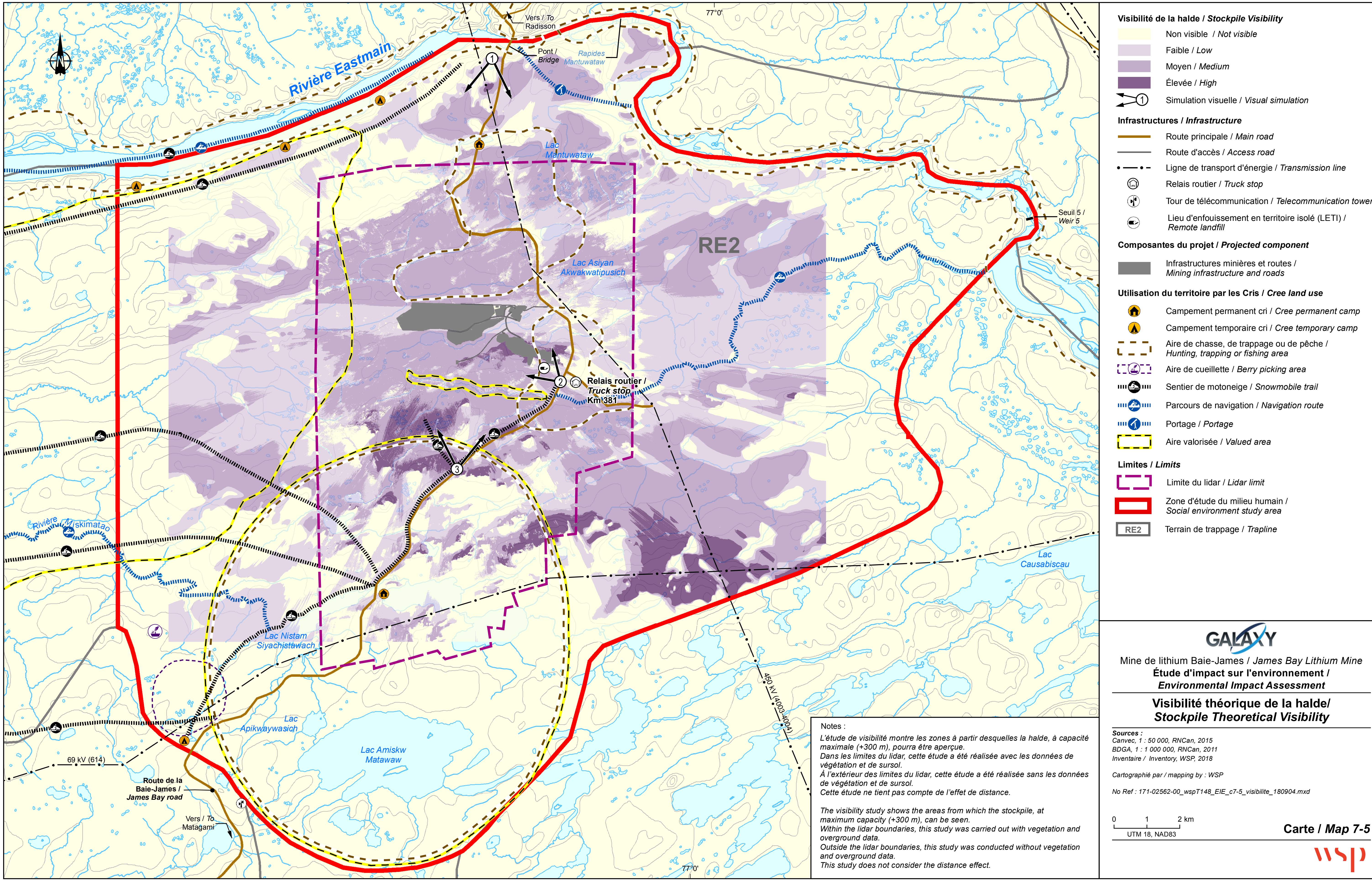
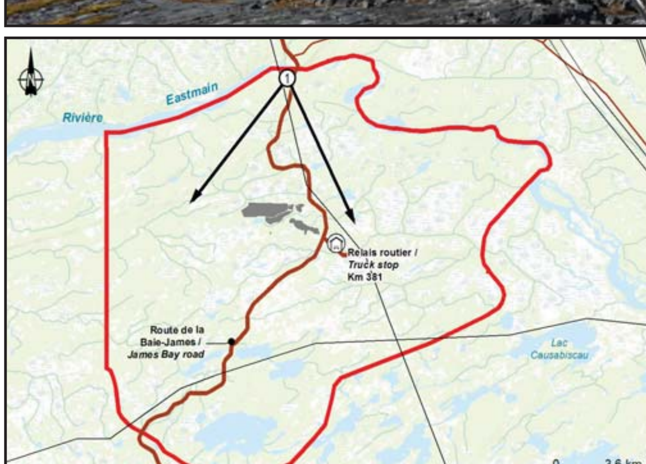

Visibilité de la halde / Stockpile Visibility
Non visible / Not visible
Faible / Low
Moyen / Medium
Élevée / High
Simulation visuelle / Visual simulation
Infrastructures / Infrastructure
Route principale / Main road
Route d'accès / Access road
Ligne de transport d'énergie / Transmission line
Relais routier / Truck stop
Tour de télécommunication / Telecommunication tower
Lieu d'enfouissement en territoire isolé (LETI) / Remote landfill
Composantes du projet / Projected component
Infrastructures minières et routes / Mining infrastructure and roads
Utilisation du territoire par les Cris / Cree land use
Campement permanent cri / Cree permanent camp
Campement temporaire cri / Cree temporary camp
Aire de chasse, de trappage ou de pêche / Hunting, trapping or fishing area
Aire de cueillette / Berry picking area
Sentier de motoneige / Snowmobile trail
Parcours de navigation / Navigation route
Portage / Portage
Aire valorisée / Valued area
Limites / Limits
Limite du lidar / Lidar limit
Zone d'étude du milieu humain / Social environment study area
RE2 Terrain de trappage / Trapline
Rivière Eastmain
Vers / To Radisson
Pont / Bridge
Rapides Mantuwataw
77°0'
Lac Mantuwataw
Seuil 5 / Weir 5
RE2
Lac Asiyan Akwakwatipusich
Relais routier / Truck stop Km 381
Rivière Miskimatao
Lac Causabiscau
Lac Nistam Siyachistawach
Lac Apikwaywasich
Lac Amiskw Matawaw
69 kV (614)
450 kV (4003-4004)
Route de la Baie-James / James Bay road
Vers / To Matagami
77°0'
Notes :
L'étude de visibilité montre les zones à partir desquelles la halde, à capacité maximale (+300 m), pourra être aperçue.
Dans les limites du lidar, cette étude a été réalisée avec les données de végétation et de sursol.
À l'extérieur des limites du lidar, cette étude a été réalisée sans les données de végétation et de sursol.
Cette étude ne tient pas compte de l'effet de distance.
The visibility study shows the areas from which the stockpile, at maximum capacity (+300 m), can be seen.
Within the lidar boundaries, this study was carried out with vegetation and overground data.
Outside the lidar boundaries, this study was conducted without vegetation and overground data.
This study does not consider the distance effect.
GALAXY
Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement / Environmental Impact Assessment
Visibilité théorique de la halde/ Stockpile Theoretical Visibility
Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Inventaire / Inventory, WSP, 2018
Cartographié par / mapping by : WSP
No Ref : 171-02562-00_wspT148_EIE_c7-5_visibilite_180904.mxd
0 1 2 km
UTM 18, NAD83
Carte / Map 7-5
wsp

Figure 7-1

Simulation visuelle #1 – Vue vers le sud / *Visual Simulation #1 - South View*
Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement / *Environmental Impact Assessment*

Situation actuelle / *Actual Conditions*

Situation future / *Future Conditons*



Vision humaine : (60° horizontale, 30° verticale)
Human sight: (60° horizontal, 30° vertical)

Numéro de la photo : 01_DSC06416
Type de simulation : Simulation photo
Technique : Modélisation 3D géoréférencée
Focale : 28 mm
Champ visuel : 60° horizontale, 30° verticale (vision humaine)
Élévation de la prise de vue par rapport au sol : 1,70 m
Distance entre l'observateur et la halde : env. 7,6 km
Coordonnées de la prise de vue : 5 798 363,52 m N , 356 972,46 m E

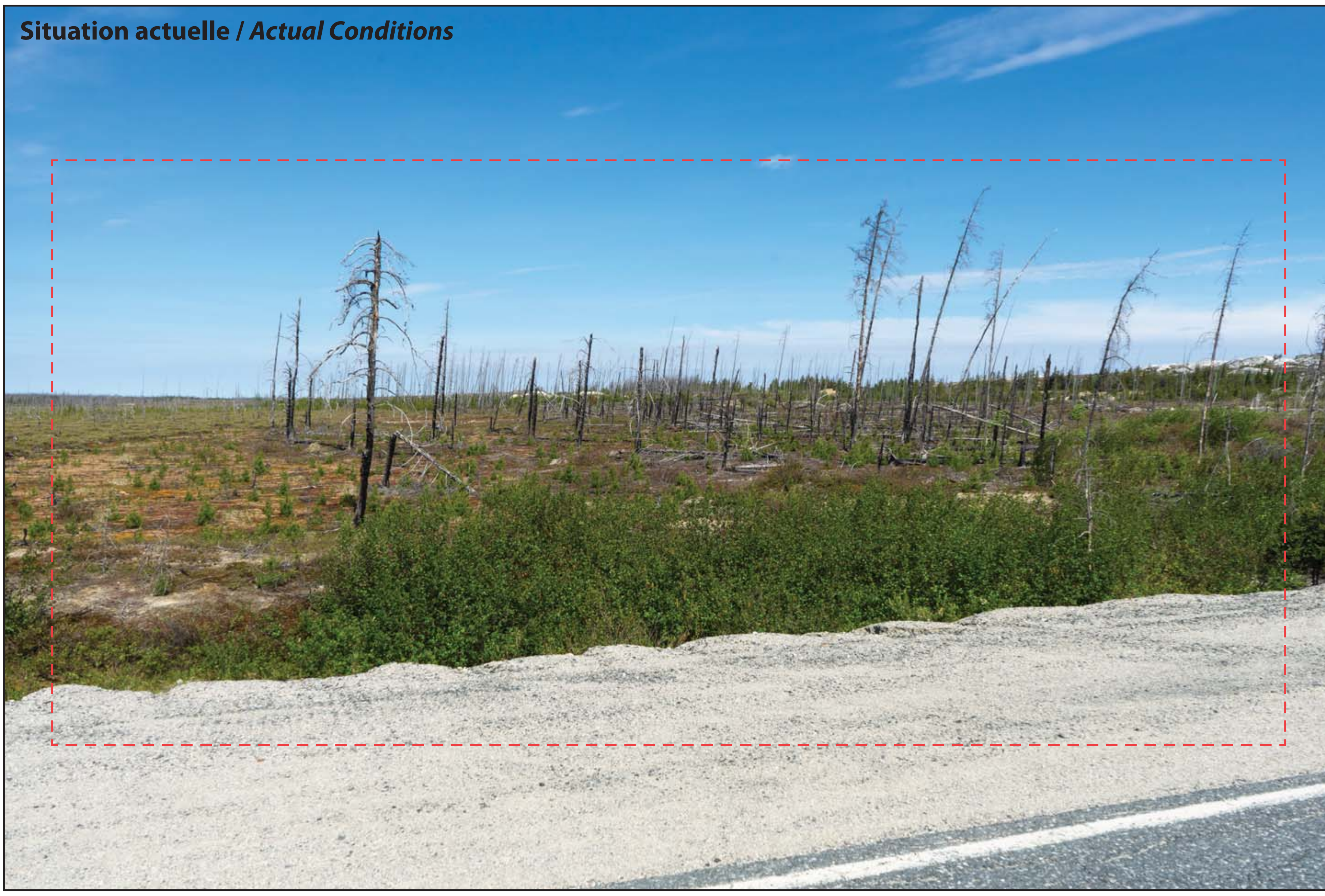
Photo number : 01_DSC06416
Simulation type: Simulation photo
Technique: 3D georeferenced model
Focal: 28 mm
Visual field: 60° horizontal, 30° vertical (human sight)
Elevation with regards to ground: 1.70 m
Distance between observer and stockpile: about 7.6 km
Camerawork coordinates: 5 798 363.52 m N , 356 972.46 m E

No ref. : 171-02562-00_wspT150_EIE_f7-1_sim_vis1_180904.ai

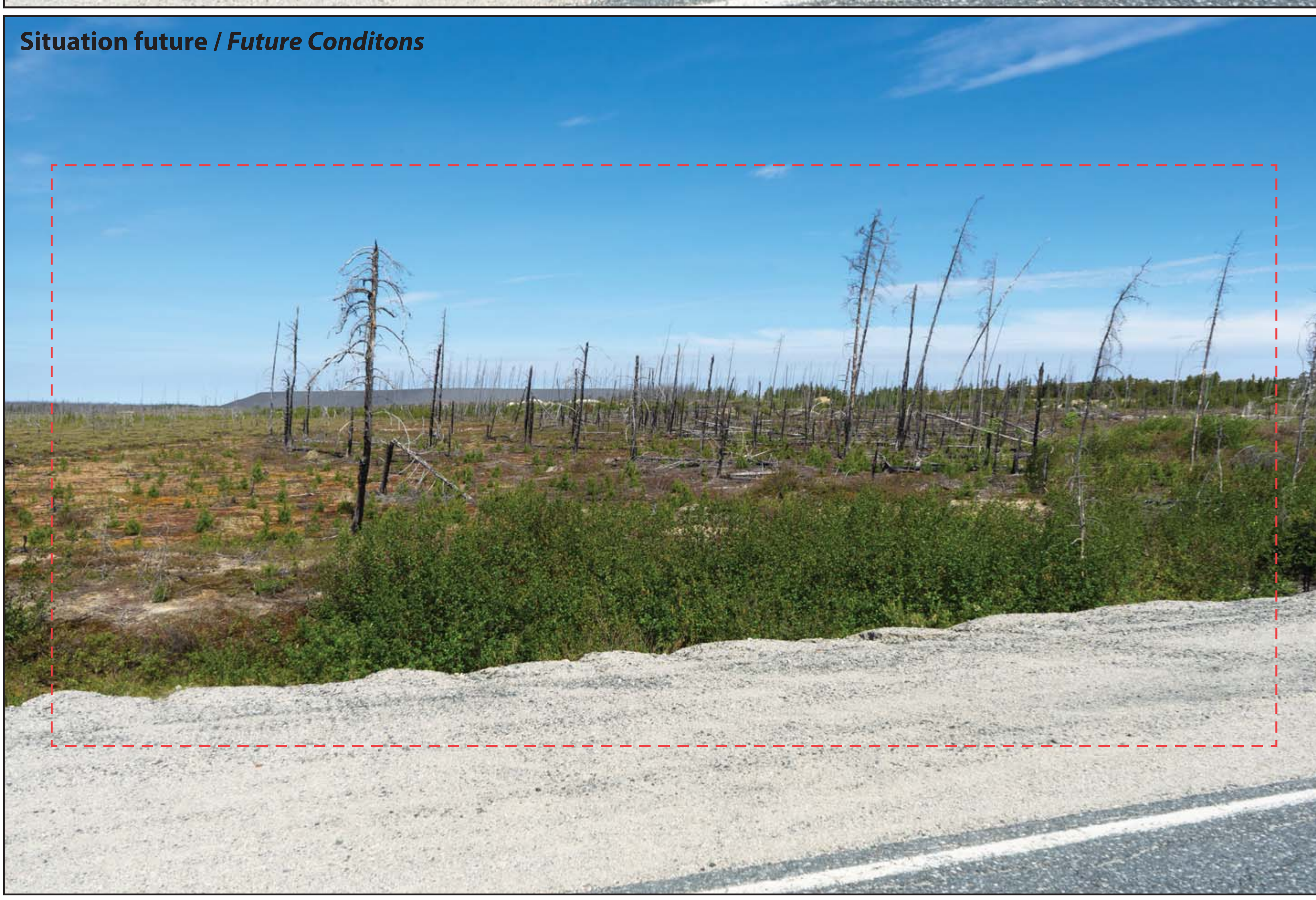
Figure 7-2

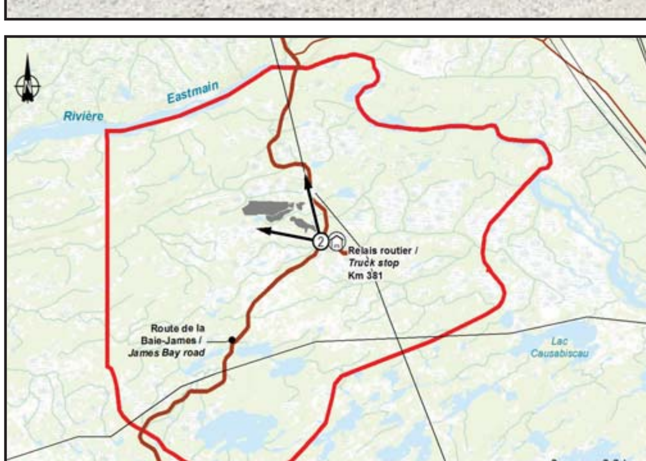
Simulation visuelle #2 – Vue vers l'ouest / *Visual Simulation #2 - West View*
Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement / *Environmental Impact Assessment*

Situation actuelle / *Actual Conditions*



Situation future / *Future Conditons*





Vision humaine : (60° horizontale, 30° verticale)
Human sight: (60° horizontal, 30° vertical)

Numéro de la photo : 06_DSC06511
Type de simulation : Simulation photo
Technique : Modélisation 3D géoréférencée
Focale : 28 mm
Champ visuel : 60° horizontale, 30° verticale (vision humaine)
Élévation de la prise de vue par rapport au sol : 1,70 m
Distance entre l'observateur et la halde : env. 2,9 km
Coordonnées de la prise de vue : 5 788 525,29 m N , 359 054,37 m E

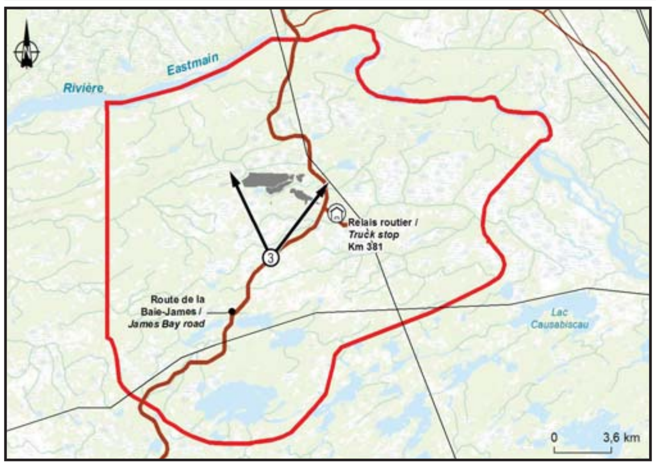
Photo number: 06_DSC06511
Simulation type: Simulation photo
Technique: 3D georeferenced model
Focal: 28 mm
Visual field: 60° horizontal, 30° vertical (human sight)
Elevation with regards to ground: 1.70 m
Distance between observer and stockpile: about 2.9 km
Camerawork coordinates: 5 788 525.29 m N , 359 054.37 m E

No ref. : 171-02562-00_wspT150_EIE_F7-2_sim_vis2_180904.ai

Figure 7-3 Simulation visuelle #3 – Vue vers le nord / *Visual Simulation #3 - North View*
Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement / *Environmental Impact Assessment*

Situation actuelle / *Actual Conditions*

Situation future / *Future Conditons*



Vision humaine : (60° horizontale, 30° verticale)
Human sight: (60° horizontal, 30° vertical)

Numéro de la photo : 08_DSC06534
Type de simulation : Simulation photo
Technique : Modélisation 3D géoréférencée
Focale : 28 mm
Champ visuel : 60° horizontale, 30° verticale (vision humaine)
Élévation de la prise de vue par rapport au sol : 1,70 m
Distance entre l'observateur et la halde : env. 4,1 km
Coordonnées de la prise de vue : 5 785 864,61 m N , 355 909,18 m E

Photo number : 08_DSC06534
Simulation type: Simulation photo
Technique: 3D georeferenced model
Focal: 28 mm
Visual field: 60° horizontal, 30° vertical (human sight)
Elevation with regards to ground: 1.70 m
Distance between observer and stockpile: about 4.1 km
Camerawork coordinates: 5 785 864.61 m N , 355 909.18 m E

No ref. : 171-02562-00_wspT152_EIE_f7-3_sim_vis3_180904.ai

Table 7-13: Assessment of residual impacts

Environmental component	Project phase	Potential source(s) of impact	Description of impact	Mitigation measures and/or applicable standards	Impact assessment: Intensity	Impact assessment: Extent	Impact assessment: Duration	Significance of residual impact
Physical environment								
Soil	Construction	• Site preparation and infrastructure construction. • Hazardous and waste materials management.	• Risk of soil erosion. • Risks of soil contamination due to the potential leak of petroleum products or accidental spills of hydrocarbons or other products.	SUR 01 to SUR 04, QUA 01 to QUA 04, QUA 08 to QUA 13, NOR 02 to NOR 04 and NOR 09	Low	Local	Short	Minor
	Operation	• Management of economic material, overburden and waste rock. • Hazardous and waste materials management.	• Risks of soil contamination due to the potential leak of petroleum products or accidental spills of hydrocarbons or other products.	SUR 01 and SUR 02, QUA 01 to QUA 05, QUA 10, QUA 12, NOR 02 to NOR 04, NOR 09 and NOR 10	Low	Local	Moderate	Minor
	Rehabilitation	• Dismantling of infrastructures. • Hazardous and waste materials management.	• Risk of soil erosion. • Risks of soil contamination due to the potential leak of petroleum products or accidental spills of hydrocarbons or other products.	SUR 02, QUA 01 to QUA 04, QUA 07, QUA 08, QUA 12, NOR 01 to NOR 04, and NOR 10	Low	Local	Short	Minor
Hydrogeology	Construction	• Site preparation and infrastructure construction. • Water management.	• Alteration of runoff flow patterns, surface and groundwater on the periphery of infrastructure.	SUR 01, SUR 02, QUA 01 to QUA 04, QUA 10, and QUA 11	Low	Isolated	Short	Minor
	Operation	• Presence and operation of the pit. • Management of economic material, unconsolidated deposits, and waste rock. • Other infrastructure in operation. • Water management.	• Water table drawdown due to pit dewatering. • Alteration of runoff flow patterns, surface and groundwater on the periphery of infrastructure.	QUA 06 and NOR 06	Moderate	Local	Long	Moderate
	Rehabilitation and post-rehabilitation	• Dismantling of infrastructures. • Pit rehabilitation. • Water management.	• Natural flooding of pit. • Alteration of runoff flow patterns, surface and groundwater on the periphery of infrastructure.	QUA 06	Moderate	Local	Long	Moderate
Hydrological regime	Construction	• Site preparation and infrastructure construction. • Water management.	• Localized change in the natural flow of surface waters. • Possible increase in surface runoff due to a decreased infiltration caused by soil compaction.	SUR 01, SUR 03, SUR 04, QUA 07, QUA 09, QUA 11, NOR 01, NOR 05, NOR 07, NOR 14, and NOR 15	Low	Isolated	Short	Minor
	Operation	• Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, unconsolidated deposits, and waste rock. • Water management.	• Encroachment of drainage basins in the study area by project infrastructure decrease their surface area. • Changes in mean and low flows of watercourses in the study area due to pit dewatering. • Changes in the water levels of watercourses in the study area.	SUR 01, QUA 05, UTT 03, NOR 01, NOR 05, NOR 07, NOR 08, NOR 14, and NOR 14	Moderate	Local	Long	Moderate
	Rehabilitation and post-rehabilitation	• Dismantling of infrastructures. • Pit rehabilitation. • Water management.	• Localized change in the natural flow of surface waters.	SUR 03, QUA 07, QUA 09, QUA 11, and NOR 01	Moderate	Isolated	Long	Moderate

Table 7-13: Assessment of residual impacts (cont.)

Environmental component	Project phase	Potential source(s) of impact	Description of impact	Mitigation measures and/or applicable standards	Impact assessment – Intensity	Impact assessment – Extent	Impact assessment – Duration	Significance of residual impact
Water and sediments	Construction	• Site preparation and infrastructure construction. • Water management. • Hazardous and waste materials management. • Transportation and traffic.	• Risk of change in the quality of water and sediments related to the spreading of ice melters in the winter. • Risks of contamination of water and sediments due to the potential leak of petroleum products or accidental spills of hydrocarbons or other products.	QUA 01 to QUA 04, QUA 08 to QUA 13, NOR 02 to NOR 04, and NOR 07 to NOR 09	Low	Local	Short	Minor
	Operation	• Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, unconsolidated deposits, and waste rock. • Water management. • Hazardous and waste materials management. • Transportation and traffic.	• Risk of contamination of water and sediments by metal leaching and by the ingress of contaminated water under the waste rock stockpile. • Risks of contamination of water and sediments due to the potential leak of petroleum products or accidental spills of hydrocarbons or other products.	QUA 01 to QUA 06, QUA 12, NOR 02 to NOR 04, NOR 06, and NOR 09	Low	Local	Moderate	Minor
	Rehabilitation	• Dismantling of infrastructures. • Pit rehabilitation. • Water management. • Hazardous and waste materials management. • Transportation and traffic.	• Risk of changes in the quality of water and sediments related to the spreading of ice melters in the winter. • Risk of contamination of groundwater by metal leaching and by the ingress of contaminated water under the waste rock stockpile. • Risks of groundwater contamination due to the potential leak of petroleum products or accidental spills of hydrocarbons or other products.	QUA 01 to QUA 04, QUA 07, QUA 08, QUA 10 to QUA 12, SUR 03, NOR 01 to NOR 04, NOR 09, and NOR 10	Low	Local	Short	Minor
Atmosphere	Construction	• Site preparation and infrastructure construction. • Hazardous and waste materials management. • Transportation and traffic.	• Deterioration of the quality of the atmosphere by gaseous compounds and total particulate matter limited to the site and its immediate environment.	AIR 01 to AIR 05, and NOR 11	Low	Local	Short	Minor
	Operation	• Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, unconsolidated deposits, and waste rock. • Hazardous and waste materials management. • Transportation and traffic.	• Increase in concentrations of particulate matter and metals in the air. • Increase in greenhouse gas emissions.	AIR 01 to AIR 05, and NOR 11	Low	Local	Moderate	Minor
	Rehabilitation	• Dismantling of infrastructures. • Pit rehabilitation. • Hazardous and waste materials management. • Transportation and traffic	• Deterioration of the quality of the atmosphere by gaseous compounds and total particulate matter limited to the site and its immediate environment.	AIR 01 and AIR 02, and NOR 11	Low	Local	Short	Minor
Artificial light at night	Construction	• Site preparation and infrastructure construction. • Transportation and traffic.	• Temporary emission of artificial light into the sky and work site limits, which is likely to disturb nocturnal landscapes and have an impact on the biological and social environments on the periphery.	LUM 01 to LUM 03	Low	Local	Short	Minor
	Operation	• Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, unconsolidated deposits, and waste rock. • Transportation and traffic.	• Changes in light at night by adding artificial light could cause local changes in the brightness of the sky and generate light trespass.	LUM 01 to LUM 03	Low	Local	Moderate	Minor
	Rehabilitation	• Dismantling of infrastructures. • Transportation and traffic.	• Temporary emission of artificial light into the sky and work site limits, which is likely to disturb nocturnal landscapes and have an impact on the biological and social environments on the periphery.	LUM 01 to LUM 03	Low	Local	Short	Minor

Table 7-13: Assessment of residual impacts (cont.)

Environmental component	Project phase	Potential source(s) of impact	Description of impact	Mitigation measures and/or applicable standards	Impact assessment: Intensity	Impact assessment: Extent	Impact assessment: Duration	Significance of residual impact
Physical environment (cont.)								
Ambient noise	Construction	• Site preparation and infrastructure construction. • Transportation and traffic.	• Increased ambient noise levels at the work site.	SON 01 and NOR 12	Low	Local	Short	Minor
	Operation	• Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, overburden and waste rock. • Transportation and traffic.	• Increased ambient noise levels due to mining activities.	SON 01 and NOR 12	Low	Local	Short	Minor
	Rehabilitation	• Dismantling of infrastructures. • Pit rehabilitation. • Transportation and traffic.	• Increased ambient noise levels.	SON 01 and NOR 12	Low	Local	Short	Minor
Vibrations and overpressure	Construction	• Site preparation and infrastructure construction.	• Vibrations and overpressure generated during blasting when the construction quarry is in operation.	VIB 01 to VIB 04 and NOR 13	Low	Local	Short	Minor
	Operation	• Presence and operation of the pit.	• Vibrations and overpressure generated during blasting when the pit is in operation.	VIB 01 to VIB 04 and NOR 13	Low	Local	Short	Minor
	Rehabilitation	• No impact.						
Biological environment								
Vegetation and wetlands	Construction and operation	• Site preparation and infrastructure construction. • Presence and operation of the pit. • Management of economic material, overburden and waste rock. • Transportation and traffic. • Hazardous and waste materials management.	• Direct alteration and loss of natural environments (land and wetland environments) as a result of the work. • Indirect impacts on plant communities preserved through development of the site and planned infrastructure.	VEG 01 to VEG 07, SUR 01 to SUR 04, QUA 01 to QUA 05, QUA 10 to QUA 12, NOR 02 to NOR 04, NOR 10 and NOR 15	Moderate	Local	Moderate	Moderate
	Rehabilitation	• Transportation and traffic. • Dismantling of infrastructures.	• Potential introduction of invasive alien plant species.	VEG 02, VEG 03 and VEG 06, QUA 01 to QUA 04, QUA 10 to QUA 12 NOR 01, NOR 02 to NOR 04 and NOR 10	Overall positive impact			
Large fauna	Construction and operation	• Site preparation and infrastructure construction. • Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, overburden and waste rock. • Transportation and traffic. • Hazardous and waste materials management. • Economic development and presence of workers.	• Incidental mortality of large fauna individuals that may occasionally occur due to collisions with vehicles during preparation, construction and operation work. • Alteration of the natural behaviour of large fauna and its movements.	SUR 01 to SUR 04, FAU 03, FAU 05, SON 01, CIR 01 to CIR 03 and LUM 01 to LUM 03	Low	Local	Moderate	Minor
	Rehabilitation	• Dismantling of infrastructures. • Transportation and traffic. • Economic development and presence of workers.	• Alteration of the natural behaviour of large fauna and its movements.	FAU 03 and FAU 05, SON 01, CIR 01 to CIR 03 and LUM 01 to LUM 03	Low	Local	Short	Minor

Table 7-13: Assessment of residual impacts (cont.)

Environmental component	Project phase	Potential source(s) of impact	Description of impact	Mitigation measures and/or applicable standards	Impact assessment: Intensity	Extent	Duration	Significance of residual impact
Biological environment (cont.)								
Small fauna and herpetofauna	Construction and operation	• Site preparation and infrastructure construction. • Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, overburden and waste rock. • Water management. • Transportation and traffic. • Hazardous and waste materials management.	• Loss of approximately 397 ha of land and wetland habitat specific to small fauna and herpetofauna. • Mortality of small fauna and herpetofauna individuals and small mammal species. • Risks of natural environment contamination, mainly because of the potential leak of petroleum products or accidental spills from equipment. • Disturbance of small fauna and herpetofauna individuals, mainly due to noise, night-time lighting, dust, vibrations and human presence. • Risks of collision related to site traffic.	SUR 01 to SUR 04, QUA 01 to QUA 05, QUA 07 to QUA 13, AIR 01, AIR 02, LUM 01 to LUM 03, SON 01, VEG 01, VEG 02, FAU 02 and FAU 05, NOR 02 to NOR 05, NOR 08, NOR 09 and NOR 14	Low	Local	Moderate	Minor
	Rehabilitation	• Dismantling of infrastructures. • Water management. • Hazardous and waste materials management. • Transportation and traffic.	• Disturbance of small fauna and herpetofauna individuals, mainly due to noise, night-time lighting, dust, vibrations and human presence. • Risks of collision related to site traffic.	SUR 02, SUR 03, QUA 01 to QUA 04, QUA 07 to QUA 13, AIR 01, AIR 02, LUM 01 to LUM 03, SON 01, VEG 02, FAU 01 and FAU 05, NOR 01 to NOR 05, NOR 08, NOR 09 and NOR 14	Low	Local	Short	Minor
Ichthyofauna	Construction	• Site preparation and infrastructure construction. • Water management. • Hazardous and waste materials management. • Transportation and traffic.	• Risk of changes to the natural flow of water that may alter fish habitat to a certain degree. • Risk of accidental spills of petroleum hydrocarbons associated with machinery use.	SUR 01, SUR 03, SUR 04, QUA 01 to QUA 04, QUA 07 to QUA 13, NOR 02 to NOR 05, NOR 09 and NOR 13 to NOR 16	Low	Isolated	Short	Minor
	Operation	• Presence and operation of the pit. • Water management. • Hazardous and waste materials management.	• Loss of fish habitat. • Risk of accidental spills of petroleum hydrocarbons associated with machinery use.	SUR 01, SUR 03, SUR 04, QUA 01 to QUA 04, QUA 06 to QUA 13, NOR 02 to NOR 09 and NOR 13 to NOR 16	Low	Local	Moderate	Minor
	Rehabilitation and post-rehabilitation	• Dismantling of infrastructures. • Water management. • Transportation and traffic.	• Limited change to the natural flow of surface waters and increase in suspended solids in water. • Risk of accidental spills of petroleum hydrocarbons associated with machinery use.	SUR 02 to SUR 04, QUA 01 to QUA 04, QUA 07 to QUA 13 and NOR 01 to NOR 09	Low	Isolated	Long	Minor
Avifauna	Construction and operation	• Site preparation and infrastructure construction. • Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, overburden and waste rock. • Water management. • Transportation and traffic.	• Loss of approximately 397 ha of land and wetland habitat specific to avifauna. • Risk of incidental bird mortality due to incidental take. • Risks of collision related to site traffic. • Mortality of avifauna individuals. • Alteration of the natural behaviour of birds and their movements. • Disturbance of avifauna individuals, mainly due to noise, night-time lighting, dust, vibrations and human presence. • Risks of natural environment contamination, mainly because of the potential leak of petroleum products or accidental spills from equipment.	SUR 01 to SUR 04, FAU 02, SON 01, LUM 01 to LUM 03, QUA 05, QUA 09, QUA 08, NOR 07 to NOR 09, NOR 13, NOR 14 and VEG 01	Low	Local	Moderate	Minor
	Rehabilitation	• Dismantling of infrastructures. • Transportation and traffic.	• Alteration of the natural behaviour of birds and their movements.	SUR 01, SUR 02, SUR 03, NOR 01, FAU 02, SON 01, LUM 01 to LUM 03, QUA 07, QUA 08, NOR 14 and VEG 01	Low	Local	Short	Minor

Table 7-13: Assessment of residual impacts (cont.)

Environmental component	Project phase	Potential source(s) of impact	Description of impact	Mitigation measures and/or applicable standards	Impact assessment: Intensity	Impact assessment: Extent	Impact assessment: Duration	Significance of residual impact
Biological environment (cont.)								
Bats	Construction and operation	• Site preparation and infrastructure construction. • Presence and operation of the pit. • Management of economic material, overburden and waste rock. • Other infrastructure in operation. • Transportation and traffic.	• Direct and indirect habitat loss. • Potential mortality of tree bat species if present during deforestation activities. • Disturbance of wetlands (peatlands) potentially resulting in greater movements to alternative feeding sites. • Changes to the habitat structure potentially changing bats' use of the area. • Disturbance of local bat populations, mainly due to noise, night-time lighting, dust, vibrations and human presence. • Risks of natural environment contamination, mainly because of the potential leak of petroleum products or accidental spills from equipment.	SUR 01, SUR 02, AIR 02, SON 01, VEG 02, FAU 02 and FAU 04, NOR 07 to NOR 09 and NOR 13	Low	Local	Moderate	Minor
	Rehabilitation	• Dismantling of infrastructures. • Transportation and traffic.	• Disturbance of local bat populations, mainly due to noise, night-time lighting, dust, vibrations and human presence. • Risk of bat mortality that may occur during the dismantling of buildings, wells or exploration drifts used as roosts by bats (day and/or maternity and/or winter roost).	SUR 02, AIR 02, SON 01, VEG 02 and FAU 04	Low	Local	Short	Minor
Social environment								
Current use of land and resources for traditional purposes	Construction	• Site preparation and infrastructure construction. • Transportation and traffic. • Economic development and presence of workers.	• Temporary disruption of the traditional activities of Cree users on territory in the study area. • Loss of use of portions of the territory where mining infrastructure will be located for the practice of certain traditional activities (e.g., berry picking and beaver trapping).	UTT01 to UTT03, CIR01, CIR02 and CIR04, AIR 01 to AIR 05, SON 01, LUM 01 to LUM 03 and VIB 01 to VIB 04	Moderate	Local	Short	Moderate
	Operation	• Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, overburden and waste rock. • Water management. • Transportation and traffic. • Economic development and presence of workers.	• Disruption of the traditional activities of Cree users on territory in the study area • Loss of use of portions of the territory where mining infrastructure will be located for the practice of certain traditional activities (e.g., berry picking and beaver trapping).	UTT01 to UTT04, CIR01, CIR02 and CIR04, AIR 01 to AIR 05, SON 01, LUM 01 to LUM 03 and VIB 01 to VIB 04	Moderate	Local	Moderate	Moderate
	Rehabilitation	• Dismantling of infrastructures. • Water management. • Transportation and traffic. • Economic development and presence of workers.	• Disruption of the traditional activities of Cree users on territory in the study area.	UTT01 to UTT04, CIR01, CIR02 and CIR04, AIR 01 to AIR 05, SON 01, LUM 01 to LUM 03 and VIB 01 to VIB 04	Low	Local	Short	Minor

Table 7-13: Assessment of residual impacts (cont.)

Environmental component	Project phase	Potential source(s) of impact	Description of impact	Mitigation measures and/or applicable standards	Impact assessment: Intensity	Extent	Duration	Significance of residual impact
Social environment (cont.)								
Infrastructure	Construction	• Transportation and traffic. • Economic development and presence of workers.	• Increased traffic on James Bay road.	CIR 01 to CIR 04, VIB 01 and NOR 13	Low	Regional	Short	Minor
	Operation	• Transportation and traffic. • Economic development and presence of workers.	• Increased traffic on James Bay road.	AIR 03, VIB 01 to VIB 04, CIR 01 to CIR 04 and NOR 13	Low	Regional	Short	Minor
	Rehabilitation	• Transportation and traffic. • Economic development and presence of workers.	• Increased traffic on James Bay road.	CIR 01 to CIR 04	Low	Regional	Short	Minor
Perception of physical environment	Construction	• Site preparation and infrastructure construction. • Water management. • Transportation and traffic.	• Risk of disturbances related to changes in air quality, artificial light at night and noise, and groundwater and surface water quality that may affect Cree users of the territory who practise activities in the mine sector or workers at the km 381 truck stop and its patrons.	PER 01, UTT 02, CIR 04, VIE 01, AIR 01 to AIR 05, SON 01, QUA 01 to QUA 05, QUA 07 to QUA 13, LUM 01 to LUM 03, VIB 01, NOR 2 to NOR 5, NOR 9, NOR 11, NOR 13 and NOR 14	Low	Isolated	Short	Minor
	Operation	• Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, overburden and waste rock. • Water management. • Transportation and traffic.	• Risk of disturbances related to changes in air quality, artificial light at night and noise, and groundwater and surface water quality that may affect Cree users of the territory who practise activities in the mine sector or workers at the km 381 truck stop and its patrons.	PER 01, UTT 02, CIR 04 and VIE 01, AIR 01 to AIR 05, SON 01, QUA 01 to QUA 05, QUA 07 to QUA 13, LUM 01 to LUM 03, VIB 01 to VIB 04, NOR 2 to NOR 9 and NOR 11 to NOR 14	Moderate	Isolated	Short	Minor
	Rehabilitation	• Dismantling of infrastructures. • Water management. • Transportation and traffic. • Economic development and presence of workers.	• Risk of disturbances related to changes in air quality, artificial light at night and noise, and groundwater and surface water quality that may affect Cree users of the territory who practise activities in the mine sector or workers at the km 381 truck stop and its patrons.	PER 01, UTT 02, CIR 04, VIE 01, AIR 01 to AIR 03, SON 01, QUA 01 to QUA 05, QUA 07 to QUA 13, LUM 01 to LUM 03, NOR 1 to NOR 9, NOR 11, NOR 12 and NOR 14	Low	Isolated	Short	Minor
Quality of life	Construction	• Site preparation and infrastructure construction. • Transportation and traffic. • Economic development and presence of workers.	• Feeling of loss and damage to the Cree cultural identity. • Decreased sense of safety among James Bay road users. • Cree workers' difficulty integrating into the working environment.	UTT 01, CIR 01 and VIE 01 to VIE 06	Low	Regional	Short	Minor
	Operation	• Presence and operation of the pit. • Other infrastructure in operation. • Management of economic material, overburden and waste rock. • Transportation and traffic. • Economic development and presence of workers.	• Feeling of loss and damage to the Cree cultural identity. • Decreased sense of safety among James Bay road users. • Cree workers' difficulty integrating into the working environment.	UTT 01, CIR 01, VIE 01 to VIE 06, ELR 07 and ELR 08	Moderate	Regional	Moderate	Moderate
	Rehabilitation	• Dismantling of infrastructures. • Pit rehabilitation. • Transportation and traffic. • Economic development and presence of workers.	• Feeling of loss and damage to the Cree cultural identity. • Decreased sense of safety among James Bay road users. • Cree workers' difficulty integrating into the working environment.	UTT 01, CIR 01 and VIE 01 to VIE 06	Low	Regional	Short	Minor

Table 7-13: Assessment of residual impacts (cont.)

Environmental component	Project phase	Potential source(s) of impact	Description of impact	Mitigation measures and/or applicable standards	Impact assessment: Intensity	Impact assessment: Extent	Impact assessment: Duration	Significance of residual impact
Social environment (cont.)								
Local and regional economy	Construction	• Economic development and presence of workers.	• Increased local demand for goods and services. • Hiring of local workforce. • Development and enhancement of local and regional expertise.	ERL01 to ERL06	Positive impact			
	Operation	• Economic development and presence of workers.	• Local demand for goods and services. • Hiring of local workforce. • Development and enhancement of local and regional expertise.	ERL01 to ERL08	Positive impact			
	Rehabilitation	• Economic development and presence of workers	• Local demand for goods and services and for workforce. • Hiring of local workforce.	ERL01 and ELR03 to ERL06	Positive impact			
Heritage and archaeology	Construction	• Site preparation and infrastructure construction.	• Fortuitous discovery of remains of archaeological or historical interest.	ARC01 and NOR17 to NOR19	Low	Isolated	Long	Minor
	Operation	• Presence and operation of the pit. • Management of economic material, overburden and waste rock.	• Fortuitous discovery of remains of archaeological or historical interest.	ARC01 and NOR17 to NOR19	Low	Isolated	Long	Minor
	Rehabilitation	• No anticipated impact.						
Landscape	Construction	• Site preparation and infrastructure construction. • Transportation and traffic.	• Transformation of the character of the landscape and change to observers' visual field.	SUR 01 to SUR 04, AIR 01, AIR 03 and AIR 05	Low	Local	Short	Minor
	Operation	• Presence and operation of the pit. • Management of economic material, overburden and waste rock. • Other infrastructure in operation. • Transportation and traffic.	• Transformation of the character of the landscape and change to observers' visual field.	SUR 01 to SUR 04, AIR 01, AIR 03 and AIR 05	Moderate	Local	Long	Moderate
	Rehabilitation	• Dismantling of infrastructures. • Pit rehabilitation. • Transportation and traffic.	• Potential impacts on landscape and visual field.	SUR 02, AIR 01, AIR 03 and PAY 01	Low	Local	Short	Minor

8 ASSESSMENT OF CUMULATIVE EFFECTS

8.1 LEGAL FRAMEWORK AND GENERAL NOTIONS

As per the requirements of the *Canadian Environmental Assessment Act*, 2012 (CEAA, 2012), a project's cumulative environmental effects must be analyzed with regard to the valued environmental components (VECs) and valued social components (VSCs). The *Environment Quality Act* (LQE) also addresses the fact that cumulative effects[15] must be taken into consideration during the environmental assessment phase of a project. To meet these requirements while also complying with the provisions of the Guidelines for the Preparation of an Environmental Impact Statement, and with the provisions of the provincial guideline titled *Directive pour le projet de mine de lithium Baie-James* (file 3214-14-055) (Appendix A), the cumulative effects of this project were studied.

8.2 METHOD FOR ASSESSING CUMULATIVE EFFECTS

8.2.1 GENERAL APPROACH

The analysis of cumulative effects is based on the method described in the Practitioner's Guide created for the CEAA (Hegmann and coll., 1999) and the CEAA's related Operational Policy Statement (ACÉE, 2015). The document titled *Addressing Cumulative Environmental Effects* (ACÉE, 2018) was also consulted.

The main steps of the method used are the following:

- identification of the environmental VCs, i.e., the environmental components valued by experts or by the populations concerned, and likely to be changed or affected by the project;
- definition of each VC's spatial and temporal boundaries, as well as the indicators for describing their evolution;
- identification, description and selection of past, present or future projects, actions or events that could potentially interact or have interacted with a VC;
- description of the reference status for each VC selected;
- description of the historic trends for each VC selected;
- definition of the cumulative effects for each VC selected;
- development of mitigation measures and processes for monitoring cumulative effects.

To be subject to an assessment of cumulative effects, a VC must:

- be highly valued by experts or by the populations concerned;
- be identified or protected by law;
- be prone to changing due to the effects of various elements -- both associated with or external to the project;
- be analyzable, based on reliable and adequate data, in terms of both the reference status and historical trends.

15 In this chapter, the terms "cumulative impacts" and "cumulative effects" have the same meaning. The only difference is that *impact* is preferred by the MDDELCC while *effect* is used by the CEAA. To make this chapter easier to read, *effect* will be used and considered as a synonym for *impact*.

8.2.2 IDENTIFICATION OF THE VALUED COMPONENTS TO STUDY

The assessment of the project effects made it possible to identify the main issues and the repercussions on natural and social environment components. It also allowed for understanding the primary concerns of the James Bay population and Cree communities touched by the project, that were recorded at the information and consultation sessions held with the local population and representatives of the various organizations concerns. Taken together, these two elements enabled the identification of the VCs associated with the project and, ultimately, the selection of those that would be subject to an assessment of cumulative effects.

As it stands, the assessment of cumulative effects is contingent on the VCs having potential for cumulative effects with other projects or actions in the areas where these effects will be examined.

8.2.3 DEFINITION OF SPATIAL AND TEMPORAL BOUNDARIES

This step involves establishing the spatial and temporal boundaries of the VCs selected to better structure their analysis.

8.2.3.1 SPATIAL BOUNDARIES

The spatial boundaries must contain a territory that, while not overly vast, is large enough to comprise all the areas where cumulative effects could occur (Hegmann and coll., 1999). If the territory is too small, certain impacts could be omitted. The areas of influence of the various projects or actions considered (past, present and future) must be established while fixing boundaries beyond which any cumulative effects would essentially be negligible. Spatial boundaries can be tailored to each VC selected. Choosing spatial boundaries thus requires:

- understanding the spatial distribution of the effects of the project being examined;
- identifying similar effects associated with other projects, activities, events, etc. and which are superimposed in space;
- ensuring that the boundaries consider VC abundance and distribution;
- making sure that the boundaries are environmentally and socially acceptable;
- confirming that the boundaries allow for data collection and analysis for each VC involved.

According to Hegmann and coll. (1999), spatial boundaries must be flexible. It is best, in fact, to establish multiple spatial boundaries that expand or retract based on the social and ecological relationships observed and the VCs analyzed.

8.2.3.2 TEMPORAL BOUNDARIES

As for temporal boundaries, two markers (one in the past and one in the future) must be identified. In theory the marker for the past precedes the effects of the actions or projects analyzed, while the marker for the future corresponds to the moment when the environmental conditions that existed prior to the product are restored or when a certain equilibrium is achieved (Hegmann and coll., 1999).

Boundaries in the past should be selected by giving due consideration to:

- the importance of selecting a period for which there is enough information available about the VCs to adequately describe the initial condition or reference status;
- the moment when the effects associated with a proposed action first occurred;
- the moment when effects similar to those of concern first occurred;
- the moment when the various uses of the territory were established;
- the pre-disruption conditions (historical reference point).

Boundaries in the future should be selected by giving due consideration to:

- the end of the project operation period;
- the period following the end of the project and reclamation of the site;

- the period following the reclamation of VCs to their post-disruption condition;
- the availability of information regarding other projects.

In practice, it bears remembering that when one goes back over long periods (more than 10 years) or looks forward into the future (more than 5 years), it becomes harder to obtain information, which means subsequent analysis can become increasingly speculative. Because of this, forecasts become increasingly uncertain the longer the projection period of the cumulative effects extends. It is generally accepted that the probability of occurrence associated with future projects or actions beyond 10 years is very hard to accurately predict (Bérubé, 2007).

8.2.4 IDENTIFICATION, SELECTION AND DESCRIPTION OF PAST, PRESENT AND FUTURE ACTIVITIES, PROJECTS AND EVENTS

During the assessment of cumulative effects, it is critical that the most comprehensive inventory possible be completed, based on the available information as well as on the projects, activities and other interventions likely to have had an effect on, be currently affecting or to one day impact the VCs selected for analysis. This assessment must be conducted within the defined spatial and temporal boundaries and comprise:

- all projects, regardless of type;
- all human actions, regardless of type;
- all events, regardless of type;
- the laws and regulations of the three main governments involved (Eeyou Istchee James Bay Regional Government, Québec Government and Government of Canada), all of which influence or are likely to influence the VCs being examined.

The next step consists of identifying the actions, projects, events and laws and regulations that could have had a significant effect on the respective VCs, and of briefly describing the influence in question using indicators. The analysis of cumulative effects only concerns the negative effects ensuing from an action (Hegmann and coll., 1999).

Indicators are known elements that allow for translating the influence of various previously mentioned actions or interventions both spatially and temporally. VCs can themselves be indicators (Hegmann and coll., 1999).

8.2.5 DESCRIPTION OF THE REFERENCE STATUS

The reference status corresponds to the situation that existed x number of years prior (i.e., the temporal boundary situated in the past). The description of this status is part of the available information, but may be very limited for certain VCs. This is the reason why the available data must be taken into consideration when setting the temporal boundaries for each VC.

8.2.6 DESCRIPTION OF HISTORIC TRENDS

Historic trends ensue from the analysis of the joint influence of the most important projects, actions and events. These trends incorporate the findings associated with the actions identified as having the potential to substantially impact VCs and are expressed from the reference status up until the completion of the project impact assessment.

8.2.7 IDENTIFICATION AND IMPORTANCE OF CUMULATIVE EFFECTS

This step focuses on establishing, for each VC, whether or not there are cumulative effects or a potential cumulative effect. The decision in this regard rests on the following elements:

- historic trends;
- likely or current projects, actions and events (within the previously defined temporal boundary for the future).

According to Hegmann and coll. (1999), determining the importance of the effects within the context of an assessment of cumulative effects is basically the same as when doing so within an impact assessment. In other words, cumulative effects can be assessed in terms of their intensity, duration and scope. The integration of these criteria then makes it possible to designate a project's cumulative effects as important, unimportant or unknown. Residual effects of high or very high importance are deemed important, while those with a medium, low or very low importance are considered unimportant.

The analysis of cumulative effects can incorporate quantitative analysis and discussions of qualitative elements. A qualitative analysis is carried out in the absence of a technical quantitative analysis or when examining qualitative elements is deemed relevant. The analysis of cumulative effects is nonetheless essentially a qualitative analysis. It concerns resources that will have a residual effect following the implementation of mitigation measures identified during the project impact assessment phase.

The cumulative effect will be considered important if the experts believe that the project will significantly diminish the existing VC. Inversely, the cumulative effect will be considered unimportant if the VC is not significantly influenced by the project's actions. If there is insufficient information such that it becomes impossible to form an opinion as to the project's cumulative effect on a component, the cumulative impact will be considered unknown.

Hegmann and coll. (1999) indicated that the following issues must be considered when assessing the probability that a project's implementation would have a cumulative effect:

— Are the environmental effects harmful?
— Are the harmful environmental effects significant?
— Are the significant and harmful environmental effects likely to occur?

8.2.8 MITIGATION MEASURES AND MONITORING PROGRAMS

This last step involves an assessment of each VC to determine whether the identified cumulative effect calls for mitigation measures and additional environmental monitoring programs other than those proposed in the project's environmental assessment.

8.3 PROJECT ISSUES

The assessment of cumulative effects considers some of the project issues that came to light following public consultations and interviews with stakeholders from James Bay and Cree communities (in 2017 and 2018) as well as during the EIA (chapter 5). The project issues considered are:

— protecting the quality of the environment (quality of the water, the air, the soil, and the wildlife and its habitat);
— protecting the biodiversity (threatened or vulnerable species and their habitats);
— upholding the integrity of traditional activities;
— ensuring sanitary conditions at and around the project site;
— safeguarding the Cree community's well-being.

It must be remembered that other issues may surface during various communication activities concerning the project.

8.4 IDENTIFICATION OF VALUED COMPONENTS

As indicated in Schedule 2 of the *Canadian Environmental Assessment Act* (which refers to subparagraph 5(1) a) and subsection 5(3)), the valued components to be considered when assessing a project's cumulative effects could include:

— fish and fish habitat;
— migratory birds;

— species at risk;
— all other relevant components.

According to the MDDELCC guideline for the project, the valued components to consider when assessing cumulative effects should be associated with project issues, namely:

— use of the territory by the Cree population;
— the region’s socioeconomic situation;
— the community’s use of the sector for cultural purposes;
— recreational and tourism activities, particularly sport hunting and fishing;
— the plant and wildlife species at risk;
— the wildlife and its habitat;
— climate change.

Furthermore, and still as per the MDDELCC guideline, the impact of the workers’ presence on wildlife must be taken into consideration, as must the repercussions this presence could have on future hunting and fishing by the Cree population. On another note, the traditional knowledge of the communities concerned must be included when assessing cumulative environmental effects.

As part of this specific project, two VCs were selected for an analysis of cumulative effects; the Chiroptera (bats, a species at risk) and traditional use of the territory by the Cree. It bears noting that fish and birds were not selected, due to few individuals and limited varieties having been identified during the field inventories. The moose inventory also attested to a similar trend. The effects of the project were thus assessed as minor and only slightly likely to influence the VCs on a larger scale. In addition, the interviews of territory residents indicated that there were no recreational and tourism activities practised by non-Indigenous people and no cultural activities near the site. There are, however, boat launches, the closest of which is 9 km from the mining site.

Even though the overall project impact on bats is judged to be minor, this species was nonetheless selected as a VC for the analysis of cumulative effects, chiefly for the reasons indicated hereafter. Firstly, the presence of bat species with a special status in the project zone was confirmed during the 2017 inventories, as was their low numbers. Secondly, the presence and rapid spread of the WNS in Québec, now heralded as the key factor behind the decline of bat populations in northeastern North America (section 8.5.5), has made bats more vulnerable to cumulative effects than any other wildlife species found in the area being studied. Comparatively, the common nighthawk, in spite of having a special status and its presence in the project zone having been confirmed, was not selected as a VC, given that its overall population is not threatened to the same extent as that of the bats. Furthermore, mitigation measures implemented during the project have allowed for curtailing the negative effects on this species.

The traditional use of the territory by the Cree was also selected as a VC for the analysis of cumulative effects, given that this use is linked to project issues, was identified as a concern during the public consultations, and will be somewhat significantly impacted by the project (impact of medium importance during the construction and operation phases). Also, other specific activities (past and future) have had, are having and will have an effect on this component. Comparatively, traffic, in spite of impacting the quality of life and having been noted as a concern during the public consultations, was not selected as a VC. In fact, the project will require that 25 additional trucks travel over the road network each day during the operation phase; according to the traffic statistics compiled by the SDBJ (section 8.5.3), this represents an increase of 16% in the number of vehicles travelling on these roads.

8.4.1 SPATIAL AND TEMPORAL BOUNDARIES

Table 8-1 illustrates the selection criteria, spatial and temporal boundaries and indicators for each VC selected for the assessment of cumulative effects. Because of each VC’s specific characteristics, there may be variations in the spatial and temporal boundaries.

Table 8-1: Temporal and spatial scope, selection criteria and indicators for the VCs selected for the assessment of cumulative effects

VCs	Selection criteria	Indicator	Temporal scope	Spatial scope
Biological environment				
Bats	Special status species	Number of sightings of the following species: • Hoary bat • Eastern red bat • Northern long-eared bat • Little brown myotis	2003–2028	Radius of 110 km around the project site
Social environment				
Traditional use of the territory by the Cree	Activities valued by the Cree (hunting, fishing, trapping, gathering, and cultural, family and healing gatherings)	Use of the territory	1980–2028	The territory of the Eastmain community as well as the traplines assigned to the latter

Maps 8-1 and 8-2 show the limits of the two study areas used for the analysis of cumulative effects. On the one hand, the study area defined for the assessment of cumulative effects on use of the territory includes the territory of the Eastmain community as well as the traplines assigned to the latter. On the other hand, the study area designated for assessing the cumulative effects on bats corresponds to the territory included within a radius of 110 km around the planned mining site.

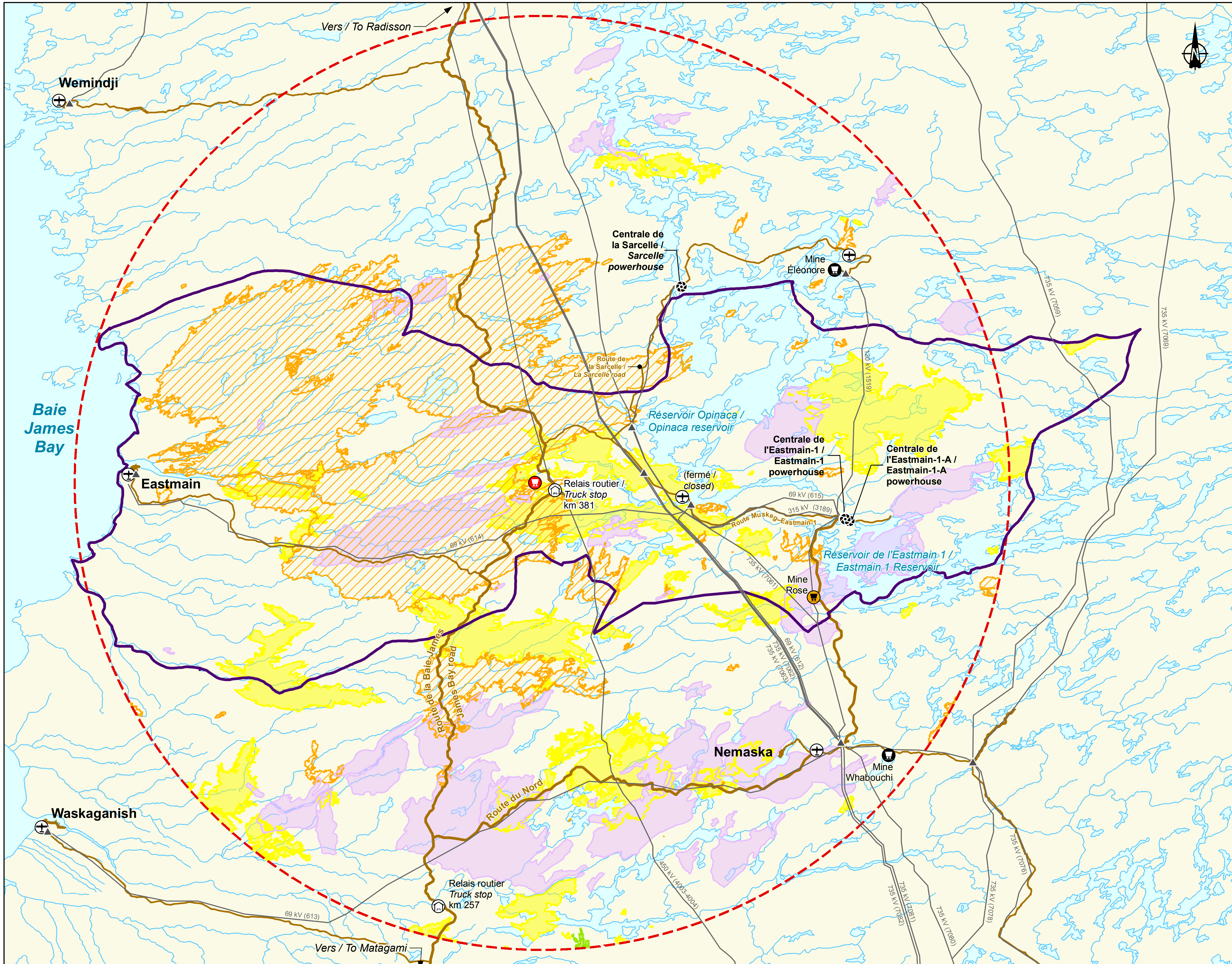
8.4.2 VALUED COMPONENTS

8.4.2.1 BATS (CHIROPTERA)

Four bat species were selected as VCs due to their special status at the federal and provincial levels. These include the hoary bat, the northern myotis and the little brown myotis, whose presence in the study area was confirmed during the 2017 surveys. Also selected was the eastern red bat, a bat species with a special status at the provincial level and which could potentially be found in the study area (Jutras and coll., 2012).

Considering that most bats (*Chiroptera*) frequenting the study area will travel several hundred kilometres during the spring and autumn migratory periods, it is difficult to identify a precise area for the cumulative effects. Given the movement patterns of bats, and the different projects underway or upcoming in proximity to the project site which may have had or may have an impact on the bats, the spatial boundary considered for the cumulative effects assessment spans an area of approximately 110 km around the project (Map 8-1). However, to dispose of a minimum of data to establish the baseline condition and past conditions of bat populations, data from the Réseau québécois d'inventaires acoustiques de chauves-souris (Réseau) have been considered, although collected at Lac Bourbeau, approximately 300 kilometres southeast of the study area. The temporal boundary corresponds to the 2003 survey, the first one conducted by the Réseau in the Nord-du-Québec region; the future temporal boundary corresponds to 10 years, since the likelihood of occurrence of another project (or another source of impact) in the study area beyond this limit is too speculative.

The indicator selected is the number of counts surveyed for the targeted species in the cumulative effect study area. However, in light of the scarcity of data for this VC in the region, and since the methodologies used vary from one study to another, caution is required when considering this indicator.



Projet mine de lithium Baie-James / *James Bay Lithium Mine Project*

Infrastructures / *Infrastructure*

- Relais routier / *Truck stop*
- Aéroport / *Airport*
- Mine existante / *Existing mine*
- Mine projetée / *Projected mine*
- Centrale hydroélectrique / *Hydroelectric powerhouse*
- Poste et ligne de transport d'énergie / *Substation and transmission line*
- Route principale / *Main road*
- Autre route / *Other road*

Limites / *Boundary*

- Zone d'étude des effets cumulatifs sur l'utilisation du territoire par les Cris d'Eastmain / *Eastmain Crees traditional landuse cumulative effect study area*
- Zone d'étude des effets cumulatifs sur les chiroptères / *Bat cumulative effect study area*

Feux de forêt / *Forest Fire*

- 1980 à / *to* 1989
- 1990 à / *to* 1999
- 2000 à / *to* 2009
- 2010 à / *to* 2016

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*

Étude d'impact sur l'environnement / *Environmental Impact Assessment*

Perturbations naturelles / *Natural Disturbance*

Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Feux de forêt / Forest fire, MFFP, 2018

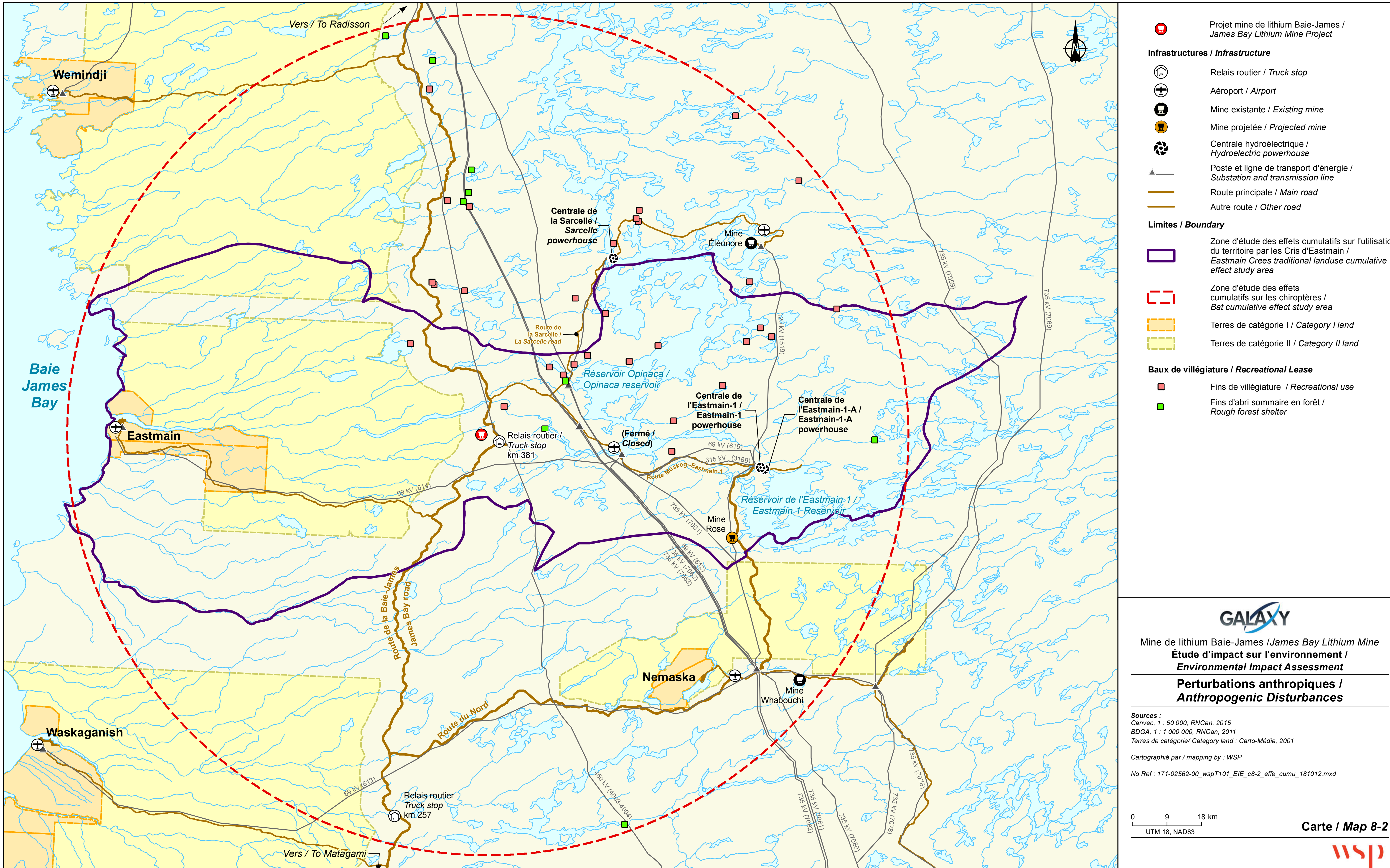
Cartographié par / mapping by : WSP

No Ref : 171-02562-00_wspT134_EIE_c8-1_feux_181012.mxd

0 9 18 km
UTM 18, NAD83

Carte / *Map 8-1*

wsp


Vers / To Radisson
Wemindji
Baie James Bay
Eastmain
Waskaganish
Nemaska
Vers / To Matagami
Centrale de la Sarcelle / Sarcelle powerhouse
Mine Éléonore
Route de la Sarcelle / La Sarcelle road
Réservoir Opinaca / Opinaca reservoir
Centrale de l'Eastmain-1 / Eastmain-1 powerhouse
Centrale de l'Eastmain-1-A / Eastmain-1-A powerhouse
(Fermé / Closed)
Relais routier / Truck stop km 381
Route Muskeg–Eastmain-1
69 kV (615)
315 kV (3189)
69 kV (614)
Réservoir de l'Eastmain 1 / Eastmain 1 Reservoir
Mine Rose
735 kV (7061)
69 kV (612)
735 kV (7062)
735 kV (7063)
735 kV (7059)
735 kV (7069)
120 kV (1519)
Route de la Baie-James
James Bay road
Route du Nord
Mine Whabouchi
69 kV (613)
Relais routier Truck stop km 257
450 kV (4003-4004)
735 kV (7082)
735 kV (7081)
735 kV (7080)
735 kV (7079)
735 kV (7076)
Projet mine de lithium Baie-James / James Bay Lithium Mine Project
Infrastructures / Infrastructure
Relais routier / Truck stop
Aéroport / Airport
Mine existante / Existing mine
Mine projetée / Projected mine
Centrale hydroélectrique / Hydroelectric powerhouse
Poste et ligne de transport d'énergie / Substation and transmission line
Route principale / Main road
Autre route / Other road
Limites / Boundary
Zone d'étude des effets cumulatifs sur l'utilisation du territoire par les Cris d'Eastmain / Eastmain Crees traditional landuse cumulative effect study area
Zone d'étude des effets cumulatifs sur les chiroptères / Bat cumulative effect study area
Terres de catégorie I / Category I land
Terres de catégorie II / Category II land
Baux de villégiature / Recreational Lease
Fins de villégiature / Recreational use
Fins d'abri sommaire en forêt / Rough forest shelter
GALAXY
Mine de lithium Baie-James / James Bay Lithium Mine
Étude d'impact sur l'environnement / Environmental Impact Assessment
Perturbations anthropiques / Anthropogenic Disturbances
Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Terres de catégorie/ Category land : Carto-Média, 2001
Cartographié par / mapping by : WSP
No Ref : 171-02562-00_wspT101_EIE_c8-2_effe_cumu_181012.mxd
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UTM 18, NAD83
Carte / Map 8-2
wsp

8.4.2.2 *TRADITIONAL USE OF THE TERRITORY BY INDIGENOUS PEOPLES*

The traditional use of the territory by the Eastmain Cree VC refers to the overall traditional practices, which mainly include the hunting, fishing and trapping activities of desired species, but also all other activities using the territory and its resources for ritual or social purposes.

Although use of the territory by the Cree has evolved over the years, this fundamental component of their culture is still as important as ever because of its heritage value. As a result, the link the Cree have with the recognized ancestral territory remains essential, above all, to the transmission of their culture to future generations.

From the 1980s onwards, the Cree witnessed important changes to the territory they occupied. These are linked to energy development, involving several diversions of watercourses and the establishment of Hydro-Québec dams, and to mining development. The year 1980 was therefore selected as past temporal scoping and the future scoping was set at 2028.

Moreover, the analysis of the cumulative effects on this VC covers the overall territory frequented by the Eastmain Cree. The considered territory extends over almost 240 km from Eastmain village. The width of the considered territory extends from 40 to 95 km (Map 8-2).

8.5 PROJECTS, ACTIVITIES OR EVENTS LINKED TO VECS AND VSCS

The most comprehensive survey possible of past, present and future projects, activities and events, both local and regional, was conducted by means of a review of available documentation. Many websites, including those of the MDDELCC, James Bay Advisory Committee on the Environment (JBACE), CEAA, MFFP, Hydro-Québec, EIJBRG, etc., and some environmental impact assessment reports on projects within the same territory or in proximity to that of the mining project (e.g, the Rose lithium-tantalum mining project by Critical Elements Corporation, the Whabouchi mining project by Nemaska Lithium, and Hydro-Québec's Eastmain-1-A–Sarcelle–Rupert project) were consulted for information on the relevant effects of these projects.

Table 8-2 shows the list of projects, activities and events (past, present and future) for each of the selected VCs. This list has been categorized in five themes:

- Infrastructure and services;
- Development of natural resources;
- Use of the territory (hunting and sport fishing activities);
- Wildlife or protected territory;
- Disturbances, natural and other.

8.5.1 *INFRASTRUCTURE AND SERVICES*

This theme regroups the key infrastructure for roadways, power transmission lines and hydroelectric production. It specifically shows the Eastmain-Sarcelle-Rupert complex project facilities which are largely contained in the study areas of the cumulative effects of the project.

Table 8-2: Projects, activities and events likely to have an impact on the VCs

Projects, activities and events	Past	Present	Future	Bats	Use of the territory
Infrastructure and services					
Development of the Eastmain community (since 1980)	X			• Loss of, and changes in habitats • Increased disturbance	• Increased fauna sampling effort • Change in use of territory and resources • Loss of territory
Diversion of the Eastmain River (1980)	X	X	X	• Loss of and changes in habitats • Increased disturbance	• Increased fauna sampling effort • Change in use of territory and resources • Loss of territory
Construction of La Grande hydroelectric complex, Phase II (1987–2002) Presence of worker camps	X	X	X	• Loss of and changes in habitats • Increased disturbance	• Increased fauna sampling effort • Change in use of territory and resources • Loss of territory
Construction of Eastmain-1 complexes (2002–2006) Presence of worker camps	X			• Loss of and changes in habitats • Increased disturbance	• Temporary increase in fauna sampling effort • Change in use of territory and resources • Loss of territory
Construction of Eastmain-1-A–Sarcelle–Rupert complexes (2007–2010) Presence of worker camps	X			• Loss of and changes in habitats • Increased disturbance	• Temporary increase in fauna sampling effort • Change in use of territory and resources • Loss of territory
Operation of the Eastmain-1 (2007) and Eastmain-1-A–Sarcelle–Rupert (2012) (diversion bays and reservoirs) Presence of worker camps	X	X	X	• Loss of and changes in habitats	• Change in use of territory and resources
Opinaca Airport (construction around 2002)	X			• Loss of and changes in habitats • Increased disturbance	• Change in use of territory and resources
Eleonore Airport (construction in 2014)	X	X	X	• Loss of and changes in habitats • Increased disturbance	• Outside the study area on use of the territory
Eastmain Airport (construction in 1986, rehabilitation in 2013)	X	X	X	• Loss of and changes in habitats • Increased disturbance	• Opening of territory • Increased fauna sampling effort • Change in use of territory and resources
Nemiscau Airport (construction around 2002)	X	X	X	• Loss of and changes in habitats • Increased disturbance	• Outside the study area on use of the territory
Rehabilitation of the James Bay road (2005–2018)	X	X	X	• Loss of and changes in habitats • Creation of potential movement corridors	• Opening of territory • Increased fauna sampling effort • Change in use of territory and resources

Table 8-2: Projects, activities and events likely to have an impact on the VCs (cont)

Projects, activities and events	Past	Present	Future	Bats	Use of the territory
Infrastructure and services (cont.)					
Access road to the Eastmain community (construction in 1994, in rehabilitation since 2011)	X	X	X	• Loss of, and changes in habitats • Creation of potential movement corridors	• Opening of territory
Construction of the Nemiscau–Eastmain-1 Road (2002)	X	X	X	• Loss of and changes in habitats • Creation of potential movement corridors	• Opening of territory
Construction of the Muskeg–Eastmain-1 Road (2007)	X	X	X	• Loss of and changes in habitats • Creation of potential movement corridors	• Opening of territory
Optimization of the Muskeg–Sarcelle Road (2008)	X	X	X	• Loss of and changes in habitats • Creation of potential movement corridors	• Opening of territory
Optimization of the Sarcelle-Mine Eleonore Road (winter road in 2010, permanent road in 2011)	X	X	X	• Loss of and changes in habitats • Creation of potential movement corridors	• Opening of territory
Construction/Optimization of secondary roads	X	X	X	• Loss of and changes in habitats • Creation of potential movement corridors	• Opening of territory
Truck stop at km 381 (reconstruction en 2013)	X	X	X	• Increased disturbance	• Increased fauna sampling effort
Nemaska-Eastmain, Nemaska–La Grande 2, Nemaska-Waskaganish, Eastmain, la Sarcelle and Eleonore transmission lines	X			• Loss of and changes in habitats • Creation of potential movement corridors	• Opening of territory
Relocation of a 315-kV line and construction of a station (linked to the Rose lithium-tantalum mining project)			X	• Loss of and changes in habitats	• Change in use of territory and resources
Development of natural resources					
Mining exploration activities	X	X	X	• Increased disturbance	• Opening of territory • Change in use of territory and resources
Eleonore Mine	X	X	X	• Loss of and changes in habitats • Increased disturbance	• Outside the study area on use of the territory
Whabouchi Mine (under development)		X	X	• Loss of and changes in habitats • Increased disturbance	• Outside the study area on use of the territory

Table 8-2: Projects, activities and events likely to have an impact on the VCs (cont)

Projects, activities and events	Past	Present	Future	Bats	Use of the territory
Development of natural resources (cont.)					
Rose lithium-tantalum mining project (under development)			X	• Loss of and changes in habitats • Increased disturbance	• Increased fauna sampling effort • Change in use of territory and resources
Use of the territory (non-Indigenous peoples)					
Sport hunting and regulations that apply to Zone 22 (hunting and fishing)	X	X	X	• Increased disturbance	• Potential disturbance of hunting, trapping and fishing activities (greatly reduced by regulations in effect)
Granting of rustic shelter leases for sport hunting and fishing (as of 1982)	X	X	X		• Potential disturbance of hunting, trapping and fishing activities
Wildlife or protected territory					
Granting of a special status under the *Act Respecting Threatened or Vulnerable Species*	X	X	X	• Protection of the four special-status bat species (occurring and potentially occurring)	
Creation of the Weh-Sees Indohoun Corporation (2002)	X				• Regulation of non-Indigenous activities in view of preserving the wildlife and fish heritage for future generations.
Abolishment of Weh-Sees Indohoun Special Zone (April 2018)		X	X		• Increased fauna sampling effort
The Paix des Braves Agreement, Nadoshtin and Boumhaounan agreements, and Agreement on Governance in the EIJB Territory	X	X	X		• Helps the Cree participate more in resource development and take charge of their own development. • Allows completion of the Eastmain Rupert diversion project.
Disturbances, natural and other					
Forest fires (cyclical phenomenon)	X		X	• Loss of, and changes in habitats	• Disturbance of animal and plant sampling activities • Change in use of territory and resources • Temporary loss of territory
White-nose syndrome (detected in Québec in 2010)	X	X	X	• High levels of mortality in hibernating populations	

8.5.1.1 *HYDROELECTRIC INFRASTRUCTURE AND CHANGE IN RIVER SYSTEM*

Based on the impact assessment study of the Eastmain-1-A and Sarcelle stations and the Rupert diversion (Hydro-Québec Production, 2004), the hydroelectric facilities of the La Grande complex led to significant permanent changes in the terrestrial, wetland and aquatic environments on the James Bay territory.

Phase I of the La Grande complex, from 1973 to 1985, resulted in the building of nine reservoirs and two diversion channels. Two more reservoirs were added with Phase II of the project (1987–1996), and the commissioning of the Eastmain 1 reservoir in 2006, less than 2 km from the Rose mine project site, has effectively completed the La Grande complex. Afterwards, the development of the Eastmain−Sarcelle−Rupert complex, completed in 2012, involved additional changes on the territory, particularly on the territory being studied for the current project.

The development of these two complexes (La Grande and Eastmain-1-A−Sarcelle−Rupert) caused the flooding of several environments, and in addition to the building of vast reservoirs, triggered various hydrological changes such as the flooding of lakes and watercourses, flow changes (stoppage, reduction or increase) to 13 rivers and raising of water level of lakes in the diversion channels (Hydro-Québec Production, 2004). In 2010, while the La Grande complex reservoir flooded 11,280 km² of terrestrial environments, the Rupert diversion bays of the Eastmain-Sarcelle-Rupert complex had likewise flooded 188 km² of terrestrial environments. This complex, which impacted 36 trapping lands linked to six Cree communities, touches a much broader territory than that of the project. The study areas of the project's cumulative effects are entirely contained in that of the Eastmain-1-A–Sarcelle–Rupert project.

Table 8-3 shows the proportion of environment types after the completion of the La Grande complex, and Eastmain-1-A–Sarcelle–Rupert project.

Table 8-3: Proportion of environment types after the completion of the La Grande complex and Eastmain-1-A–Sarcelle–Rupert generating stations

Condition of environment	Size (km²)		
	Aquatic environment	Terrestrial environment	Total
Natural condition	35,000 (10%)	315,000 (90%)	350,000 (100%)
After La Grande complex	46,280 (13%)	303,720 (87%)	350,000 (100%)
After the Eastmain-1-A-Rupert project	46,468 (13%)	303,532 (87%)	350,000 (100%)
Note: Proportion of environment types in the Eastmain-1-A–Sarcelle–Rupert project study area.			

Source: Hydro-Québec Production (2004)

The construction of the Eastmain-Sarcelle-Rupert complex required the erection of many permanent and temporary facilities, namely:

— the Eastmain-1-A and Sarcelle generating stations;
— four dams and 74 dikes, five instream flow release structures incorporated to certain retaining structures for diversion bays (Nemiscau-1, Nemiscau-2, Ruisseau-Arques, Lemare and LR-51-52);
— one spillway and eight hydraulic structures on the Rupert River;
— a 2.9-km transfer tunnel between the upstream and downstream diversion bays and nine channels with a total length of approximately 7 km;
— Two 315-kV transmission lines (one 101-km line between the la Sarcelle and Eastmain-1 power plants and one 0.5-km line between the Eastmain-1 and Eastmain 1-A stations);
— a permanent road network (131 km) and some temporary construction roads;
— six camps for workers: two used previously during the construction of the Eastmain-1 facility, and four new ones (Hydro-Québec Production, 2012).

8.5.1.2 *ROAD TRANSPORTATION AND POWER TRANSMISSION INFRASTRUCTURE*

Prior to 1974, the road network was concentrated in the southern part of James Bay. With the building of the La Grande complex to the north and forest operations to the south, it has increased significantly in the James Bay territory, playing a key role in the gradual opening up of the region (Hydro-Québec Production, 2004).

The transportation infrastructure in the study areas of the project's cumulative effects was especially marked by the rehabilitation of the James Bay road (620-km long). Built in 1971 and opened to the public in 1986, this road extends from Matagami to Radisson, and provides access to the Robert-Bourassa generating station. It has been undergoing reconstruction since 2005. As shown in Table 8-4, other works are underway or upcoming in 2018.

Then, in 1993, came the construction of the Route du Nord; the latter is a gravel road linking Chibougamau to the James Bay road and is located just south of the cumulative effect study areas. In 1994, the access road to the

Eastmain Cree Community took shape. This road joins the James Bay road, covering 102.4 km. It has been in reconstruction since 2011 to improve the intersection with the James Bay road, refill and fix deformations, excavate ditches, bypass km 38, pave km 0 to 30, and complete new surfacing treatment. A second 30-km section will be paved in upcoming years (central). Toward 2002, the road connecting Nemiscau to Eastmain-1 was built and then, in 2007, came the road linking the Muskeg cogeneration plant to Eastmain-1. Expansion of the road leading to La Sarcelle occurred in the same period.

Table 8-4: Situation of reconstruction on the James Bay road

Kilometres targeted by the work	Date of work	Nature of work	Constraints	Section included in the study areas
Km 38, Waswanipi River Bridge	May 28 to August 16, 2018	Bridge refurbishment	Maximum load (70 T) Potential traffic	No
Km 144 to 200	May 28 to October 30, 2018	Replacement of culverts, pavement rehabilitation and pulverization work. Other work underway.	Maximum load (62 T) Single-lane traffic Alternating traffic controlled by lights Slowdowns	No
Km 306, Pontax I Bridge	June 26 to August 10, 2018	Bridge refurbishment	Maximum load (62 T) Single-lane traffic Alternating traffic controlled by lights Slowdowns	Bats: Yes Use of territory: No
Km 312, Pontax II Bridge	July 26 to August 10, 2018	Bridge refurbishment	Maximum load (62 T) Single-lane traffic Alternating traffic controlled by lights Slowdowns	Bats: Yes Use of territory: No
Km 380 to 480	August 13 to 24, 2018	Resurfacing of shoulders	Single-lane traffic	Bats: Yes Use of territory: Km 380 to 428
Km 0 to 620	July 23 to August 13, 2018	Pavement marking	Slowdown	Bats: Km 244 to 530 Use of territory: Km 333 to 428

Source: SDBJ (2018).

In addition, many access roads to hydroelectric facilities (substations, power plants, dikes, dams, transmission line rights-of-ways, borrow pits, etc.) form a discontinuous network of several hundred kilometres within the James Bay territory affected by hydroelectric development (Hydro-Québec Production, 2004).

Two airports are also found in the study area for the social environment. That of Eastman is located 100 km from the project, but the Opinaca airport is within about 30 km. The latter airport served mainly construction workers of the Eastmain-1 and Eastmain-1-A–Rupert project and those of Les Mines Opinaca until an airstrip was constructed near it. Since 2014, a permanent road has also provided access to the Opinaca mine from the end of the road leading to the Sarcelle generating station. Unused for three years, the Opinaca airport was returned to service in 2009 for the Hydro-Québec projects in the Eastmain, Opinaca and Sarcelle sector.

The territory affected by the Eastmain-1-A–Rupert hydroelectric project already had seven high-voltage power lines in 2004 (six 735-kV lines and one 450-kV direct current line). Connected to this network, several different voltages supply various consumption points, such as workers' camps, villages and mines. They cover a total of 6,508 km, to which are added, for the Eastmain-1-A–Rupert project, two lines at 315 kV (totalling 160 km), a temporary line at 69 kV (42 km) and distribution lines to temporary camps for workers and permanent structures (60 km). (Hydro-Québec Production, 2004) A 315-kV line between the Eastmain-1 and Eastmain-1-A switching yards, and between the Sarcelle and Eastmain-1 substations was constructed in 2011 (Hydro-Québec Production, 2017). A 315-kV transmission line crossing the Rose mining project site will be moved to allow completion of the project.

Although it is currently powered by diesel generators, the truck stop at km 381 will soon be connected to the Hydro-Québec network. This connection will be via the addition of a power line (MERN, 2018). Studies are underway to assess the electricity demand for the James Bay Lithium Mine project. Galaxy plans to connect to the Hydro-Québec power distribution system via a 69-kV line. Depending on the route set by Hydro-Québec, this connection could require up to 11 km of additional power lines.

8.5.2 DEVELOPMENT OF NATURAL RESOURCES

This theme covers various forest and mining activities, past, present and future.

8.5.2.1 FORESTRY ACTIVITIES

Since 1980, forest clearcuts done in the study area were associated primarily with the completion of various projects. Cuts were done for the purposes of borrow pits (sandpits or quarries) to build road right-of-ways and power transmission lines, to prepare construction sites, and to set up worker camps. Several headrace areas were also deforested prior to flooding. However, these cuts are not considered entirely to be forestry activities since they were related to the various projects listed above and had been considered.

No commercial timber harvesting was done in the cumulative effect study areas.

8.5.2.2 MINING ACTIVITIES

Since 2007, several mining exploration activities have been done in the territory and, more specifically in the cumulative effect study areas. In 2018, numerous mining exploration rights are pending near the Galaxy mining project site. However, little information is available and accessible regarding the mining exploration activities (MERN, 2016).

One mine is operating and two others are being developed within a 110-km radius of the project. Les Opinaca Mines, a wholly owned subsidiary of Goldcorp Inc., operates the Éléonore mine, an underground gold deposit near the Opinaca Reservoir. Opened in 2011, this mine is located 85 km northeast of the project. It is accessible year-round via an access road roughly 60 km long and connected to the north end of the access road to Hydro-Québec's Sarcelle generating station. According to the 2014 Goldcorp Annual Report, it was expected to be one of the largest gold mines in Canada in 2018, with a capacity of 7,000 t of ore daily (Goldcorp, 2015).

Projects under development include the Rose lithium-tantalum mining project (Critical Elements Corporation), located 60 km southeast of the project site. It will be an open-pit spodumene mine with a targeted production rate of 4,600 t/day. Operation of this mine is expected to span 19 years, for a total project duration of roughly 22 years. The Whabouchi mining project (Nemaska Lithium) is located more than 100 km southeast of the project. It has been in development since 2016 and will exploit a spodumene deposit. This mine is currently in the preproduction stage.

In addition, numerous deposits are located outside the cumulative effect study areas. Indeed, close to the Whabouchi mining project, there are several less advanced projects, primarily under study at the exploration stage, targeting spodumene-bearing pegmatite on or near the surface (MRNF, 2011; Noka Resources, 2016). So other lithium mining projects could see light of day in the Nemiscau-Eastmain sector.

There is also the Troilus mine, 280 km southeast, which could soon return to operation; it ceased activities in 2010, after some 15 years of open-pit mining of copper, gold and silver. In addition, about 15 mines are located further from the project, between 250 km and 350 km away.

8.5.3 USE OF THE TERRITORY BY NON-INDIGENOUS PEOPLE

This theme covers sport fishing and hunting activities and the associated recreation infrastructure. These involve primarily use of the territory by non-Indigenous people.

Since 1980, development of the James Bay road has resulted in increased recreational activities within the territory (tourism, sport fishing and hunting), especially since the opening of the James Bay road to non-Indigenous people in 1986. However, these activities have remained concentrated primarily in the southern portion of James Bay and east of the Robert-Bourassa hydroelectric facilities. In 1991, a follow-up done to evaluate the impact of sport fishing and hunting on animal populations recorded nearly 11,000 vehicles at the entrance to the James Bay road (Hydro-Québec Production, 2001). Traffic statistics compiled by the SDBJ showed 56,139 recorded trips on the James Bay road in 2014 and 55,632 in 2017 (personal communication with the SDBJ, 2018).

Some activities, such as snaring of hares, trapping, and fishing of sturgeon and whitefish, are reserved exclusively for beneficiaries of the JBNQA throughout the territory. Hunters and fishers who are not JBNQA beneficiaries are subject to the laws and regulation in force in the territory and must hold a sport hunting or fishing licence from the Québec Government, applicable on all Category III land. Before April 1, 2018, and since 2002, different regulations applied to the hunting sectors of Weh-Sees Indohoun (WSI) and Eastmain, in which the project is located. To hunt and fish on Category I and II lands, authorization must have been issued by the Band Councils concerned.

In the past, recreational hunting and fishing activities in the project sector were practised mostly by Hydro-Québec workers involved in building the Eastmain-1-A and Sarcelle hydroelectric projects, and the Rupert River diversion. However, there are far fewer of these workers since construction work associated with the Eastmain-Sarcelle-Rupert complex finished, and the MFFP believes that the vast majority of these workers have left the territory.

According to the Québec Original website (Tourisme Québec), there are three outfitters within a 150-km radius of the project site, but it is possible that some small Cree outfitters were not recorded. Some families have opened outfitter's camps, or plan to do so to offer guided hiking, hunting and fishing trips (Goldcorp, not dated). However, little information is available on this matter. During the 2017–2018 consultation conducted for this EIA, a very preliminary outfitting project was mentioned by users of trapline VC35. This trapline is located northeast of the project, on the north shore of the Eastmain River.

According to the EIA of the Whabouchi mining project (Nemaska Lithium, 2013), a series of land rights were issued to non-Indigenous people by MERN in the Whabouchi mining project. About 10 km north of the project site, there is a vacation lot lease. Including this lease, 16 vacation lot leases are located within the borders of the study area of the cumulative effects on use of the territory. (Map 8-2) Some 20 km northeast of the study area there is a vacation lot lease for rustic shelters. Including this lease, there are three vacation lot leases for rustic shelters in the study area.

8.5.4 WILDLIFE OR PROTECTED TERRITORIES

This theme covers the territories with special protection status, as well as the management, conservation or recovery plans by the governments of Québec and Canada for the protection and management of wildlife species and habitats.

8.5.4.1 WILDLIFE RESERVES, SANCTUARIES AND BIODIVERSITY RESERVES

No wildlife reserve is located within the study areas of cumulative effects.

On the other hand, biodiversity reserves are planned within the JBNQA territory. The primary objective of these planned reserves is to maintain biodiversity in the terrestrial environment. For each biodiversity reserve planned, a conservation plan is developed. Within biodiversity reserves, mining activities and forest management are prohibited. The end date of temporary protection varies from one reserve to the next, and ranges between 2018 and 2025.

The planned Paakumshumwaau-Maatuskaau biodiversity reserve follows a proposal by the Cree community of Wemindji who want to preserve the watersheds of the Vieux-Comptoir and Des Peupliers rivers, a territory that has traditionally been used by the Cree Nation for over 3,500 years (Gouvernement du Québec, 2010). Located roughly 32.5 km north of the Cree village of Eastmain, the planned reserve is located outside the study area of the cumulative effects of land use, but falls within that for bats. The temporary protection of the reserve is slated to end on June 11, 2020.

8.5.4.2 *OTHER PROTECTION*

GRANTING OF A SPECIAL STATUS

On December 17, 2014, at the recommendation of COSEWIC, the Government of Canada added three species of bats to the List of Wildlife Species at Risk in Canada (Appendix I *Species at Risk Act*): little brown bats (*Myotis lucifugus*), northern long-eared bats (*Myotis septentrionalis*) and tri-coloured bats (*Perimyotis subflavus*). These three bat species have been designated as “endangered” because of the imminent threat to their survival posed by white-nose syndrome (Gouvernement du Canada, 2014).

In Québec the eastern red bat appears on the list of wildlife species likely to be designated as threatened or vulnerable under the *Act respecting threatened or vulnerable species* (Gouvernement du Québec, 2006). However, it should be noted that there are no specific protective measures for the eastern red bat, either in Québec or Canada.

EEYOU MARINE REGION

Commonly known as the Cree Offshore Agreement, the Eeyou Marine Region Land Claims Agreement is the product of a decade of negotiations concerning the rights and obligations of the Cree and the Government of Canada in the Eeyou Itschee offshore region. This marine region, traditionally occupied and used by the Cree, is known as the Eeyou Marine Region.

This treaty recognizes ownership and other rights in some sectors off the coast. It also constitutes a recognition by the Cree of the application of certain Canadian laws in these sectors. All Cree appearing in the register prepared by the JBNQA are automatically entered as beneficiaries of this agreement, whether they live on the coast or inland.

WEH-SEES INDOHOUN

In October 2003, the WSI was implemented by the Québec Government, Hydro-Québec and the Grand Council of the Cree under the Boumhounan and Nadoshtin agreements. The objective was to create a special hunting and fishing zone and apply specific sport hunting and fishing measures during construction of the Eastmain-1 and Eastmain-1-A–Sarcelle–Rupert hydroelectric projects.

Starting in 2015, this area was managed by the WSI subcommittee, which was made up of representatives of the Cree Nation government, Cree communities included in this area (Nemaska, Waskaganish, Wemindji, Eastmain, Mistissini), the Cree Trapper’s Association, the MFFP as well as the Hunting, Fishing and Trapping Coordinating Committee (WSI, not dated). The management measures implemented in the WSI zone, such as access rights and the fish catch registration system, ensured the capture of important information for supervising the health and exploitation of populations following increased opening of the territory. With the aid of the information collected, management measures were periodically reviewed to ensure their effectiveness (WSI, not dated).

The WSI zone was made up of two sport hunting and fishing sectors: the Weh-Sees Indohoun sector and the Eastmain sector. While moose hunting was prohibited at all times in the Eastmain sector, it was authorized (with some restrictions in the WSI sector. Having a total area of 16,656 km², these two sectors included Category I and II lands of the Nemaska Cree Nation, and Category III lands (WSI, not dated).

The MFFP officially abolished the WSI zone in the spring of 2018, since most workers on the large Hydro-Québec hydroelectric development projects had left the territory. According to information amassed since 2003, this abolition will not affect the sustainability of wildlife resources (MFFP, 2018).

Among the most notable changes arising from the abolition of the WSI zone is that sport fishers are no longer required to obtain an access right to fish in the rivers and bodies of water located within this zone. They are nonetheless required to have a fishing licence from the Québec government, and to respect catch and possession limits and the regulations in force, depending on the sector. In regard to sport hunting, hunters who are not beneficiaries of the JBNQA are now subject to the laws and regulations in force in this territory and must hold a hunting licence from the Québec government.

PAIX DES BRAVES, NADOSHTIN AND BOUMHAOUNAN AGREEMENTS, AND AGREEMENT ON GOVERNANCE IN THE EIJB TERRITORY

In 2002, Québec and the Cree signed the Agreement concerning a new relationship between the Gouvernement du Québec and the Crees of Québec. The Paix des Braves established the modalities of a forest regime adapted to the James Bay territory. Specific modalities for logging were put in place, such as the implementation of block cuttings.

The Nadoshtin and Boumhounan agreements created, respectively, in the Eastmain-1 and Eastmain-1-A-Rupert projects, mechanisms to manage road access and the use of fish and wildlife resources (by the WSI) as well as to ensure that the Cree have opportunities for contracts and to promote their training and hiring (Hydro-Québec Production, 2004).

The Agreement on Governance in the Eeyou Istchee James Bay Territory was signed by the Cree of Eeyou Istchee and the Québec Government in July 2012. The EIJJBRG aims to harmonize relations between the Jamesians and the Cree in the area of governance of the EIJB territory, and to enable the two communities to contribute significantly to the prosperity of the territory (Chapter 6).

8.5.5 *DISTURBANCES, NATURAL AND OTHER*

This theme covers natural disturbances that may have affected one or more VCs; in the present case, these are forest fires and the white-nose syndrome.

8.5.5.1 *FOREST FIRES*

As mentioned in the EIA of the Eastmain-1-A–Rupert project (Hydro-Québec Production, 2004), forest fires occasionally affect Cree traplines and terrestrial ecosystems. Areas for the study of cumulative effects are located entirely within northern zones protected by SOPFEU.

A number fires have occurred in the James Bay territory since the 1970s (RNCan, 2017). Between 1975 and 2003, an area of 5,933,272 ha was destroyed by fire in the James Bay territory (Nemaska Lithium, 2013). In all time periods, lightning has proved to be the primary cause of forest fires.

In June 2013, the largest forest fire in the province’s history occurred at James Bay (2,196,455 ha). That fire mainly affected land belonging to the Eastmain Cree community, forcing the evacuation of some 350 people from the community (Radio-Canada, 2013). SOPFEU does not generally intervene north of the 51st parallel, except when a fire threatens persons or property deemed essential for public safety. This was the case for Eastmain in 2013. At this time, the km 381 truck stop caught fire.

Some 68 fires occurred within a radius of 110 km around the project site between 1980 and 2016. Among the largest fires to occur within the territory were those of 2013 (584,000 ha), 2005 (208,708 ha), 2006 (44,026 ha) and 2010 (35,122 ha).

8.5.5.2 *WHITE-NOSE SYNDROME*

The WNS is a fungal infection affecting bats, particularly cave-dwelling species, in northeastern North America, including Québec. It is characterized by massive bat mortality, often associated with the observation of a whitish fungal growth on certain parts of the body, mainly the snout, of infected bats (MFFP, 2016b; MFFP, 2017).

Discovered during the winter of 2006–2007 in Howe Cave in the State of New York, WNS reached Ontario and Québec in 2010. Since WNS is spreading with great rapidity, at about 300 km/year, the affected areas and the number of threatened bats is increasing steadily year by year. Today, WNS thus represents the principal threat to bat populations in northeastern North America.

8.6 ANALYSIS OF CUMULATIVE EFFECTS ON VCS

8.6.1 *BATS*

8.6.1.1 *PROJECTS, ACTIONS OR EVENTS*

Past, current and future projects, actions or events that may have had or could have an effect on bats (*Chiroptera*) are set out in table 8-2. The main elements that may have affected or could affect the evolution of bat populations are discussed below.

Aside from wind energy projects, which may cause bat mortality directly through collision or barotrauma (Arnett and coll., 2008; Baerwald and coll., 2008), the potential effects of anthropogenic development projects on bat populations mainly involve habitat loss (Tremblay and Jutras, 2010). Human activity can also cause disturbance to individuals, particularly through emissions of light, noise and vibration (Bunkley and coll., 2015; EC, 2015; Stone and coll., 2015).

There is no existing wind farm within the spatial boundaries defined for the assessment of cumulative effects on bats and, based on available information, no wind energy project is currently planned for this area.

On the other hand, development of anthropogenic activity in the region has over time led to habitat loss for bats, mainly through deforestation of mature forest stands and encroachment on wetlands and hydrous environments (watercourses). This is particularly the case for mining activities, hydroelectricity projects, road and airport infrastructure, and energy transmission lines. To a lesser extent, hunting and the opening of the territory to human activity contribute to an increase in sources of disturbance for bats (light, noise, vibrations). Moreover, hydroelectricity projects such as the La Grande complex have also led to habitat loss through artificial flooding.

In parallel with the development of these anthropogenic activities, particularly during recent decades, measures have been taken to ensure the protection and management of wildlife species and natural habitats. Laws and regulations formulated for these purposes have gradually been integrated into anthropogenic development activities. This is particularly the case for conservation plans, the designation of conservation areas, and the creation of parks and reserves. Some of these activities are potential sources of positive effects for bat populations.

In regard to natural disturbances, forest fires constitute a source of habitat loss for bats. These fires, generally caused by lightning, shape the region's forest dynamics (Nemaska Lithium, 2013). Several major forest fires have occurred in the study area, particularly the fire of 2013, which affected close to 15% of its area. The loss of large-diameter trees and snags in mature forest environments, which bats prefer, has a negative effect on the bat VC.

As mentioned earlier, one of the major sources of impact for bat populations is WNS, which was first detected in Québec in 2010 (MFFP, 2017). This syndrome is spreading rapidly and is now present in over 15 northeastern U.S. states, its impact demonstrated by the fact that over 1 million bats are estimated to have succumbed to the disease since its discovery (MFFP, 2016a). Most North American bat species may be affected by WNS. However, bats of the genus *Myotis*, the big brown bat and the tri-coloured bat have been particularly badly hit in the northeastern United States and Ontario (MFFP, 2016b). Since the winter of 2010–2011, the first observations of WNS have been recorded in bat populations of Québec, including those of the Nord-du-Québec region (MFFP, 2017). Although the significance of its effect on bat populations in the region has not yet been assessed with precision, the disease has so far caused an overall decline of 94% in known numbers of *Myotis* bats hibernating in Nova Scotia, New Brunswick, Ontario and Québec (EC, 2015). WNS is therefore a major event in terms of its cumulative effects.

8.6.1.2 *BASELINE CONDITION*

There is little data available to provide a relevant baseline condition for bats in the region. Since the earliest data concerning bat populations in Northern Québec date from 2003, that year has been taken as the past temporal boundary for the assessment of the project's cumulative effects on the bat CV. According to the latest figures published by the Réseau in its CHIROPS newsletter (Jutras and Vasseur, 2011), bats of the genus *Myotis* accounted for 5 of the 7 records collected in the Nord-du-Québec region in 2003 (71.4%). The two other species identified in this region were the hoary bat (1 record, 14.3%) and the big brown bat (1 record, 14.3%). Only the eastern red bat was not identified in the 2003 survey.

In regard to data obtained during the acoustic survey conducted by WSP in 2017, the survey confirmed the presence of bats of the genus *Myotis* (4.41% of records), the big brown bat (1.47% of records) and the hoary bat (86.7% of records), for a total of 68 passes recorded. Considering the survey effort (261 station-nights), few passes were recorded for the various bat species (section 6.3.6.2).

8.6.1.3 *HISTORICAL TRENDS*

Information on bats in the Nord-du-Québec region is very scarce and fragmentary, making it difficult to define historical trends concerning populations of the various species of bats. Data from the Réseau provide annual monitoring between 2003 and 2009, but the numbers of observations are too small to allow a useful comparison of relative numbers from one year to another. However, the presence of species identified by the Réseau, namely bats of the genus *Myotis*, the hoary bat and the big brown bat, was confirmed in almost every year during this period, except for 2004 and 2008, when the big brown bat was absent from records collected (Jutras and Vasseur, 2011). Moreover, the presence of these species was confirmed during the 2017 acoustic survey.

The main impact on bat populations is undoubtedly the appearance of WNS, which was first identified in Québec in 2010 (MFFP, 2016*a*) and has been observed since the winter of 2010–2011 in the Nord-du-Québec region as far as Chibougamau (MFFP, 2016*b*). As mentioned earlier, WNS has caused significant mortality (94% of known numbers) in resident bat populations, particularly those of the genus *Myotis*.

Since 2003, the effects of anthropogenic development projects on bat populations have largely come as a result of habitat loss (Tremblay and Jutras, 2010). Whether infrastructure and services projects (e.g., the Eastmain 1 reservoir, and the Nemiscau and Opinaca airports) or mining projects (Éléonore and Whabouchi), all such projects entail deforestation and encroachment on wetlands and hydrous environments (watercourses), which constitute potential sources of habitat loss and modification for bats. These projects are also associated with the creation of roads and/or energy transmission corridors that also contribute to habitat loss, but which can also be sources of positive effects for bats. This is because, as they travel from one site to another, bats generally use linear gaps in the forest structure for guidance, such as road or power line rights-of-way (Grindal and Brigham, 1998; Henderson and Broders, 2008).

Deforestation activities associated with anthropogenic development projects constitute the only sources of forest operations within the spatial boundaries considered for this CV. Like forest fires, deforestation activities also contribute to the fragmentation of forest habitats and result in the creation of linear elements that are used by certain species of bats (EC, 2015).

In 2012, recognizing the massive mortality of bats caused by WNS, COSEWIC recommended that three bat species be classified “endangered”: the tricoloured bat, the little brown myotis and the northern myotis. This status was reviewed and confirmed in November 2013 (COSEWIC, 2014), and these species were added to Schedule 1 of the SARA on December 17, 2014 (COSEWIC, 2016; Gouvernement du Canada, 2014). The little brown myotis and the northern myotis had not previously been granted any special provincial or federal status.

In conclusion, because of the lack of specific data on regional population dynamics, there is no clear trend for the study area under consideration. It can therefore only be supposed that the population is suffering a decline similar to that in the rest of Québec, because the main cause of this decline seems to be WNS.

8.6.1.4 *CUMULATIVE EFFECTS*

The main threats facing bats are habitat loss, wind energy developments and WNS (Tremblay and Jutras, 2010). Given the absence of wind energy projects in the region, the potential negative effects of human development projects essentially involve habitat loss.

The assessment of the James Bay Lithium Mine project’s impact in terms of habitat loss and disturbance for bat populations concluded that the residual effect is of minor significance, even considering the fact that bats of the genus *Myotis* and the hoary bat are species with a special status. Also, because of forest fires, most of the natural environments that will be affected by the project are characterized by the absence or virtual absence of a tree stratum. These environments are therefore not the most propitious for the bat species identified in the study area, which are essentially arboreal. In addition, considering the planned remediation activities, habitat loss is not likely to compromise the integrity of local populations. Moreover, if deforestation is not carried out during the breeding season, the fact that there are sufficient replacement habitats of similar quality in the region means that the effect of this habitat loss will not prove significant for bat populations.

Past, present and future actions likely to lead to habitat loss in the area include projects leading to the disappearance of mature forest stands or wetlands and hydrous environments, or potential travel corridors (encased valleys, lakeshores, watercourses, etc.). Essentially, these are represented by the creation of the Eastmain 1 reservoir and the Eastmain-Sarcelle-Rupert complex, the Nemiscau and Opinaca airports, the Whabouchi and Éléonore mining projects and the roads and energy transmission lines associated with them. Their effects are nevertheless limited in terms of surface area in view of the spatial boundaries considered for the assessment of cumulative effects.

Forest fires have caused, and will likely continue to cause, substantial habitat loss inside the spatial and temporal boundaries considered, particularly with regard to forest stands. Thus, when compared with losses caused by forest fires, the anticipated habitat loss caused by the present project is very minor.

Again, in connection with natural disturbances, the appearance of WNS has already caused and will probably continue to cause substantial mortality in resident bat populations, particularly in species of the genus *Myotis*. Because the fungus attacks bats during the hibernation period, they die of exhaustion before winter's end (Chauve-souris.ca, 2018). Very little data is available regarding the location of hibernation sites in the Nord-du-Québec region. The northernmost known hibernation site lies a little to the north of Lebel-sur-Quévillon. Nevertheless, since bats can cover hundreds of kilometres to reach their hibernation site, the risk that species of hibernating bats identified in the study area will be affected by WNS during the hibernation period is high, which could cause a marked fall in the number of bats present in the study area. As a guide, in hibernation sites in the United States, the recorded decline in the species that are present in Québec stands at 91% for the little brown myotis (*Myotis lucifugus*), 98% for the northern myotis (*Myotis septentrionalis*), 41% for the big brown bat (*Eptesicus fuscus*), 75% for the tri-coloured bat (*Perimyotis subflavus*) and 12% for the eastern small-footed myotis (*Myotis leibii*) (Chauve-souris.ca, 2018). Consequently, the effects of the white-nose syndrome constitute heavy pressure on bats of the genus *Myotis* within the spatial and temporal boundaries considered.

Finally, the anticipated cumulative effects of the project on bats are judged to be negligible and will consist mainly in an increase in disturbance of bats near the site, as well as occasional loss and modification of the habitat. For this reason, the cumulative effect on bats is deemed to be of low magnitude, local scope and long duration. The importance of this cumulative effect is definitively deemed to be minor. The project will therefore not entail substantial cumulative effects on bats (*chiroptera*).

8.6.1.5 *MITIGATION MEASURES AND FOLLOW-UP*

No additional mitigation measures or additional environmental follow-up beyond those proposed in the specific environmental assessment are required for this component.

8.6.2 LAND USE FOR TRADITIONAL PURPOSES

8.6.2.1 *PROJECTS, ACTIONS OR EVENTS*

The year 1980 was used as the anterior temporal boundary to assess the project's cumulative effects on the VC land use for traditional purposes by the Eastmain Crees. This was the year in which this community's Crees saw the biggest changes made to the land due to Hydro-Québec's diversion of almost the entire flow of the Eastmain River to the La Grande watershed via the Opinaca reservoir.

Many actions, projects or events have affected land use since then. All these events and their gradual combination have contributed to changes in land use practises over the years. Since the signing of the JBNQA, land and resource use for traditional purposes, more specifically hunting, fishing and trapping, has changed significantly. Over the years, the Eastmain Crees have had to adapt their habits to this environment, which has undergone major changes since the construction of the La Grande and Eastmain-Sarcelle-Rupert complexes.

Four of Eastmain's fifteen traplines have been affected by reservoirs and river alterations related to the La Grande complex. An area of 916 km^2 was flooded and 274 km of rivers (Eastmain and Opinaca) were diverted. These two stretches of river are fed only by their tributaries. These changes have dramatically altered the activities of the Eastmain Crees in these areas despite corrective work to maintain wildlife. For instance, the diversion of the Eastmain River has reduced its flow by 90% (Hydro-Québec, 2001).

Although some parts of the land have been abandoned because of the major changes they have undergone, the construction of roadways and power lines has greatly facilitated access to other parts. For example, power line rights-of-way offer easy access to hunting, fishing and trapping, and are widely used by the Crees. The development of the power transmission system has therefore had an impact on the opening of the territory but to a lesser extent than the road network (Hydro-Québec Production, 2004). It should be noted that as part of the development of the Eastmain-Sarcelle-Rupert complex, almost the entire Sarcelle-Eastmain-1 315-kV transmission line and Muskeg-Eastmain-1 access road were erected on land belonging to the Eastmain Cree community (Hydro-Québec and Société d'énergie de la Baie-James, 2012).

The presence of worker camps also disrupted the tranquility of the Eastmain Crees and sometimes increased pressure on the resource. Some Cree users were particularly concerned about overfishing in popular lakes. For example, in 2011, there were 6,531 sport fishing trips in the special zone managed by WSI, for a total of 1,328 anglers. These anglers came from the Eastmain, Sarcelle, Habitations Trans-Énergie (near Nemaska) and other worker camps (Hydro-Québec Production, 2012). Note that in the WSI special zone, workers (or other non-Cree anglers) caught 34% fewer fish in 2011 than in 2010 (23,102 fish in 2011 compared to 34,844 in 2010) (Hydro-Québec Production, 2012).

The presence of non-Indigenous workers can also lead to a decreased sense of security for the Crees. Concerns are sometimes raised about traffic accidents or vandalism (COMEX, 2013). However, the disruption caused by workers of the hydroelectric projects diminished once construction of the Eastmain-1-A-Rupert project was completed. The Eastmain camp, located 70 km northeast of the project site, had 837 beds at the beginning of 2011 and less than half at the end of the year. The Sarcelle camp, located at the northern edge of the study area, housed between 450 and 600 workers in 2011 and closed in 2012.

In 2014, a 450-unit camp was set up for the Éléonore mine (85 km northeast of the project), which had 1,200 workers in 2015. All mining activities in the region (including any related road and air traffic), whether past, present or potential, have or could affect the traditional activities of Crees using the land, especially if the effect is felt nearby and in the near term. Currently, only the Opinaca Éléonore mine (in operation) is within 110 km of the mine project site. In addition, the Whabouchi mine, located more than 100 km southeast of the project, has been under construction since 2016 and was scheduled for commissioning in 2018. However, at the time of the assessment, it was still not open.

Forest fires in the study area since 1980 (about 68) have also influenced land use by the Crees. A fire in 2013 alone destroyed a large part of the Eastmain Crees' land. In an article published by *La Presse* (July 5, 2013), an Eastmain Cree lamented the consequences of the fire, which prevent the Crees from practising their traditional activities. He also pointed out that 8 of the 15 traplines in his community were burned to the ground (Sioui and Côté, 2013). In addition to limiting trapping activities, it is not unreasonable to assume that forest fires can cause substantial property loss (destruction of camps and equipment).

8.6.2.2 *BASELINE CONDITION*

In 1980, more than a third of Crees lived permanently in villages. This reality extended beyond Eastmain; nearly two thirds therefore use the territory over long periods. This sedentarization of a growing proportion of the population and the creation of villages are the direct consequences of the advent, in the 1950s, of paid employment and government health, education and social services programs. Despite the external cultural influences resulting from this sedentarization, in 2000 approximately 30% of Cree families regularly engage in traditional activities (Hydro-Québec Production, 2001).

In the early 1980s, the land was already divided into traplines used by Crees. This division of the land is the result of the creation of beaver reserves in the 1930s and 1940s (Hydro-Québec Production, 2004). The Crees still hold exclusive rights to trap fur-bearing animals. To get to their traplines, some use canoes, others fly, while others use snowmobiles or land vehicles when there are roads. Transportation and equipment costs are mainly covered by income derived from trapping and government benefits. However, the high cost of travelling to remote traplines combined with sedentarization have led to decreased use of these traplines (Hydro-Québec Production, 2004).

Also in the 1980s, the construction of the La Grande hydroelectric complex resulted in changes to various watercourses in the study area. The change with the greatest impact on members of the Eastmain community was the diversion of the Eastmain River, which left just 446 km for hunting, fishing and trapping.

The development of the La Grande complex also brought about changes in the Crees' fish consumption habits. Although it remains an important food source for the James Bay Crees, the discovery in the 1980s of high mercury levels in fish in the La Grande complex reservoirs caused them to change their harvesting and fish consumption practises. It is against this backdrop that in 1986 the Crees signed the Mercury Agreement, which aims to minimize the potential effects of mercury on their health and to preserve their lifestyle and traditional activities. This agreement also provides, where appropriate, for Hydro-Québec to undertake work to reduce mercury concentrations in fish (Hydro-Québec, 2018). Despite the Agreement, a 2010 study found that about 70% of James Bay Crees consume local fish less than once a week.

Like Québec as a whole, the individual income of Crees more than doubled between 1981 and 2001 (Hydro-Québec Production, 2004). Crees who regularly trap face new financial obligations such as housing children during the school year, paying rent or buying motorized equipment. The social context of the Cree community has changed significantly in recent years. For example, there is a sharing of authority between the tallymen and elders, who traditionally were the most influential figures in the community, and Cree administrators and politicians (Hydro-Québec Production, 2004).

8.6.2.3 *HISTORICAL TRENDS*

Since the signing of the JBNQA, land and resource availability has changed mainly due to hydroelectric projects, the development of road and electricity networks, and fires. However, the JBNQA, the Paix des Braves and the Nadoshtin and Boumhounan Agreements recognized the Crees' right to harvest and allowed for the enactment of provisions protecting this right and encouraging hunting, fishing and trapping (Hydro-Québec Production, 2004). This special legal framework also encouraged the Cree government to develop a mining policy to establish guidelines for exploration and mining activities based on sustainable development that respects the Crees' rights and interests. This policy aims to ensure Cree participation in mining activities on the territory, including exploration, extraction and mine closure projects (GCC and ARC, 2010).

Further, the Agreement on Governance in the Eeyou Istchee James Bay Territory, signed in 2012, now allows the Cree Nation Government to assume broader responsibilities with respect to municipal management and management of land and resources on Category II lands (Secrétariat aux affaires autochtones, 2016).

As mentioned above, the changes to the land entailed adaptations in terms of its use, such as traditional activities, sedentarization and human use of the territory.

Between 1975 and 2004, land and resource availability was changed by the hydroelectric projects. In regard to the cumulative effects, the diversion of the Eastmain and Opinaca rivers around 1980, along with the flooding of the areas occupied by the Opinaca and Eastmain reservoirs, and later by the Rupert diversion bays, caused loss of land used by the Crees. It also led to the development of new areas or increased use of traditional areas.

Some users have turned away from areas used by the community or families mainly due to lower fishing or hunting success or fears of mercury contamination. One of the first changes to the land affecting the communities contemplated by the study area on the cumulative effects on traditional land use is the diversion of the Eastmain River to the La Grande River watershed via the Opinaca Reservoir. This diversion resulted in the loss of fishing sites, including one in a nearby estuary that was used by the community. If they cannot adapt to the land changes, users must turn to other activity areas and, according to the COMEX report (2013), many Crees are still in the process of adapting to new activity areas. During the project consultation, one user stated that the Eastmain River diversion had resulted in a deterioration in sturgeon quality but that he was beginning to notice an improvement in this regard.

However, the road network, corrective work and numerous mitigation and enhancement measures have reduced the impact of hydroelectric development on resources and facilitated access to them. For example, various measures have been put in place by Hydro-Québec to encourage the continuation of spring goose hunting, which is still highly valued by the Crees; namely, four new goose hunting ponds on the Eastmain traplines (in areas affected by the Eastmain-1-A-Sarcelle-Rupert project) and four redeveloped ponds (which had been developed during Phase I of the La Grande complex). In addition, approach corridors and foraging areas for geese have been cleared (Hydro-Québec and SDBJ, 2012). Goose hunting also takes place on the James Bay coast and in some ponds, as well as along the roads and reservoirs created. Most of it takes place on the shores of the Eastmain 1 and Opinaca reservoirs.

Although in the past resource proximity dictated camp locations, today road proximity is also a factor (Hydro-Québec Production, 2001). In fact, most of the camps replaced as part of the Eastmain-1-A mitigation measures were built along roadsides. Accesses and snowmobile and ATV trails were also built as part of the project's mitigation or compensation measures (Hydro-Québec and SDBJ, 2012). Access routes, roads and trails now make it easier to access the territory. In addition, because of improved employability in the communities, long stays on the territory have increasingly given way to more frequent and shorter stays. Thanks to roadways, weekend trips can be easily envisioned. Thus, corrective work and mitigation measures aimed at improving access and wildlife harvesting by the Crees have made it easier to travel to certain parts of the modified territory.

James Bay road runs directly east of the project and has been undergoing repairs since 2015. Combined with the 2013 reconstruction of the km 381 truck stop, this repair makes this area of James Bay a top tourist attraction.

Lastly, nature and adventure tourism is growing, and the Crees are working together to develop cultural and adventure products showcasing their knowledge of the land and their traditional way of life. The Crees rely on the vitality of their traditions and way of life in developing their tourism offer (Tourisme Baie-James, 2016).

8.6.2.4 *CUMULATIVE EFFECTS*

According to the impact assessment, the project would have a moderate residual effect on Cree land use. For Cree users, the loss of tranquility in the area surrounding the project could lead to avoidance of some popular areas or disruption of traditional activities. It should be noted that there will be a permanent worker camp at the mine site, which is on the RE2 trapline, and that it will house 150 employees during the operating period. The presence of these mainly non-Indigenous workers may cause Cree users to worry about contamination or disturbance of the natural environment and animal and fish populations. Mine activities may create the same kind of fears. These concerns could eventually lead to avoidance of certain areas near the mine or a decrease in harvesting of certain animal or fish species. It should be noted, however, that Galaxy will not allow mine workers to hunt or fish.

Of the previous projects on the territory, those that most affected land use near the project site are the diversion of the Eastmain River and the creation of the Eastmain 1 reservoir and Eastmain-Sarcelle-Rupert complex. The COMEX report (2013) on the public consultations held following construction of the Eastmain-1-A and Sarcelle powerhouses and the Rupert diversion states that, without denying the project's significant impacts on the territory and its inhabitants, the proponent took the necessary measures to mitigate the residual effects to an acceptable level. It states that one of the most important issues for the Crees in all the James Bay development projects reviewed by COMEX is protection of the Cree traditional way of life as it evolves. In that light, it considers that the real challenge is to ensure the Crees can continue to practise their traditional activities and can adapt to the altered environments. The changes brought about by the new hydroelectric developments (Eastmain-1 and Eastmain-1-A/Sarcelle/Rupert) may lead to a decline in some species and an increase in others as nature seeks to return to equilibrium in the coming years. At the same time, the Cree population is growing (from 2,500 at the beginning of the 20th century to over 17,700 today[16]), and non-Indigenous people are showing an ever-increasing interest in hunting and fishing on the territory. "At this rate, the environment and natural resources may no longer be able to meet the population's needs as they did in the past. New solutions must be found to prevent overharvesting of wildlife" (COMEX, 2013).

Among the current or future projects that could affect land use by the Eastmain community are the Rose lithium-tantalum mining project by the Critical Elements Corporation. The anticipated effects of this project on land and resource use are quite similar to those of this project: disruption of hunting, trapping, gathering practices and firewood collection, and changes to access to the territory. Once the various mitigation measures were put in place (hunting and fishing ban), the residual effect on land and resource use was evaluated as low and non-significant.

The completion of the Rose lithium-tantalum project will change current land and resource use, particularly within the RE1 traplines, which are used by many members of the Eastmain community. Located 60 km northwest of the proposed Rose mine, the present project affects RE2 users, including those who had to adapt their use of the land to the Eastmain River diversion in 1980. This group expressed fears about the project's effect on sturgeon. VC33 and VC35 tallymen also raised concerns that echoed those of RE1 and RE2 users, particularly with respect to the effects on hunting grounds (section 5.5.1). These Eastmain users are therefore especially affected by changes on their traplines. Although the territory is still vast and can support the displacement of harvesting activities (hunting, fishing, trapping), the Crees must invest time and resources to search for and adapt to new harvesting sites.

Users worry about the risk of contamination of resources and the water system as well as an increase in cancer rates due to contaminants in the food chain. They also worry about contamination of vegetation, especially by dust. This worry is even greater among Cree users located between the three mines.

Some fear that the project will exacerbate the impacts of other sources. For example, many expressed concern that the project is detrimental to the regeneration of vegetation in the area, which is only beginning to recover after the 2013 forest fires. Saying that beaver no longer tastes the same since the construction of James Bay road because of the pollution, one RE2 trapline user says he is afraid the situation will get worse. In general, the users surveyed during the consultations are afraid that the projected effects of the mine will be minimized.

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[16] Crees residing and not residing in Cree communities.

Deforestation related to construction of the mine and its infrastructure will result in the loss of more land for users, although as a result of legislation, it will be revegetated in the long run (about 30 years) and likely be usable again for hunting, gathering and trapping.

With respect to natural disturbances, forest fires have caused, and are likely to cause, temporary disruptions to traditional Cree activities and even material losses for some members of the community.

Although individually, the project and each of the other projects on the territory may have overall low residual effects on the VC land use for traditional purposes by the Crees, they each result in changes to parts of the traplines (increased traffic, noise and light disturbances, changes in air and water quality, pressure on the resource, avoidance of the area and land loss) which, cumulatively, can disrupt Cree activities in the long run. However, although the projects mentioned will change the way these activities are practised on the territory, they will not prevent their continuation.

The cumulative effect on land use is limited to a small area. It will be especially felt by families who use the trapline where the project is located (RE2). The cumulative effect on this VC could increase with completion of the potential mining projects in the area, despite taking Cree users into consideration in the various compensation plans and mitigation measures planned. Noise, light, dust, increased traffic, loss of wildlife habitat and related traditional activities will affect a growing number of users for each new project on the territory, especially since the number of users is expected to continue growing.

Several major forest fires have occurred in the study area, particularly the fire of 2013, which affected a large part of Eastmain land. Temporary loss of land has an adverse effect on this VC.

With respect to the project in relation to other past sources of impact, particularly the major hydroelectric projects and forest fires, the cumulative effect on the Crees' current use of the land and resources is considered of low intensity, point-like in extent and long-term in duration; therefore, low. The cumulative effect of the project on Cree use of the land for traditional purposes is therefore non-significant.

8.6.2.5 *MITIGATION MEASURES AND FOLLOW-UP*

Given that the expected cumulative effect on the VC is non-significant, no mitigation measures other than those in Chapter 7 are necessary and no special follow-up is required.

8.7 RESULTS OF THE CUMULATIVE EFFECTS ASSESSMENT

The cumulative effects analysis for the two valued components indicates that the project's adverse cumulative effects on the Eastmain Cree community and on the bats in the study areas (spatial scope) for the time periods used (temporal scope) is non-significant.

As a result, no additional mitigation measures or environmental follow-up programs beyond those proposed in the specific assessment of this project are required.

9 ACCIDENT RISK MANAGEMENT

During the construction, operation, infrastructure demolition and project site rehabilitation phases, there are risks that potentially hazardous events could impact environmental components. Unexpected events occurring independently of the activities or conditions normally associated with a project's performance are considered accidents or malfunctions.

The first line of defence against accidents and malfunctions is the introduction of best practices in the areas of health and safety and environmental protection. Potential accidents and malfunctions are associated with risks that will continue to exist despite the strict implementation of exemplary management systems. Should such events occur despite prevention efforts, it will then be important to minimize environmental impacts through planning, the development of effective mitigation measures and the implementation of an EMP.

Being located a fair distance from any permanent dwellings, the James Bay Lithium Mine project poses very little risk to the populations in the area in the event of an accident (the only exception being the km 381 truck stop). An accident could nonetheless impact the persons and property at the site, as well as the environment. The site's location, far from resources that could be deployed, makes it important to identify risks and ensure that resources are put in place to be able to respond diligently and confidently in the event of a major accident.

These measures were incorporated into the design, planning and implementation phases and will therefore be in place throughout the life of the project. The purpose of implementing such measures is to reduce the likelihood of unforeseen accidents and malfunctions occurring. The implementation of preventive measures will also reduce the impact of potential accidents. This approach is part of a stewardship initiative aiming to reduce risks at the source while mitigating their impacts on the environment.

Galaxy is committed to ensuring that the risk management process ensure that the plausible consequences of any accident scenarios that have been identified are sufficiently reduced to keep risk levels as low as reasonably achievable.

9.1 ASSESSMENT OF RISK OF MAJOR ACCIDENTS

9.1.1 RISK DETERMINATION METHOD

The analysis of the risks of major technological accidents associated with the project seeks to identify the major accidents likely to occur, assess their possible impacts on the community and the environment, and determine the project's acceptability in terms of risk. It also serves in the development of protective measures designed to prevent the worst-case scenarios (accidents or malfunctions) that could realistically occur or to limit their frequency and impacts.

The notion of risk comprises the following elements:

- hazards that arise in an accident scenario;
- the severity of the consequences for the various accident scenarios;
- the probability of occurrence of the accident scenarios.

The approach adopted complies with the requirements of the MDDELCC's guide to the analysis of major technological risks, *Analyse de risques d'accidents technologiques majeurs* (Théberge, 2002) (hereinafter referred to as the MDDELCC Guide). The analysis also adheres to the main recommendations of the Conseil pour la réduction des accidents industriels majeurs' publication entitled *Guide de gestion des risques d'accidents technologiques majeurs* (MIACC, 2017).

The first steps consist in identifying the sensitive elements in the environment, along with the external hazards linked to the activities, infrastructure or equipment at the site, and subsequently determining the history of accidents at similar sites. The next step is to develop accident scenarios associated with the identified risks.

Subsequent steps will entail identifying the potential consequences of the scenarios identified and estimating the probabilities of occurrence. Safety measures designed to eliminate or reduce the risk of accidents will also be established. A risk management plan including an EMP will also be developed to manage any residual risks that cannot be eliminated.

The methods used during the various steps are detailed further in the following subsections.

9.1.1.1 *HAZARD IDENTIFICATION AND DEVELOPMENT OF ACCIDENT SCENARIOS*

Hazard identification requires drawing up a list of the hazards associated with the project. The method adopted is based on analysis of the following three categories of potentially hazardous elements:

- products that could be found inside the facilities examined;
- equipment and operations;
- external events (i.e., not connected to the processes), whether natural or not.

This identification will subsequently be used to identify worst-case scenarios along with their causes and the preventive and control measures in place.

9.1.1.2 *EVALUATION OF SEVERITY OF CONSEQUENCES FOR VARIOUS ACCIDENT SCENARIOS*

The severity of the consequences for each worst-case accident scenario identified was determined by experts.

9.1.1.3 *ESTIMATION OF THE PROBABILITIES OF OCCURRENCE*

The various accident scenarios were analyzed to determine probability (their likelihood of occurring). These probabilities were established mainly on the basis of accidents at similar sites in past years.

9.1.1.4 *DETERMINATION OF RISK LEVELS*

Risk levels are established based on criteria for determining an incident’s level of severity and probability of occurrence.

PROBABILITY CLASSES

Probability of occurrence signifies the likelihood that an identified hazard will result in an incident or accident.

The scores for expressing the probability of occurrence of an incident or accident were developed by taking historical events into account whenever possible. The classes are defined in Table 9-1.

Table 9-1: Classes of probability of occurrence

Probability class	Definition
Very high	Current event: can occur more than once a year. Will occurs in the short term.
High	Highly probable event: can occur less than once a year. Could occur several times during the facility's operation.
Moderate	Probable event: could occur less than once every five years. Could occur once during the facility's operation.
Low	Improbable event: could occur less than once every 20 years. Could occur; has occurred within the industry somewhere in the world.
Very low	Highly improbable event: can occur less than once every 100 years. Not impossible, based on what we currently know, but also not an incident encountered anywhere in the world over numerous years of operation. Would occur only in exceptional circumstances.

LEVEL OF SEVERITY OF CONSEQUENCES

The elements that can be considered when determining the level of severity are as follows:

- People: health and safety of workers at the site and of people located within the impact radius at the time of the incident;
- Environment: impacts on the environment (water, air, soil, fauna, flora);
- Property: damage to infrastructure and property, and impact on operations.

The levels of severity of the consequences are established based on the descriptions in Table 9-2.

The level of severity of each element considered (people, environment and/or property, is determined. The overall level of severity, however, is the highest one. For example, a specific accident could have a low level of severity with regard to property but a high level in terms of impacts on the environment. The accident's overall level of severity would then be considered high.

RISK LEVEL

Once the probability of a risk occurring and the associated level of severity have been established, the matrix in Table 9-3 can be used to determine the risk level of a given event.

The risk level thus identified takes into consideration the preventive and mitigation measures that have been put in place, so long as these are robust and reliable.

Table 9-4 presents risk acceptability criteria.

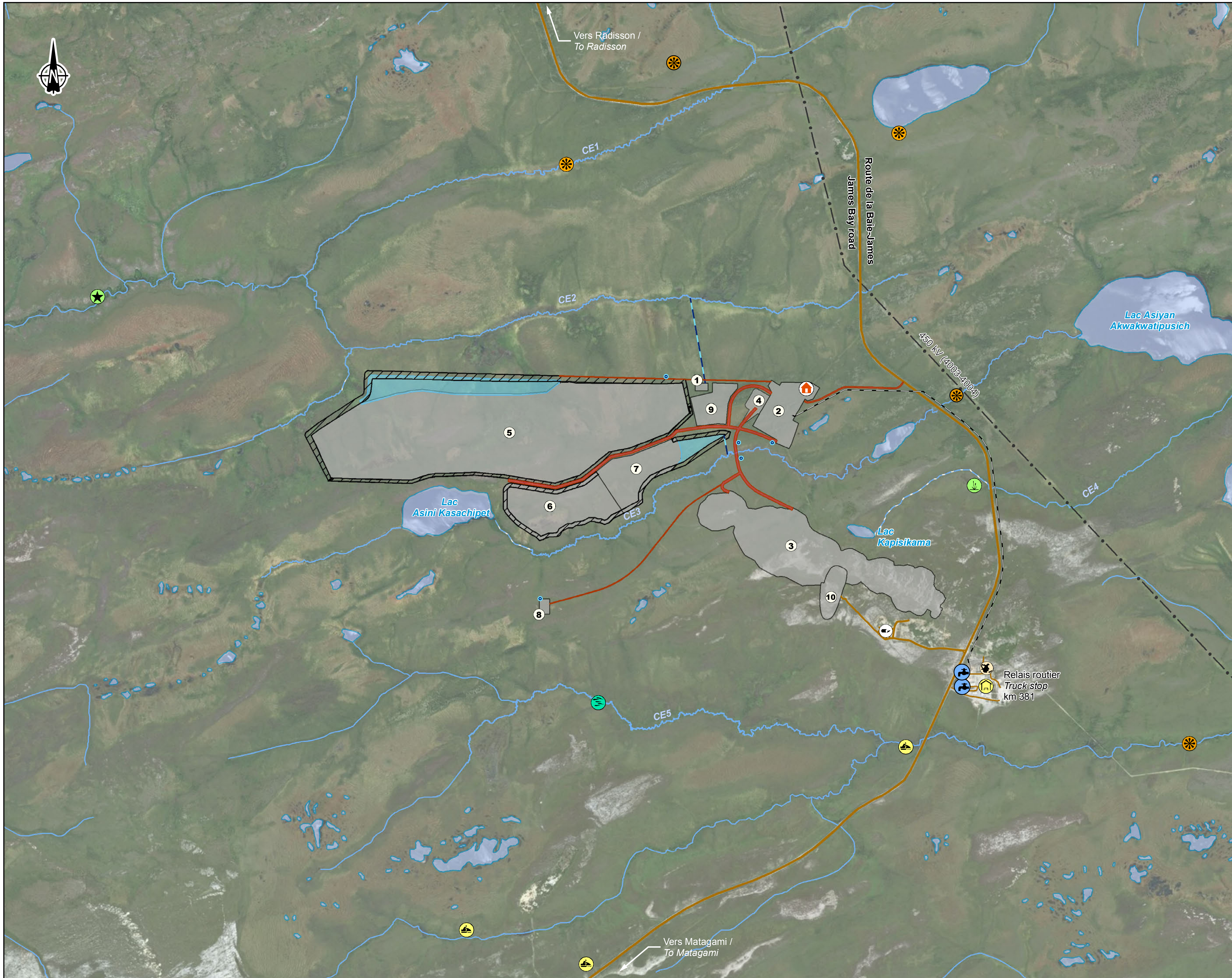
9.1.2 IDENTIFICATION OF SENSITIVE ELEMENTS IN THE ENVIRONMENT

Sensitive elements in the environment that must be taken into consideration during this technological risk analysis are those that, given their proximity, could be impacted in the event of a major accident at the project site. These include the local population, public spaces, infrastructure and sensitive or protected environmental elements. The identification of sensitive elements is limited to a radius of about 1.5 km around the project site (Map 9-1).

Table 9-2: Levels of severity of consequences

Level of severity of consequences	Community	Workers	Environment	Property
Very high	• Several neighbours significantly impacted • Possible evacuation of the community • Significant impacts on lifestyle (traditional use of the land, access to roads and services)	• Loss of human life due to direct exposure	• Regional contamination of watercourses, soil, air or groundwater • Disruptions affecting animal and/or plant species at a regional level • Contamination of the aquifer and drinking water supply	• Major damage to property rendering buildings not usable • Operations interrupted for more than a month
High	• Several neighbours possibly impacted • Measurable impacts on lifestyle (traditional use of the land, access to roads and services)	• Permanent disability	• Contamination of watercourses, soil, air or groundwater over an area that extends beyond the site • Disruptions affecting animal and/or plant species over an area that extends beyond the site • Local contamination of the aquifer	• Major damage to property, rendering buildings not usable • Operations interrupted for a month
Moderate	• Some neighbours potentially impacted • Minor impacts on lifestyle (traditional use of the land, access to roads and services)	• Serious injury • Temporary disability	• Minor local contamination of watercourses, soil, air or groundwater over the short term, but which could possibly extend beyond the site • Disruptions affecting animal and/or plant species over an area close to the site, presence of habitats with sensitive elements or presence of animal or plant species with special status	• Substantial damage • Operations interrupted for a week
Low	• Some nearby individuals possibly impacted	• Injuries requiring medical assistance • Injuries resulting in modified work duties • Diminished quality of life • Minor illness	• Major incident with impacts within the site boundaries • Some of the animal and/or plant species present at the site negatively impacted	• Minor damages • Operations interrupted for a day
Very low	• No measurable impact on the community	• Injury requiring first aid • Slightly diminished quality of life (slight discomfort)	• Minor incident • No risk of contamination of sensitive environments (watercourses, wetlands) • No disruptions affecting animal and/or plant species	• No damages • Operations interrupted for 12 hours or less

Notes: In the event of a spill, levels of severity are determined in ascending order (minor, major, significant, very significant). These levels of severity consider the overall extent of a spill as well as the characteristics (toxicity, flammability, etc.) of the product involved.
A contained hazardous material spill is a spill that can be controlled or contained to the site itself through the onsite implementation of mitigation or preventive measures.



Composantes du projet / *Project Component*

- Route / *Road*
- Effluent minier / *Mine effluent*
- Station de pompage / *Pumping station*
- 1 Usine de traitement de l'eau / *Water treatment plant*
- 2 Secteur administratif et industriel / *Administrative and industrial sector*
- 3 Fosse / *Pit*
- 4 Halde à minerai / *ROM pad*
- 5 Halde à stériles / *Waste rock stockpile*
- 6 Halde à matière organique / *Organic matter stockpile*
- 7 Halde à dépôts meubles / *Unconsolidated deposit stockpile*
- 8 Entrepôt à explosifs / *Explosives magazine*
- 9 Cour d'entreposage / *Dry storage area*
- 10 Carrière / *Quarry*
- Digue et berme / *Dike and berm*
- Bassin de rétention d'eau / *Water retention basin*
- Câble de fibre optique / *Optical fiber cable*

Infrastructures / *Infrastructure*

- Route principale / *Main road*
- Route d'accès / *Access road*
- Ligne de transport d'énergie / *Transmission line*
- Lieu d'enfouissement en territoire isolé (LETI) / *Remote landfill*

Hydrographie / *Hydrography*

- *CE3* Numéro de cours d'eau / *Stream number*
- Cours d'eau permanent / *Permanent stream*
- Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*
- Plan d'eau / *Waterbody*

Récepteurs sensibles / *Sensitive Receptor* [1]

- Campement de travailleurs / *Worker's camp*
- Relais routier / *Truck stop*
- Sentier de motoneige / *Snowmobile trail*
- Aire de chasse, de trappage ou de pêche / *Hunting, trapping or fishing area*
- Aire valorisée / *Valued area*
- *Carex sterilis / Carex sterilis*
- Cours d'eau valorisé / *Valued stream*
- Source d'eau potable / *Drinking water source*
- Site archéologique connu / *Known archaeological site*

1 Lorsqu'il s'agit d'une aire ou d'une composante linéaire, le pictogramme représente le point le plus rapproché des infrastructures du projet.

The pictogram denotes the closest point to the project infrastructure in the case of a surface or a linear component.

Mine de lithium Baie-James / James Bay Lithium Mine

Étude d'impact sur l'environnement /

Environmental Impact Assessment

Composantes sensibles du milieu / *Sensitive Environmental Components*

Sources :

Orthoimage : Galaxy, août / august 2017

Données du projet / Project data : Galaxy, 2018

No Ref : 171-02562-00_wspT115_EIE_c9-1_RS_composante_180904.mxd

0 300 600 m

UTM 18, NAD83

Carte / *Map* 9-1

Table 9-3: Risk levels

Levels of severity of the consequences						
	Very high	Moderate	High	Very high	Very high	Very high
	High	Moderate	Moderate	High	Very high	Very high
	Moderate	Low	Moderate	Moderate	High	Very high
	Low	Low	Low	Moderate	Moderate	High
	Very low	Very low	Low	Low	Moderate	Moderate
		Very low	**Low**	**Moderate**	**High**	**Very high**
	Probability of occurrence					

Table 9-4: Acceptability criteria

Risk levels	Definition
Very high	Unacceptable risks that could potentially result in serious damage. Management is alerted to such risks and must ensure that alternative solutions are implemented.
High	Risks calling for preventive control measures and risk reduction plans as well as a reassessment of risks at regular intervals.
Moderate	Risks that have been reasonably reduced but that remain subject to a continuous improvement approach designed to achieve the lowest possible degree of risk while maintaining acceptable economic conditions and based on the knowledge and practices associated with the vulnerability of the facilities’ environment.
Low	Acceptable risks. Control measures must exist and be in effect Regular monitoring is necessary.
Very low	Negligible risks.

9.1.2.1 *HYDROLOGY*

The project site is located inside the Eastmain River drainage basin, which covers an area of approximately 46,000 km² and drains water from several lakes and rivers.

Three watercourses flow near the facilities (CE2, CE3 and CE4). Creek CE2 flows to the west, running north of the concentrator location before joining the Eastmain River (Map 9-1). Creeks CE3 and CE4 flow to the east and also join the Eastmain River. They respectively run between the concentrator location and the ditch connecting Asini Kasachipet Lake and Asiyan Akwakwatipisich Lake and east of the ditch.

9.1.2.2 *BIOLOGICAL ENVIRONMENT*

VEGETATION

The surveys carried out as part of the EIA indicated that most of the groups (wetland and land) had a low potential of occurrence for species designated or likely to be designated as threatened or vulnerable. Only one plant species with a special status was identified during the surveys carried out in the summer of 2017. The species observed was the sterile sedge (*Carex sterilis*), a species likely to be designated as threatened or vulnerable. It is found east of the infrastructure, between the processing facilities and the pit (Map 9-1).

TERRESTRIAL FAUNA

Three species of large mammals are likely to frequent the project zone: caribou, moose and black bear.

Twenty small terrestrial fauna species could also be found in the project zone. Two of these species have a special status: the least weasel, which is on the list of species likely to be designated as threatened or vulnerable in Québec, and the wolverine, a threatened species in Québec and a species considered as endangered in Canada.

Of the small mammal species captured in the study area, only one – the rock vole – is on the list of species likely to be designated as threatened or vulnerable in Québec.

FISH AND FISH HABITAT

Many species have been seen in creeks CE2 and CE3. They are the brook trout and the lake chub in CE2 and the brook trout, white sucker, brook stickleback and lake chub in CE3. No adequate spawning ground was observed in either of these watercourses. As for creek CE4, fish were not found in the section west of the James Bay road.

AVIFAUNA

Among the bird species present in the study area, there are three species at risk in Québec or in Canada: the common nighthawk, the rusty blackbird and the bald eagle. The first one nests in burnt areas and on barren land, which are widely available near the project site. The second frequents swamps, beaver ponds and peatlands, all of which are still well-represented habitats in the project zone. As for the bald eagle, suitable habitats for feeding and nesting are available, although the species was not detected during the 2012 and 2017 surveys.

BATS

The presence of *Myotis* and two other species of bats (the big brown bat and the hoary bat) has been confirmed. However, considering the survey effort (261 station nights), the number of observations recorded for the various chiroptera species was very low.

Moreover, since no natural cavity or mine opening was found in the sector, the possible presence of bat hibernaculum in or around the project site is considered null.

9.1.2.3 *SOCIAL ENVIRONMENT*

INFRASTRUCTURE

The James Bay road, a 620-km stretch of road linking Matagami and Radisson, is a continuation of Route 109. Its original purpose was to provide access to major hydroelectric projects in the 1970s. Many Aboriginal communities, among them Eastmain, Waskaganish, Wemindji and Chisasibi, can be reached by this route, which their population also uses to travel.

Except for a rest area at kilometre 381, there are no other populated areas on the outskirts of the project site. The km 381 truck stop offers travellers accommodations, food and meals, meeting facilities and vehicle repair services (SDBJ, 2017). It includes a convenience store, laundromat, cafeteria, motel, two garages and a gas station.

CURRENT USE OF THE LAND AND RESOURCES FOR TRADITIONAL PURPOSES

Nine Cree communities are found on the Eeyou Istchee territory. One of these, the Eastmain community, is in the project zone. It has 15 traplines. The planned mining infrastructure will be located mostly on trapline RE2, which accounts for 5.8% of the total area of the Eastmain community traplines (15,668 km^2). The project will not affect any other traplines.

NATURAL AND CULTURAL HERITAGE

The km 381 truck stop zone includes a known archaeological site. In addition, 27 zones of prehistoric archaeological potential have been identified in a radius of approximately 1.5 km around the project infrastructure. These sites, illustrated on Map 6-22 in Chapter 6, represent the areas most likely to comprise remains attesting to a human presence from prehistoric times up to the twentieth century.

9.1.3 HISTORY OF ACCIDENTS

The history of accidents points to potential hazards and can be used to create accident scenarios for risk assessment purposes This information can also help improve the design of infrastructure and the associated equipment, determine the necessary safety equipment and better define the risk management plan.

The Analyse, Recherche et Information sur les Accidents (ARIA) database of the French Ministry of Ecology and Sustainable Development's risk and industrial pollution analysis office was consulted online.

This search was not meant to be exhaustive but was carried out to identify potential accident scenarios, establish their causes and possible consequences, and estimate their probability of occurrence. Furthermore, all the identified accidents did not necessarily occur on sites with the same characteristics as the project site (type of mine [pit or underground], material processed, type of process adopted, operating conditions, etc.).

9.1.3.1 *MINING ACCIDENTOLOGY*

Given that mining activity involves many more substances than merely lithium, the ARIA database search was expanded to cover mining operations in general. The search encompassed accidents that occurred since January 2000 during the following activities:

- B.07.10: iron mining;
- B.07-21: uranium and thorium mining;
- B.07.29: mining of other non-ferrous metals;
- B.08.99: other mining activities.

The search results are included in Table 9-5.

Accidents are classified by type of event (dike breaches, landslides or ground collapses, release of contaminated water into the environment, fires, explosions and others).

Since January 2000, 44 mining-related accidents were recorded. These accidents consisted of:

- landslides, ground collapses, slumping (13 accidents, or around 29.5% of all incidents);
- dike breaches or storage basin overflows (7 accidents, or around 16% of all incidents);
- explosions (9 accidents, or around 20.5% of all incidents);
- fires (6 accidents, or around 13.5% of all incidents);
- contaminant spills or leaks (5 accidents, or around 11.5% of all incidents);
- non-classified occurrences (4 accidents, or 9% of all incidents).

9.1.3.2 *ACCIDENTS AT THE AUSTRALIAN SITE*

Since April 2016, no major accidents (e.g. spills, fires or major explosions) have occurred at Galaxy Resources' Australian site.

Between April 2016 and December 2017, 26 spills of more than one litre occurred. These spills involved hydraulic oil (15), diesel (5), used oil (2), gear oil (1), metal (1), process water (1) or slurry (1). The largest volume spilled was 150 litres. No spills reached the boundaries of the site.

9.2 IDENTIFICATION OF HAZARDS

External hazards are events from natural or anthropogenic sources that may affect the proper functioning or integrity of a site.

9.2.1 EXTERNAL HAZARDS OF NATURAL ORIGIN

9.2.1.1 *EARTHQUAKES*

Eastern Canada is in a stable continental region of the North American plate and therefore has relatively low seismic activity. On the NRCan (2017*a*) simplified Québec seismic hazard map, the study area is part of zone 1 (very low risk) on a scale of 5 (very high risk).

Table 9-5: Accidentology related to extractive activity

Date	Country	ARIA no.	Description of incident	Causes (if known)
Dike failure				
05/11/2015	Brazil	47369	At 15:30 a breach developed in an iron ore tailings dam. Emptying of the reservoir was begun, but the structure broke at 16:20. The entire impoundment emptied into the valley downstream, causing the rupture of a second dam. A mudslide (approximately 60 M tonnes) engulfed a village of 620 inhabitants. The operator alerted some residents by telephone, but its list was incomplete. It had no alarm sirens as required by good mining practice. No plan to alert or evacuate the public was in place. The incident led to 19 deaths and an environmental disaster. Weak seismic shocks were recorded in the area on the day of the accident, but no link with the rupture of these embankment dams was established. The dam, at the limit of its capacity, was in the process of having its height raised. Accident scenarios had greatly downplayed the volume of the flow of tailings in the event of a rupture: they were based on the 2008 construction height of 45 m, while the dam was twice as high on the day of the accident.	Poor design and structural failure
04/08/2014	Canada	45566	A dike at a storage pond for mining effluent at a copper and gold mine broke. The contents flooded into Hazeltine Creek and Polley Lake and Quesnel Lake downstream. The pond contained copper, nickel, arsenic, lead, selenium and cadmium. The authorities prohibited consumption and use of the water, as well as swimming. Debris was carried up to 12 km downstream. Residents complained of strong odours. The operator pumped the polluted contents of the lakes into an empty mineshaft. An investigation was launched by the mining authorities. In 2013, the pond concerned had received 326 t of nickel, 177 t of lead and 18,400 t of copper and copper compounds.	-
23/04/2009	France	36208	Two landslides occurred on the sides of a 600,000 t tailings pond at an abandoned gold mine upstream of the Gourg Peyris River, a tributary of the Rieussec River, which empties into the Orbiel River. The containment dike was ripped open over a distance of 25 metres in two places, leaving solid materials high in arsenic, cyanide, lead and other heavy metals exposed to the open air. Since the pond had been fitted with an impermeable bottom (geotextile), the tailings (which had been covered with vegetated soil to prevent it from being carried off by the wind) had become saturated with water during heavy rains. The pond contents became heavier, exceeding the pond's ability to contain them, leading to the landslides. During the last years of the mine's operation, the pond had been raised several metres above its original level. A dike had also been built downhill as protection in the event of landslides and subsequently enlarged following ground movement. Operations at the ore extraction and processing facility were shut down permanently in 2004. Under an agreement signed between the site operator and the French government in July 2010, the government acquired ownership of some of the most highly polluted lands as well as responsibility for decontamination of the site, in return for a substantial contribution from the operator. Remediation of the site was overseen by the ADEME (the agency overseeing the environment and energy) between 1999 and 2008, at a cost of close to €50 million. The 80 years of mining activity at the site had caused long-lasting arsenic pollution (ARIA 4446, 25267) of the soils and the Orbiel River, whose water was not fit for consumption (affecting a total of 20 municipalities). The sale of thyme and leafy vegetables was also prohibited over an area encompassing five municipalities.	Landslide

Table 9-5: Accidentology related to extractive activity (cont)

Date	Country	ARIA no.	Description of incident	Causes (if known)
Dike failure (cont.)				
30/04/2006	China	31750	At a gold mine near Miliang in Shaanxi province, the dike of a tailings pond was breached, releasing water laden with potassium cyanide (KCN) into the Huashui River, which was polluted over more than 5 km. The flooding triggered a landslide that destroyed about 20 houses at the base of the dam, and 17 people were lost. The quantity of KCN spilled is not known. Since the levels of the chemical exceeded national criteria, local authorities asked residents not to drink water from the river, and ordered five towns downstream to test water quality and organize water supply for affected residents. According to mine officials, the search for missing residents did not begin until five days after measures to combat pollution of the watercourse. Calcium hydroxide and bleach were added to the water in an attempt to reduce the concentration of cyanide by converting it to cyanates through oxidation.	-
11/09/2002	Philippines	39967	On August 27, heavy rains caused two tailings ponds to overflow at a copper and silver mine that had been operated between 1980 and 1997. The ponds were 120 m high and had a total capacity of 110 mm^3 of consolidated tailings. An inspection found that spillways had overflowed and suffered erosion, and that effluent had been discharged into Mapanuepe Lake and the St. Thomas River downstream. On September 5, the department of the environment and natural resources (DENR) deemed a sudden failure of the two dams unlikely and estimated that, in the event of a breach, Lake Mapanuepe would be capable of dealing with the overload caused by the release of an estimated maximum 9 mm^3 of water. On September 11 at 13:00, a leak appeared in the damaged spillways, causing a limited volume of sludge to discharge. 250 families from three neighbouring villages were evacuated as a precaution, followed by 750 more on September 12 because of the constant rain. The operator brought in heavy pumping equipment from another mining company to pump water out of the pond and began repair work. Heavy rains in July and August had caused the volume of impounded water to increase beyond the spillway evacuation capacity. The mine had been abandoned in 1997, three years ahead of the initially planned date, because of the unstable slopes and annual flooding.	Impoundment overflow Heavy rainfall

Table 9-5: Accidentology related to extractive activity (cont)

Date	Country	ARIA no.	Description of incident	Causes (if known)
Dike failure (cont.)				
08/09/2000	Sweden	21970	A tailings dam at a copper mine failed over a length of 120 m, releasing 2.3 mm^3 of sludge into a 15 mm^3 settling pond lying immediately downstream. The settling pond level rose by 1.2 m, and to preserve its stability the operator opened it and released 1.5 mm^3 of slurry into the Leipojoki and Sakijoki rivers, whose bed was covered with a whitish deposit over 8 km. An estimated 23 kg of copper was released in the effluent. On December 4, a second release of 1.5 mm^3 of liquid – containing 9 kg of copper – from the settling pond was made to lower the level of the pond by 1 m and prevent it from breaking. Repair work, which began immediately after the failure, lasted three months. Because of the resultant pollution, a judicial investigation against the operator was initiated by the public prosecutor of Lulea on September 12, 2000. On October 8, 2001, the investigating commission reported that the main cause of the accident was caused mainly by shortcomings during the construction and operation of the dam and, to a lesser degree, heavy rainfall (which did not, however, exceed the values that had been taken into account in calculating the structure's dimensions). The procedure for monitoring the pond, which was in line with standards at the time of its construction (which began in 1968), proved insufficient and failed to detect the high water level and pore pressure in the body of the dam, despite leaks and local instabilities observed on the side of the structure. The commission brought to light violations of construction permits by the operator during the building of the dam. It recommended instrumentation and tighter monitoring of mining and hydraulic structures that could cause substantial damage to property and persons at the site concerned and the rest of the country.	Poor design and heavy rainfall
30/01/2000	Romania	17265	At a plant opened in May 1999 to reprocess gold-bearing tailings, a waste settling pond ruptured after a 25 m-long crack developed. 287,500 m^3 of effluent containing cyanide (400 mg/L, or 115 t in total) and heavy metals (Cu, Zn) contaminated 14 ha of land and polluted the Sasar River. A "wave of cyanide" 40 km long flowed over the Lapus, Szamos, Tisza and Danube rivers. Cyanide levels reached 50 mg/l in the Lapus, 2 mg/l in the Yugoslav portion of the Tisza (February 12) and 0.05 mg/l in the Danube delta, 2,000 km downstream of Baia Mare (February 18). Romania, Hungary, Yugoslavia, Bulgaria and Ukraine were impacted.	Design flaw, unfavourable weather conditions
Collapse/Landslide				
01/03/2012	France	44758	A geologist was examining an outcrop uncovered during digging of an unshored trench at a gold mine. For some unknown reason, a landslide occurred and the geologist was buried at the bottom of the trench.	Landslide
08/05/2011	Turkey	42972	Internal embankments collapsed in two places at a reservoir of cyanide-containing water at a silver ore processing plant. No leak was detected on the external banks. Activity at the plant was halted and 250 residents were evacuated. The external embankment was reinforced. A group of experts determined that there was no risk of total rupture. A new reservoir was built to hold the effluent. Production resumed after 20 days of stoppage. Operating losses were estimated at $30 million (€21 million).	Embankment collapse

Table 9-5: Accidentology related to extractive activity (cont)

Date	Country	ARIA no.	Description of incident	Causes (if known)
Collapse/Landslide				
27/06/2010	Ghana	38555	A gold mine collapsed following heavy rainfall at Dunkwa-on-Offin. The mine, which had been abandoned by its owners, was being operated clandestinely. According to press reports, 136 miners were present at the time of the accident: 15 were found alive, 32 were found dead, and 89 were reported missing. Rescuers installed pumps to clear the mine entrance, but operations were hindered by bad weather. The three owners of the mine were taken into custody.	Collapse Heavy rainfall
21/07/2009	South Africa	36939	At midday, the ground collapsed at a platinum mine operated at a depth of over 1,000 m. Nine miners were killed.	Collapse
05/06/2009	China	36583	At around 15:00, a landslide occurred in a mining region: several million cubic metres came away from a mountainside, burying dwellings and the mining zone located in the valley over a length of 600 m and a width of 300 m and damming the Wujiang. At least a dozen dwellings were buried under 40 m of materials, and several areas of the city suffered cuts in electricity and communications. In the eight days following the disaster, major equipment was deployed for rescue operations and to re-establish the course of the river. Many shafts were drilled in an unsuccessful attempt to reach a tunnel in the mine located at a depth of between 150 m and 200 m in which the authorities estimated that miners could have survived for 5 to 7 days with air and water. On June 12, the authorities reported 42 deaths and 63 missing persons, including the 27 miners.	Landslide
23/04/2009	France	36208	This incident is described in the previous section (dike breaches).	Landslide
12/11/2008	Guinea	35532	A collapse occurred at an open-pit gold mine. At least 14 clandestine workers were killed and, according to witnesses, many others were injured. These gold washers were working illegally without safety measures in shafts abandoned by the mine operator. No official report was provided by local authorities, but this did not rule out a large number of victims given the number of clandestine workers on the site.	Collapse
06/05/2008	Indonesia	34567	A landslide occurred in the evening at a gold and copper mine; 12 miners were killed and at least 15 others were reported missing.	Landslide
13/10/2007	Colombia	33747	A rockslide occurred at an open-pit gold mine near Suarez in the southwest part of the country, killing 21 miners and injuring 24 others.	Rockslide
23/07/2002	Zimbabwe	22840	Following a collapse at a gold mine that had been abandoned since 1940, between 15 and 20 clandestine miners were reported missing. Rescue operations were hindered by the instability of the land in the area.	Collapse
08/01/2002	Congo	21708	A mine collapsed at a peak time, burying dozens of diggers and merchants who had come to supply them. A total of 39 persons were killed or reported missing.	-
24/11/2001	Colombia	21710	The collapse of an abandoned gold mine resulted in numerous victims being buried under tons of mud: 47 bodies were recovered, but the number of victims was considered tentative according to local emergency services. A further 32 people were injured.	Collapse
09/04/2001	Zambia	20673	Ground movement occurred at a copper mine. A slope collapsed, burying 10 miners.	Landslide

Table 9-5: Accidentology related to extractive activity (cont)

Date	Country	ARIA no.	Description of incident	Causes (if known)
Release of contaminated water into the environment				
06/08/2015	United States	46802	The Environmental Protection Agency was conducting a technical study to assess water release from an old gold mine, methods of treating this water, and possibilities for site remediation. While agents were excavating above the old mine entrance, pressurized water began leaking and flowed into the nearby watercourse. Approximately 11,500 m³ of orange-coloured water laden with lead, copper, arsenic, iron and zinc polluted downstream watercourses over 160 km. The authorities prohibited navigation, swimming, watering of farm animals and the consumption of water from specific collection points. Lead and arsenic levels were respectively 12,000 and 26 times higher than acceptable levels.	-
06/08/2014	Mexico	45640	Approximately 40,000 m³ of sulphuric acid and heavy metals spilled from a copper mine effluent storage pond. The coloured water polluted two rivers over 150 km, and 20,000 people were deprived of drinking water for many days. The operator poured 100 t of calcium hydroxide into the watercourses to neutralize the effluent. Other leaks were observed during the month of September. Measuring campaigns were conducted in the adjacent border country. The mining company spent €120 million on clean-up operations. The authorities imposed a €2.5 million fine on the operator. The Mexican federal environmental agency launched an investigation into the accident. The mine operator considered that the spill was due to heavy rainfall causing the pump to overflow. Government authorities challenged this explanation.	Storage pond leak Heavy rainfall
04/06/2014	France	45987	Sulphuric acid (H_2SO_4) leaked through a flange at an abandoned uranium mine. 20 m³ of the chemical were contained in the storage pond and then pumped out by a specialist company. The pond had to be repaired. The flange concerned had been corroded by the acid. Contrary to what the operator believed, it was not made of stainless steel. The operator replaced the PE tank with another made of HDPE. The authorities responsible for inspecting classified facilities were notified.	Poor design
05/05/2014	France	45256	During a transfer operation at around 23:00, almost 100 m³ of effluent of pH 1.1 laden with hydrochloric acid and metals leaked at a metallurgical plant. The spill reached a river, causing its total acidification to dip below a pH of 3 and killing over 1,000 fish. The leak was not discovered until 13:30 the next day and was stopped at 14:00. Fishing and swimming were prohibited. The classified facilities inspection authorities and elected officials visited the site. The plant was shut down temporarily. Local residents expressed their displeasure following this new spill, similar pollution having occurred in 2009. A rain advisory necessitated the use of an isolated transfer circuit that had undergone repair work and had not been sufficiently checked before being brought back into service. The system was partially open following removal of a valve and the leak was not discovered during the operator’s routine inspection round at shift changeover.	Procedure/organization
08/03/2005	France	29390	Lead pollution was detected at a small village close to an abandoned lead and zinc mine that had been closed since 1991. According to press reports, samples revealed levels of metals 5 to 13 times higher than European standards. While awaiting additional analysis, a municipal decree banned the consumption of fruits and vegetables in the community, as well as the use of water from private springs for food-related purposes. The mayor ordered that cellar entrances be sealed off and recommended that floors be washed rather than swept while dry. As a precautionary measure, children under 10 were screened for lead poisoning.	Contaminant leak

Table 9-5: Accidentology related to extractive activity (cont)

Date	Country	ARIA no.	Description of incident	Causes (if known)
Fire				
08/05/2012	France	42146	At an acid production unit at a nickel extraction plant, water in some pipes cause them to corrode, leading to a leak of sulphuric acid (H_2SO_4). The metal was attacked by the acid, causing hydrogen (H_2) to form. The plant was evacuated. Between 50 and 100 t of acid were collected from the plant's "first flush" ponds before being directed to the waste processing unit. The acid that could not be recovered was neutralized with calcium hydroxide and limestone, and then pumped out. No environmental impact was recorded. The classified facilities inspection authorities visited the premises.	Poor condition of pipes (corrosion)
06/08/2010	China	38775	At 17:00, fire broke out at the bottom of a gold mine in which 329 miners were working: 279 managed to get out on their own. Emergency services evacuated the remaining miners, with the exception of seven who were reported missing. The human cost was nonetheless heavy: 16 deaths by asphyxiation in the mineshaft or in hospital, and several dozen injured. An electrical cable may have been the cause of the fire, which was not brought under control until 8:30 the following morning. According to press reports, the manager of the mine, which was operated legally, was arrested.	Electrical defect
01/06/2009	South Africa	36550	82 miners working illegally died by asphyxiation when a fire broke out at an abandoned gold mine. 294 other illegal workers living and working at the disused mine at 1,400 m below ground were arrested during operations to recover the bodies of the victims. South African miners' unions demanded a government inquiry to look into the question of whether the site had been secured by the last official operator. According to the unions, working conditions at mines in general do not comply with all legal safety requirements.	
27/09/2008	France	35578	At around 22:00, fire broke out at a disused 1,000 m² building that had been in the process of being demolished for the past two months. The building had housed the heating plant of a former potash mine. The fire, which spread through the wooden floors and electrical shafts, gave off thick smoke. After cutting off the power supply, firefighters brought in 26 men and heavy equipment, including two high-capacity tankers to address a shortage of water on the site. Aside from this water shortage, the dilapidated condition of the premises and the instability of the floors complicated the work of the emergency responders, who could not get inside the building even with the use of independent breathing apparatus. The fire was brought under control within 30 minutes, and the emergency response ended at around 02:00. The chosen hypothesis was that thieves had broken in to steal metal and set fire to rubber-sheathed cables in order to recover copper. The site had been placed under video surveillance and was equipped with an alarm system that failed to work.	Malice (fire for the purpose of theft)
26/11/2004	China	28654	Fire broke out at five iron mines: the number of casualties was estimated at 68. The fire started at a private mine and then spread to four other mines, all connected, trapping about 100 miners. Accidents are frequent in China and kill over 7,000 miners annually, according to official figures. Initial investigations suggested that an electrical cable was the cause of the fire.	Electrical defect
20/09/2000	Ukraine	18771	Two accidents occurred successively in the same region: the first fire broke out apparently because of noncompliance with safety rules. It caused the death of a miner, who was asphyxiated by gases. The second fire led to the evacuation of 24 miners. It was quickly contained and there were no victims.	Human error

Table 9-5: Accidentology related to extractive activity (cont)

Date	Country	ARIA no.	Description of incident	Causes (if known)
Explosion				
01/10/2013	Germany	44844	A controlled explosion was set off 700 m deep at a potash mine at 13:10. The release of carbon dioxide killed three employees; four others were rescued. The dust rose to the surface and settled in the surrounding area. Activity at the site was halted. The operator ventilated the entrances and repaired the technical facilities.	-
20/06/2009	China	36397	At around 03:20, a violent explosion rocked a plant producing quartz sand (300,000 t/year) and processing quartz crystals located in the Fengyang district of eastern China. 16 employees were killed and 44 people, most of them local residents, were injured. The plant was destroyed, leaving behind a crater. According to a Chinese official agency, the manager, who was arrested, had illegally stockpiled 7 t of explosives in the offices.	Illegal storage of explosives
12/12/2008	Russia	35883	An explosion occurred at an apatite mine (apatite is a calcium phosphate mineral used in fertilizer production). 12 workers were killed and 6 others were injured. 55 t of explosives made up of a mixture of ammonium nitrate, aluminum powder and used oils, placed at several points in the mine for use in blasting, were reportedly set on fire accidentally during excavation work. A judicial inquiry was opened to look into the alleged violation of safety rules during mining work.	Human error, failure to comply with health and safety rules
26/11/2007	Ecuador	34188	A dynamite store at a gold mine exploded; 7 miners were killed, 40 injured, and 30 reported missing. Rescuers suggested a short-circuit in the mine's electrical network as a possible cause.	Dynamite store Electrical short circuit
20/04/2005	Zambia	29698	An explosion occurred at an explosives factory located on the site of a copper mine. Initial reports stated that more than 50 people were killed. Preliminary findings suggested that those in charge had not observed basic safety rules. The authorities requested that an investigation be opened.	Human error, failure to comply with safety rules
15/12/2003	Poland	26061	43 miners were injured, two of them seriously, in an explosion at a copper mine at a depth of 670 m. The apparent cause of the accident was the transportation of dynamite. Fire spread to a vehicle carrying 2 t of dynamite (domino effect). Temperatures were thought to have reached 1,000 °C.	Transportation of explosives
08/05/2001	South Africa	20682	An explosion at a gold mine at a depth of 800 m killed at least 12 miners. A search for missing workers was launched, but the work of rescuers was complicated by the absence of a list of personnel present at the bottom of the mine at the time of the accident. An investigation was launched to determine the causes of the explosion.	-
15/03/2001	Russia	18804	Two miners were killed and two others injured when 21 t of explosives stored in a mine at a depth of 200 m exploded accidentally. An investigation was launched to determine who was responsible for the accident.	-
15/05/2000	South Africa	19205	An explosion at a gold mine killed 7 workers.	-

Table 9-5: Accidentology related to extractive activity (cont)

Date	Country	ARIA no.	Description of incident	Causes (if known)
Other				
18/11/2014	Russia	46033	A flood caused a 40 m diameter crater to form at a potash mine. Employees were evacuated and operations stopped. This mine extracts 10% of global production, approximately 3 Mt per year.	-
15/03/2012	Finland	43054	An employee taking samples close to an ore-processing plant at a nickel, zinc, cobalt and copper mine died after being asphyxiated by hydrogen sulphide (H_2S). The victim was not wearing a gas detector or respiratory protection. Atmospheric measurements in the area indicated 50 to 300 ppm of H_2S. An investigation was carried out by the police and the government body responsible for investigating industrial accidents. The plant was shut down. The H_2S, used to purify the solution produced by bacterial leaching of ore stockpiles, had leaked outside the plant after a sample that had been taken was left open on a pre-neutralization tank. In the tank, lime sludge had reacted with the effluent already present and formed carbon dioxide (CO_2) which pushed out the H_2S that was already present. No gas detector was installed outside the buildings, despite the fact that in the two weeks preceding the accident high levels of H_2S had been detected in the area of the accident. The area was marked out, but not all personnel likely to be in the area had been warned of the danger. In addition, the absence of preventive maintenance meant that H_2S measuring systems were not functioning properly. It also transpired that the ore purification process was new and that the operator, seeking to obtain an extremely pure finished product, had used excessive quantities of H_2S.	Human error and the absence of protective measures
08/10/2009	China	37188	At around 9:15, an accident occurred at a tin mine involving two elevators carrying workers. A cage crashed to the bottom of the shaft, killing 26 of the 31 miners present and injuring the remaining five. A malfunction of the braking system reportedly caused the two elevator cages to collide and then one of them to fall. The vice-governor visited the site and the government ordered an immediate check of workplace safety throughout the province.	Technical failure
03/02/2002	China	21858	Six miners died of carbon monoxide poisoning at a gold mine and 30 others were hospitalized. Some workers lost consciousness after they had come to rescue other workers located at a depth of 270 m.	

A magnitude 3 earthquake is strong enough to be felt in the surrounding area, while a magnitude 5 earthquake generally marks the threshold at which an event is likely to cause damage.

In the study area, the National Building Code (2015) established the probability of a seismic event at 0.000404 per year. This means that, for a 50-year recurrence interval, there is a 2% chance that an earthquake will cause greater than expected ground motion (NRCan, 2017*b*).

Natural Resource Canada (NRCan) has listed all earthquakes in Canada between 1663 and 2012 (NRCan 2017c). Earthquakes with a magnitude greater than 5 and where the epicentre was closest to the study site occurred approximately 630 km from the site, one to the southeast and the other to the southwest. They were 5.9 (1988 – Saguenay) and 6.1 (1935 – Québec border – Ontario – Temiskaming region) magnitude earthquakes respectively.

It should be noted that all the project's structural facilities will meet the earthquake resistance standards of the Québec Construction Code and the National Building Code of Canada. Therefore, the risk of an earthquake with major consequences in the study site is considered low.

9.2.1.2 *FLOODING*

Flooding typically occurs upstream of a crest (rise in water levels or narrowing of banks) that impedes water drainage. The formation of ice jams can also contribute to flooding by obstructing water drainage, particularly at the points where watercourses narrow during the spring freshet.

There are no significant watercourses near the project site that could produce a major flood. In the event of heavy precipitation, local accumulations could occur. The water would then be drained by the drainage system in place.

9.2.1.3 *TERRAIN INSTABILITY*

Terrain instability can generally be attributed to relief and the nature of the soils (Landry, 2013). Sloping may lead to a landslide when the materials in place do not provide sufficient shear strength. This phenomenon depends on both the steepness of the slope and the composition of the soil. Some other soil instability phenomena, such as coulees, are related to soil types, made of plastic or heterogeneous materials. Moreover, areas filled with heterogeneous materials may be prone to soil instability as a result of settlement or subsidence.

Given the small difference in elevation in the study area, there are no problems with regard to the stability of surface deposits.

9.2.1.4 *EXCEPTIONAL WEATHER CONDITIONS*

Exceptional weather conditions in the form of heavy rainfall, hail or high winds may occur during the summer. In winter, such conditions may include heavy snowfall, high winds and ice storms. These phenomena are caused by particular conditions associated with temperature and humidity gradients between different air masses.

The consequences of these exceptional weather conditions may be direct or indirect. In fact, wind, precipitation, snow and ice may result in overloads and directly jeopardize the integrity of buildings or equipment.

Building and equipment designs will be in accordance with the current codes and regulations to withstand the overloads created by extreme weather conditions. In addition, excessive snow and ice loads will be removed, as needed. Extreme weather conditions, however, remain a plausible accident scenario that should be considered.

9.2.1.5 *FOREST FIRES*

The MFFP is the entity that deals with forest fire management in Québec. The ministry is supported by the Société de protection des forêts contre le feu (SOPFEU) on fire prevention, detection and firefighting. It should nonetheless be noted that, at this latitude, forest fire control is partial (northern protection zone). The fight against forest fires in this area is carried out through agreements only or in support of emergency preparedness. Therefore, responses take place mainly near infrastructures such as villages and energy production and processing facilities.

The project area is considered to be a region in which forest fires are the most active and in which some of the largest fires were recorded. From 1840 to 2013, a fire occurred on average every 3.5 years somewhere along the James Bay road over a distance of 340 km. Burnt areas cover 2.4% of the land area each year over the past century, and fires spanning over 90 km have occurred every 20-30 years (Erni and coll., 2016).

The MFFP keeps annual records of forest fires in Québec. These records were consulted and show the following:

- In 2005, forest fires reached within one kilometre of the project site from the northeast and the south. These fires affected 23,208 ha and 39,267 ha respectively. The km 381 truck stop had been impacted.
- In 2009, many forest fires were observed to the west and southwest of the project site and one reached within approximately one kilometre to the southwest.
- In 2013, a forest fire burned an area of 501,689 ha, forming a tongue facing southwest/northeast and reaching the km 381 truck stop. The fire passed within one kilometre from the project site.

Map 6-13 shows the areas impacted by these fires in the project area.

In addition, many studies indicate that increasing GHG concentrations in the atmosphere should increase the conditions conducive to forest fires, increasing both the number of fires and their severity (Girardin and Terrier, 2015). Therefore, the risk of a forest fire in the project area is considered very high.

9.2.2 ANTHROPOGENIC EXTERNAL HAZARDS

9.2.2.1 AIR TRANSPORT

No active airport is located near the site. The airfields closest to the project site are the airports located at the Eastmain River (97 km), Nemiscau (88 km) and the Eleonore Mine, which are located to the northeast of the Opinaca Reservoir (85 km).

The risk of a plane crash is higher in the landing and departure zones. For large aircraft, this area extends over approximately 8.5 km from the end of the runways and is approximately 5 km wide. For small aircraft, this area corresponds to a circle of approximately 4 km around the centre of the runway (De Grandmont, 1994). The project site is located outside any aerodrome landing or departure zones.

In addition to these areas covering the immediate periphery of an airport, the risk of an accident is also higher in corridors used for air traffic. With the exception of these areas, the probability of a plane crash at a specific location is considered very low.

9.2.2.2 POWER TRANSMISSION LINES

Two transmission lines are present near the site. From north to south, the 4003-4004 circuit (450 kV) runs along the James Bay road and cuts it in two. The 614 circuit (69 kV) crosses the territory from east to west, approximately 7 km to the south.

9.2.2.3 REMOTE LANDFILL

A remote landfill is located to the south of the planned pit. It is connected to the activities at the km 381 truck stop. The site has been used for waste management since December 5, 1983. Before this use, a quarry was located at the same place. MRNF (now MERN) issued a lease in 2012 to the SDBJ. This site will be fenced.

9.2.3 HAZARDS RELATED TO THE ACTIVITIES ON SITE

The main hazards identified on the site are related to the following activities:

- Operation of an extraction pit.
- Operation of a spodumene mill.
- Using radioactive sources.
- Operation of a water treatment plant.
- Storage and use of petroleum products.
- Storage and use of propane.
- Storage and use of chemical products.
- Storage and use of explosives.

— Mechanical maintenance activities.
— Use of oil-filled electrical transformers.
— Storage areas, overburden, topsoil and waste rock.
— Presence of a containment dike.
— Transporting of hazardous materials and concentrates.

9.3 ACCIDENTS AND MALFUNCTIONS

The following sections detail the hazards that have been identified and the assessment of their severity and probability. Table 9-10 presents a risk analysis summary for the project.

9.3.1 OPEN-PIT MINING

This section covers the risks associated with the extraction pit. Two accident scenarios have been identified:

— Pit flooding.
— Falling rocks along the walls of the pit.

9.3.1.1 *PIT FLOODING*

Water ingress is an inherent hazard in mining operations. With respect to the pit, surface water or groundwater may enter the pit as a result of rock damage caused by blasting or damage to t rock structure showing excessive cracking, leading to a flow of water towards the pit or major flooding. Excess water ingress into the pit will then have to be pumped, requiring operations at the pit to be interrupted.

Prevention and control measures

The following prevention and mitigation measures will be put in place to reduce the risk of pit flooding:

— Completion of geological and geotechnical studies to characterize the site.
— Monitoring of effects of blasting (in pit) for the formation of excessive cracking
— Installation of pumps to bring back the water to the surface
— Diversion of rainwater from areas not affected by mining operations to the extent possible to prevent them from reaching the mine pit.
— Design and operation of the pit in accordance with the criteria of the Canadian Dam Association and the *Dam Safety Act* (R.S.Q. chapter S-3.1.01).
— The designer’s operating work guide will be followed.
— An inspection program based on the designer’s specifications will be implemented.

Probability of occurrence

Pit flooding by water ingress could occur, as this type of incident occurred at similar sites. The probability of occurrence is deemed **low**.

Severity

The consequences of such a flood could potentially entail injuries, including permanent disability and the cessation of pit operations for up to one month. The severity level is deemed **high**.

Estimated risk level

The inclusion of components and severity brings the level of risk of pit flooding by water ingress to **moderate**. The risk level is based on risks for workers and property.

9.3.1.2 *FALLING ROCKS AND LANDSLIDES ALONG PIT WALLS*

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of falling rocks and landslides along pit walls:

— Completion of geological and hydrogeological studies to characterize the site.
— Design of pit slopes in accordance with the *Regulation respecting occupational health and safety in mines* (R.S.Q. chapter S-2.1 r.14).
— Monitoring of potential of landslides or rocks in the pit.
— Sizing of horizontal and vertical bearings so as to ensure the stability of the extraction pit's slope.

PROBABILITY OF OCCURRENCE

Falling rocks or unconsolidated deposits along the walls of the pit may occur. The accident history has shown that this type of accident has already occurred a number of times at similar sites. Given the preventive measures taken, the probability of occurrence is deemed **low**.

SEVERITY

This type of accident may cause injuries that can lead to permanent disability and significant economic losses. The severity level is deemed **high**.

ESTIMATED RISK LEVEL

Inclusion of the probability and severity components brings the level of risk of falling rocks or landslides along the walls of the pit to **moderate**. The risk level is based on risks for workers and property.

9.3.2 PROCESSING

This section covers the risks associated with material processing.

The material processing approach planned for the site will entail a spodumene concentration process. The selected process involves crushing of the material followed by dense-media separation (DMS).

Three accident scenarios have been identified:

— Fire.
— Exposure to ionizing radiation.
— Dust emissions.

9.3.2.1 *FIRE*

A fire could occur at the processing facilities. The causes could be:

— Welding on equipment with an interior rubber lining.
— Conveyor belt friction.
— Short-circuit or overheating of an electric motor.
— Use of defective heating equipment or supplementary heating systems.
— Negligence during hot work.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of fire:

— Maintenance of conveyors to prevent belt slippage and friction.
— Thermally controlled sprinklers on conveyors and water flow alarm system connected to the fire station.
— Monitoring of welding on equipment with interior rubber lining.
— Design based on National Fire Protection Association (NFPA) standards.

- Fire extinguishers at each drive unit for conveyors as well as in all areas with a risk of fire.
- Hydraulic firefighting system and fire hydrants.
- Sprinkler systems in offices and shops.
- Creation of a fire brigade.
- Continually updated emergency response plan that includes a fire response procedure.

PROBABILITY OF OCCURRENCE

A fire could occur at the future facilities, as this type of incident has already occurred at similar sites. However, it is not likely given the preventive measures in place. The probability of occurrence is deemed **low**.

SEVERITY

Generally speaking, when a fire takes place at a building, the consequences primarily concern the health effects associated with thermal radiation and toxic fumes. The severity level of a fire may vary, but it can lead to severe injuries or permanent disability.

It can also cause economic losses (cessation of operations, substantial damage to expensive equipment, etc.).

In the event of an incident that spreads beyond the buildings and infrastructure, the natural environment could be impacted. The main impacts anticipated would be dead vegetation, disruption of forest growth as well as short- or long-term habitat loss or loss of plant species conducive to the presence of a number of wildlife species. Wildfires affect the ecological role of forests in all respects: species, stand and landscape. Water quality at affected watercourses may also be impacted by spills of particulate matter and other contaminants into the water.

The severity level is deemed **high**.

ESTIMATED RISK LEVEL

Inclusion of the probability and severity components brings the level of risk for a fire to **moderate**. The risk level is based on risks for workers, the environment and property.

9.3.2.2 *EXPOSURE TO IONIZING RADIATION*

Nuclear gauges will be used to measure pulp density at the treatment plant (concentrator). Between 10 and 15 gauges of different sizes are expected to be used. They will all use gamma rays. This equipment is governed by regulations administered by the Canadian Nuclear Safety Commission.

An incident resulting in exposure to ionizing radiation could occur in the event of a fall or collision involving a nuclear gauge or during a fire.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of exposure to ionizing radiation:

- Periodic leak tests on nuclear gauges.
- Securing of gauges by double fastening to a fixed and supporting structure.
- Installation of gauge protection for shocks.
- Identification of nuclear gauges using notices in compliance with regulations.
- Application of radiation safety manual requirements.
- Preventive maintenance of gauges to prevent breakage and premature wear.
- Training for the fire brigade and certification for firefighters as first responders in the event a nuclear gauge breaks.
- Continually updated emergency response plan comprising a procedure for an incident involving a nuclear gauge.

PROBABILITY OF OCCURRENCE

Accidental exposure to ionizing radiation may occur in exceptional circumstances. This is a very unlikely event. As a result, the probability of occurrence is deemed **very low**.

SEVERITY

Exposure to ionizing radiation could cause injury to exposed workers, up to and including permanent disability. The severity level is therefore deemed **high**.

ESTIMATED RISK LEVEL

Inclusion of the probability and severity components brings the level of ionizing radiation exposure risk to **moderate**. The risk level is based on risks for workers.

9.3.2.3 *DUST EMISSIONS*

Dust will be released during crushing and conveyance operations.

The processing plant will be equipped with dust extractors, where required, to control dust emissions into the air. However, a breakdown or improper handling could lead to the accidental emission of dust into the air.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of exposure to dust:

- Preventive dust extractor maintenance;
- Monitoring of pressure inside filters;
- Channelled dust extraction system;
- Water spray in tailing handling areas and on roads;
- Inspection program.

PROBABILITY OF OCCURRENCE

Dust emission and exposure could occur during the facility's operation. This is therefore a probable incident. As a result, the probability of occurrence is considered **moderate**.

SEVERITY

Such emission is likely to affect the health of nearby workers. Spodumene is the most likely product to be emitted, but is not highly toxic.

Dust emitted in manoeuvring and handling areas may reduce visibility. Environmental impacts will be limited to the property. Vegetation around manoeuvring and handling areas could be affected locally. The severity level is therefore considered **low**.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establishes the level of dust exposure risk at **moderate**. The risk level is based on risks to workers and the environment.

9.3.3 MINE WATER TREATMENT PLANT

A mine WTP will be built near the containment dike, in the northern part of the site. It will be designed to treat water from the collection pond collecting the site's drainage water, mainly the waste rock stockpile and the potential input from the water collection pond of overburden stockpiles, when their quality does not meet regulatory criteria.

A water treatment system malfunction could cause the accidental discharge of harmful substances into the final effluent. A discharge of untreated or partially treated mine water could contaminate stream CE2 waters and violate the MDMER and D019. This non-compliant discharge could be due to a design or operation flaw, human error or mechanical failure.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of non-compliant discharge into the final effluent:

- Verification of treatment effectiveness through periodic analyses;
- Ongoing pH and turbidity monitoring: site automation network instrumentation, available in the plant control room.

PROBABILITY OF OCCURRENCE

A non-compliant discharge into the final effluent could potentially occur, as this has already happened at similar sites. The probability of occurrence is therefore considered to be **low**.

SEVERITY

Spills of substances harmful to the environment could impact animal and/or plant species over an area that extends beyond the site.

Potential impact on wetlands

The discharge of raw (untreated) effluent will have a potential impact on the quality of CE2 stream waters.

Potential impact on benthic fauna

The potential effects on the benthic community would be contamination potentially leading to mortality, decreased benthic abundance and diversity, as well as lower recruitment (eggs and larvae), food consumption and growth rates.

Potential impact on fish fauna and its habitat

Fish may ingest very toxic substances and transmit them to the predators that eat them. A hazardous material spill in an aquatic environment may seriously hinder the next generation of fish.

Generally speaking, fish populations can be affected by a spill at different times of the year if their habitat or their prey is affected in terms of reproduction, rearing, feeding, migration and wintering.

Fish capable of moving within their habitat and potentially relocating to an environment less exposed to contaminants in the event of a spill are less likely to feel the effects of such an event, except during the reproduction and egg incubation period.

The severity level is therefore considered **high**.

RISK LEVEL

The inclusion of the probability and severity components establishes the level of risk of non-compliant discharge into the final effluent at **moderate**. The risk level is based on risks to the environment.

9.3.4 STORAGE AND USE OF PETROLEUM PRODUCTS

During the construction phase, diesel will be supplied by truck. There are no plans to install a diesel tank.

Three diesel tanks will then be used, each with a 80,000 L capacity. Installation of these tanks is expected to happen in the southeastern part of the industrial sector. These tanks will be above ground. Annual diesel consumption is expected to be 14 million of litre.

Fuel will be delivered by tanker trucks. Table 9-6 shows the diesel characteristics.

Produced during the distillation of oil, diesel is composed of various hydrocarbons in series C_{10} and higher. It is a clear, yellow liquid. It is not very volatile at ambient temperature, but may emit vapours that form an explosive mix with the air when heated. Diesel is less dense than water (density of 0.85) and is water-insoluble.

Table 9-6: Diesel characteristics

Product	State	Flash point (°C)	Self-ignition temperature (°C)	Flammable limits		Reactivity	Classification
				LFL	UFL		
Diesel	Liquid	>40	>225	0.7	6	Strong oxidizers and strong acids	

The danger of flammability associated with flammable products is related to:

- the product's emission into the air in proportions found within the flammability range;
- the presence of an ignition source.

Diesel is not currently listed in the Environmental Impact Regulation (EER) as a substance with potential to cause a major technological accident. However, it is listed in an amended version of this regulation. The stated threshold quantity is 2,500 metric tonnes. The quantity expected to be stored is therefore lower than this threshold.

Hydraulic and lubricating oils as well as greases will also be used. These oils are hydrocarbons and come from a fairly heavy petroleum fraction. This means they are viscous and have high flash points.

This section covers the potential risks associated with the transportation, storage and use of petroleum products. Three accident scenarios have been identified:

- Spill of petroleum products
- Fire and/or explosion of petroleum products
- Spill of oils and greases

9.3.4.1 *SPILL OF PETROLEUM PRODUCTS*

Factors likely to cause an accidental spill of petroleum products include mainly:

- an accident during transport of a petroleum product by truck on the site;
- a collision causing a fuel tank failure (vehicle, machinery or other);
- a leak from a valve, pipe or connection;
- a machinery breakdown;
- corrosion of equipment;
- overflow of a tank or another container during filling;
- human error.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of petroleum products spills.

During the construction phase

- Ensure that a sufficient number of emergency kits for the recovery of petroleum products and chemicals is available in sensitive locations.
- Through frequent inspections, ensure that machinery is in good working order (clean with no contaminant leaks) and that fuel and lubricant tanks are perfectly sealed. Any discovered leaks require immediate repairs to the tank in question.
- The usual precautions should be taken during maintenance (draining, greasing, etc.) and refuelling of machinery on site to avoid any accidental spills. Maintenance is to be permitted only in authorized locations intended for that purpose (garage, mechanical workshop); refuelling is to take place in specifically designated areas.
- Equip all fixed equipment containing oils and/or fuel (lighting tower, generator, crusher, sifter, etc.) located less than 60 m from a watercourse or body of water with a leakproof recovery system. Equipment must be equipped with absorbents for quick and effective response in the event of an accidental spill.

- Any vehicle and machinery maintenance is prohibited outside the designated areas.
- Mark out access, paths and work areas before undertaking work, and prohibit parking and movement of machinery and vehicles outside those areas.
- Machinery fuel will be supplied by ground transportation. All suppliers must comply with the *Transportation of Dangerous Goods Act* and the *Regulation respecting hazardous materials*. They will be required to develop safety and emergency procedures.
- The contractor will be required to hold a permit for the use of high-risk petroleum equipment if installing or using an aboveground tank with a capacity of 10,000 L or more of diesel fuel or a tank with a capacity of 2,500 L or more of gas. This permit comes with inspection and servicing obligations.

During the operation phase

- Transfer, equipment and tank areas will be designed in compliance with regulations, standards, applicable codes and industrial best practices.
- Tanks will be installed on a concrete slab.
- The tanks will be double-walled with a secondary containment system that can hold 110% of the stored volume.
- A level detection system will be installed in fuel tanks: an instrument panel showing the tank level to prevent overfilling and confirm the integrity of the double wall.
- A petroleum product receiving and distribution procedure will be developed.
- Tanks and related equipment will undergo preventive maintenance against breakage and premature wear.
- Workers responsible for bulk petroleum hydrocarbon assigned to the transfer and handling will be trained.
- Spill kits containing absorbents will be available near transfer and handling points.
- A regular inspection schedule will be established for petroleum product transfer and storage locations.
- The emergency response plan will include a procedure for responding to spills of petroleum products.

PROBABILITY OF OCCURRENCE

A spill of petroleum products, regardless of the quantity spilled, may occur multiple times during the life of the mine. As a result, the probability is considered **high**.

SEVERITY

A spill of petroleum products in a containment system or on a waterproof surface, such as a concrete slab, will have no effects once cleaned up.

In the event of an unconfined spill of petroleum products, the product could drain into the ground under the effects of gravity and accumulate in a depression. In a worst-case scenario, which is highly unlikely, the spill could reach a wetland or the CE3 creek.

A spill of petroleum products could also cause a fire if the oil slick is ignited. This scenario is explored in the next section.

Although potentially major, this type of spill would be controlled at the site of the incident, given the prevention (double-walled tanks, containment system, etc.) and response (spill kit and means of containment) measures in place. The affected environment may include soil, a wetland or, at worst, a watercourse, depending on the location of the spill. The severity level may vary from low (soil) to **moderate** (wetland or watercourse).

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk of a petroleum products spill at **moderate**. The risk level is based on risks to the environment.

9.3.4.2 *FIRE AND/OR EXPLOSION OF PETROLEUM PRODUCTS*

Petroleum products may catch fire in the diesel storage area or during transport and distribution.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of fire and/or explosion of petroleum products:

- Design of transfer, equipment and tank areas in compliance with regulations, standards, applicable codes and industrial best practices.
- Installation of tanks on a concrete slab.
- Fuel tank level detection: an instrument panel showing the tank level to prevent overfilling and confirm the integrity of the double wall.
- Development of a petroleum product receiving and distribution procedure.
- Preventive maintenance of tanks and related equipment against breakage and premature wear.
- Training of workers responsible for bulk petroleum hydrocarbon transfer and handling.
- Training of a fire brigade.
- Assessment of risks and compliance of petroleum product transfer and storage locations as part of internal inspections.
- Dedicated water reserve for fire protection.
- Update of an emergency response plan comprising a fire response procedure.

PROBABILITY OF OCCURRENCE

A fire or even an explosion involving petroleum products could occur in exceptional circumstances, such as during a fire near petroleum product tanks or if fuel ignites during a spill. As a result, the probability of occurrence is considered **very low**.

SEVERITY

Fire

If petroleum product tanks catch fire, the fire is not very likely to spread to nearby infrastructure given their location. Therefore, the only impacts would be on the people present, on infrastructure and on vegetation due to the heat release.

Explosion

An explosion is a physical phenomenon leading to the significant release of energy in a very short amount of time in the form of high-pressure, high-temperature gas production. It is a wave of excessive pressure accompanied by projection effects (blasts) and/or thermal effects (heat emission). The impact distances are difficult to assess because they depend on the topography, the presence of obstacles and/or buildings, and the quantity of explosive substance involved.

An explosion of petroleum products may cause flammable materials to ignite due to the thermal effect or the projection of burning debris. In such case, the impacts on environmental components as well as the prevention and control measures will be those set forth in the preceding section.

However, this type of incident could lead to permanent disability, or even loss of human life, within the impact radius as well as significant damage to nearby buildings and infrastructure, requiring an interruption in production and causing considerable economic losses.

With respect to environmental impacts, vegetation near the explosion site (petroleum product storage area) could be destroyed by the heat. Further away from the explosion site and in the absence of fire, the potential impacts on vegetation will be related to blast and projection effects. As for the wildlife within the impact perimeter, the potential outcome would be injuries or even death.

The severity level is therefore considered **very high**.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk of a petroleum products fire and/or explosion at **moderate**. The risk level is based on risks to workers and property.

9.3.4.3 *SPILL OF OILS AND GREASES*

A spill of petroleum products such as lubrication oils and greases could occur. The causes could be an equipment failure, operator error or an equipment spill.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of spills of oils and greases:

- Design of transfer, equipment and tank areas in compliance with regulations, standards, applicable codes and industrial best practices.
- Containment systems for spills in storage, distribution and usage areas.
- Environmental protection and awareness training for workers.
- Availability of spill kits containing absorbents near transfer and handling points.
- Update of an emergency response plan comprising a petroleum product spill procedure.

PROBABILITY OF OCCURRENCE

An oil and grease spill is not very likely given the prevention measures in place. However, it may occur. The probability of occurrence is considered **low**.

SEVERITY

The severity level for the natural environment is considered **low** given the quantities involved, the fact that these products are used and stored in buildings, and the mitigation measures in place. The impact will therefore be highly localized.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk of an oil or grease spill at **low**. The risk level is based on risks to the environment.

9.3.5 PROPANE STORAGE AND USE

This section covers the risks associated with the storage and use of propane.

Propane is planned to be used for the heating system in buildings in the administrative and industrial sector.

Six tanks are expected to be installed in the northern part of the treatment plant sector. Each tank will have a capacity of 113,562 L, for a total capacity of 681,372 L. These tanks will be independent from one another. Annual consumption is expected to be 9,033,845 L. Table 9-7 shows the propane characteristics.

Table 9-7: Propane characteristics

Product	State	Flash point (°C)	Self-ignition temperature (°C)	Flammable limits		Reactivity	Classification
				LFL	UFL		
Propane	Liquefied gas	-103	430	2.1	9.5	Strong oxidizers, chlorine dioxides	

Propane is a flammable, explosive liquefied gas. It is a substance that appears on the list of hazardous materials in the MDDELCC guide with potential to cause a major technological accident. It is also an EER-regulated substance. However, since the threshold quantity is 4.5 metric tonnes and the density of propane is approximately 2.01 kg/m^3, the threshold will not be exceeded.

Two accident scenarios have been identified:

- Propane tank fires
- Propane vapour cloud formation

9.3.5.1 *PROPANE TANK FIRES*

Propane leaks caused by a broken flexible hose, broken pipes or a vehicle colliding with the tank could result in a fire or explosion of the tank. A building or forest fire could also cause a propane fire/explosion.

PREVENTION AND CONTROL MEASURES

The following prevention and control measures will be put in place to reduce the risk of a propane tank fire:

- Facilities in accordance with CSA B149.2-05 (Propane Storage and Handling Code).
- Installation of shock protection devices around tanks, aboveground pipes and related equipment.
- Area surrounding propane tanks free of combustible materials, vegetation, debris, etc.
- Ground under propane tanks sloped toward the periphery to avoid the accumulation of combustible liquid under the tank in case of accidental leakage.
- Qualified propane supplier.
- Training of workers responsible for propane transfer and handling operations.
- Portable fire extinguishers located near tanks.
- Update of emergency plan including an accident response procedure for propane.

PROBABILITY OF OCCURRENCE

A propane tank fire/explosion could occur in an exceptional situation. The probability of occurrence is considered **very low**.

SEVERITY

The exposure of a propane tank to flame leads to a rise in tank pressure, a weakening of the tank walls, rupture resulting in a fireball, a shock wave and projection of fragments. The situation develops very fast. Such a situation could lead to loss of life and significant damage to the surroundings, leading to a major operations interruption and economic loss.

The severity level is therefore considered **very high**.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk level for a propane tank fire/explosion at **moderate**. The risk level is based on risks to workers and property.

9.3.5.2 *PROPANE VAPOUR CLOUD FORMATION*

Propane vapour cloud formation could occur because of a propane leak in a pipe or valve due to equipment failure. The vapours are likely to concentrate to explosive levels. The explosive range for propane is 2.4% v/v to 9.5% v/v.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of propane vapour cloud formation:

- Facilities in accordance with CSA B149.2-05 (Propane Storage and Handling Code).
- Installation of shock protection devices around tanks, aboveground pipes and related equipment.
- Ground under propane tanks sloped toward the periphery to avoid the accumulation of combustible liquid under the tank in case of accidental leakage.
- Qualified propane supplier.
- Training of workers responsible for propane transfer and handling operations.
- Update of emergency plan including an accident response procedure for propane.

PROBABILITY OF OCCURRENCE

Propane vapour cloud formation could occur in an exceptional situation. The probability of occurrence is considered **very low**.

SEVERITY

A flammable propane vapour cloud formation could result in a fire and/or explosion causing loss of life and significant damage to the surroundings, leading to major operations interruption and economic loss. The severity level is therefore considered **very high**.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk level for propane vapour cloud formation at **moderate**. The risk level is based on risks to workers and property.

9.3.6 STORAGE AND USE OF NON-PETROLEUM PRODUCTS

Table 9-8 lists the main products used, how they are stored and quantities expected. Table 9-9 shows product characteristics.

Table 9-8: Main products used

Product	Use	Storage method	Annual quantity used (t)	Maximum quantity stored (t)
Ferrosilicon	Added to the DMS process to separate spodumene	One-ton bags, stored outside next to the DMS product warehouse	1,414	350
Hydrated lime	Added to prevent corrosion in the DMS process	20 Kg bags, stored on wood pallet in the DMS product warehouse	3.4	1.7
Sodium nitrate	Added to prevent corrosion in the DMS process	20 Kg bags, stored on wood pallet in the DMS product warehouse	0.7	0.35
Flocculant	Added to the water tanks to precipitate suspended solids before recycling the water back into the DMS system	Inside the DMS product warehouse	12	6
Scale inhibitor	Added to the water system distribution tanks for system treatment	Inside the DMS product warehouse	1.0	0.5
Sulfamic acid	Used to clean the water system	Inside the DMS product warehouse	2.6	1.3

This section covers the potential risks associated with the transportation, storage and use of non-petroleum products. An accident scenario was identified, i.e. a chemical spill.

Accidental chemical spills may occur during the transportation, use, handling or storage of these products. Equipment failure or human error can also cause a spill.

Table 9-9: Characteristics of main products used

Product	Characteristics			
	State	Colour	Reactivity	Classification
Ferrosilicon	Solid (granulated)	Grey	Releases flammable gas on contact with water (hydrogen) Oxidizing agent	 
Hydrated lime (calcium hydroxide)	Solid	Colourless or white	Reacts violently in the presence of strong acids, maleic anhydride, nitro-alkanes, phosphorus, ammonium salts, hydrides, nitrides, sulphides and peroxides. It attacks certain metals (aluminum, copper, zinc and certain steels).	
Sulfamic acid	Solid in crystal form	White	Incompatible with acids, chlorine, fuming nitric acid. Becomes corrosive when wet. Reacts quickly with alkalis and metals.	 

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of chemical spills.

Storage

Storage will respect the compatible product classes defined by the Workplace Hazardous Materials Information System (WHMIS) as well as the *National Fire Code* (NFC) and *Regulation respecting hazardous materials.*

Storage areas will be established and storage conditions will take into account interactions between products.

Secondary retention systems at transfer points will be designed to contain the worst-case spill scenario. Containment volume will be established for each chemical reagent bulk delivery, based on transfer rates and supplier recommendations.

All used and non-reusable chemicals will be stored for up to one year in accordance with the *Regulation respecting hazardous materials.* Used hazardous materials will be recovered by companies authorized to recover the products. Secure collection areas with specialized waste disposal and hazardous materials containers separated by category will be provided at appropriate locations, depending on the production site. Temporary storage areas will be inspected on a regular basis and all employees will be instructed as to their use to avoid mixing errors or overfilling.

Handling

Chemicals will be employed in accordance with supplier instructions as well as applicable regulations. When handling chemicals, wearing appropriate protective equipment is mandatory (e.g. safety glasses or goggles, chemical resistant gloves [neoprene, butyl rubber, rubber or leather], appropriate protective clothing [e.g. full face mask]). Equipment required in critical areas will be indicated by posters. They will also be defined beforehand in a health and safety program. National Institute for Occupational Safety and Health (NIOSH) approved respirators may also be required to reduce worker exposure to dust and/or fumes when handling certain chemicals.

Training

Employees responsible for the handling and transportation of hazardous materials will have specialized handling and related hazards training, such as Transportation of Dangerous Substances, WHMIS, or other appropriate instructions. Employees must be informed about the contents of the hazardous products material safety data sheets.

Transport

It is expected that chemicals will be transported to the site by truck. Transportation arrangements will comply with the Transportation of Dangerous Substances Regulation and the Transportation of Dangerous Substances Guide (MTMDET, 2017). Hazardous products will be placed in leak-proof containers to minimize the risk of a spill if they are tipped over by the carrier.

Response equipment

Spill response kits, customized to the type and quantity of substance, will be placed at strategic locations on the site (storage and refuelling areas). The contents of the kits will be checked periodically.

Emergency showers and eyewash fountains will also be installed where chemicals are used.

Emergency plan

An emergency plan will be developed and updated. It will include response strategies in the event of a chemical spill.

PROBABILITY OF OCCURRENCE

A chemical spill is unlikely due to existing safety measures. However, it could occur like on similar sites. The probability of occurrence is considered **low**.

SEVERITY

In the case of a chemical spill, the product, if not confined, could reach the ground by gravity and accumulate in a depression. It's unlikely that it can reach a waterway. The level of impact on the environment is therefore considered low due to the quantities involved, the fact that the products will be used and stored in buildings and the existing mitigation measures. The impact would therefore be very localized.

However, in the case of a spill:

- Ferrosilicon, when in contact with water, emits a flammable, highly explosive and toxic gas, phosphine (or hydrogen phosphide).
- Lime, with its very basic pH, poses a risk to aquatic life if it reaches a waterway.
- Sulfuric acid's highly acidic pH poses a risk to aquatic life if it reaches a waterway.

The impact level is considered **high** because of the reactivity of ferrosilicon.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk level for chemical product spills at **moderate**. The risk level is based on risks to workers and the environment.

9.3.7 EXPLOSIVES HANDLING AND STORAGE

Pit blasting will be carried out using an emulsion explosive consisting of ammonium nitrate, fuel oil and surfactant. Storage will be at three sites, the explosives warehouse (ammonium nitrate), the emulsion warehouse and the detonator warehouse.

The expected amount of explosives used, as follows:

- Detonators: 27,000
- Ammonium nitrate: 159 kg
- Emulsion: 76.5 kg

A specialized supplier will be responsible for the procurement, operation and maintenance of the explosives transfer site. This section covers the risks associated with explosives. Two hazards that can lead to major accidents are:

- Explosion of explosive materials
- Theft of explosive material

9.3.7.1 *EXPLOSION OF EXPLOSIVE MATERIALS*

An accidental explosion could occur due to an accident involving a transport vehicle, an explosives storage site fire or a poorly controlled blast.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of aboveground explosions.

Use

- To prevent negligence or error, the handling and use of explosives will be entrusted to a specialized supplier.
- Workers handling explosives must hold an explosives certificate issued by the Sûreté du Québec.
- Heat sources and open flame and other pyrotechnic or flammable materials are removed before a spill clean-up, because an explosive can explode when located near a fire source.
- Specific controls will be put in place to check drill hole dimensions, depth and direction as well as the charges.
- Weather conditions (e.g. rain, wind) can influence the effectiveness of an explosion. If water is present in the blast holes, the detonation will not be as effective as in dry weather. Some of the explosives, such as ammonium nitrate, could also be converted into a nitrogen oxide vapour, a toxic gas. Thus, the blasting schedule will be based on weather conditions to reduce the risk of faulty blasting and to protect workers.
- Blasting must comply with the requirements of the *Regulation respecting occupational health and safety in mines* (R.S.Q., ch. S-2.1 r.14).
- Signs prohibiting smoking will be posted in the explosives assembly facility and within the blasting zone.
- Particular attention will be paid to emissions when wet explosives are detonated or in the event of faulty blasting in order to not impact worker health and the environment.

Storage

Storage facilities and explosives preparation management will also be the responsibility of a specialized contractor. Contractors must ensure that:

- Storage methods (location, distance, size, etc.) will comply with applicable provincial and federal provisions, including the *Regulation respecting hazardous materials* (R.S.Q., ch. Q-2, r.32), Explosives Regulatory Division (ERD) quantity-distance principles and the Guidelines for Bulk Explosives Facilities (NRCan, 2014).
- Explosives are stored in warehouses. They will be secured to prevent unauthorized personnel from trespassing and will comply with provincial and federal explosives laws (R.S.Q., ch. E-22 and R.S.C., ch. E-17) regarding construction standards, safety distances from site facilities, protection measures, well-ventilated areas and protected from moisture.
- The products used are clearly identified.
- Emulsions and detonators are stored separately.

Transport

Explosives will also be transported by a specialized supplier as specified in the *Regulation respecting hazardous materials*. Vehicles used to transport explosive agents will be marked and the people transporting explosives will have the necessary training and skills.

PROBABILITY OF OCCURRENCE

An explosion could occur, but in exceptional circumstances; thus, the probability is considered **very low**.

SEVERITY

Ammonium nitrate is used in explosives and is accompanied by gas emissions, namely carbon dioxide (CO_2), nitrogen (N_2), hydrogen (H_2), nitrogen oxides (NO_x) sulfur dioxide (SO_2) and carbon monoxide (CO). Under normal operating conditions during blasting, none of these gases represent health risks to workers. However, nitrogen oxide vapours from burning ammonium nitrate are extremely toxic.

An explosion is a physical phenomenon resulting in a sudden massive burst of energy in the form of a high pressure and temperature gas production. It's a pressure wave accompanied by projection (fragments) and/or thermal effects (heat emissions). Impact distances are difficult to determine because they depend on the topography, the presence of obstacles and/or buildings and the amount of explosive material.

A petroleum product or explosive material explosion can ignite combustible materials by thermal effects or burning debris. In such a case, the impact on the immediate environment as well as prevention and control measures will be the same as a fire situation.

Such a situation would result in serious injury or in a worst-case scenario, loss of life. Depending on the location of the explosion, the latter could also have a significant impact on infrastructure and bring operations to a halt for around a month.

Vegetation near the site of the explosion could be destroyed by heat. Further away from the explosion site and in the absence of fire, the potential impacts on vegetation will be related to blast and projection effects. As for the wildlife within the impact perimeter, the potential outcome is injuries or even death. It is expected the number of feeding areas and shelters will decrease when habitats are disturbed. Finally, the water quality could also be affected by the introduction of debris and contaminants.

The severity level is considered **very high**.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk level for an explosion of explosive material at **moderate**. The risk level is based on risks to workers and property.

9.3.7.2 *EXPLOSIVE MATERIAL THEFT*

Stolen explosives could be used for criminal purposes.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of explosive material theft:

- Explosives deliveries supervised at all times.
- Maintenance of inventory records for explosives and detonators.
- Warehouses located in enclosed areas.

PROBABILITY OF OCCURRENCE

Explosive material theft could occur, but in exceptional circumstances, thus, the probability is considered **very low**.

SEVERITY

Misuse of stolen explosives could result in serious injury and/or loss of life. The severity level is considered **high**.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk level for explosive material theft at **moderate**. The risk level is based on risks to workers and property.

9.3.8 TRANSFORMER USE

An electrical substation will be built in the area of the treatment plant. A 69/4.16-kV, 10-MVA transformer will be installed. In addition, five 4.16/0.6-kV, 2.5-MVA transformers will be installed on the site. The transformers will contain mineral oil.

The transformers will not contain polychlorinated biphenyls (PCBs).

This section covers the risks associated with the presence of transformers. Two hazards that can lead to major accidents are:

- Dielectric oil spills.

— A fire, explosion involving a transformer.

9.3.8.1 *DIELECTRIC OIL SPILL*

Dielectric oil spills could be caused by corrosion, breakage or human error.

PREVENTION AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of dielectric oil spills:

— Transformer and related equipment preventive maintenance to prevent breakage and premature wear.
— Lightning protection.
— A catch basin for transformers containing dielectric fluid.
— An emergency generator at the treatment plant and at the work camp.
— Update of an emergency plan including an incident response procedure in the case of a spill.

PROBABILITY OF OCCURRENCE

A dielectric oil spill could possibly occur, because it has already happened at similar sites. However, the probability of occurrence is considered **low**.

SEVERITY

The impact on the environment is considered to be **low** because of a catch basin confining the spill to the incident site.

ESTIMATED RISK LEVEL

The inclusion of the probability and severity components establish the risk level for dielectric oil spills at **low**. The risk level is based on risks to the environment.

9.3.8.2 *TRANSFORMER FIRE/EXPLOSION*

Transformer fire is a potential risk. Possible causes are contaminated transformer oil, a short circuit and overheating.

PREVENTIVE AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of transformer fire:

— Preventive maintenance of transformers and related equipment to prevent breakdowns and premature wear;
— Lightning protection;
— An emergency generator for the worker camp and processing plant that will be used in case of transformer malfunction so as to avoid a production stoppage;
— An emergency response plan comprising a fire response procedure will be kept up to date.

PROBABILITY OF OCCURRENCE

A transformer fire could occur as this has already happened at similar sites. The probability of occurrence is therefore deemed **low**.

SEVERITY

An explosion could result in the projection of debris causing serious injury and damage to equipment and infrastructure. The risk is therefore deemed **high**.

ESTIMATED RISK LEVEL

The inclusion of the likelihood and severity components brings the level of risk of a transformer fire and/or explosion to **moderate**. The risk level is based on risks to workers.

9.3.9 ACCUMULATION AREAS

Accumulation (containment) areas will be set up west of the processing area, more specifically, waste rock, overburden and topsoil stockpiles.

A runoff collection pond and an exfiltration pond, as well as a dike, will be built around each accumulation area (map 9-1).

This section addresses the risks associated with the accumulation areas. The risks are:

- stockpile collapse;
- failure of a retaining dike.

9.3.9.1 STOCKPILE COLLAPSE

An unstable slope could cause the materials to fall and slide outside the containment area. The instability could be caused by extreme weather or errors and omissions during construction.

PREVENTIVE AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of stockpile collapse:

- Hydrogeological and geotechnical studies will be carried out;
- A slope analysis will be carried out;
- A monitoring program will be implemented.

PROBABILITY OF OCCURRENCE

The stockpile could collapse but this is unlikely. The probability of occurrence is therefore deemed **low**.

SEVERITY

Since there will be dikes around the stockpile containment areas, the collapse of a stockpile would have little or no effect on infrastructure (buildings, power lines, roads, etc.), with the exception of the road between the accumulation areas. The presence of workers at the time of the collapse would, however, increase the severity of the incident. The severity level is therefore deemed **high**.

ESTIMATED RISK LEVEL

The inclusion of the likelihood and severity components brings the level of risk of a stockpile collapse to **moderate**. The risk level is based on risks to workers.

9.3.9.2 FAILURE OF A RETAINING DIKE

A retaining dike could fail as a result of:

- extreme weather (e.g. heavy flooding, heavy rains, strong winds);
- an earthquake;
- errors or omissions during its construction;
- ageing of the structure.

PREVENTIVE AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of dike failure:

- An analysis of dike failure risks and potential consequences will be carried out;
- Retention structures will be designed according to the criteria of the Canadian Dam Association and the *Dam Safety Act* and its regulation;
- Geological and hydrogeological studies, including dig stability, will be carried out;
- Dig design will take into consideration seismic data for the area;
- The dike designer’s operating guide will be carefully followed at all times;

- An inspection and maintenance program will be implemented for the retention structures;
- Monitoring instrumentation will be used;
- An emergency response plan laying out a response procedure will be kept up to date.

PROBABILITY OF OCCURRENCE

The dig could fail but this is extremely unlikely. The probability of occurrence is therefore deemed **very low**.

SEVERITY

Dike failure could result in heavy property damage and the release of contaminants (e.g. suspended solids, leachate, residual reagents, debris) into the environment, thus violating the MDMER and Mining D019.

A failure in the north retaining dike would affect environmental components north of the site, particularly in the vicinity of the creek CE2 and subsequent watercourses to the north.

A failure in the south retaining dike of topsoil and overburden stockpiles would affect environmental components south of the site, particularly in the vicinity of the CE3 creek.

An analysis of dike failure risks and potential consequences will be carried out following completion of the project's detailed engineering. This study will make it possible to define areas where human and biological environments would be affected.

However, at this stage, the risk is deemed **very high** for the environmental components.

ESTIMATED RISK LEVEL

The inclusion of the likelihood and severity components brings the level of risk of a retaining dig failure to **moderate**. The risk level is based on risks to workers, the environment and property.

9.3.10 ROAD TRANSPORT

This section covers the risks associated with road use, particularly James Bay road. Two accident scenarios have been identified:

- Accident involving hazardous materials;
- Accident involving a truck carrying spodumene concentrate.

9.3.10.1 *ACCIDENT INVOLVING HAZARDOUS MATERIALS*

Hazardous materials and other chemicals will be transported by tank trucks and 53-foot closed trucks. An accident involving hazardous materials on James Bay road could be the result of a spill from a tank truck carrying petroleum products (diesel, gasoline) or chemicals. The causes can be:

- loss of vehicle control by the driver due to poor weather, human error or health issue;
- collision with another vehicle.

PREVENTIVE AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of hazardous material spills on the road:

- Drivers assigned to transport hazardous materials will be trained;
- A preventive maintenance program will be put in place to prevent vehicle breakdowns and premature wear;
- The emergency response plan will include a procedure for road spills.

Also, James Bay road is designed according to the MTMDET standards for heavy truck transport.

PROBABILITY OF OCCURRENCE

Hazardous material could spill on the road as this type of situation has already happened. It is, however, unlikely. The probability of occurrence is therefore deemed **low**.

SEVERITY

The severity of the incident will depend on the product involved and location of the spill. Depending on its location, the spill could reach a watercourse or just contaminate the soil.

Spill in a terrestrial environment

Some of the product will seep into the soil until it encounters an impermeable layer or an area saturated with water such as an aquifer. The proportion of product flowing versus the amount that infiltrates depends on the permeability of the soil and the characteristics of the spilled product. Some compounds of the spilled product may eventually escape into the air. Upon contact with groundwater, some of the product is also likely to dissolve.

The magnitude of the effect in a terrestrial environment will depend, among other things, on the time of year, weather, characteristics of the spilled product, amount spilled and the depth of its penetration into the soil.

Potential impact on vegetation

A hazardous materials spill would probably affect vegetation in the following manner:

— Foliage depigmentation, patches on leaves, decrease in density, stem height and number of leaves on the stem;
— Alteration of plant reproduction pattern;
— Mortality of exposed vegetation;
— Loss, over time, of habitat or plant species favourable to the presence of several species of wildlife.

Potential impact on wetlands

In the event of a hazardous material spill in wetlands, the product would come into contact with plants, sediment and the underlying soil. A spill in such an environment would harm the ecosystem, i.e. aquatic fauna and flora, including the loss over time of habitats or plant species favourable to the presence of wildlife. It would also lead to the use of complex rehabilitation techniques and subsequently, wetland replacement. The cost of wetland rehabilitation is high and depends mainly on the volume of product spilled, reaction time and effectiveness of the response strategies. The environmental impact will depend on the ecological value of the affected wetland.

Potential impact on terrestrial fauna and avifauna

Hazardous material spills can cause health problems for any animal that comes in direct or indirect contact with the product. Mammals, reptiles and bird species that come into direct physical contact with the spilled material may, depending on the product, suffer skin and eye damage or chemical burns that may result in death.

Animals affected by the spilled product may experience reproductive problems due to disease or interference with normal breeding patterns. Birds may see a reduction in the number of eggs laid and their thickness. In general, mammalian and bird populations can be affected by a land spill if their habitat or prey is affected in terms of reproduction, juvenile rearing, feeding and/or wintering.

However, mammals and birds capable of moving within their habitat and relocating to an environment less exposed to contaminants in the event of a spill are less likely to be affected.

Potential impact on herpetofauna and its habitat

In general, mammalian and bird populations can be affected by a land spill if their habitat or prey is affected in terms of reproduction, juvenile rearing, feeding and/or wintering.

Herpetofauna is a group with limited ability to move. In the event of a spill, it is less able to relocate to an environment that is less exposed to contaminants. It is therefore more likely to be affected, especially during the reproductive and egg incubation periods, and larval stages.

The potential effects on herpetofauna are:

— mortality of individuals that came into contact with the product;
— lower egg and larvae yields;
— deterioration in the quality of breeding and feeding sites, and shelters.

Spill in an aquatic environment

As previously mentioned, if a hazardous material spills on the ground, it will flow under the effect of gravity and could reach a watercourse. The environment likely to be affected would then be the water environment as well as benthic fauna, fish and their habitats.

Potential impact on hydrous environments

Several streams and bodies of water are present along the routes to the site.

Petroleum products are mostly insoluble in water. When they are poured in water, they spread to the surface where they form an oily film or fall to the bottom in the case of heavy oil products. Chemicals are mostly soluble in water and are rapidly diluted. In all cases, alteration of water quality is expected, including sediment contamination.

Potential impact on benthic fauna and its habitat

The potential effects on the benthic community would be contamination potentially leading to mortality, decreased benthic abundance and diversity, as well as lower recruitment (eggs and larvae), food consumption and growth rates.

Potential impact on fish and their habitat

Fish and shellfish may ingest toxic substances and transmit them to the predator that eats them. A hazardous material spill in an aquatic environment may have a dire impact on the next generation of fish and shellfish.

Generally speaking, fish populations can be affected by a spill at different times of the year if their habitat or prey is affected in terms of reproduction, hatching, feeding, migration and wintering.

Fish capable of moving within their habitat and potentially relocating to an environment less exposed to contaminants in the event of a spill are less likely to feel the effects, except during the spawning and egg incubation period.

Severity level

In light of the foregoing, the severity level is deemed **high**.

ESTIMATED RISK LEVEL

The inclusion of the likelihood and severity components brings the level of risk of a hazardous material spill on the road network to **moderate**. The risk level is based on risks to the environment.

9.3.10.2 *ACCIDENT INVOLVING A TRUCK CARRYING CONCENTRATE*

The spodumene concentrate will be transported by a closed semi-trailer truck. Moving trucks carrying spodumene could lead to road accidents with spodumene spills.

The causes can be:

— loss of vehicle control by the driver due to poor weather, human error or health issue;
— collision with another vehicle.

PREVENTIVE AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risk of hazardous material spills on the road:

— Drivers assigned to transport hazardous materials will be trained;
— A preventive maintenance program will be put in place to prevent vehicle breakdowns and premature wear;
— The emergency response plan will include a procedure for road spills.

Also, James Bay road is designed according to the MTMDET standards for heavy truck transport.

PROBABILITY OF OCCURRENCE

A spodumene spill on the road network could occur. It is, however, unlikely. The probability of occurrence is therefore deemed **low**.

SEVERITY

Such an incident could lead to injuries that do not cause disability but temporary discomfort through inhalation. The effects on the natural environment will be at the site of the spill. Since it is solid, spodumene will spread only if it reaches a watercourse, in which case it will tend to settle at the bottom. The severity level is therefore deemed **low**.

ESTIMATED RISK LEVEL

The inclusion of the likelihood and severity components brings the level of risk of a spodumene spill on the road network to **low**. The risk level is based on risks to workers and the environment.

9.3.11 RISKS ASSOCIATED WITH EXTERNAL HAZARDS

9.3.11.1 *FOREST FIRE*

There have been several forest fires near the project site in the past. Forest fires can be the result of human activity but lightning is the main cause.

PREVENTIVE AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the consequences of a forest fire:

- The peat will be removed down to the mineral soil over a 35 m radius around the processing facilities, mine water treatment unit and explosives storage site;
- The site will be cleared;
- A periodic inspection program will be implemented;
- Personnel will be educated about forest fires;
- An agreement will be made with SOPFEU;
- SOPFEU will provide periodic advice concerning fire hazards;
- There will be a dedicated water reserve for fire protection;
- A water supply network with a fire hydrant will be installed;
- A fire brigade will be formed and trained in fighting forest fires;
- An emergency response plan comprising a procedure for forest fires will be kept up to date.

PROBABILITY OF OCCURRENCE

Given the history of forest fires in the project area, the probability of occurrence is deemed **high**.

SEVERITY

A forest fire threatening the facilities could result in serious firefighter injury as well as heavy damage to infrastructure if it were to catch fire. However, these risks will be reduced due to the mitigation measures in place.

The effects on the environmental components will vary depending on the magnitude of the fire and its spread.

Potential impact on vegetation

There are several types of fires with different effects on land vegetation:

- Crown fires burn trees up their entire length to the top. These are the most intense and dangerous vegetation fires;
- Surface fires burn only surface litter and humus. These are the easiest fires to extinguish and those that cause the least forest damage;
- Ground fires (sometimes called underground or subsurface fires) occur in deep accumulations of humus, peat and similar dead vegetation that become dry enough to burn. These fires move very slowly but can become difficult to fully put out, or suppress. Occasionally, especially during prolonged drought, such fires can smoulder all winter underground and then emerge at the surface again in spring.

In the event of fire, the anticipated impacts are vegetation mortality, disturbance in the evolution of the forest and loss over time of habitats or plant species favourable to the presence of several species of wildlife. In forests, wildfires have an ecological influence at all levels: species, stand and landscape.

Potential impact on terrestrial fauna and avifauna

Fires affect populations of terrestrial and avian species, whose need for cover and food forces them to move as the type of forest changes. Highly dependent on the vegetation in its habitat, terrestrial wildlife responds to fire by evacuating and avoiding the area during the fire and following changes in vegetation cover.

In the event of fire, the effects on terrestrial and avifauna are potential mortality during juvenile rearing, a reduction in the availability of foraging areas and shelter when habitats are disturbed, and egg destruction during nesting season.

Potential impact on hydrous environments

A fire can alter water quality by adding particulate matter and other contaminants to the water and allowing them to spread.

Potential impact on herpetofauna and its habitat

Fires affect herpetofauna populations, whose need for cover and food forces them to move as the type of forest changes. Highly dependent on the vegetation in its habitat, herpetofauna responds to fire by evacuating and avoiding the area during the fire and following changes in vegetation cover.

In the event of fire, the potential effects on herpetofauna are mortality, egg destruction during the incubation period, and a reduction in the availability of foraging areas and shelter when habitats are disturbed.

Severity level

In light of the foregoing, the severity level is deemed **moderate**.

ESTIMATED RISK LEVEL

The inclusion of the likelihood and severity components brings the level of risk of a forest fire threatening the facilities to **high**. The risk level is based on risks to persons, property and the environment.

9.3.11.2 *EXTREME WEATHER*

Unusual or extreme weather could occur, including strong winds, heavy snowfalls and ice storms.

PREVENTIVE AND CONTROL MEASURES

The following prevention and mitigation measures will be put in place to reduce the risks associated with extreme weather:

- Infrastructures will be designed in accordance with applicable laws, regulations and codes;
- The camp will be equipped with generators;
- Spare electrical equipment will be kept on site;
- An emergency response plan laying out an evacuation procedure for mine personnel will be developed.

PROBABILITY OF OCCURRENCE

Although extreme weather could occur, it is highly unlikely. Consequently, the probability of occurrence is deemed **very low**.

SEVERITY

The consequences of such weather can vary but could go as far as heavy damage to infrastructure and damage to Hydro-Québec's 450-kV line or to the internal line, depriving the site of power for a long time and seriously disrupting activities. Such a situation could require an evacuation to ensure worker safety.

The severity level is therefore deemed **high**.

ESTIMATED RISK LEVEL

The inclusion of the likelihood and severity components brings the level of risk for extreme weather to **moderate**. The risk level is based on risks to persons, property and the environment.

9.3.12 RISK SUMMARY

The technological risks identified in the preceding sections are summarized in Table 9-10.

9.4 PRELIMINARY EMERGENCY RESPONSE PLAN

An emergency response plan is an essential tool to ensure a quick and effective response in an emergency. A preliminary plan has been developed. Presented in Appendix I, it contains:

— a list and description of events considered as high and very high risk;
— the roles and responsibilities of the stakeholders;
— the phone numbers of the main external stakeholders;
— an alert and mobilization procedure;
— an emergency response procedure;
— an evacuation procedure;
— the return to normal process.

The emergency plan will be known to internal stakeholders, updated annually, quickly accessible in an emergency and easy to consult.

Response measures will be in accordance with applicable regulations and industry best practices. When required, this plan will be revised and adapted to any new activity on the site.

9.5 CORPORATE POLICY

Galaxy is firmly committed to limiting environmental impacts resulting from the development of mineral resources, while building a successful business that fully assumes its responsibilities in the communities where it operates.

This commitment is put into practice daily by integrating the social, economic and environmental dimensions to the company's decision-making process and through the ongoing respect of the interests of its many stakeholders.

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In its environmental policy, Galaxy plans to conduct its activities in a manner that respects the environment and all applicable regulations, and to implement a management system that will ensure that the highest environmental standards possible are applied to its products, services and processes. In its health and safety policies, Galaxy wants to take all possible and feasible measures to ensure the health and safety of its employees and other members of its personnel directly or indirectly involved in the project by eliminating all occupational injuries and diseases. Galaxy guarantees that no business objectives will compromise safety.

Table 9-10: Summary of risk analysis results

Activity	Scenario	Probability of occurrence	Severity level	Risk level
Pit	Pit flooding	Low	High	Moderate
	Rock and landslide	Low	High	Moderate
Material processing	Fire	Low	High	Moderate
	Exposure to ionizing radiation	Very low	High	Moderate
	Dust emission	Moderate	Low	Moderate
Storage and use of petroleum products	Spill of petroleum products	High	Moderate	High
	Fire/Explosion of petroleum products	Very low	Very high	Moderate
	Spill of oils and greases	Low	Low	Low
Propane storage and use	Fire	Very low	Very high	Moderate
	Formation of a propane vapour cloud	Very low	Very high	Moderate
Chemical storage and use	Chemical spill	Low	High	Moderate
Explosive storage and handling	Explosion of explosive material	Very low	Very high	Moderate
	Theft of explosives	Very low	High	Moderate
Use of electric transformers	Transformer oil spill	Low	Low	Low
	Fire/Explosion	Low	High	Moderate
Mine water treatment	Non-compliant discharge into final effluent	Low	High	Moderate
Accumulation area	Stockpile collapse	Low	High	Moderate
	Failure of retaining dike	Very low	Very high	Moderate
Road transport	Hazardous material spill	Low	High	Moderate
	Spodumene concentrate spill	Low	Low	Low
External hazards	Forest fire	High	Moderate	High
	Extreme weather	Very low	High	Moderate

10 SURVEILLANCE AND MONITORING PROGRAM

10.1 ENVIRONMENTAL MANAGEMENT SYSTEM

Through its environmental policy, Galaxy commits to implementing and applying a management system that will ensure the highest environmental standards are applied to its products, services and processes.

To facilitate fulfilling this commitment, the Corporate Environmental and Workplace Health and Safety Division has asked its Canadian representatives to implement an ISO-14001:2015-type environmental management system, with a view to subsequent certification.

The ISO-14001-type system puts environmental concerns at the forefront, and is not limited to legal compliance – it also strives to continuously improve environmental performance. All levels, functions, and decisional processes are invested in the company's environmental performance. One of the guiding principles is to establish a corrective action trigger zone between normal conditions and harmful conditions: more inspections and minor corrective actions, and fewer major corrective actions.

The comprehensive system will be developed and implemented for the operating period. During the construction period, the environmental management rules will be integrated in the project execution plan (PEP). Thus, certain system elements planned for the operation phase will be implemented during construction. Table 10-1 presents all of the elements in a 14001-type system, along with their implementation phase. Setting up an organized system also ensures better use of resources, a reduction in pollution and improved environmental performance, all of which contribute to a decrease in costs.

Galaxy will also set up a system for receiving and managing complaints. Generally speaking, the procedure applied will be as follows:

- Any person who feels they have suffered prejudice and would like to file a complaint shall, within a reasonable amount of time after the alleged events, contact the person appointed by Galaxy. The complainant may formulate their complaint using one of the following channels: online, by telephone, in person or in writing.
- Galaxy will acknowledge receipt of all complaints and date them. Galaxy will review the complaint, determine its admissibility in accordance with the procedure criteria to be established and will respond to all complainants. In collaboration with the complainant, Galaxy will seek to find a solution and will ensure the complaints are followed up.
- Throughout the process, all documents associated with the complaint shall be kept in a complaint log. Complaints will also be handled confidentially by all stakeholders.

10.2 MONITORING COMMITTEE

As required under *An Act to amend the Mining Act* (section 101.0.3), Galaxy will establish a monitoring committee to foster the participation of the communities involved in the project's execution. This committee will be created prior to the mine's construction and will remain active throughout its life, until such time as the works provided for in the mining site rehabilitation plan are fully completed.

The committee's membership will be determined as per the regulations established under the Act, and it will be comprised of at least one representative from the Eastmain Band Council, one from the business community, one from the community of Eastmain and one from the EIJBRG. Furthermore, the RE2 Tallyman or a member of his family will be included on this committee.

Table 10-1: Implementation of the ISO-14001 system

Numbering ISO-14001:2015	System element	Type of document	Construction phase	Operation phase
4.1 – 4.3	Context of the organization	Manual		X
5.1	Leadership and commitment	Manual		X
5.2	Environmental policy	Page signed by upper management	X	X
5.3	Roles and responsibilities	PEP and manual	X	X
6.1.1	Planning – identification of risks and opportunities	Manual		X
6.1.2	Environmental aspects	Register of aspects		X
6.1.3	Compliance requirements	Register of legal requirements	X	X
6.1.4	Planning – actions	Manual		X
6.2	Environmental objectives	Register of objectives		X
7.1	Commitment to supply resources	Manual		X
7.2	Skills	Training matrix		X
7.3	Awareness	Integrated in the contracts Welcome session	X	X
7.4.1	Internal communication	Bulletin board Internal bulletin	X	X
7.4.2	External communication	Register	X	X
7.5	Documented information	System procedures		X
8.1	Operational proficiency	Operational procedures	X[1]	X[2]
8.2	Emergency response	EMP	X	X
9.1	Supervision	Documented inspections with references to legal requirements and issued authorizations	X	
9.1.1	Supervision, measure, analysis and assessment	Operational procedures and programs		X
9.1.2	Compliance assessment	Procedure		X
9.2	Internal audit	Procedure		X
9.3	Management review	Procedure		X
10	Improvement	Register of non-compliances and corrective actions	X	X

1 During construction, new and used hazardous materials management, waste materials management and spill management will be documented in procedures; compliance with these procedures will be integrated in inspections.

2 During operation, all activities with impacts or risks deemed to be significant will be documented in procedures.

Galaxy is committed to preparing and making public an annual report of the monitoring committee's activities. The annual report, the contents of which will be more specifically defined in collaboration with the committee members, will include at least the following elements:

- Nature and number of activities carried out;
- Roles and mandates of the local stakeholders involved;
- Subjects and concerns addressed;

- Actions undertaken;
- Local stakeholders' level of satisfaction;
- Responses to the recommendations, as applicable.

10.3 ENVIRONMENTAL SURVEILLANCE

An environmental monitoring program describes the means and mechanisms implemented to ensure compliance with legal and environmental requirements. More specifically, the program targets compliance with the laws, regulations and other environmental considerations set out in the plans and specifications, as well as in the authorizations and permits issued by government authorities.

The environmental monitoring program helps to ensure work is progressing smoothly, and equipment and facilities are operating properly. It also ensures that any environmental disturbance caused by project execution is monitored. Environmental monitoring therefore is intended to ensure mitigation measures, conditions set out in the governmental authorizations, Galaxy's commitments, as well as the requirements set out in laws and regulations are all followed.

Environmental monitoring will also be enforced during project implementation. Galaxy will ensure this general environmental monitoring itself. Its responsibilities will include:

- Monitoring and overseeing all tasks that require preventive, mitigation or corrective measures with regards to the environment;
- Updating the environmental management system;
- Ensuring work is carried out in accordance with the laws, regulations and conditions set out in authorization certificates;
- Updating the storage and disposal condition follow-up logs for any hazardous waste materials required for the project;
- Monitoring the petroleum product refuelling procedures for project equipment;
- Managing and following procedures to follow in the event of an accidental spill, including monitoring the conditions for temporary stockpiling of contaminated soils, if applicable.

The preliminary environmental monitoring program presented hereunder will be completed at a later date, subsequent to receipt of authorization for project implementation. The final program will include:

- List of elements that require environmental monitoring;
- All measures and means planned to protect the environment;
- Consultation with involved stakeholders;
- Detailed characteristics of the monitoring program, wherever foreseeable (e.g.: location of interventions, planned protocols, list of parameters measured, analysis methods used, completion schedule, human and financial resources allocated to the program);
- An intervention mechanism in the event of non-compliance with legal and environmental requirements;
- Commitments with regards to filing monitoring reports (number, frequency and content);
- Galaxy's commitments in terms of distribution of environmental monitoring results to the population affected.

The environmental monitoring program must be an activity included in the construction site procedures, and be documented just as all other activities are. The first step will consist in forming an inspection team that has experience with this type of project, so that they can adequately monitor execution of the work. Together with the contractors, the construction and environmental managers will organize numerous construction meetings, the first of which will take place at the very start of the work. One notable goal will be to inform and raise the awareness of personnel assigned to the construction site of the environmental and safety provisions that must be observed throughout the work period, as well as of the general functioning of supervision activities.

Prior to the start of work, the following activities must be carried out:

- Verify that all necessary authorizations and permits have been obtained;
- Ensure that all contributors on the construction site have been informed of the environmental concerns and protective measures;
- Establish clear-cut roles and authority for each one, according to a hierarchical system, in preparation for unexpected or non-compliant situations, so that appropriate preventive and corrective measures can be applied;
- Establish measures that contributors will need to apply to protect the environment, according to their respective activities;
- Verify that the spill response plan is available and understood by all;
- Implement the programs and procedures to ensure the businesses' policies are followed;
- Implement the mechanisms to ensure compliance with the procedures in place.

Galaxy will ensure regular monitoring during the construction phase. The environmental monitoring program must ensure that all environmental provisions specified in the plans, specifications and authorizations are followed.

The program will include regular construction site inspection, documentation control, preparation of reports and compliance with communication channels. Construction site supervision involves direct communication between the person responsible and all other personnel to ensure non-compliant situations are resolved efficiently and immediately, and that action is quickly taken in the event of an environmental emergency.

A process will be established to document and follow-up on construction activities, construction site observations, decisions on how to resolve non-compliant situations, corrective actions taken and results observed as a result of these actions and, lastly, preventive measures implemented to ensure that these non-compliances will not recur.

During the work, mitigation measures must be carefully applied, most particularly during work performed near waterways and bodies of water. Furthermore, throughout the work, Galaxy may also identify improvements to make to mitigation measures while complying with environmental requirements, specifications, goals and objectives set out in the environmental impact assessment.

Generally speaking, Galaxy will visit the work areas regularly, take note of the contributors' strict compliance with commitments, obligations, measures and other provisions, assess the quality and efficiency of the measures applied and note any non-compliances observed.

Just as with the construction phase, an environmental monitoring program will be developed for the mine's site rehabilitation phase. The roles and responsibilities presented above will be the same during site rehabilitation work. Thus, as for the construction phase, the stakeholders involved will be consulted when the environmental monitoring program is developed for the site rehabilitation phase.

10.4 ENVIRONMENTAL MONITORING DURING OPERATIONS

10.4.1 WATER QUALITY MONITORING

Water quality will be monitored to ensure compliance with the MDMER on the federal level, and D019 at the provincial level. An EDO monitoring program will also be defined.

10.4.1.1 *METAL AND DIAMOND MINING EFFLUENT REGULATIONS*

The MDMER, under the Fisheries Act, requires mines to conduct environmental effects monitoring (EEM) as a condition for effluent authorization. The purpose of EEM is to assess the potential effects that effluents would have on fish, fish habitat and use of fish resources.

The study area covered by EEM will include all waterways exposed to the mine effluent (CE2 and CE3), as well as a reference waterway located outside the mine's area of influence. First, the water quality will be monitored (environment and effluent). This process will consist of three distinct activities:

- Characterization of the effluent;
- Sublethal toxicity test on the effluent at the final discharge point;
- Water quality monitoring, sampled from the exposed area near the effluent inlet point and final discharge point, in the reference areas, and in the selected sampling areas, within the context of the biological monitoring study.

Regarding the biological environment, the following activities will be undertaken:

- **Monitoring the fish population**: The purpose of this is to take measurements of the health indicators of the fish population in the exposed area and reference areas, in order to determine whether the mine's effluents have an effect on the fish. This study is required if effluent concentration in the exposed area is greater than 1% at 250 m from the final discharge point.
- **Monitoring the benthic invertebrate community**: The purpose of this is to determine whether the effluent has an effect on the fish habitat by sampling the benthic organisms in the exposed area and reference area.
- **Monitoring fish tissue**: This will assess whether mercury from the effluent is affecting the use of fishery resources. This monitoring is only necessary if total mercury concentration in the effluent is equal to or greater than 0.10 µg/L.

An EEM is conducted as follows: the effluent will be characterized four times per calendar year, with at least one month between characterizations. The first characterization will be done no later than six months following the date when the mine becomes subject to the MDMER. Sublethal toxicity tests are performed twice per calendar year for the first three years, and once per year thereafter. Water quality monitoring will be done no later than six months following the date when the mine becomes subject to the MDMER. It is performed four times per calendar year, with at least one month between tests.

The first EEM study plan will be presented no later than 12 months following the date when the mine becomes subject to the MDMER. The various other studies outlined will be performed in accordance with the terms and conditions of the study plan. Furthermore, the first interpretation report will be presented no later than 30 months following the date when the mine becomes subject to the MDMER.

10.4.1.2 *MINING INDUSTRY DIRECTIVE 019*

The mine will need to monitor the various parameters on a regular basis, according to the frequency established within the context of this directive, i.e. three times per week for SSes [Suspended Solids], once per week for the selected metals and once per month for acute toxicity. Furthermore, due to the fact that effluent volume exceeds 1000 m^3/day, the pH and flow rate will also need to be continuously recorded.

Each year, the mine will need to analyze or measure effluents during the month of July or August. Measurement and sampling of the parameters outlined for annual monitoring must be done over the course of the same day, and will replace the usual monitoring for that week. All results of the annual monitoring must be sent to the MDDELCC no later than September 30 of that year. It should be noted that the D019 requirements are usually included in the provincial authorization requirements.

10.4.1.3 *EFFLUENT DISCHARGE OBJECTIVES*

Galaxy will monitor the EDOs defined by the MDDELCC. The provisions for this monitoring program will be developed in conjunction with the MDDELCC at a later date.

10.4.2 GROUNDWATER MONITORING

OBJECTIVE

The groundwater monitoring program falls within the framework of the project. Under D019, a network of monitoring and collection wells must be set up around any facilities that could possibly affect groundwater quality. This network must include observation wells upstream and downstream of each facility at risk. Furthermore, since dewatering of the pit could affect the surrounding groundwater level, monitoring the changes in water level is also proposed.

STUDY AREA

The monitoring wells will be spread out upstream and downstream of the waste rock stockpile (seven sites), the pit (four sites) and the industrial sector (eight sites). They will be used for monitoring. Depending on the stratigraphic context, the wells will be dug either in the rock or unconsolidated deposits. Information regarding the proposed wells is found in Table 10-2 and their locations are illustrated on Map 10-1.

Table 10-2: Geographic coordinates of the wells for groundwater monitoring

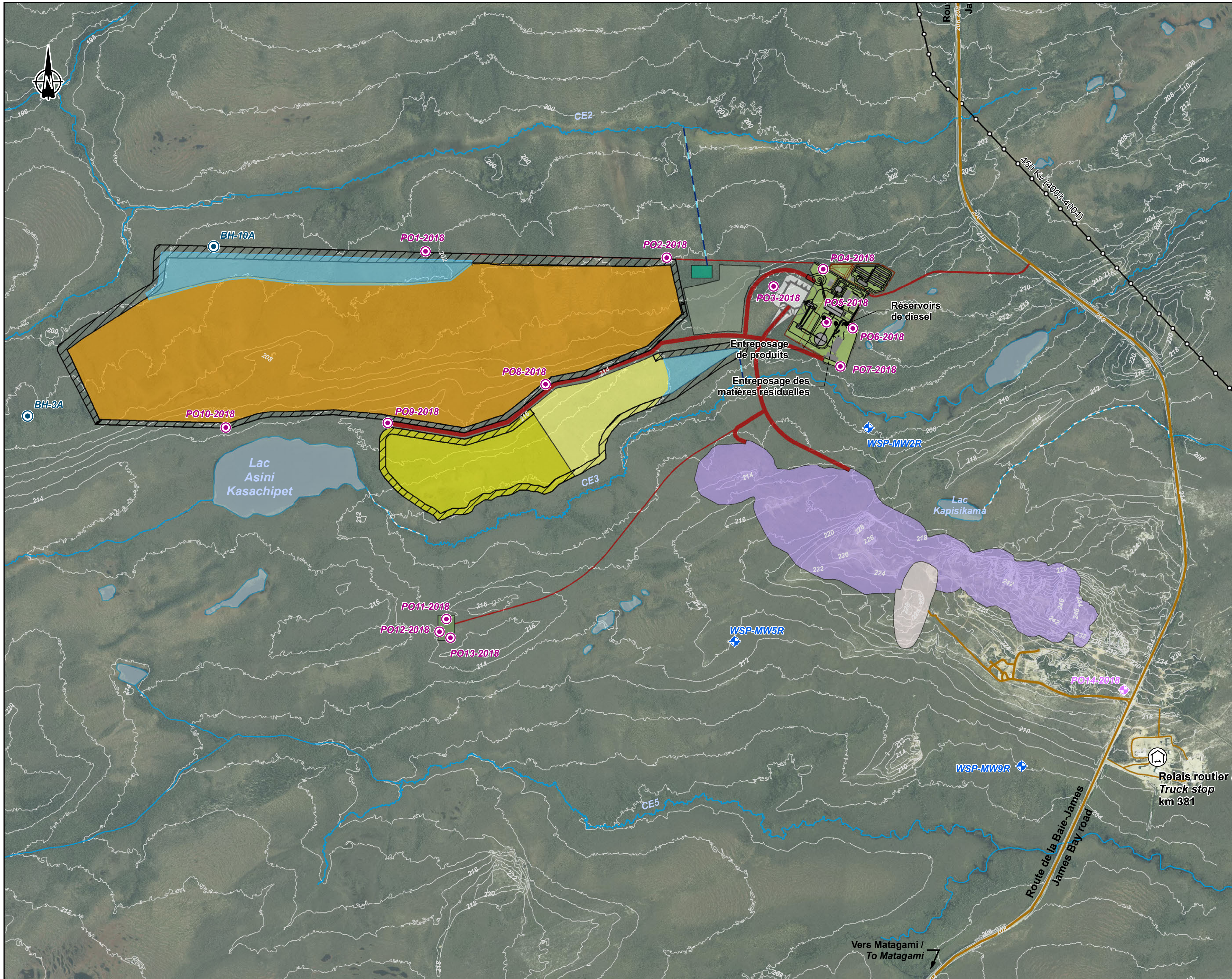
Sector	Well	X UTM18 (m)	Y UTM18 (m)
Groundwater quality monitoring			
Waste rock stockpile	PO1-2018	355813.73	5790918.25
	PO2-2018	356962.31	5790888.72
	PO8-2018	356384.74	5790284.89
	PO9-2018	355633.24	5790101.12
	PO10-2018	354862.05	5790078.15
	BH-3 (A and B)	353918.27	5790133.96
	BH-10 (A and B)	354804.51	5790941.07
Industrial sector	PO3-2018	357470.97	5790750.89
	PO4-2018	357707.25	5790832.93
	PO5-2018	357723.66	5790580.24
	PO6-2018	357848.36	5790550.70
	PO7-2018	357789.29	5790370.21
	PO11-2018	355912.18	5789165.84
	PO12-2018	355879.37	5789106.77
	PO13-2018	355931.87	5789077.24
Water level monitoring			
Pit	PO14-2018	359137.94	5788829.37
	WSP-MW-2R	357922.00	5790078.77
	WSP-MW-5R	357283.96	5789061.02
	WSP-MW-9R	358650.81	5788466.24

MONITORING ACTIVITIES

Monitoring activities will include:

1. Monitoring groundwater quality
2. Monitoring water levels around the pit

Relevant details are presented hereunder.



Suivi des niveaux des eaux / *Water level monitoring*

- Puits existant / *Existing well*
- Puits proposé / *New well*

Suivi de la qualité de l'eau / *Water quality monitoring*

- Puits existant / *Existing well*
- Puits proposé / *New well*

Infrastructures / *Infrastructure*

- Route principale / *Main road*
- Route d'accès / *Access road*
- Ligne de transport d'énergie / *Transmission line*
- Relais routier / *Truck stop*

Hydrographie / *Hydrography*

- CE3 Numéro de cours d'eau / *Stream number*
- Cours d'eau / *Stream*
- Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*
- Plan d'eau / *Waterbody*

Composantes du projet / *Project Component*

- Route / *Road*
- Effluent minier / *Mine effluent*
- Usine de traitement de l'eau / *Water treatment plant*
- Secteur administratif et industriel / *Administrative and industrial sector*
- Fosse / *Pit*
- Halde à minerai / *ROM pad*
- Halde à stériles / *Waste rock stockpile*
- Halde à matière organique / *Organic matter stockpile*
- Halde à depôts meubles / *Unconsolidated deposit stockpile*
- Entrepôt à explosifs / *Explosives magazine*
- Cour d'entreposage / *Dry storage area*
- Carrière / *Quarry*
- Digue et berme / *Dike and berm*
- Bassin de rétention d'eau / *Water retention basin*

GALAXY

Mine de lithium Baie-James / *James Bay Lithium Mine*
Étude d'impact sur l'environnement /
Environmental Impact Assessment

Suivi des eaux souterraines / *Groundwater Monitoring*

Sources :
Orthoimage : Galaxy, août / august 2017
Inventaire / Inventory: WSP 2017

No Ref : 171-02562-00_wspT160_c10-1_suivi_eaux_sout_180904.mxd

0 185 370 m
UTM 18, NAD83

Carte / *Map 10-1*

wsp

Monitoring groundwater quality

The micropurge method with parameter stabilization will be used for sampling. This method allows sampling at a low flow rate, which provides a sample that is representative of the aquifer, while minimizing disturbances in the observation wells. Sampling will be done once the physico-chemical parameters are stable. pH, conductivity, temperature and dissolved oxygen data will be compiled regularly using a multi-parameter sensor each time an observation well is purged and whenever a sample is taken.

Water level readings will be taken during the sampling campaigns (spring and summer) in all wells sampled.

Parameters to analyze were chosen according to site usage and include those required under D019. Sampling frequency will be twice per year, at summer low flow and spring freshet. The analytical program parameters will be:

- Petroleum hydrocarbons C_{10}-C_{50};
- Major ions (bicarbonates, calcium, carbonates, chlorides, fluoride, magnesium, potassium, sodium and sulfates);
- Dissolved metals (Ag, Al, As, B, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Ni, Pb, Se, Sb, Sn, Sr, Ta, Ti, U, V, Zn);
- Nutrients (ammoniacal nitrogen, total Kjeldahl nitrogen, nitrates, nitrites, total phosphorus);
- Other parameters (total cyanides, total dissolved solids, total sulphurs);
- Field measurements (pH, electrical conductivity, temperature, dissolved oxygen, ORP).

A quality control program will be applied to confirm the validity of the various parameter measurement methods. At least 10% of samples will be taken in duplicate and sent to the laboratory for analysis and to verify that their results match the results of the original samples. Field and trip blanks will also be taken with each sampling campaign and sent to the laboratory.

Considering the groundwater at the study site could end up in surface water, the chemical analysis results will be compared to the criteria for resurgence in surface water, or RSW (*résurgence dans les eaux de surface*, or RES) set out in the *Guide d'intervention: Protection des sols et réhabilitation des terrains contaminés* from the MDDELCC (2016).

Moreover, RSW criteria for metals will be adjusted to a hardness of 10 mg/L, which is representative of the water in surrounding streams.

Given certain criteria (Cu, Ba, Mn, Zn) were exceeded when groundwater was sampled, background levels were assessed under D019. The results were presented in the specialized hydrogeology report (WSP 2018*a*). In the event that they exceed the RESIE criterion, background levels assessed will be used as the criteria. Lastly, for parameters with no criteria, results will be compared to the values generally observed in the groundwater and concentrations obtained under the initial conditions.

Monitoring water levels around the pit

Piezometric variation will be continually monitored in certain wells using three levelogger-type sensors. A fourth barologger-type sensor will be used to measure atmospheric pressure. Three probes, installed in the pit sector, will enable temperature and water pressure to be measured. These sensors will monitor how pit dewatering affects the water levels near the surface waterways.

SCHEDULE

As soon as operation begins, sampling campaigns will be conducted twice per year, in the spring and summer. The program may be re-evaluated while it is in progress, in collaboration with the MDDELCC, according to the results obtained.

Water levels around the pit will be continuously monitored every hour. Sensor data will be able to be collected twice per year during the sampling campaigns.

10.4.3 MONITORING VEGETATION SURROUNDING THE INFRASTRUCTURE

OBJECTIVE

In addition to areas directly affected by work, the development of the site and projected infrastructures will have an indirect impact on preserved plant communities. Construction of the mining infrastructures could modify the terrestrial and wetland plant communities in the vicinity; modification to the drainage patterns could also lead to modification in the hydrology of certain wetland areas.

This monitoring program will allow assessment of the project's indirect impacts on the terrestrial and wetland plant communities, as well as re-assessment, depending on results obtained, of the surface area that will need to be compensated. A monitoring report will be produced and mitigation measures enhanced, as needed.

STUDY AREA

The monitoring method will include the detailed inventory of vegetation in the survey plots located along the transects, in a 25-m band, in order to be able to discern a potential disturbance gradient.

MONITORING ACTIVITIES

Vegetation and hydrology of the plant communities will be monitored in a 25-m band around the mining infrastructures. The purpose of this monitoring program will be to document the following parameters:

- Characterization of vegetation in plant communities adjacent to mining infrastructures;
- Comparison with the composition of original vegetation in the plant community;
- Characterization of the hydrology of wetlands (hydrological and pedological indicators) adjacent to mining infrastructures;
- Comparison with original hydrological and pedological indicators;
- Identification of modifications in terms of composition and/or hydrology.

SCHEDULE

The first inventory will be carried out during the site construction phase, and monitoring will be conducted over a five-year period, on years 1, 3 and 5.

10.4.4 MONITORING TRANSPLANTATION OF CAREX STERILIS PLANTS

OBJECTIVE

A population of *Carex sterilis* plants, which is a plant species likely to be designated as threatened or vulnerable, will be affected by the mining infrastructure construction work. A portion of these plants will be relocated to a favourable habitat.

MONITORING ACTIVITIES

Considering the little information available regarding the ecology and spread of this species, this relocation is intended to limit the impact on it and should be considered experimental. Transplanting details will be provided in the compensation program.

The transplanted *Carex sterilis* plants' survival will be monitored to determine whether transplanting is an effective compensation method that ensures the species will be maintained at least over the medium term. The following information will be acquired through this monitoring:

- Characterization of the vegetation's transplantation environment;
- Survival of the transplanted *Carex sterilis* plants;
- Evaluation of the health of the population through the presence of mature fruit-bearing plants.

For each of these years, a monitoring report will be prepared, and the study results will be communicated to the authorities.

SCHEDULE

The monitoring schedule is as follows:

— The first year after transplanting;
— On the third, fifth, seventh and tenth years after transplanting.

10.4.4.1 *MONITORING OF THE INTRODUCTION AND SPREADING OF INVASIVE ALIEN PLANT SPECIES*

OBJECTIVE

Construction work and activities associated with mine operations could contribute to the accidental introduction and spreading of invasive alien plant species (IAPS) on the territory.

STUDY AREA

Work and traffic areas on the mining site.

MONITORING ACTIVITIES

The monitoring program will aim to:

— Survey all areas where work takes place and machinery travels during the plant growth period (July and August) to identify possible IAPS;
— Mark out and characterize any IAPS colonies with a GPS and take photos;
— Identify the most appropriate control method, eradicate and manage the waste and soils contaminated by these plants to prevent subsequent spreading;
— If required, monitor the colony and its eradication for a three-year period.

SCHEDULE

Annual follow-up will take place to detect the presence of IAPS in areas affected by the work. Introduction and spreading of IAPS will be monitored every year during the mine construction, operation and rehabilitation phases. Once rehabilitation is complete, the area will be monitored one more time. An annual report will be produced and mitigation measures enhanced if significant issues associated with IAPS are detected.

10.4.4.2 *MONITORING EFFECTIVENESS OF COMPENSATION PROJECTS FOR LOSS OF WETLANDS*

If the compensation program for loss of wetlands includes arrangement, rehabilitation or creation of wetlands, specific monitoring programs will be developed to assess their effectiveness over the medium term. These projects will be subject to pre-approval from the MDDELCC.

10.4.5 MONITORING AIR QUALITY

OBJECTIVE

Air quality will be monitored within the context of the project. The purpose of the monitoring program is to measure the impact that mining activities have on the local air quality. It will be carried out in order to determine whether the mining operations are acceptable and compliant with applicable standards and criteria, i.e. those set out in the MDDELCC's *Normes et critères québécois de qualité de l'atmosphère* [Quebec's atmospheric quality standards and criteria]. This program will primarily consist of sampling the ambient air.

STUDY AREA

A measuring station will be set up near the km 381 truck stop. The exact location of this measurement station will depend on the direction of prevailing winds and other dust sources. The proposed location will be submitted to the MDDELCC beforehand for validation. A verification will be carried out to ensure Environment Canada and MDDELCC location criteria are met, i.e.:

- Minimum distance of 100 m from a waterway or body of water;
- Minimum distance of twice the height of any windbreak obstacles;
- Sampling points located at least 2 m from the ground;
- Measurements taken are representative of the study area's conditions.

The site selected will also need to be far enough from the James Bay road and km 381 truck stop to ensure values obtained are representative of operations.

MONITORING ACTIVITIES

Galaxy proposes monitoring the total particulate matter (TPM) from the very start of operations, and then modulated according to data collected. A high-volume (Hi-Vol) sampler is recommended for the TPM analysis. Hi-Vol sampling will be for a 24-hour period from midnight to midnight the next day, and carried out for TPM once every six days. These samples will also be used to monitor exposure to certain metals. Metals with standards based on smaller average particle sizes will be first measured on total particulate. If standards are exceeded, then the size of the particles will then be measured.

All analyses will be performed in a laboratory that has been certified by the MDDELCC. Methods used will comply with those developed by the CEAEQ [Centre d'expertise en analyse environnementale du Québec], whenever available. Several quality control and quality assurance (QC/QA) measures will be instituted within the framework of the sampling campaign to ensure results are representative and accurate.

SCHEDULE

The measurement station will be installed at the very start of operations and will run continuously throughout the site operation phase.

10.4.6 MONITORING THE SOCIAL ENVIRONMENT

10.4.6.1 MONITORING THE SOCIOECONOMIC ENVIRONMENT

OBJECTIVE

The project will have positive benefits on training, jobs and the Cree communities' economy, most particularly the community of Eastmain. The proposed monitoring program is intended to qualify and quantify the economic benefits, and to evaluate the effectiveness of the measures implemented, and whether or not the community's expectations have been reached.

MONITORING ACTIVITIES

Monitoring the socioeconomic conditions will be based on documentary research and meetings with organizations and workers in the Eastmain community. With regard to documentary research, monitoring will be based on available data and statistics, most notably the following:

- Training programs, school clientele and success rate;
- Number of Cree employees at the mine, type and duration of jobs, and the workers' socioeconomic profile;
- Value of contracts won by Cree businesses;
- Data on the active population, employment rate and unemployment rate (Institut de la statistique du Québec [Quebec Statistics Institute], Statistics Canada, etc.).

Furthermore, meetings with stakeholders from Eastmain will provide an opportunity to obtain information on various aspects associated with training, jobs and contracts. Some of the organizations that could be met are:

- Council of the Cree Nation of Eastmain;
- Cree School Board;
- Wabannutao Eeyou Development Corporation (WEDC).

Galaxy will also survey Cree workers at the mine to document their assessment of and experience with their jobs. A monitoring report will be produced each year.

SCHEDULE

This monitoring program will be conducted after ten years of operation.

10.4.6.2 *MONITORING CURRENT USE OF LAND AND RESOURCES FOR TRADITIONAL PURPOSES*

OBJECTIVE

The proposed monitoring program is intended to document and evaluate the effects that the project has on the practice of traditional activities of the RE2 trapline Tallyman and the members of his family, as well as the effectiveness of the measures implemented. Frequent and regular contact will also be maintained with the RE2 trapline Tallyman to ensure that the mining activities do not hinder the territory users' activities, and to make any necessary adjustments.

STUDY AREA

The territory in consideration corresponds to the study area illustrated on Map 6-22.

MONITORING ACTIVITIES

This monitoring is based on meetings with the RE2 trapline Tallyman and members of his family. These meetings will provide an opportunity to update data and information collected during interviews conducted within the context of the EIA and to gather information regarding the current situation at the time of monitoring. Interviews will address the following subjects:

- Use and frequentation of the study area;
- Traditional hunting, fishing, trapping and other activities;
- Trails for snowmobiles and other modes of transport;
- Frequentation of camps;
- Problems using the territory;
- Accessibility to activity areas and travel;
- Assessment of the state of the resources;
- Changes that occurred and perceived effects;
- Assessment of measures implemented to mitigate the effects.

SCHEDULE

Monitoring activities will be carried out according to the following schedule:

- Upon completion of construction;
- On the third, seventh, twelfth and last year of operation;
- One year after mine rehabilitation work has been completed.

10.4.6.3 *MONITORING QUALITY OF LIFE AND WELL-BEING*

OBJECTIVE

Consultation activities carried out within the context of this environmental assessment brought to light the significance of the concerns that stakeholders who were interviewed expressed regarding quality of life and well-being in Cree communities. The monitoring program focuses on the population in the community of Eastmain.

MONITORING ACTIVITIES

The monitoring program will pertain to:

- Improving the quality of life of the members of this community;
- Tensions between the Cree population and mine workers;
- Social problems most notably associated with alcohol and drug consumption and compulsive gambling;
- Managing the enrichment of a portion of the community;

- Sense of loss and damage to cultural identity;
- James Bay road users' diminished sense of security;
- Pressure on the health and social services systems.

This aspect will be based on meetings and discussion groups with stakeholders from the Eastmain community, which will allow the population an opportunity to express themselves regarding this aspect of the project.

Some of the organizations that could be met are:

- Council of the Cree Nation of Eastmain;
- Cree Board of Health and Social Services of James Bay

SCHEDULE

Monitoring activities will be carried out according to the following schedule:

- Upon completion of construction;
- On the second, seventh, twelfth and last year of operation;
- One year after mine rehabilitation work has been completed.

10.5 POST-REHABILITATION MONITORING

A monitoring program will be included in the site rehabilitation plan. The purpose of the monitoring program is to validate whether the measures applied to the site meet expectations. The following elements will be considered.

10.5.1 GEOTECHNICAL MONITORING

Subsequent to rehabilitation activities, a monitoring program must be implemented to validate the stability of the infrastructures left in place. The integrity of the waste rock stockpiles, the ROM pad and civil engineering work will be checked for erosion, movement, settling and cracking. Annual inspections will be conducted by an engineer for the first three years, and then periodically for the next ten years, at the frequency the engineer recommends.

10.5.2 MONITORING OF WATER QUALITY

Surface and groundwater quality monitoring will be required post-rehabilitation. A biannual groundwater monitoring campaign (summer and fall) will be carried out, and compliance criteria will be validated against those set out in D019. Furthermore, surface water effluent will also be the subject of a monitoring program.

10.5.3 MONITORING OF VEGETATION RECOVERY

Monitoring of vegetation recovery on restored surfaces is required. The purpose is to ensure that the site rehabilitation activities helped to establish an adequate vegetation density to protect against erosion, and adequately revegetated areas disturbed by mining activities. The monitoring program will aim to characterize the plant cover and species composition in restored areas, and to identify signs of erosion. Monitoring will continue for five years.

11 REFERENCES

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